The Department of Defense

DoD Departments:

Department of the Army

Department of the Navy

DARPA

Defense Advanced Research Projects Agency

Special Operations Command

OSD
DDR&E

Office of Secretary of Defense
Director Defense Research and Engineering

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PROGRAM SOLICITATION 99.2
CLOSING DATE: 11 AUGUST 1999

FY 1999 SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROGRAM SOLICITATION

Number 99.2

Small Business
Innovation
Research Program

IMPORTANT

The DoD updates its SBIR mailing list annually. To remain on the mailing list or to be added to the list, send in the Mailing List form (Reference F) found at the back of this solicitation or complete the electronic form at http://www.teltech.com/sbir/form.html. Failure to send the form annually will result in removal of your name from the mailing list.

If you have questions about the Defense Department's SBIR program, please call the SBIR/STTR Help Desk at (800) 382-4634, or see the DoD SBIR/STTR Home Page, at http://www.acq.osd.mil/sadbu/sbir.

U.S. Department of Defense
SBIR Program Office
Washington, DC 20301

May 3, 1999:	Solicitation issued for public release
July 1, 1999:	DoD begins accepting proposals
August 11, 1999:	Deadline for receipt of proposals at tl DoD Components by 3:00 p.m. local time

OFFICE OF THE UNDER SECRETARY OF DEFENSE

3000 DEFENSE PENTAGON
WASHINGTON DC 20301-3000

ACQUISITION AND TECHNOLOGY

IMPORTANT NEW INFORMATION ABOUT THE DOD SBIR PROGRAM

1. **The DoD SBIR/STTR Help Desk** can address your questions about this solicitation, the proposal preparation process, contract negotiations, getting paid, government accounting requirements, intellectual property protection, the Fast Track, obtaining outside financing, and other program-related areas. You may contact the Help Desk by:

   Phone: 800-382-4634 (8AM to 8PM EST)
   Fax: 800-462-4128
   Email: SBIRHELP@teltech.com

2. **The DoD SBIR/STTR Home Page (http://www.acq.osd.mil/sadbu/sbir)** offers electronic access to the SBIR solicitations, hyperlinks to the Component SBIR programs within DoD, answers to commonly-asked questions about contracting with the government, sample SBIR proposals, model SBIR contracts, abstracts of SBIR projects funded between 1983 and 1998, the latest updates on the SBIR program, information on the Small Business Technology Transfer (STTR) program, hyperlinks to the laws and regulations referenced in this solicitation, hyperlinks to sources of business assistance and financing, and other useful information.

3. **DoD has adopted commercialization of SBIR technology (in military and/or private sector markets) as a critical measure of performance** for both the DoD SBIR program and the companies that participate in the program, under a new policy approved by the Under Secretary of Defense for Acquisition and Technology. This new policy is reflected in Sections 3.4h and 3.6 of this solicitation (Commercialization Strategy); Section 3.4n (Company Commercialization Report on Prior SBIR Awards, which now must be submitted electronically); Section 4.4 (Assessing Commercial Potential of Proposals); and Section 5.4 (Commercialization Report Updates).

4. **Each DoD Component (Army, Navy, Air Force, etc.) has developed its own Phase II Enhancement policy, to encourage the transition of SBIR R&D into DoD acquisition programs as well as the private sector.** Under this policy, the Component will provide a Phase II company with additional Phase II SBIR funding if the company can match the additional SBIR funds with non-SBIR funds from DoD acquisition programs or the private sector. See each Component's section of the solicitation for details.

5. **Under the SBIR "Fast Track" policy, SBIR projects that attract some matching cash from an outside investor for the Phase II effort have a significantly higher chance of Phase II award** and also receive expedited processing and interim funding between Phases I and II to ensure no delay in reaching the market. See Sections 4.3 and 4.5 of this solicitation. For the latest Fast Track results/statistics, see the DoD SBIR Home Page.

6. **You may contact the DoD authors of solicitation topics to ask questions about the topics** before you submit a proposal. Procedures for doing so are discussed in Section 1.5(c) of this solicitation. Please note that you may talk by telephone with a topic author to ask such questions only between May 3, when this solicitation was publicly released, and July 1, when DoD begins accepting proposals. At other times, you may submit written questions, and all such questions and the responses will be posted electronically on the Home Page for general viewing.

7. **Before DoD can award your company a contract under this solicitation, your company must be registered in the DoD Central Contractor Registration database.** To register, see http://ccr.edi.disa.mil, or call 1-888-227-2423.

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DoD PROGRAM SOLICITATION FOR SMALL BUSINESS INNOVATION RESEARCH

1.0 PROGRAM DESCRIPTION

1.1 Introduction

The Army, Navy, Defense Advanced Research Projects Agency (DARPA), Office of Secretary of Defense (OSD), and U.S. Special Operations Command (SOCOM), hereafter referred to as DoD Components, invite small business firms to submit proposals under this solicitation for the Small Business Innovation Research (SBIR) program. Firms with the capability to conduct research and development (R&D) in any of the defense-related topic areas described in Section 8.0, and to commercialize the results of that R&D, are encouraged to participate.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research or research and development results.

The Federal SBIR Program is mandated by Public Laws PL 97-219, PL 99-443, and PL 102-564. The basic design of the DoD SBIR Program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive, January 1993. The DoD Program presented in this solicitation strives to encourage scientific and technical innovation in areas specifically identified by DoD Components. The guidelines presented in this solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to the DoD and the private sector.

1.2 Three Phase Program

This program solicitation is issued pursuant to the Small Business Innovation Development Act of 1982, PL 97-219, PL 99-443, and PL 102-564. Phase I is to determine, insofar as possible, the scientific, technical, and commercial merit and feasibility of ideas submitted under the SBIR Program. Phase I awards are typically $60,000 to $100,000 in size over a period not to exceed six months (nine months for the Air Force). Proposals should concentrate on that research or research and development which will significantly contribute to proving the scientific, technical, and commercial feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research or research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other applications.

Subsequent Phase II awards will be made to firms on the basis of results of their Phase I effort and the scientific, technical, and commercial merit of the Phase II proposal. Phase II awards are typically $500,000 to $750,000 in size over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research or research and development effort and is expected to produce a well-defined deliverable prototype. A more comprehensive proposal will be required for Phase II.

Under Phase III, the small business is expected to obtain funding from the private sector and/or non-SBIR Government sources to develop the prototype into a viable product or non-R&D service for sale in military and/or private sector markets.

Under a policy approved by the Under Secretary of Defense for Acquisition and Technology in October 1998, DoD now tracks the extent to which technologies developed under Phase II are successfully commercialized in Phase III (in military and/or private sector markets), as discussed in Section 5.4 of this solicitation. Furthermore, DoD has adopted such commercialization success as a critical measure of performance for both the DoD SBIR program and the companies that participate in the program.

This solicitation is for Phase I proposals only. Only proposals submitted in response to this solicitation will be considered for Phase I award. Proposers who were not awarded a contract in response to a prior SBIR solicitation are free to update or modify and re-submit the same or modified proposal if it is responsive to any of the topics listed in Section 8.0.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts will be considered (Section 4.3 and 5.2).

DoD is not obligated to make any awards under either Phase I, II, or III, and all awards are subject to the availability of funds. DoD is not responsible for any monies expended by the proposer before award of any contract.

1.3 Proposer Eligibility and Limitations

Each proposer must qualify as a small business for research or research and development purposes as defined in Section 2.0 and certify to this on the Cover Sheet

(Appendix A) of the proposal. In addition, a minimum of two-thirds of the research and/or analytical work in Phase I must be carried out by the proposing firm. For Phase II, a minimum of one-half of the research and/or analytical work must be performed by the proposing firm. The percent of work is usually measured by both direct and indirect costs, although proposers planning to subcontract a significant fraction of their work should verify how it will be measured with their DoD contracting officer during contract negotiations. For both Phase I and II, the primary employment of the principal investigator must be with the small business firm at the time of the award and during the conduct of the proposed effort. Primary employment means that more than one-half of the principal investigator's time is spent with the small business. Primary employment with a small business concern precludes full-time employment at another organization. Deviations from the requirements in this paragraph must be approved in writing by the contracting officer (during contract negotiations).

For both Phase I and Phase II, all research or research and development work must be performed by the small business concern in the United States. "United States" means the fifty states, the Territories and possessions of the United States, the Commonwealth of Puerto Rico, the Commonwealth of the Northern Mariana Islands, the Trust Territory of the Pacific Islands, and the District of Columbia.

Joint ventures and limited partnerships are permitted, provided that the entity created qualifies as a small business in accordance with the Small Business Act, 15 USC 631, and the definition included in Section 2.2.

1.4 Conflicts of Interest

Awards made to firms owned by or employing current or previous Federal Government employees could create conflicts of interest for those employees in violation of 18 USC and 10 USC 2397. Such proposers should contact the cognizant Ethics Counselor from the employees' Government agency for further guidance.

1.5 Questions about SBIR and Solicitation Topics

a. General Questions/Information. The DoD SBIR/STTR Help Desk is prepared to address general questions about this solicitation, the proposal preparation process, contract negotiation, payment vouchers, Government accounting requirements, intellectual property protection, the Fast Track, financing strategies, and other program-related areas. The Help Desk may be contacted by:

Phone: 800-382-4634 (8AM to 8PM EST)
Fax: 800-462-4128
Email: SBIRHELP@teltech.com

The DoD SBIR/STTR Home Page offers electronic access to SBIR solicitations, answers to commonly asked questions, sample SBIR proposals, model SBIR contracts, abstracts of ongoing SBIR projects, the latest updates on the SBIR program, hyperlinks to sources of business assistance and financing, and other useful information.

DOD SBIR/STTR HOME PAGE:
http://www.acq.osd.mil/sadbu/sbir

b. General Questions about a DoD Component. General questions pertaining to a particular DoD Component (Army, Navy, Air Force, etc) should be submitted in accordance with the instructions given at the beginning of that Component's topics, in Section 8.0 of this solicitation.

c. Technical Questions about Solicitation Topics. On May 3, 1999, this solicitation was issued for public release on the DoD SBIR/STTR Home Page (**http://www.acq.osd.mil/sadbu/sbir**), along with the names of the topic authors and their phone numbers. The names of topic authors and their phone numbers will remain posted on the Home Page until July 1, 1999, giving proposers an opportunity to ask technical questions about specific solicitation topics by telephone.

Once DoD begins accepting proposals on July 1, 1999, telephone questions will no longer be accepted, but proposers may submit written questions through the SBIR Interactive Topic Information System (SITIS), in which the questioner and respondent remain anonymous and all questions and answers are posted electronically for general viewing. Proposers may submit written questions to SITIS via internet (see "Solicitations" on the DoD SBIR/STTR Home Page), e-mail, fax, mail, or telephone as follows:

Defense Technical Information Center
MATRIS Office, DTIC-AM
ATTN: SITIS Coordinator
53355 Cole Road
San Diego, CA 92152-7213
Phone: (619) 553-7006
Fax: (619) 553-7053
E-mail: sbir@dticam.dtic.mil
www: http://dticam.dtic.mil/sbir/

The SITIS service for this solicitation opens on or around May 26, 1999 and closes to new questions on July 28, 1999. SITIS will post all questions and answers on the Internet (see Solicitations on the DoD SBIR/STTR Home Page) from May 26, 1999 through August 11, 1999. (Answers will also be emailed or faxed directly to the inquirer if the inquirer provides an e-mail address or fax number.) Answers are generally posted within seven working days of question submission.

All proposers are advised to monitor SITIS during the solicitation period for questions and answers, and other information, relevant to the topic under which they are proposing.

1.6 Requests for Copies of DoD SBIR Solicitation

To remain on the DoD Mailing list for the SBIR and STTR solicitations, send in the Mailing List form (Reference F). You may also order additional copies of this solicitation from:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

The DoD SBIR and STTR solicitations can also be accessed via internet through the DoD SBIR/STTR Home Page at **http://www.acq.osd.mil/sadbu/sbir**.

1.7 SBIR Conferences and Outreach

The DoD holds two National SBIR Conferences a year and participates in many state-organized conferences for small business. For information on these events, see our Home Page (**http://www.acq.osd.mil/sadbu/sbir**). We have a special outreach effort to socially and economically disadvantaged firms.

2.0 DEFINITIONS

The following definitions apply for the purposes of this solicitation:

2.1 Research or Research and Development

Basic Research - Scientific study and experimentation to provide fundamental knowledge required for the solution of problems.

Exploratory Development - A study, investigation or minor development effort directed toward specific problem areas with a view toward developing and evaluating the feasibility and practicability of proposed solutions.

Advanced Development - Proof of design efforts directed toward projects that have moved into the development of hardware for test.

Engineering Development - Full-scale engineering development projects for DoD use but which have not yet received approval for production.

2.2 Small Business

A small business concern is one that, at the time of award of a Phase I or Phase II contract:

a. Is independently owned and operated and organized for profit, is not dominant in the field of operation in which it is proposing, and has its principal place of business located in the United States;

b. Is at least 51% owned, or in the case of a publicly owned business, at least 51% of its voting stock is owned by United States citizens or lawfully admitted permanent resident aliens;

c. Has, including its affiliates, a number of employees not exceeding 500, and meets the other regulatory requirements found in 13 CFR Part 121. Business concerns, other than investment companies licensed, or state development companies qualifying under the Small Business Investment Act of 1958, 15 USC 661, et seq., are affiliates of one another when either directly or indirectly (1) one concern controls or has the power to control the other; or (2) a third party or parties controls or has the power to control both. Control can be exercised through common ownership, common management, and contractual relationships. The term "affiliates" is defined in greater detail in 13 CFR Sec. 121.103. The term "number of employees" is defined in 13 CFR Sec. 121.106. Business concerns include, but are not limited to, any individual, partnership, corporation, joint venture, association or cooperative.

2.3 Socially and Economically Disadvantaged Small Business

A small business that is at the time of award of a Phase I or Phase II contract:

a. At least 51% owned by an Indian tribe or a native Hawaiian organization, or one or more socially and economically disadvantaged individuals, and

b. Whose management and daily business operations are controlled by one or more socially and economically disadvantaged individuals.

A socially and economically disadvantaged individual is defined as a member of any of the following groups: Black Americans, Hispanic Americans, Native Americans, Asian-Pacific Americans, Subcontinent-Asian Americans, or other groups designated by SBA to be socially and economically disadvantaged.

2.4 Women-Owned Small Business

A women-owned small business is one that is at least 51% owned by a woman or women who also control and operate it. "Control" in this context means exercising the power to make policy decisions. "Operate" in this context means being actively involved in the day-to-day management of the business.

2.5 Funding Agreement

Any contract, grant, or cooperative agreement entered into between any Federal Agency and any small business concern for the performance of experimental, developmental, or research work funded in whole or in part by the federal Government. *Only the contract method* *will be used by DoD components for all SBIR awards.*

2.6 Subcontract

A subcontract is any agreement, other than one involving an employer-employee relationship, entered into by a Federal Government contract awardee calling for supplies or services required solely for the performance of the original contract. This includes consultants.

2.7 Commercialization

The process of developing a product or non-R&D service for sale (whether by the originating party or by others), in Government and/or private sector markets.

3.0 PROPOSAL PREPARATION INSTRUCTIONS AND REQUIREMENTS

3.1 Proposal Requirements

A proposal to any DoD Component under the SBIR Program is to provide sufficient information to persuade the DoD Component that the proposed work represents an innovative approach to the investigation of an important scientific or engineering problem and is worthy of support under the stated criteria.

The quality of the scientific or technical content of the proposal will be the principal basis upon which proposals will be evaluated. The proposed research or research and development must be responsive to the chosen topic, although need not use the exact approach specified in the topic (see Section 4.1). Any small business contemplating a bid for work on any specific topic should determine that (a) the technical approach has a reasonable chance of meeting the topic objective, (b) this approach is innovative, not routine, and (c) the firm has the capability to implement the technical approach, i.e. has or can obtain people and equipment suitable to the task.

Those responding to this solicitation should note the proposal preparation tips listed below:

- Read and follow all instructions contained in this solicitation, including the instructions in Section 8.0 of the DoD component to which you are applying.
- Use the free technical information services from DTIC and other information assistance organizations (Section 7.1 - 7.4).
- Mark proprietary information as instructed in Sec. 5.6.
- Limit your proposal to 25 pages (excluding Company Commercialization Report).
- Use a type size no smaller than 12 pitch or 11 point.
- Do not include proprietary or classified information in the project summary (Appendix B).
- Include a copy of Appendix A, Appendix B, and Company Commercialization Report (see Section 3.4n) as part of the original of each proposal. (Additional copies of all Appendices can be downloaded from **http://www.acq.osd.mil/sadbu/sbir**).

3.2 Proprietary Information

If information is provided which constitutes a trade secret, proprietary commercial or financial information, confidential personal information, or data affecting the national security, it will be treated in confidence to the extent permitted by law, provided it is clearly marked in accordance with Section 5.6.

3.3 Limitations on Length of Proposal

This solicitation is designed to reduce the investment of time and cost to small firms in preparing a formal proposal. Those who wish to respond must submit a direct, concise, and informative research or research and development proposal of no more than 25 pages, excluding Company Commercialization Report, (no type smaller than 11 point or 12 pitch on standard 8½" X 11" paper with one (1) inch margins, and a maximum of 6 lines per inch), *including Proposal Cover Sheet (Appendix A), Project Summary (Appendix B), Cost Proposal (Appendix C), and any enclosures or attachments.* Promotional and non-project related discussion is discouraged. <u>Cover all items listed below in Section 3.4 in the order given.</u> The space allocated to each will depend on the problem chosen and the principal investigator's approach. In the interest of equity, proposals in excess of the 25-page limitation (including attachments, appendices, or references, but excluding Company Commercialization Report <u>will not</u> be considered for review or award.

3.4 Phase I Proposal Format

All pages shall be consecutively numbered and the ORIGINAL of each proposal must contain a completed copy of Appendix A, Appendix B and Company Commercialization Report (see Section 3.4n).

a. Cover Sheet. Complete and sign Appendix A, photocopy the completed form, and use a copy as Page 1 of each additional copy of your proposal.

b. Project Summary. Complete Appendix B, photocopy the completed form, and use a copy as Page 2 of each additional copy of your proposal. The technical abstract should include a brief description of the project objectives and description of the effort. Anticipated benefits and commercial applications of the proposed research or research and development should also be summarized in the space provided. The Project

Summaries of proposals selected for award will be publicly released on the Internet and, therefore, should not contain proprietary or classified information.

c. Identification and Significance of the Problem or Opportunity. Define the specific technical problem or opportunity addressed and its importance. (Begin on Page 3 of your proposal.)

d. Phase I Technical Objectives. Enumerate the specific objectives of the Phase I work, including the questions it will try to answer to determine the feasibility of the proposed approach.

e. Phase I Work Plan. Provide an explicit, detailed description of the Phase I approach. The plan should indicate what is planned, how and where the work will be carried out, a schedule of major events, and the final product to be delivered. The Phase I effort should attempt to determine the technical feasibility of the proposed concept. The methods planned to achieve each objective or task should be discussed explicitly and in detail. This section should be a substantial portion of the total proposal.

f. Related Work. Describe significant activities directly related to the proposed effort, including any conducted by the principal investigator, the proposing firm, consultants, or others. Describe how these activities interface with the proposed project and discuss any planned coordination with outside sources. The proposal must persuade reviewers of the proposer's awareness of the state-of-the-art in the specific topic.

Describe previous work not directly related to the proposed effort but similar. Provide the following: (1) short description, (2) client for which work was performed (including individual to be contacted and phone number), and (3) date of completion.

g. Relationship with Future Research or Research and Development.

(1) State the anticipated results of the proposed approach if the project is successful.
(2) Discuss the significance of the Phase I effort in providing a foundation for Phase II research or research and development effort.

h. Commercialization Strategy. Describe in approximately one page your company's strategy for commercializing this technology in DoD and/or private sector markets. Provide specific information on the market need the technology will address and the size of the market. Also include a schedule showing the quantitative commercialization results from this SBIR project that your company expects to achieve and when (i.e., amount of additional investment, sales revenue, etc. - see items a through f in Section 5.4).

i. Key Personnel. Identify key personnel who will be involved in the Phase I effort including information on directly related education and experience. A concise resume of the principal investigator, including a list of relevant publications (if any), must be included.

j. Facilities/Equipment. Describe available instrumentation and physical facilities necessary to carry out the Phase I effort. Items of equipment to be purchased (as detailed in Appendix C) shall be justified under this section. Also state whether or not the facilities where the proposed work will be performed meet environmental laws and regulations of federal, state (name), and local Governments for, but not limited to, the following groupings: airborne emissions, waterborne effluents, external radiation levels, outdoor noise, solid and bulk waste disposal practices, and handling and storage of toxic and hazardous materials.

k. Consultants. Involvement of a university or other consultants in the project may be appropriate. If such involvement is intended, it should be described in detail and identified in Appendix C. A minimum of <u>two-thirds</u> of the research and/or analytical work in Phase I, as measured by direct and indirect costs, must be carried out by the proposing firm, unless otherwise approved in writing by the contracting officer.

l. Prior, Current, or Pending Support of Similar Proposals or Awards. *Warning* -- While it is permissible, with proposal notification, to submit identical proposals or proposals containing a significant amount of essentially equivalent work for consideration under numerous federal program solicitations, it is unlawful to enter into contracts or grants requiring essentially equivalent effort. If there is any question concerning this, it must be disclosed to the soliciting agency or agencies before award.

If a proposal submitted in response to this solicitation is substantially the same as another proposal that has been funded, is now being funded, or is pending with another Federal Agency or DoD Component or the same DoD Component, the proposer must so indicate on Appendix A and provide the following information:

(1) Name and address of the Federal Agency(s) or DoD Component to which a proposal was submitted, will be submitted, or from which an award is expected or has been received.
(2) Date of proposal submission or date of award.
(3) Title of proposal.
(4) Name and title of principal investigator for each proposal submitted or award received.
(5) Title, number, and date of solicitation(s) under which the proposal was submitted, will be submitted, or under which award is expected or has been received.
(6) If award was received, state contract number.
(7) Specify the applicable topics for each SBIR proposal submitted or award received.

Note: If Section 3.4.1 does not apply, state in the proposal "No prior, current, or pending support for proposed work."

m. Cost Proposal. Complete the cost proposal in the form of Appendix C for the Phase I effort only. Some items of Appendix C may not apply to the proposed project. If such is the case, there is no need to provide information on each and every item. What matters is that enough information be provided to allow the DoD Component to understand how the proposer plans to use the requested funds if the contract is awarded.

(1) List all key personnel by name as well as by number of hours dedicated to the project as direct labor.
(2) Special tooling and test equipment and material cost may be included under Phases I and II. The inclusion of equipment and material will be carefully reviewed relative to need and appropriateness for the work proposed. The purchase of special tooling and test equipment must, in the opinion of the Contracting Officer, be advantageous to the Government and should be related directly to the specific topic. These may include such items as innovative instrumentation and/or automatic test equipment. Title to property furnished by the Government or acquired with Government funds will be vested with the DoD Component, unless it is determined that transfer of title to the contractor would be more cost effective than recovery of the equipment by the DoD Component.
(3) Cost for travel funds must be justified and related to the needs of the project.
(4) Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of a Phase I proposal.

When a proposer is selected for award, the proposer should be prepared to submit further documentation to its DoD contracting officer to substantiate costs (e.g., a brief explanation of cost estimates for equipment, materials, and consultants or subcontractors).

n. Company Commercialization Report on Prior SBIR Awards. Each small business firm submitting a Phase I or Phase II proposal is required to register at the following password-protected web site – **http://www.dodsbir.net/companycommercialization** – and, through this site, to report the quantitative commercialization results of the firm's prior Phase II projects. (Even firms that have not previously participated in SBIR must register.) Once the firm has reported these results, it is required to:
(1) Print out the Company Commercialization Report and Summary Page, as described on the web site;
(2) Sign and date the Report;
(3) Attach the Summary Page as the cover sheet to the Report; and
(4) Attach both documents to the back of the proposal.

The firm may also, at its option, attach to the back of the Report additional, explanatory material (no more than five pages) relating to the firm's record of commercializing its prior SBIR or STTR projects, such as: commercialization successes (in government and/or private sector markets) that are not fully captured in the quantitative results; any mitigating factors that could account for low commercialization; and recent changes in the firm's organization or personnel designed to increase the firm's commercialization success. The Summary Page, Report, and additional explanatory material (if any) will not be counted toward the 25-page limit for Phase I proposals.

A Report showing that a firm has received no prior Phase II awards will not affect the firm's ability to obtain an SBIR award. Firms that do not yet have access to the Internet should contact the DoD SBIR Help Desk (800/382-4634) for assistance.

3.5 Bindings

Do not use special bindings or covers. Staple the pages in the upper left hand corner of each proposal.

3.6 Phase II Proposal Format

This solicitation is for Phase I only. A Phase II proposal can be submitted only by a Phase I awardee and only in response to a request from the agency; that is, Phase II is not initiated by a solicitation.

Each Phase II proposal must contain a Cover Sheet (Appendix A), a Project Summary Sheet (Appendix B), and a Company Commercialization Report (see Section 3.4n). In addition, each Phase II proposal must contain a two-page commercialization strategy, addressing the following questions:

(1) What is the first product that this technology will go into?
(2) Who will be your customers, and what is your estimate of the market size?
(3) How much money will you need to bring the technology to market, and how will you raise that money?
(4) Does your company contain marketing expertise and, if not, how do you intend to bring that expertise into the company?
(5) Who are your competitors, and what is your price and/or quality advantage over your competitors?

The commercialization strategy must also include a schedule showing the quantitative commercialization results from the Phase II project that your company expects to report in its Company Commercialization Report Updates one year after the start of Phase II, at the completion of Phase II, and after the completion of Phase II (i.e., amount of additional investment, sales revenue, etc. - see items a through f in section 5.4).

Copies of Appendices along with additional instructions regarding Phase II proposal preparation and submission will be provided or made available by the DoD Components to all Phase I winners at time of Phase I contract award.

3.7 False Statements

Knowingly and willfully making any false, fictitious, or fraudulent statements or representations may be a felony under the Federal Criminal False Statement Act (18 U.S.C. Sec 1001), punishable by a fine of up to $10,000, up to five years in prison, or both.

4.0 METHOD OF SELECTION AND EVALUATION CRITERIA

4.1 Introduction

Phase I proposals will be evaluated on a competitive basis and will be considered to be binding for six (6) months from the date of closing of this solicitation unless the offeror states otherwise. If selection has not been made prior to the proposal's expiration date, offerors will be requested as to whether or not they want to extend their proposal for an additional period of time. Proposals meeting stated solicitation requirements will be evaluated by scientists or engineers knowledgeable in the topic area. Proposals will be evaluated first on their relevance to the chosen topic. A proposal that meets the goals of a solicitation topic but does not use the exact approach specified in the topic will be considered relevant. (Prospective proposers should contact the topic author as described in Section 1.5 to determine whether submission of such a proposal would be useful.)

Proposals found to be relevant will then be evaluated using the criteria listed in Section 4.2. Final decisions will be made by the DoD Component based upon these criteria and consideration of other factors including possible duplication of other work, and program balance. A DoD Component may elect to fund several or none of the proposed approaches to the same topic. In the evaluation and handling of proposals, every effort will be made to protect the confidentiality of the proposal and any evaluations. There is no commitment by the DoD Components to make any awards on any topic, to make a specific number of awards or to be responsible for any monies expended by the proposer before award of a contract.

For proposals that have been selected for contract award, a Government Contracting Officer will draw up an appropriate contract to be signed by both parties before work begins. Any negotiations that may be necessary will be conducted between the offeror and the Government Contracting Officer. It should be noted that only a duly appointed contracting officer has the authority to enter into a contract on behalf of the U.S. Government.

Phase II proposals will be subject to a technical review process similar to Phase I. Final decisions will be made by DoD Components based upon the scientific and technical evaluations and other factors, including a commitment for Phase III follow-on funding, the possible duplication with other research or research and development, program balance, budget limitations, and the potential of a successful Phase II effort leading to a product of continuing interest to DoD. DoD is not obligated to make any awards under Phase II or the Fast Track, and all awards are subject to the availability of funds. DoD is not responsible for any monies expended by the proposer before award of a contract.

Upon written request and after final award decisions have been announced, a debriefing will be provided to unsuccessful offerors on their proposals.

4.2 Evaluation Criteria - Phase I

The DoD Components plan to select for award those proposals offering the best value to the Government and the nation considering the following factors.

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.
b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.
c. The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Technical reviewers will base their conclusions only on information contained in the proposal. It cannot be assumed that reviewers are acquainted with the firm or key individuals or any referenced experiments. Relevant supporting data such as journal articles, literature, including Government publications, etc., should be contained or referenced in the proposal.

4.3 Evaluation Criteria - Phase II

The Phase II proposal will be reviewed for overall merit based upon the criteria below.

a. The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.

b. The qualifications of the proposed principal/key investigators, supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

c. The potential for commercial (Government or private sector) application and the benefits expected to accrue from this commercialization.

The reasonableness of the proposed costs of the effort to be performed will be examined to determine those proposals that offer the best value to the Government. Where technical evaluations are essentially equal in merit, cost to the Government will be considered in determining the successful offeror.

Phase II proposal evaluation may include on-site evaluations of the Phase I effort by Government personnel.

Fast Track Phase II proposals. Under the regular Phase II evaluation process, the above three criteria are each given roughly equal weight (with some variation across the DoD Components). For projects that qualify for the Fast Track (as discussed in Section 4.5), DoD will evaluate the Phase II proposals under a separate, expedited process in accordance with the above criteria, and will select these proposals for Phase II award provided:

(1) they meet or exceed a threshold of "technically sufficient" for criteria (a) and (b); and
(2) the project has substantially met its Phase I technical goals

(and assuming budgetary and other programmatic factors are met, as discussed in Section 4.1). Fast Track proposals, having attracted matching cash from an outside investor, presumptively meet criterion (c). Consistent with DoD policy, this process should result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects.

4.4 Assessing Commercial Potential of Proposals

A Phase I or Phase II proposal's commercial potential will be assessed using the following criteria:

a. The proposer's commercialization strategy (see Sections 3.4h and 3.6) and, as discussed in that strategy: (1) any commitments of additional investment in the technology during Phase II from the private sector, DoD prime contractors, non-SBIR/STTR DoD programs, or other sources, and (2) any Phase III follow-on funding commitments; and

b. The proposer's record of commercializing its prior SBIR and STTR projects, as shown in its Company Commercialization Report (see Section 3.4n). If the "Commercialization Achievement Index" shown on the Summary Page of the Report is at the 5th percentile or below, the proposer will receive no more than half of the evaluation points available under evaluation criterion c in Sections 4.2 and 4.3 ("potential for commercialization"), unless the SBIR program manager for the DoD Component receiving the proposal (Army, Navy, Air Force, etc.) recommends, in writing, that an exception be made for that proposer, and the contracting officer approves the exception.

A Company Commercialization Report showing that the proposing firm has no prior Phase II awards will not affect the firm's ability to win an award. Such a firm's proposal will be evaluated for commercial potential based on its commercialization strategy in item a, above.

4.5 SBIR Fast Track

a. In General. On a pilot basis, the DoD SBIR program has implemented a streamlined Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort (as well as for the interim effort between Phases I and II). The purpose is to focus SBIR funding on those projects that are most likely to be developed into viable new products that DoD and others will buy and that will thereby make a major contribution to U.S. military and/or economic capabilities.

Outside investors, as defined in DoD's Fast Track Guidance (Reference D), may include such entities as another company, a venture capital firm, an individual investor, or a non-SBIR, non-STTR government program; they do not include the owners of the small business, their family members, and/or affiliates of the small business.

As discussed in detail below, projects that obtain matching funds from outside investors and thereby qualify for the SBIR Fast Track will (subject to the qualifications described herein):

(1) Receive interim funding of $30,000 to $50,000 between Phases I and II;
(2) Be evaluated for Phase II award under a separate, expedited process; and
(3) Be selected for Phase II award provided they meet or exceed a threshold of "technically sufficient" and have substantially met their Phase I technical goals (and assuming other programmatic factors are met), as described in Section 4.3.

Consistent with DoD policy, this process should prevent any significant gaps in funding between Phases I and II for Fast Track projects, and result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects.

All DoD Components administer the Fast Track according to the procedures in this section, except for BMDO. BMDO administers slightly different procedures that have been approved by the Under Secretary of Defense for Acquisition and Technology – see the BMDO proposal instructions in Section 8.0 of this solicitation.

b. How To Qualify for the SBIR Fast Track. To qualify for the SBIR Fast Track, a company must submit a Fast Track application within 150 days after the effective start date of its Phase I contract, unless a different deadline for Fast Track applications is specified by the DoD Component funding the project (see the Component's introductory page in Section 8 of this solicitation - the deadlines range from 120 to 180 days). The company is encouraged to discuss the application with its Phase I technical monitor; however, it need not wait for an invitation from the technical monitor to submit either a Fast Track application or a Fast Track Phase II proposal.

A Fast Track application consists of the following items:

(1) A completed Fast Track application form, found at Appendix D. On the application form, the company and its outside investor must:

(a) State that the outside investor will match both interim and Phase II SBIR funding, in cash, contingent on the company's selection for Phase II award, as described on the form at Appendix D. The matching rates needed to qualify for the Fast Track are as follows:

- For companies that have never received a Phase II SBIR award from DoD or any other federal agency, the minimum matching rate is 25 cents for every SBIR dollar. (For example, if such a company receives interim and Phase II SBIR funding that totals $750,000, it must obtain matching funds from the investor of $187,500.)
- For all other companies, the minimum matching rate is 1 dollar for every SBIR dollar. (For example, if such a company receives interim and Phase II SBIR funding that totals $750,000, it must obtain matching funds from the investor of $750,000.)

(b) Certify that the outside funding proposed in the application qualifies as a "Fast Track investment," and the investor qualifies as an "outside investor," as defined in DoD Fast Track Guidance (Reference D).

(2) A letter from the outside investor to the company, containing:

(a) A commitment to match both interim and Phase II SBIR funding, in cash, contingent on the company's selection for Phase II award, as discussed on the form at Appendix D.

(b) A brief statement (less than one page) describing that portion of the effort that the investor will fund. The investor's funds may pay for additional research and development on the company's SBIR project or, alternatively, they may pay for other activities not included in the Phase II contract's statement of work, provided these activities further the development and/or commercialization of the technology (e.g., marketing).

(c) A brief statement (less than one page) describing (i) the investor's experience in evaluating companies' ability to successfully commercialize technology; and (ii) the investor's assessment of the market for this particular SBIR technology, and of the ability of the company to bring this technology to market.

(3) A concise statement of work for the interim SBIR effort (less than four pages) and detailed cost proposal (less than one page). Note: if the company has already negotiated an interim effort (e.g., an "option") of $30,000 to $50,000 with DoD as part of its Phase I contract, it need only cite that section of its contract, and need not submit an additional statement of work and cost proposal.

The company should send its Fast Track application to its Phase I technical monitor, with copies to the appropriate Component program manager and to the DoD SBIR program manager, as indicated on the back of the application form.

Also, in order to qualify for the Fast Track, the company:

(1) Must submit its Phase II proposal within 180 days after the effective start date of its Phase I contract, unless a different deadline for Fast Track Phase II proposals is specified by the DoD Component funding the contract (see the Component's introductory page in Section 8 of this solicitation - the deadlines range from 150 days to 210 days).

(2) Must submit its Phase I final report by the deadline specified in its Phase I contract, but not later than 210 days after the effective start date of the contract.

(3) Must certify, within 45 days after being notified that it has been selected for Phase II award, that the entire amount of the matching funds from the outside investor has been transferred to the company. Certification consists of a letter, signed by both the company and its outside investor, stating that "$______ in cash has been transferred to our company from our outside investor in accord with the SBIR Fast Track procedures." The letter must be sent to the DoD contracting office along with a copy of the company's bank statement showing the funds have been deposited. IMPORTANT: If the DoD contracting office does not receive, within the 45 days, this certification showing the transfer of funds, the company will be ineligible to compete for a Phase II award not only under the Fast Track but also under the regular Phase II competition, unless a specific written exception is granted by the Component's SBIR program manager. Before signing the certification letter, the company and investor should read the cautionary note at Section 3.7. If the outside

investor is a non-SBIR/non-STTR DoD program, it must provide a line of accounting within the 45 days that can be accessed immediately.

Failure to meet these conditions in their entirety and within the time frames indicated will generally disqualify a company from participation in the SBIR Fast Track. Deviations from these conditions must be approved in writing by the contracting office.

c. Benefits of Qualifying for the Fast Track. If a project qualifies for the Fast Track:

(1) It will receive interim SBIR funding of $30,000 to $50,000, commencing approximately at the end of Phase I. Consistent with DoD policy, the vast majority of projects that qualify for the Fast Track should receive interim SBIR funding. However, the DoD contracting office has the discretion and authority, in any particular instance, to deny interim funding when doing so is in the Government's interest (e.g., when the project no longer meets a military need or the statement of work does not meet the threshold of "technically sufficient" as described in Section 4.3).

(2) DoD will evaluate the Fast Track Phase II proposal under a separate, expedited process, and will select the proposal for Phase II award provided it meets or exceeds a threshold of "technically sufficient" for evaluation criteria (a) and (b), as described in Section 4.3 (assuming budgetary and other programmatic factors are met, as discussed in Section 4.1). Consistent with DoD policy, this process should result in a significantly higher percentage of Fast Track projects obtaining Phase II award than non-Fast Track projects. However, DoD is not obligated, in any particular instance, to award a Phase II contract to a Fast Track project, and DoD is not responsible for any funds expended by the proposer before award of a contract.

(3) It will receive notification, no later than ten weeks after the completion of its Phase I project, of whether it has been selected for a Phase II award.

(4) If selected, it will receive its Phase II award within an average of five months from the completion of its Phase I project.

d. Additional Reporting Requirement. In the company's final Phase II progress report, it must include a brief accounting (in the company's own format) of how the investor's funds were expended to support the project.

5.0 CONTRACTUAL CONSIDERATIONS

Note: Eligibility and Limitation Requirements (Section 1.3) Will Be Enforced

5.1 Awards (Phase I)

a. Number of Phase I Awards. The number of Phase I awards will be consistent with the agency's RDT&E budget, the number of anticipated awards for interim Phase I modifications, and the number of anticipated Phase II contracts. No Phase I contracts will be awarded until all qualified proposals (received in accordance with Section 6.2) on a specific topic have been evaluated. All proposers will be notified of selection/non-selection status for a Phase I award no later than February 11, 2000. *The DoD Components anticipate making 250 Phase I awards from this solicitation.* On average, 1 in 8 Phase I proposals receive funding.

b. Type of Funding Agreement. All winning proposals will be funded under negotiated contracts and may include a fee or profit. The firm fixed price or cost plus fixed fee type contract will be used for all Phase I projects (see Section 5.5). *Note: The firm fixed price contract is the preferred type for Phase I.*

c. Average Dollar Value of Awards. DoD Components will make Phase I awards to small businesses typically on a one-half person-year effort over a period generally not to exceed six months (subject to negotiation). PL 102-564 allows agencies to award Phase I contracts up to $100,000 without justification. The typical size of award varies across the DoD Components; it is therefore important for a proposer to read the introductory page of the Component to which it is applying (in Section 8.0) for any specific instructions regarding award size.

d. Timing of Phase I Awards. Across DoD, the median time between the date that the SBIR solicitation closes and the award of a Phase I contract is 4 months.

5.2 Awards (Phase II)

a. Number of Phase II Awards. The number of Phase II awards will depend upon the results of the Phase I efforts and the availability of funds. *The DoD Components anticipate that approximately 40 percent of its Phase I awards will result in Phase II projects.*

b. Type of Funding Agreement. Each Phase II proposal selected for award will be funded under a negotiated contract and may include a fee or profit.

c. Average Dollar Value of Awards. Phase II awards will be made to small businesses based on results of the Phase I efforts and the scientific, technical, and commercial merit of the Phase II proposal. Average Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). PL 102-564 states that the Phase II awards may be up to $750,000 each without justification. See special instructions for each DoD Component in Section 8.

d. Timing of Phase II Awards. Across DoD, the median time between DoD's receipt of a Phase II proposal and the award of a Phase II contract is 6.5 months.

5.3 Phase I Report

a. Content. A final report is required for each Phase I project. The report must contain in detail the project objectives, work performed, results obtained, and estimates of technical feasibility. A completed SF 298, "Report Documentation Page", will be used as the first page of the report. (A blank SF298 is provided in Section 9.0, Reference C.) In addition, monthly status and progress reports may be required by the DoD agency.

b. Preparation.

(1) If desirable, language used by the company in its Phase II proposal to report Phase I progress may also be used in the final report.

(2) For each unclassified report, the company submitting the report should fill in block 12a (Distribution/Availability Statement) of the SF298, "Report Documentation Page" with one of the following statements:
 (a) Approved for public release; distribution unlimited.
 (b) Distribution authorized to U.S. Government Agencies only; contains proprietary information.
 Note: The sponsoring DoD activity, after reviewing the company's entry in block 12a, has final responsibility for assigning a distribution statement.

(3) Block 13 (Abstract) of the SF 298, "Report Documentation Page") must include as the first sentence, "Report developed under SBIR contract for topic [insert solicitation topic number]". The abstract must identify the purpose of the work and briefly describe the work carried out, the finding or results and the potential applications of the effort. Since the abstract will be published by the DoD, it must not contain any proprietary or classified data.

(4) Block 14 (Subject Terms) of the SF 298 must include the term "SBIR Report".

c. Submission. The company shall submit FIVE COPIES of the final report on each Phase I project to the DoD in accordance with the negotiated delivery schedule. Delivery will normally be within thirty days after completion of the Phase I technical effort. The company shall, at the same time, submit ONE ADDITIONAL COPY of each report directly to the DTIC:

ATTN: DTIC-OCA
Defense Technical Information Center
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218.

If the report is classified, the sponsoring DoD activity will provide special submission instructions. *Note: The sponsoring DoD activity has final responsibility for ensuring that the company or the DoD activity provide DTIC with all applicable Phase I and Phase II technical reports, classified and unclassified, developed under SBIR contract, per DoD Directive 3200.12 (http://web7.whs.osd.mil/dodiss/directives/direct2.htm).*

5.4 Company Commercialization Report Updates

If, after completion of Phase I, the contractor is awarded a Phase II contract, the contractor shall be required to electronically update its Company Commercialization Report (discussed in Section 3.4n) on a periodic basis, to report the following commercialization results of this Phase II project:

- **a.** Sales revenue from new products and non-R&D services resulting from the Phase II technology;
- **b.** Additional investment from sources other than the federal SBIR/STTR program in activities that further the development and/or commercialization of the Phase II technology;
- **c.** Whether the Phase II technology has been used in a fielded DoD system or acquisition program and, if so, which system or program;
- **d.** The number of patents resulting from the contractor's participation in the SBIR/STTR program;
- **e.** Growth in number of firm employees; and
- **f.** Whether the firm has completed an initial public offering of stock (IPO) resulting, in part, from the Phase II project.

These updates on the project will be required one year after the start of Phase II, at the completion of Phase II, and subsequently when the contractor submits a new SBIR or STTR proposal to DoD. Firms that do not submit a new proposal to DoD will be asked to provide updates on an annual basis after the completion of Phase II.

5.5 Payment Schedule

The specific payment schedule (including payment amounts) for each contract will be incorporated into the contract upon completion of negotiations between the DoD and the successful Phase I or Phase II offeror. Successful offerors may be paid periodically as work progresses in accordance with the negotiated price and payment schedule. Phase I contracts are primarily fixed price contracts, under which monthly payments may be made. The contract may include a separate provision for payment of a fee or profit. Final payment will follow completion of contract performance and acceptance of all work required under the contract. Other types of financial assistance may be available under the contract.

5.6 Markings of Proprietary or Classified Proposal Information

The proposal submitted in response to this solicitation may contain technical and other data which the proposer does not want disclosed to the public or used by the Government for any purpose other than proposal evaluation.

Information contained in unsuccessful proposals will remain the property of the proposer except for Appendices A and B. The Government may, however, retain copies of all proposals. Public release of information in any proposal submitted will be subject to existing statutory and regulatory requirements.

If proprietary information is provided by a proposer in a proposal which constitutes a trade secret, proprietary commercial or financial information, confidential personal information or data affecting the national security, it will be treated in confidence, to the extent permitted by law, provided this information is clearly marked by the proposer with the term "confidential proprietary information" and provided that the following legend which appears on the title page (Appendix A) of the proposal is completed:

> "For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used, or disclosed in whole or in part, provided that if a contract is awarded to the proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the contract. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained in page(s)________of this proposal."

Any other legend may be unacceptable to the Government and may constitute grounds for removing the proposal from further consideration and without assuming any liability for inadvertent disclosure. The Government will limit dissemination of properly marked information to within official channels.

In addition, each page of the proposal containing proprietary data which the proposer wishes to restrict must be marked with the following legend:

> "Use or disclosure of the proposal data on lines specifically identified by asterisk (*) are subject to the restriction on the cover page of this proposal."

If all of the information on a particular page is proprietary, the proposer should so note by including the word "PROPRIETARY" in both the header and footer on that page.

The Government assumes no liability for disclosure or use of unmarked data and may use or disclose such data for any purpose.

In the event properly marked data contained in a proposal in response to this solicitation is requested pursuant to the Freedom of Information Act, 5 USC 552, the proposer will be advised of such request and prior to such release of information will be requested to expeditiously submit to the DoD Component a detailed listing of all information in the proposal which the proposer believes to be exempt from disclosure under the Act. Such action and cooperation on the part of the proposer will ensure that any information released by the DoD Component pursuant to the Act is properly determined.

Those proposers that have a classified facility clearance may submit classified material with their proposal. Any classified material shall be marked and handled in accordance with applicable regulations. Arbitrary and unwarranted use of this restriction is discouraged. Offerors must follow the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M) procedures for marking and handling classified material.

5.7 Copyrights

To the extent permitted by statute, the awardee may copyright (consistent with appropriate national security considerations, if any) material developed with DoD support. DoD receives a royalty-free license for the Federal Government and requires that each publication contain an appropriate acknowledgment and disclaimer statement.

5.8 Patents

Small business firms normally may retain the principal worldwide patent rights to any invention developed with Government support. The Government receives a royalty-free license for its use, reserves the right to require the patent holder to license others in certain limited circumstances, and requires that anyone exclusively licensed to sell the invention in the United States must normally manufacture it domestically. To the extent authorized by 35 USC 205, the Government will not make public any information disclosing a Government-supported invention for a period of five years to allow the awardee to pursue a patent.

5.9 Technical Data Rights

Rights in technical data, including software, developed under the terms of any contract resulting from proposals submitted in response to this solicitation generally remain with the contractor, except that the Government obtains a royalty-free license to use such technical data only for Government purposes during the period commencing with contract award and ending five years after completion of the project under which the data were generated. Upon expiration of the five-year restrictive license, the Government has unlimited rights in the SBIR data. During the license period, the Government may not release or disclose SBIR data to any person other than its support services contractors except: (1) For evaluational purposes; (2) As expressly permitted by the contractor; or (3) A use, release, or disclosure that is necessary for emergency repair or overhaul of items operated by the Government. See FAR clause 52.227-20, "Rights in Data - SBIR Program" and DFARS 252.227-7018, "Rights in Noncommercial Technical Data and Computer Software -- SBIR Program."

5.10 Cost Sharing

Cost sharing is permitted for proposals under this solicitation; however, cost sharing is not required nor will it be an evaluation factor in the consideration of any Phase I proposal.

5.11 Joint Ventures or Limited Partnerships

Joint ventures and limited partnerships are eligible provided the entity created qualifies as a small business as defined in Section 2.2 of this solicitation.

5.12 Research and Analytical Work

a. For Phase I a minimum of two-thirds of the research and/or analytical work must be performed by the proposing firm unless otherwise approved in writing by the contracting officer.

b. For Phase II a minimum of one-half of the research and/or analytical work must be performed by the proposing firm, unless otherwise approved in writing by the contracting officer.

The percentage of work is usually measured by both direct and indirect costs, although proposers planning to subcontract a significant fraction of their work should verify how it will be measured with their contracting officer during contract negotiations.

5.13 Contractor Commitments

Upon award of a contract, the contractor will be required to make certain legal commitments through acceptance of Government contract clauses in the Phase I contract. The outline that follows is illustrative of the types of provisions required by the Federal Acquisition Regulations that will be included in the Phase I contract. This is not a complete list of provisions to be included in Phase I contracts, nor does it contain specific wording of these clauses. Copies of complete general provisions will be made available prior to award.

a. Standards of Work. Work performed under the contract must conform to high professional standards.

b. Inspection. Work performed under the contract is subject to Government inspection and evaluation at all reasonable times.

c. Examination of Records. The Comptroller General (or a fully authorized representative) shall have the right to examine any directly pertinent records of the contractor involving transactions related to this contract.

d. Default. The Government may terminate the contract if the contractor fails to perform the work contracted.

e. Termination for Convenience. The contract may be terminated at any time by the Government if it deems termination to be in its best interest, in which case the contractor will be compensated for work performed and for reasonable termination costs.

f. Disputes. Any dispute concerning the contract which cannot be resolved by agreement shall be decided by the contracting officer with right of appeal.

g. Contract Work Hours. The contractor may not require an employee to work more than eight hours a day or forty hours a week unless the employee is compensated accordingly (that is, receives overtime pay).

h. Equal Opportunity. The contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin.

i. Affirmative Action for Veterans. The contractor will not discriminate against any employee or applicant for employment because he or she is a disabled veteran or veteran of the Vietnam era.

j. Affirmative Action for Handicapped. The contractor will not discriminate against any employee or applicant for employment because he or she is physically or mentally handicapped.

k. Officials Not to Benefit. No member of or delegate to Congress shall benefit from the contract.

l. Covenant Against Contingent Fees. No person or agency has been employed to solicit or secure the contract upon an understanding for compensation except bona fide employees or commercial agencies maintained by the contractor for the purpose of securing business.

m. Gratuities. The contract may be terminated by the Government if any gratuities have been offered to any representative of the Government to secure the contract.

n. Patent Infringement. The contractor shall report each notice or claim of patent infringement based on the performance of the contract.

o. Military Security Requirements. The contractor shall safeguard any classified information associated with the contracted work in accordance with applicable regulations.

p. American Made Equipment and Products. When purchasing equipment or a product under the SBIR funding agreement, purchase only American-made items whenever possible.

5.14 Contractor Registration [NEW]

Before DoD can award a contract to a successful proposer under this solicitation, the proposer must be registered in the DoDCentral Contractor Registration database. To register, see http://ccr.edi.disa.mil or call 1-888-227-2423.

5.15 Additional Information

a. General. This Program Solicitation is intended for informational purposes and reflects current planning. If there is any inconsistency between the information contained herein and the terms of any resulting SBIR contract, the terms of the contract are controlling.

b. Small Business Data. Before award of an SBIR contract, the Government may request the proposer to submit certain organizational, management, personnel, and financial information to confirm responsibility of the proposer.

c. Proposal Preparation Costs. The Government is not responsible for any monies expended by the proposer before award of any contract.

d. Government Obligations. This Program Solicitation is not an offer by the Government and does not obligate the Government to make any specific number of awards. Also, awards under this program are contingent upon the availability of funds.

e. Unsolicited Proposals. The SBIR Program is not a substitute for existing unsolicited proposal mechanisms. Unsolicited proposals will not be accepted under the SBIR Program in either Phase I or Phase II.

f. Duplication of Work. If an award is made pursuant to a proposal submitted under this Program Solicitation, the contractor will be required to certify that he or she has not previously been, nor is currently being, paid for essentially equivalent work by an agency of the Federal Government.

g. Classified Proposals. If classified work is proposed or classified information is involved, the offeror to the solicitation must have, or obtain, security clearance in accordance with the Industrial Security Manual for Safeguarding Classified Information (DoD 5220.22M). The Manual is available on-line at **http://www.dis.mil** or in hard copy from:

Defense Investigative Service
1340 Braddock Place
Alexandria, VA 22314
Phone: (703) 325-5324

6.0 SUBMISSION OF PROPOSALS

An original plus (4) copies of each proposal or modification will be submitted, in a single package, as described below, unless otherwise stated by specific instructions in Section 8.0.

NOTE: THE ORIGINAL OF EACH PROPOSAL MUST CONTAIN A COMPLETED APPENDIX A (COVER SHEET), APPENDIX B (PROJECT SUMMARY), AND COMPANY COMMERCIALIZATION REPORT (see Section 3.4n).

6.1 Address

Each proposal or modification thereof shall be submitted in sealed envelopes or packages addressed to that DoD Component address which is identified for the specific topic in that Component's subsection of Section 8.0 to this solicitation.

The name and address of the offeror, the solicitation number, the topic number for the proposal, and the time and date specified for proposal receipt must be clearly marked on the outside of the envelope or package. To protect your proposal against rough handling, damage in the mail, and the possibility of unauthorized disclosures, it is recommended that your proposal be double-wrapped and that both the inner and outer envelopes or wrappings be clearly marked.

Offerors using commercial carrier services shall ensure that the proposal is addressed and marked on the outermost envelope or wrapper as prescribed above.

Mailed or handcarried proposals must be delivered to the address indicated for each topic. Secured packaging is mandatory. The DoD Component cannot be responsible for the processing of proposals damaged in transit.

All copies of a proposal must be sent in the same package. Do not send separate information copies or several packages containing parts of the single proposal.

6.2 Deadline of Proposals

Deadline for receipt of proposals at the DoD Component is 3:00 p.m. local time, August 11, 1999. Any proposal received at the office designated in the solicitation after the exact time specified for receipt will not be considered unless it is received before an award is made, and:

(a) it was sent by registered or certified mail not later than August 5, 1999;

(b) it was sent by mail or hand-carried (including delivery by a commercial carrier) and it is determined by the Government that the late receipt was due primarily to Government mishandling after receipt at the Government installation; or

(c) it was sent by U.S. Postal Service Express Mail Next Day Service-Post Office to Addressee, not later than 5:00 p.m. at the place of mailing on August 9, 1999.

Note: There are no other provisions for late receipt of proposals under this solicitation.

The only acceptable evidence to establish the date of mailing of a late proposal sent either by registered or certified mail is the U. S. Postal Service postmark on the envelope or wrapper and on the original receipt from the U.S. Postal Service. Both postmarks must show a legible date or the proposal shall be processed as if mailed late. "Postmark" means a printed, stamped, or otherwise placed impression (exclusive of a postage meter machine impression) that is readily identifiable without further action as having been supplied and affixed by employees of the U. S. Postal Service on the date of mailing. Therefore, offerors or respondents should request the postal clerk to place a legible hand cancellation bull's-eye postmark on both the receipt and the envelope or wrapper. Acceptable evidence to establish the time of receipt at the Government installation includes the time/date stamp of the installation on the proposal wrapper, other documentary evidence of receipt maintained by the installation, or oral testimony or statements of Government personnel. The only acceptable evidence to establish the date of mailing of a late proposal sent by Express Mail Next Day Service-Post Office to Addressee is the date entered by the post office receiving clerk on the "Express Mail Next Day Service-Post Office to Addressee" label and the postmark on both the envelope or wrapper and on the original receipt from the U.S. Postal Service. Therefore, offerors should request the postal clerk to place a legible hand cancellation bull's eye postmark on both the receipt and the envelope or wrapper.

Proposals may be withdrawn by written notice or a telegram received at any time prior to award. Proposals may also be withdrawn in person by an offeror or his authorized representative, provided his identity is made known and he signs a receipt for the proposal. *(Note: the term telegram includes mailgrams.)*

Any modification or withdrawal of a proposal is subject to the same conditions outlined above. Any modification may not make the proposal longer than 25 pages (excluding Company Commercialization Report). Notwithstanding the above, a late modification of an otherwise successful proposal which makes its terms more favorable to the Government will be considered at any time it is received and may be accepted.

6.3 Notification of Proposal Receipt

Proposers desiring notification of receipt of their proposal must complete and include a self-addressed stamped envelope and a copy of the notification form (Reference A) in the back of this brochure. If multiple proposals are submitted, a separate form and envelope is required for each. Notification of receipt of a proposal by the Government does not by itself constitute a determination that the proposal was received on time or not. The determination of timeliness is solely governed by the criteria set forth in Section 6.2.

6.4 Information on Proposal Status

Evaluation of proposals and award of contracts will be expedited, but no information on proposal status will be available until the final selection is made. However, contracting officers may contact any and all qualified proposers prior to contract award.

6.5 Debriefing of Unsuccessful Offerors

An unsuccessful offeror that submits a written request for a debriefing within 30 days of being notified that its proposal was not selected for award will be provided a debriefing. The written request should be sent to the DoD organization that provided such notification to the offeror. Be advised that an offeror that fails to submit a timely request is not entitled to a debriefing, although untimely debriefing requests may be accommodated at the government's discretion.

6.6 Correspondence Relating to Proposals

All correspondence relating to proposals should cite the SBIR solicitation number and specific topic number and should be addressed to the DoD Component whose address is associated with the specific topic number.

7.0 SCIENTIFIC AND TECHNICAL INFORMATION ASSISTANCE

7.1 DoD Technical Information Services Available

The Defense Technical Information Center (DTIC) provides background technical information services to assist SBIR/STTR participants in proposal preparation, bid decisions, product development, marketing and networking. The following services are available at no cost. See the DTIC SBIR/STTR web site for access to these free services and additional information **(http://www.dtic.mil/dtic/sbir)** :

1. **Public STINET** is DTIC's online technical database. SBIR/STTR participants should use the database to identify documents in their areas of technical interest.
2. **TRAIL**, an e-mail alerting service has online, instant registration and provides listing biweekly of new DTIC accessions matching the recipient's interest profile.
3. **Free Reports**: A firm receives a total of ten hard copy technical reports at no cost from DTIC during the SBIR , or the combined SBIR/STTR, solicitation period. Additional reports and services may be charged to a credit card or deposit account.
4. **SITIS**, providing answers to specific technical questions concerning DoD topic descriptions, is also on the web site. See the description of SITIS in Section 1.5.c.
5. **OLTIPS**: Following the release of the DoD topics, DTIC prepares a database search for each topic and makes the resulting bibliographies available through OLTIPS.

DTIC is a major component of the DoD Scientific and Technical Information Program, managing the technical information resulting from DoD-funded research and development **(http://www.dtic.mil)**. DTIC also manages and provides access to specialized information services and subject matter expertise. MATRIS, a DTIC component, is the focal point for information on manpower, training systems, human performance, and human factors **(http://dticam.dtic.mil)**. The DTIC-managed Centers for Analysis of Scientific and Technical Information (the IACs) are the DoD centers of expertise concerned with engineering, technical and scientific documents and databases worldwide **(http://www.dtic.mil/iac/)**.

Call or visit (by prearrangement) DTIC at the location most convenient to you.

ATTN: DTIC-SBIR
Defense Technical Information Center
8725 John J Kingman Road, Suite 0944
Ft. Belvoir, VA 22060-6218
Ph: (800) 363-7247
Fax: (703) 767-8228
Email: sbir@dtic.mil
www: http://www.dtic.mil/dtic/sbir

DTIC Northeastern Regional Office
Building 1103
5 Wright Street
Hanscom AFB, MA 01731-3012
Ph: (781) 377-2413
Fax: (781) 377-5627
Email: boston@dtic.mil

DTIC Southwestern Regional Office
AFRL-PSO/TL/STIC
3550 Aberdeen Ave, SE
Kirtland AFB, NM 87117-5776
Ph: (505) 846-6797
Fax: (505) 846-6799
Email: albuq@dtic.mil

DTIC Midwestern Regional Office
Bldg. 196, Area B
2261 Monahan Way
Wright-Patterson AFB, OH 45433-7022
Ph: (937) 255-7905
Fax: (937) 676-7002
Email: dayton@dtic.mil

DTIC Western Regional Office
Bldg. 80
2420 Vela Way, Suite 1467
El Segundo, CA 90245-4659
Ph: (310) 363-8980
Fax: (310) 363-8972
Email: losangel@dtic.mil

7.2 Other Technical Information Assistance Sources

Other sources provide technology search and/or document services and can be contacted directly for service and cost information. These include:

National Technical Information Services
5285 Port Royal Road
Springfield, VA 22161
Ph: (703) 605-6000 or (800) 553-6847
Fax: (703) 321-8547
Email: infntis@fedworld.gov
www: www.ntis.gov

University of Southern California
Office of Patents and Copyright Administration
3716 South Hope Street, Suite 313
Los Angeles, CA 90007-4344
Ph: (213) 743-2282
Fax: (213) 744-1832
www: www.usc.edu/dept/Patents_Copyrights

Center for Technology Commercialization
1400 Computer Drive
Westborough, MA 01581-5043
Ph: (508) 870-0042
Fax: (508) 366-0101
www: www.ctc.org

Great Lakes Technology Transfer Center/Battelle
25000 Great Northern Corporate Center, Suite 260
Cleveland, OH 44070
Ph: (216) 734-0094
Fax: (216) 734-0686
www: www.battelle.org/glitec/

Midcontinent Technology Transfer Center
Texas Engineering Experiment Station
The Texas A&M University System
301 Tarrow, Suite 119
College Station, TX 77840-7896
Ph: (409) 845-8762
Fax: (409) 845-3559
www: www.tedd.org

Mid-Atlantic Technology Applications Center
University of Pittsburgh
3200 Forbes Avenue
Pittsburgh, PA 15260
Ph: (412) 383-2500
Fax: (412) 383-2595
www: www.mtac.pitt.edu

Southern Technology Application Center
University of Florida, College of Engineering
Box 24, 13709 Progress Boulevard
Alachua, FL 32615
Ph: (904) 462-3913
Ph: (800) 225-0308 (outside FL)
Fax: (904) 462-3898
www: www.state.fl.us/stac/

Federal Information Exchange, Inc.
555 Quince Orchard Road, Suite 360
Gaithersburg, MD 20878
Ph: (301) 975-0103
Fax: (301) 975-0109
www: www.rams-fie.com

7.3 DoD Counseling Assistance Available

Small business firms interested in participating in the SBIR Program may seek general administrative guidance from small and disadvantaged business utilization specialists located in various Defense Contract Management activities throughout the continental United States. These specialists are available to discuss general administrative requirements to facilitate the submission of proposals and ease the entry of the small high technology business into the Department of Defense marketplace. The small and disadvantaged business utilization specialists are expressly prohibited from taking any action which would give an offeror an unfair advantage over others, such as discussing or explaining the technical requirements of the solicitation, writing or discussing technical or cost proposals, estimating cost or any other actions which are the offerors responsibility as outlined in this solicitation. (See Reference B at the end of this solicitation for a complete listing, with telephone numbers, of Small and Disadvantaged Business Utilization Specialists assigned to these activities.)

7.4 State Assistance Available

Many states have established programs to provide services to those small firms and individuals wishing to participate in the Federal SBIR Program. These services vary from state to state, but may include:

- Information and technical assistance;
- Matching funds to SBIR recipients;
- Assistance in obtaining Phase III funding.

Contact your State Government Office of Economic Development for further information.

8.0 TECHNICAL TOPICS

Section 8 contains detailed topic descriptions outlining the technical areas in which DoD Components request proposals for innovative R&D from small businesses. Topics for each participating DoD Component are listed and numbered separately. Each DoD Component Topic Section contains topic descriptions, addresses of organizations to which proposals are to be submitted, and special instructions for preparing and submitting proposals to organizations within the Component. Read and follow these instructions carefully to help avoid administrative rejection of your proposal.

Appendices A, B, C, and D follow the Component Topic Sections. Appendix A is a Proposal Cover Sheet, Appendix B is a Project Summary form, Appendix C is an outline for the Cost Proposal, and Appendix D is the Fast Track Application Form. A completed copy of Appendix A and Appendix B, a completed Cost Proposal, and a Company Commercialization Report (see Section 3.4n) must be included with each proposal submitted.

Many of the topics in Section 8 contain references to technical literature or military standards, which may be accessed as follows:

- References with "AD" numbers are available from DTIC, by calling 800/DoD-SBIR or sending an e-mail message to sbir@dtic.mil
- References with "MIL-STD" numbers are available from the Department of Defense Single Stock Part for Military Specifications, Standards, and Related Publications at http://www.dodssp.daps.mil.
- Other references can be found in your local library or at locations mentioned in the reference.

U.S. ARMY
SUBMISSION OF PROPOSALS

Topics

The Army participates in one solicitation each year with a two-tiered Phase I and Phase II proposal evaluation and selection process. The Army has identified 167 technical topics and the Phase III dual-use applications for each which address Army mission requirements. Each topic relates to one of the following 10 technology areas described in the Defense Technology Area Plan (DTAP):

1. Air Platforms
2. Chemical/Biological Defense and Nuclear
3. Information Systems Technology
4. Ground and Sea Vehicles
5. Materials/Processes
6. Biomedical
7. Sensors, Electronics and Battlespace Environment
8. Space Platforms
9. Human Systems
10. Weapons

A definition of these technology areas and a discussion of the DTAP are located on the Internet at http://www.dtic.mil/dstp/97_docs/dtap/dtaps.htm. Please do not submit SBIR proposals against the above general technology areas. Only proposals submitted against the specific topics following this introduction will be accepted.

New This Year

✓ The Army now requires proposers to submit their Proposal Cover Sheet (Appendix A) and Project Summary (Appendix B) electronically through the Army SBIR Website (address: http://www.aro.army.mil/arowash/rt/). Prior to accessing the Appendix A&B templates, you must register your company on this Website. You must print out these forms directly from the Website, sign them, and submit them with the hard copies of your proposal. Please note that a proposal is not considered accepted until the Army receives the entire packet in hard copy. Please read the detailed instructions which follow.

✓ The DoD now requires that all proposers submit their Commercialization Report (Appendix E) electronically to a centralized DoD SBIR Website. As with the Appendix A and B, you must print out this form from the Website, sign it, and submit it with the hard copies of your proposal. Refer to section 3.4n at the front of this solicitation for detailed instructions. **Please note that improper handling of this form may result in the proposal being substantially delayed. Information provided may have a direct impact on the review of the proposal.**

✓ The Army only accepts proposals with a base Phase I effort not to exceed $70,000 and an option not to exceed $50,000 to conduct initial Phase II activities, should the project be accepted for transition to Phase II.

✓ ***Phase II Plus*** is a three-year pilot program to be implemented immediately as of release of the 99.2 DoD SBIR solicitation. The objectives of ***Phase II Plus*** are to (1) extend Phase II R&D efforts beyond the current Phase II contract to meet the product, process, or service requirements of a third party investor, preferably an acquisition program, and (2) accelerate the Phase II project into the Phase III commercialization stage. "Third party investor" means Army (or other DoD) acquisition programs as well as the private sector. The general concept is to provide qualified Phase II businesses with additional Phase II SBIR funding if they can obtain matching non-SBIR funds from acquisition programs, the private sector, or both. Under ***Phase II Plus***, additional funds may be provided by modifying the Phase II contract, and where appropriate, use will be made of the flexibility afforded by the SBA 1993 Policy which allows total Phase I + Phase II SBIR funding to exceed $850,000. Additional SBIR matching funds, subject to availability, will be provided on a one-to-one matching basis with third-party funds, but not to exceed to $100,000. The additional SBIR funds must be used for advancing the R&D-related elements of the project; third-party investor funds can be used for R&D or other business-related efforts to accelerate the innovation to commercialization. More information will be available on the Army SBIR Website address: http://www.aro.army.mil/arowash/rt/.

Operation and Support Cost Reduction (OSCR)

The U. S. Army spends a large part of its overall budget, directly or indirectly, on the operation and support (O&S) of equipment ranging from small generators to large, sophisticated weapon systems. O&S costs cover a broad spectrum of items including spare/repair parts, fuels, lubricants, and the facilities and people involved in training operators and mechanics. The Army is seeking ways to reduce these costs as a broad Acquisition Reform initiative. To this end, the Army has implemented the Operation and Support Cost Reduction (OSCR) Program. This solicitation includes 62 topics that address specific OSCR concerns identified by the Army's research and development community.

Phase I Proposal Guidelines

The Army has enhanced its Phase I-Phase II transition process by implementing the use of a Phase I Option that the Army may exercise to fund interim Phase I - II activities while a Phase II contract is being negotiated. The maximum dollar amount for a Phase I is $70,000. The Phase I Option, which **must** be proposed as part of the Phase I proposal, covers activities over a period of up to four months and at a cost not to exceed $50,000. All proposed Phase I Options must be fully costed and should describe appropriate initial Phase II activities which would lead, in the event of a Phase II award, to the successful demonstration of a product or technology. **The Army will not accept Phase I proposals which exceed $70,000 for the Phase I effort and $50,000 for the Phase I Option effort**. Only those Phase I efforts selected for Phase II awards through the Army's competitive process will be eligible to exercise the Phase I Option. To maintain the total cost for SBIR Phase I and Phase II activities at a limit of $850,000, the total funding amount available for Phase II activities under a resulting Phase II contract will be $730,000, unless Phase II - Plus funds are provided.

Companies submitting a Phase I proposal under this Solicitation must complete the Cost Proposal, Appendix C, within a total cost of up to $70,000 (plus up to $50,000 for the Phase I Option). Phase I and Phase I Option costs must be shown separately; however, they may be presented side-by-side on a single Appendix C. The Phase I Option proposal must be included within the 25-page limit for the Phase I proposal. In addition, all offerors will prepare an Appendix E, Company Commercialization Report, for each proposal submitted. Appendix E does not count toward the 25-page Phase I proposal limitation.

Selection of Phase I proposals will be based upon scientific and technical merit, will be according to the evaluation procedures and criteria discussed in this solicitation document, and will be based on priorities established to meet the Army's mission requirements. Due to limited funding, the Army reserves the right to limit awards under any topic, and only those proposals of superior scientific and technical quality will be funded.

Proposals not conforming to the terms of this solicitation and unsolicited proposals will not be considered. Awards will be subject to the availability of funding and successful completion of contract negotiations.

Phase II Proposal Guidelines

Phase II proposals are invited by the Army from Phase I projects that have demonstrated the potential for commercialization of useful products and services. The invitation will be issued in writing by the Army organization responsible for the Phase I effort. Invited proposers are required to develop and submit a commercialization plan describing feasible approaches for marketing the developed technology. Fast Track participants may submit a proposal without being invited. Cost-sharing arrangements in support of Phase II projects and any future commercialization efforts are strongly encouraged, as are matching funds from independent third-party investors, per the SBIR Fast Track program (see section 4.5) or the Phase II Plus program described earlier under the "New This Year" section. Commercialization plans, cost-sharing provisions, and matching funds from investors will be considered in the evaluation and selection process, and Fast Track proposals will be evaluated under the Fast Track standard discussed in Section 4.3. Phase II proposers are required to submit a budget for a base year (first 12 months) and an option year. These costs must be submitted using Appendix C, Cost Proposal, and may be presented side-by-side on a single Cost Proposal Sheet. The total proposed amount should be indicated on Appendix A, Proposed Cost. Phase II projects will be evaluated after the base year prior to extending funding for the option year.

The Army is committed to minimizing the funding gap between Phase I and Phase II activities. With the implementation of Phase I Options effective with the 98.2 Solicitation, all Army Phase II proposals will receive expedited reviews and be eligible for interim funding. Accordingly, all Army Phase II proposals, including Fast Track submissions, will be evaluated within a single two-tiered evaluation process and schedule. Phase II proposals will thus typically be submitted within 5 months from the scheduled DoD Phase I award date (the scheduled DoD award date for Phase I, subject to the Congressional Budget process, is 4 months from close of the DoD Solicitation).

Submission of Army SBIR Proposals

All proposals written in response to topics in this solicitation must be received by the date and time indicated in Section 6.2 of the introduction to this solicitation. Submit your proposal(s) well before the deadline. The Army does not accept late proposals.

All Phase I proposals - one original (clearly marked, with original signatures) and four copies - must be submitted to the Army SBIR Program Management Office at the address below. Each copy must include Appendices A, B, and E generated and printed out by the on-line systems. All hand deliveries must be made to the Army Material Command (AMC) building mail room, located at the rear of the AMC building. Proposers should be aware that the AMC mail room hours are 0730-1530 hrs (local) and are subject to change without prior notice.

Dr. Kenneth A. Bannister
U.S. Army Research Office-Washington
Room 8N31, Army Material Command Building
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

Electronic Submission of Appendices A and B Using the Army Website

You must submit your Appendices A and B to the Army using the online forms. This site allows your company to come in any time (prior to the closing of the solicitation) to edit or print out your Appendices A and B. **The Army WILL NOT accept any form other than those from the Army SBIR Website as valid proposal submission forms for the Appendix A and B.** Proposers must use the following procedures.

1. Go to Internet address http://www.aro.army.mil/arowash/rt/ and click on "Access Phase I Electronic Submissions", then click on "Submit or Edit Phase I Appendix A and B" and follow instructions.
2. **Fill out all the information requested!** N.B.:The screen format will look different than the forms in the solicitation. Once you have filled in the data, follow the instructions to electronically save/submit appendices. That is, make sure you click on the Save/Submit button, which will save your appendices to the Army server. You will still be able to return and edit this text up to the date and time of the solicitation closing, at which time the Army will close down the site. Your electronically-submitted version should match the signed hardcopy appendices submitted with your proposal.
3. After you click on the Save/Submit button, follow instructions to print out the hardcopies of appendices and sign them. N.B.: The printed forms from the Website may look different than the forms in this solicitation book and the signature block may appear on the second page. The Army requires you to include these forms with the mailed hard copy of your proposal. Do not use any other version of the signed forms.
4. Mail the signed Appendix A, B, and E forms, along with one original and four copies of your entire proposal (the copies should include four copies of the signed Appendix A, B, and E forms) to the Army SBIR Program Management Office at the above address.

Key Dates

99.2 Solicitation Open	1 July - 11 August 1999
Phase I Evaluations	August - November 1999
Phase I Selections	November 1999
Phase I Awards	December 1999*
	* Subject to the Congressional Budget process.

Recommendation for Future Topics

Small Businesses are encouraged to suggest ideas that may be included in future Army SBIR solicitations. These suggestions should be directed to the SBIR points-of-contact at the respective Army research and development organizations.

Inquiries

Inquiries of a general nature should be addressed to:

Dr. Kenneth A. Bannister
Army SBIR Program Manager
U.S. Army Research Office - Washington
Room 8N31
5001 Eisenhower Avenue
Alexandria, VA 22333-0001
(703) 617-7425

Dr. Robert Rohde
Headquarters, Department of the Army
Office of the Assistant Secretary of the Army
(Acquisition, Logistics, and Technology)
2511 Jefferson Davis Highway
Arlington, VA 22202-3911
(703) 601-1515

ARMY SBIR PROGRAM
POINTS OF CONTACT SUMMARY

U.S. Army Materiel Command

ARDEC	John Saarmann	(973) 724-7943
ARL	Dean Hudson	(301) 394-4808
ARO	LTC Ken Jones	(919) 549-4200
AVRDEC	Brenda Haglich	(757) 878-5400
CECOM	Joyce Crisci	(732) 427-2665
ERDEC	Marvin Hohenstein	(410) 436-2855
MRDEC	Otho Thomas	(205) 842-9227
NRDEC	Gerald Raisanen	(508) 233-4223
STRICOM	Mark McAuliffe	(407) 384-3929
TARDEC	Alex Sandel	(810) 574-7545
TECOM	John Schnell	(410) 278-1478

U.S. Army Corps of Engineers

COE/CERL	Carol Mihina	(217) 373-6746
COE/CRREL	Theresa Salls	(603) 646-4651
COE/TEC	Susan Nichols	(703) 428-6631
COE/WES	Phil Stewart	(601) 634-4113

Deputy Chief of Staff for Personnel (Army Research Institute)

ARI	Dr. Jonathan Kaplan	(703) 617-8828

U.S. Army Space and Missile Defense Command

SMDC	Fred Clarke	(256) 955-5451

Army Medical Command

MRMC	Herman Willis	(301) 619-2471

DEPARTMENT OF THE ARMY
PROPOSAL CHECKLIST

This is a Checklist of Requirements for your proposal. Please review the checklist carefully to assure that your proposal meets the Army SBIR requirements. **Failure to meet these requirements will result in your proposal not being considered for review or award**. Do not include this checklist with your proposal.

*___ 1. The Cover Sheet (Appendix A) and the Project Summary Sheet (Appendix B) are the first two pages of your proposal, and were completed using the Army's Online SBIR Proposal System (address: http://www.aro.army.mil/arowash/rt/). Appendix A (Page 1) clearly shows the proposal number assigned by the system to your proposal.

*___ 2. The proposal addresses a Phase I effort (up to **$70,000** with up to a six-month duration) AND an optional effort (up to **$50,000** for an up to four-month period to provide interim Phase II funding).

____ 3. The proposal is limited to only ONE Army solicitation topic.

____ **4. The Project Summary, Appendix B, contains no proprietary information, does not exceed 200 words, and is limited to the space provided.**

____ 5. The Technical Content of the proposal, including the Option, begins on PAGE 3 and includes the items identified in Section 3.4 of the solicitation.

____ 6. The proposal, including the Phase I Option, is 25 pages or less in length. (Excluding Appendix E: Company Commercialization Report.) Proposals in excess of this length will not be considered for review or award.

____ 7. The proposal contains only pages of 8-1/2" X 11" size. No other attachments such as disks, and video tapes. are included.

____ 8. The proposal contains no type smaller than 11-point font size (except as legend on reduced drawings, but not tables).

____ 9. The Contract Pricing Proposal (Appendix C) has been completed for **the Phase I and Phase I Option** and their costs are shown separately. The Appendix C is included as the last page of the proposal.

____ 10. The proposal is stapled in the upper-left-hand corner, and no special binding or covers are used.

____ 11. An original with original signatures **(clearly marked)** and four copies of the proposal are submitted.

____ **12. Appendix E, Company Commercialization Report, is submitted in accordance with Section 3.4.n. This report is required even if the company has not received any SBIR funding. (This report does not count towards the 25-page limit)**

____ 13. Include a self-addressed, stamped envelope and a copy of the Notification Form (Reference A) located in the back of the solicitation book, if notification of proposal receipt is desired. **No responses will be provided if these are not included with your proposal.**

____ 14. The proposal must be sent registered or certified mail, postmarked by August 4, 1999, or delivered to the Army SBIR Office no later than **August 11, 1999, 3:00 p.m. local time** as required (see Section 6.2). Offerors who elect to use commercial courier services do so at their own risk. The Army **can not** accept responsibility for proposals delivered late by commercial couriers.

INDEX OF ARMY FY99 TOPICS

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A99-001 Hyperspectral Data Fusion
A99-002 Smart Tie-down Technology
A99-003 Innovative Non-line-of-sight Passive Acoustic Sensors for Target Location
A99-004 Automated Material-handling Equipment
A99-005 Innovative Treatment of Depleted Uranium Contaminated Soils
A99-006 Flexible Metrology for Aspheric and Conformal Optical Surfaces
A99-007 Innovative Manufacturing Designs for Energetics
A99-008 Alternative Energy Source for Illumination
A99-009 Fragmentation of Energetic Materials via Directed Ultrasonic Energy
A99-010 Miniaturized Smart Munition Concepts for the Objective Sniper Rifle

Also see OSCR Topics A99-106 thru A99-109

U.S. Army Research Institute (ARI)

A99-011 Development and Test of a Framework for Critical Thinking Skills in a Military Context

Also see OSCR Topic A99-110

U.S. Army Research Laboratory (ARL)

A99-012 Lightweight Personal Protective Head Gear Communication System
A99-013 Human Communicative Performance in High Noise Environments
A99-014 Multi-modal Speech Recognition
A99-015 Laser Beam Tracking System for Optical Communication Link Between Moving Vehicle
A99-016 Speech Translation for Mobile Environments
A99-017 Monolithic Integrable Optoelectronic Devices With Variation of the Bandgap and Strain
A99-018 Hyper-spectral Terrain Understanding for an Unmanned Ground Vehicle (UGV)
A99-019 Oil-free Auxiliary Power Unit and Propulsion System Technology
A99-020 Innovative Processing of Multifunctioning Composite Armor for Ground Vehicles

See also OSCR Topics A99-111 thru A99-124

U.S Army Research Office (ARO)

A99-021 Production of High Energy-absorbing Metallic Foam Structural Components
A99-022 Tunable Materials for Integrated Adaptive Electronics
A99-023 Full Field Spray Diagnostics
A99-024 Novel Short Wavelength Light Source System for Portable Sensor Application
A99-025 Application of Recent Algorithm Research to ATRs in Cluttered Environments
A99-026 Digital Image Management: Integrated Computer Interfaces for Image-guided Systems
A99-027 Engineering Design Software for Military Incinerators
A99-028 Sensor System for In-situ 3D Soil Stress Analysis
A99-029 4D Remote Measurement of Tracer Concentrations for Atmospheric Dispersion Studies

See also OSCR Topics A99-125 thru A99-127

U.S Army Aviation Research, Development, and Engineering Center (AVRDEC)

A99-030 Innovative Methods for Evaluating Combat Performance using Full Mission Simulation
A99-031 Predictive and Real-time Visual Assessment System and Tools
A99-032 Engineering and Information System for Simulation-based Design and Acquisition
A99-033 Aerodynamic Design Tools for Advanced Rotor Configurations
A99-034 Enhanced Symbology for Wide Field-of-View for Helmet-mounted Displays (HMDs)

See also OSCR Topics A99-128 thru A99-133

U.S. Army Communications and Electronics Command (CECOM)

A99-035	Mines/Unexploded Ordnance (UXO) Confirmatory System
A99-036	Landmine Detection
A99-037	Low-cost Null-steering Processor for Phased Array Antennas
A99-038	Low-cost Ethernet Encryption
A99-039	Multicast Transport Protocols for Dynamic Wireless Networks
A99-040	Display Management for Command and Control Applications
A99-041	Micro-acoustic Sensor for Future Scout Unmanned Aerial Vehicle (UAV)
A99-042	Free Space Optical Communications for Ground Tactical Applications
A99-043	Command, Control, and Communications Infrastructure Situation Awareness
A99-044	Lightweight, High-power, Ground Vehicle-mounted, Gas Turbine Auxiliary Power Unit
A99-045	Soldier's Antenna
A99-046	Unmanned Aerial Vehicle (UAV) Remote Sensor Control and Data Retrieval
A99-047	Human Computer Understanding
A99-048	Integrated Circuit and Package Switching Applications Architecture
A99-049	Low-cost Attitude and Heading Reference Systems for Phased-array Antennas
A99-050	Advanced Intrusion Detection Techniques
A99-051	Hybrid Pixel Miniaturization
A99-052	Automatic Signal Exploitation
A99-053	Rangefinder/Illuminator Read-Out Integrated Circuit (ROIC)
A99-054	Laser Protection Device for Near Infrared (IR) Optical Devices
A99-055	Solid State Infrared (IR) Chopper for Uncooled Infrared Camera

See also OSCR Topics A99-134 thru A99-145

U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)

A99-056	Preflight Deicing and Anti-icing of Helicopters

U.S Army Chemical Biological Center of Excellence (CBCOE)

A99-057	Synthetic Receptors for Reagentless Biosensors
A99-058	Microfabrication-based Biodetectors

See also OSCR Topic A99-149

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A99-059	Small, Low-cost GPS Anti-jam System
A99-060	Liquid Crystal Polymer as a High-density, High-reliability, Electronic Substrate Material
A99-061	Alternative Liner Materials for Main Charge Warheads
A99-062	Internet Solutions for Information Integration
A99-063	Object Tracking through Rapid Sensor Orientation Change

See also OSCR Topics A99-150 thru A99-156

U.S. Army Medical Research and Materiel Command (MRMC)

A99-064	Environmental Recording for Monitoring Soldiers Wearing Head-mounted Devices
A99-065	Systems for Improved Manufacture of Human Fibrinogen
A99-066	Attractant/Insecticide to Eliminate Transmission of Tick- and Chigger-borne Diseases
A99-067	Biological Agent Sample Preparation for the Detection and Identification of Multiple Agents by Nucleic Acid-based Analysis
A99-068	Non-invasive Pneumothorax Detection for High-noise Environments
A99-069	Interrogatable Micro-environmental Sensor Pod for Dismounted Infantry
A99-070	Portable Oxygen Generators
A99-071	Systems for Improved Homeostasis

A99-072	Novel procedures for determination of Immunologic Consequences of Repeated exposures of Homologous Cholinesterases in Nonhuman Primates
A99-073	CANCELLED
A99-074	Non-intrusive Lactate Sensor
A99-075	Blast Mitigation Jacket for Training
A99-076	Non-invasive, Lightweight Cardiac Output Detection for Use in the Battlefield and High Noise Environments
A99-077	Stabilization of Critical Reagents

Natick Soldier Center (NSC)

A99-078	Nanotechnology for Ballistic Protection
A99-079	Novel Forming Techniques of Complex Shapes in Personnel Armor

See also OSCR Topics A99-157 thru A99-160

U.S Army Space and Missile Defense Command (SMDC)

A99-080	Common Sense Reasoning to Locate Threats
A99-081	Mitigation of Magnetohydrodynamic Electromagnetic Pulse Effects on Long Lines for Missile Defense System and Infrastructure Protection
A99-082	Combine Auditory/Olfactory Sensory Immersion for Decision Support
A99-083	High-energy Laser Optical and Diagnostic Development

See also OSCR Topic A99-161

U.S. Army Simulation, Training, and Instrumentation Command (STRICOM)

A99-084	Distributed Collaborative Java-based Positioning Instrumentation Modules
A99-085	Advancements in Individual Combatant Simulation Technology

See also OSCR Topics A99-162 thru A99-164

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A99-086	Compression Ignition Engine Technology Insertion
A99-087	Smart Lead Acid Batteries for Starting, Lighting, and Ignition Applications
A99-088	Advanced Opposed-piston 2-stroke Diesel Demonstrator
A99-089	Surfactant Resistant Fuel Filtration
A99-090	Semiactive Shock Absorber for HMMWV
A99-091	Sensor Technology for Detecting and Monitoring Corrosion of Land-based Vehicles
A99-092	Computer Modeling the Corrosion and Durability of Land-based Vehicles
A99-093	Hyperspectral Evaluation of Signature-managed Materials
A99-094	Mine-resistant Track Development
A99-095	Portable Fuel Analyzers
A99-096	Smart Structures for Combat Ground Vehicles
A99-097	Video Compression for Standard Teleoperation Kits
A99-098	Recycling of Discarded Rubber Tires

See also OSCR Topic A99-165

U.S. Army Topographic Engineering Center (TEC)

A99-099	Semantic Mapping Tools

See also OSCR Topic A99-166

U.S. Army Test and Evaluation Command (TECOM)

A99-100	Remote Autonomous Zoned Optical Range
A99-101	Solid State Oxygen Concentration Measurement System
A99-102	Ordnance Detection

See also OSCR Topic A99-167

U.S. Army Waterways Experiment Station (WES)

A99-103	Device for Measuring Response of Windows and Window Retrofit System
A99-104	Bistatic Radar Measurements and Inversion Modeling
A99-105	Miniature Blast Sensors for Conventional Weapons Effects Studies

Topics Addressing U.S. Army Operating and Support Cost Reduction (OSCR) Intiatives

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A99-106	Innovative Structural Control and Devices using Smart Material Technologies
A99-107	Intelligent Multi-agent Hybrid Systems Control Technology
A99-108	Proficient Gun Barrels
A99-109	Acoustic Mine Detection and Neutralization

U.S. Army Research Institute (ARI)

A99-110	Training Adaptability in Digital Skills

U.S. Army Research Laboratory (ARL)

A99-111	Micromagnetic Sensor Technology
A99-112	Logistics Site Planning and Operation Tool (LOGSPOT)
A99-113	Novel Wear Resistant and Thermally Insulative Materials
A99-114	Smart Materials for Collapsible Fuel and Water Storage Tanks
A99-115	Low-cost, Adhesiveless Method for Assembling Fibrous Preforms
A99-116	High-mobility Trailer
A99-117	Energetic Materials for Batteries and Electrochemical Capacitors
A99-118	Sampling Sensors for Monitoring Hazardous Gaseous Combustion/Pyrolysis Chemicals
A99-119	Low-cost Fabrication Technologies to Produce Transparent Armor Ceramics
A99-120	Compact, High-power Microwave Antenna
A99-121	Wavelength Division Multiplexing Fiber Optic Microwave Delay System
A99-122	Time-efficient, High Rate Production and Manufacturing for Nanoparticulates
A99-123	Direct Digital Synthesis Technology
A99-124	Real-time Image Restoration Processor

U.S Army Research Office (ARO)

A99-125	Hybrid Power Systems in the 10-50 Watt Power Range
A99-126	Enhancements to Hand-held Detectors for Unexploded Ordnance and Landmine
A99-127	Ammonia-based Hydrogen Sources for Small Fuel Cells

U.S Army Aviation Research, Development, and Engineering Center (AVRDEC)

A99-128	Dual-alloy Technology for Turboshaft Engines
A99-129	Aircraft Engine and Transmission Wear Monitoring Sensor
A99-130	Lightweight Double Helical Gears for Aerospace Applications
A99-131	Battle Damage/Fault-tolerant Reconfigurable Open Systems Avionics Architecture
A99-132	Graphics Display Systems for Night Vision Goggles (NVG)
A99-133	Affordable Fuel System Computer

U.S. Army Communications and Electronics Command (CECOM)

A99-134	Low-cost Helicopter Collision Warning System
A99-135	Radio Frequency Communications Modeling using Distributed Simulation
A99-136	Near Real-time Radio Frequency Emitter Mapping
A99-137	Low-cost Modular Intelligence System
A99-138	Physically Small, Very High-frequency/Ultra-high Frequency Conformal Antennas
A99-139	Tactical Vehicle Inverter System
A99-140	Lightweight Integrated Navigation and Communications Radio System
A99-141	Application of Distance Learning to Training for Logisticians and Command Post XXI
A99-142	Electrooptic Active Ambient Attenuator
A99-143	Innovative Backlight Technologies for Miniature Active Matrix Liquid Crystal Display
A99-144	Dual-voltage, Multiconfigurable Nonrechargeable Battery Design with Adapter
A99-145	Speech Intercept Intelligibility for Spectrum Supremacy

U.S. Army Construction Engineering Research Laboratory (CERL)

A99-146	Asbestos Neutralization by In-situ Chemical Digestion
A99-147	Magnetic Fluxgate Micro-electromechanical Systems (MEMS)for Structural Integrity
A99-148	Artificial Intelligence (AI) for Identifying Pavement Defects From Visual Image Data

U.S Army Chemical Biological Center of Excellence (CBCOE)

A99-149	Self-contained Surface Bio-sampling Apparatus

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A99-150	Novel Imaging Techniques for Compact Aerial Vehicles
A99-151	Alternative Communications for Nonline-of-sight Applications
A99-152	2D High-speed Bipolar Optical Modulator Array
A99-153	Enhanced Scramjet Combustion
A99-154	Steerable Array Antenna using Micro Electro Mechanical Switches (MEMS) Technology
A99-155	An Effective Mixing Process for Gelled Propellants
A99-156	Spatial Antenna Arrays/Processing for C3 with Unmanned Ground Vehicles (UGV)

Natick Soldier Center (NSC)

A99-157	Onsite Packaging and Food Waste Disposal (Safe Incineration)
A99-158	Portable Rapid Analytical Technology for Food Safety
A99-159	High-speed/Low-cost Impermeable Seaming for Synthetic Tentage and Collective Protection Shelters
A99-160	Human Performance Modeling of Paratrooper Landings

U.S Army Space and Missile Defense Command (SMDC)

A99-161	Fluorine and other Extremely Hazardous Chemicals Gas-handling Equipment

U.S. Army Simulation, Training, and Instrumentation Command (STRICOM)

A99-162	Robust, Low-cost Target System Data Link
A99-163	Software Tools for Visualization of Terrain Databases
A99-164	Multi-resolution Modeling

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A99-165	Unique Hardkill Active Protection Countermeasures Mechanisms

U.S. Army Topographic Engineering Center (TEC)

A99-166	Methods for Achieving Improved Position and Orientation Performance from Small, Low-cost Sensors

U.S. Army Test and Evaluation Command (TECOM)

A99-167	Marrying Commercial-off-the-shelf (COTS) and Government-off-the-shelf (GOTS) Equipment for Tracking Chemical Releases

ARMY FY99 TOPICS

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A99-001 TITLE: Hyperspectral Data Fusion

TECHNOLOGY AREA: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To miniaturize the electronics that implement algorithms used in hyperspectral data fusion.

DESCRIPTION: Algorithms developed for and by the Army for fusing hyperspectral data act on intensity measurements (pixels) of 16 bit integers stored in three dimensional arrays where two dimensions (of less than or equal to 512 x 512 pixels) are spatial and the third (of less than or equal to 256 values) is spectral. The algorithms involve match filtering (functions of 256 - 16 bit integer values or less) and convolution of determinable functions (functions of up to 64 x 64 x 256 - 16 bit integer values) with the data. Examples might include the response function of the human eye or a least squares matching to a spectral function representing vegetation. Data processing throughput can be greater than one giga-pixel per second. Current implementation of hyperspectral processing entails use of massive amounts of costly electronics including field programmable gate arrays (FPGA). With the required supporting electronics, FPGAs are considered too bulky to be a solution.

This solicitation is for custom hardware which can fit into as small a volume as possible(6 cubic inches maximum) to process the data. The hardware must include data storage for the raw data, and intermediate and final results. The hardware needs to interface to input channels and output channels commensurate with the data rates mentioned.

PHASE I: Design and simulate the electronics for the operation. An application specific integrated chip is anticipated.

PHASE II: Fabricate, test and deliver the electronics. Several fabrication and testing iterations to perfect the electronics should be anticipated.

PHASE III DUAL-USE APPLICATIONS: Hyperspectral imaging has many applications. The field is just starting to grow. Fast, small, and generic processing chips are required before the full benefit of this field will be experienced. Applications include hyperspectral infrared imaging, hyperspectral x-ray, and data fusion in general. Specific applications are military target identification and classification, battlefield damage assessment, friend or foe discrimination, non-destructive inspection, smart munitions, medical diagnostics, and smart cars.

KEYWORDS: data fusion, hyperspectral imaging, hyperspectral, ASIC, VLSI, match filtering, convolution, data processing, algorithms.

REFERENCES: "Real-Time, PC Based Color Fusion Displays," J. Waterman, et.al., presented at 1999 IRIS Specialty Group on Passive Sensors Conference, Web site: http://www-datafusion.cma.fr/

A99-002 TITLE: Smart Tie-down Technology

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop an advanced materials grid matrix which enables munitions and other cargo to be rapidly secured or unsecured to a 20 foot long by 8 foot wide steel shipping platform.

DESCRIPTION: The Palletized Load System (PLS) is composed of a prime mover truck with integral self-loading and unloading capability, a 16.5-ton payload trailer, and demountable cargo beds (flatracks). The PLS is the U.S. Army's key transportation component of the ammunition distribution system. It will perform long range hauling, local hauling and unit re-supply of ammunition. Currently a new flatrack for the PLS, the Container Roll-in, Roll out Platform (CROP), is being fielded. The CROP will provide the Army with new capability - a direct link between commercial transportation systems and battlefield distribution systems. However, although the CROP will speed up the movement and delivery of munitions it has one flaw. The method for securing munitions and cargo to the CROP takes too long and is too labor intensive. Securing ammunition or cargo to the CROP involves 12 nylon straps with ratchets and wood blocking and bracing. Completing this tie-down procedure takes two or three soldiers 15-20 minutes to complete. The procedure takes this long because the soldiers must adhere to specific strapping guidelines to make the load safe for transport. These strapping guidelines, while nice to follow in peacetime, are highly impractical in a wartime situation. CROP loads will constantly be altered, therefore trying to find strapping procedures for every possible combination will be highly impractical. The future methodology for securing and un-securing munitions to the CROP must be improved. Tomorrow's technology can provide such an improvement. A grid matrix using bio-materials (spider silk) or rigid polyurethane foams would provide great strength, low weight, and flexibility.

Production costs for the matrix must prove to be comparable to the production costs for standard strapping systems. The grid matrix must also provide a rapid and automated self-tightening capability to assure the munition load is securely and rigidly fastened to the CROP. Optical or electrical sensors embedded in the matrix provide self-adjusting characteristics under various loading conditions. Potential applications of the grid matrix are unlimited. This program will also explore ways of using the grid matrix to secure cargo on Army tactical cargo trucks (i.e., 2.5 ton, 5 ton, 10 ton) and trailers (i.e., M871 - 30' and M872 - 40' trailers), as well as commercial 20' and 40' trailers.

PHASE I: Develop the overall approach, design and functionality of the grid matrix. Investigate and assess the utility of biomaterials, rigid polyurethane foams, sensors and other materials for the matrix. Select an optimum material and develop concept drawings. Demonstrate the concept by small-scale model or Computer Aided Design. The model or design will illustrate the integration of all subsystems, or show individual subsystems and how they meet final design requirements.

PHASE II: Develop, assemble and demonstrate a prototype system. The system will be inserted into a realistic environment with Army supplied inert munitions and other cargo types. Testing of the design will be performed at the Army's National Training Center. After testing the design will be enhanced or modified to incorporate needed changes.

PHASE III DUAL-USE APPLICATIONS: The technology developed under this program would have widespread application to the commercial logistics, cargo, and package shipping industry. It would provide tremendous cost savings in reduced manpower currently required to secure cargo and packages to tractor-trailer beds, trucks, railcars, aircraft 463L pallets, and logistics shipping platforms.

KEYWORDS: Smart Tie Down Technology, Cargo containers, Weapon Pallets, Automated Handling, Advanced Materials

A99-003 TITLE: Innovative Non-line-of-sight Passive Acoustic Sensors for Target Location at Extended Ranges

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Determine methods or Improvements to Increase Target Location Determination/Bearing Accuracy for Acoustic Sensors at Extended Ranges

DESCRIPTION: The Army needs intelligent acoustic sensors for battlefields of the 21st century. These needs include battlefield surveillance, situation awareness and cueing for other sensors. As a result of these needs, the demand for improved acoustic sensor performance has also increased. One of the operational requirements pushed in acoustic sensors is to increase the range for target detection. However, the complexity of the acoustic propagation environment and the extreme diversity of combat operations under which acoustic sensors may be employed have caused sensors to perform with accuracy errors of 2 to 3 degrees at best. Consequently, as the sensors detection ranges increase to 5-6KM, the target location/bearing error also increases in proportion. For example: 3 degrees of bearing error at 2 Km is 105m vs 3 degrees of bearing error at 6Km equals 314m. Therefore, proposals are invited to develop innovative methods or techniques to improve acoustic sensor performance in target location determination/ bearing accuracy considering atmospheric conditions and terrain at extended ranges with the following considerations: 1. Conventional and adaptive beamforming techniques 2. Sensor array designs (Battlefield application must considered) 3. Fusion of integrated sensors/sensor arrays with overlapping coverage. 4. Innovative detection methods or techniques to increase detection range and/or resolution, e.g., wave guide, passive signature relay to modulate signature data from a node (or nodes) to a sensor, etc.

PHASE I: Develop an overall method (or technique) design in block-diagram form that includes specifications of how to enhance acoustic detection considering atmospheric conditions and terrain at extended ranges with high resolutions. This phase will illustrate the contractor's understanding of the requirements, appropriateness of the approach, and expectation of meeting the Phase II objectives. During this phase the detection range of environmental conditions, terrain features, sensor characteristics, and target arrays will be defined.

PHASE II: During this phase the detection range of environmental conditions, terrain features, sensor characteristics, and target arrays will be defined.

PHASE II: Develop and demonstrate a prototype system in a realistic environment. Conduct testing to determine the feasibility over extended operating conditions.

PHASE III DUAL-USE APPLICATIONS: Employment of acoustic sensors for intrusion detection/tracking, such as large storage area depots, border surveillance, or monitoring of wilderness areas to detect unauthorized activity, have the same general requirements. These non-defense applications also desire increases in detection range capability to improve the overall sensor effectiveness. Phase III opportunities exist for extended range capability wherever intelligent acoustic sensors are employed.

REFERENCES: Battlefield Acoustic Sensor Integration System (BASIS), Principal Investigator/Author: David C. Swanson, Applied Research Laboratory, Pennsylvania State University, 1 May 1996, Final Report (Phase 1) to Mr. Ted Saffos at Naval Surface Warfare Center Dahlgren Division.

KEYWORDS: acoustic sensors, target location, beamforming techniques, sensor fusion

A99-004 TITLE: Automated Material-handling Equipment

TECHNOLOGY AREAS: Ground and Sea Vehicles

OBJECTIVE: Develop a low cost hybrid sensor suite providing an automated pallet acquisition capability thereby removing the need for a ground guide during munitions resupply operations.

DESCRIPTION: Significant progress has been made in developing advanced teleoperated control systems for generic wheeled or tracked vehicles. Specifically, a standardized teleoperation system (STS) has been developed for driving these vehicles without a man at the wheel. The ATLAS forklift is essentially a teleoperated material handling carriage caused by the obscured view the operator has of the end effector. This partial view of the workspace requires the presence of a ground guide as an aid in performing munitions resupply operations. A need exists to provide positional information of the immediate workspace environment and decision aids enabling the driver to perform the required operations without the need of a ground guide or any other personnel in the local vicinity. The target platform will be the ATLAS, a 10,000 pound payload rough terrain forklift with an extendable boom designed for stuffing and unstuffing 20 foot ISO containers as well as standard forklift operations. The material handling system can be reduced to a 6 degrees of freedom (DOF) manipulator that must be precision controlled to execute all tasks defined by the systems operational envelope. To fulfill this requirement technical issues of mobility and base motion effect, knowledge based/flexible task level control, multi-sensor integration, path planning, navigation and obstacle detection/avoidance must be balanced against passive solutions such as vision blocks, tactile antennae and light tubes etc. to attain real time performance. Also, a standardized software development environment must be used to generate the algorithm implementation required for system operation.

PHASE I: Develop methodology and algorithmic approaches for automatic control of the material handling carriage for applications of palletized munitions handling and compare these capabilities to that of a passive low cost system. Perform preliminary modeling and simulation studies to determine performance/robustness characteristics of the control laws and algorithms, real time processing and sensor requirements. Provide analysis for evaluating control laws and provide control processor design and system hardware specifications.

PHASE II: Develop controller hardware/software and development environment for interface with the forklift system. Develop low cost passive solution prototype for field test. Develop test scenarios to demonstrate controller performance and integrated system capabilities. Provide fully instrumented prototype vehicle system with operators control station, documented source code, development environment and complete operators manual suitable for training non-technical personnel for evaluation exercises.

PHASE III DUAL-USE APPLICATIONS: The technology developed under this program can be utilized on any commercially available forklift style material handling equipment (MHE). The technology is also applicable to automated warehousing, rail head and port operations, handling of hazardous materials, security, counter terrorism and law enforcement.

KEYWORDS: automated equipment, forklift, ISO containers, material handling, control technology

A99-005 TITLE: Innovative Treatment of Depleted Uranium (DU) Contaminated Soils

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To conduct research in the area of organic based emulsions and their application to in-situ stabilization of DU contaminated soils for both the purpose of site remediation as well as for on-going maintenance of operational DU firing ranges. This work will include a laboratory treatability study/proof-of-principal demonstration as well as a field trial.

DESCRIPTION: Uranium is an extremely dense metal used in kinetic energy penetrators and tank armor. DU contains isotopes found in natural Uranium, but the radioactive components are in much lesser concentrations. Over the past twenty years, the Department of the Army has developed, tested and fielded a number of weapon systems containing DU. Other services (i.e., Air Force, Navy, etc.) have also engaged in similar programs. DU contaminated soil at test facilities poses potential health risks due to DU migration via multiple pathways. The extent and significance of the potential health risks are the subjects of on-going studies by the Army. The main methods of migration are either movement due to wind, water erosion, dissolution or suspension of DU containing particles in runoff, and percolation through the soil (leaching). A treatment method must therefore prevent DU from potentially leaching to groundwater and from surface migration due to wind and water erosion. Existing remediation methods include excavation, bulk treatment and off-site disposal, which is extremely expensive, and bioremediation, which is time consuming and requires specific soil types. None of these methods provide a cost-effective method for ongoing maintenance of an active firing range. The highly regulated nature of DU, combined with public perception of health risk, create pressure to address the problem. Additionally, in order for needed testing of DU weapons to continue, on-site waste materials must be properly managed in order for the test facility to remain within the operating limits of its Nuclear Regulatory Commission license. Hence, Army readiness relies upon the development of practical, cost-effective cleanup and ongoing maintenance strategies.

PHASE I: Demonstrate proof of principle of an emulsion-based system's ability to chemically and physically immobilize the DU in soil. Conduct laboratory analysis to evaluate the reduction in leaching potential of treated soil and determine its durability and resistance to mechanical migration. Evaluate the optimal treatment procedures and anticipated remediation effectiveness. This initial evaluation should also include recommended equipment and construction methodologies for in-situ processing of impacted soils, all equipment and materials necessary to scarify and treat the impacted areas, and the requirements for an on-going range maintenance program.

PHASE II: Design and conduct an actual field demonstration of the proposed stabilization system. This would include multiple test sections to determine effective application methods and rates. These test sections would also be used to evaluate the system's ability to control the spread of particulate matter by wind action or mechanical means and would be designed to validate preliminary cost estimates and provide information necessary for full deployment..

PHASE III DUAL-USE APPLICATIONS: This concept would have multi-Service application as well as widespread DoE usage. With disposal costs for DU contaminated soils well in excess of $1500 per ton, and contaminated soils on Army sites alone conservatively estimated at several hundred thousand tons, tremendous opportunities exist to save substantial money. Significant international interest is also forecast. The United Kingdom, Russia, Turkey, Saudi Arabia, Pakistan, Thailand, Israel, France and others are developing or already have DU-containing weapon systems. This approach could also have application to provide effective remediation and/or containment after battlefield operations (i.e., Desert Storm).

KEYWORDS: depleted uranium, contaminated soils, low level radionuclides, migration pathways

A99-006 TITLE: <u>Flexible Metrology for Aspheric and Conformal Optical Surfaces</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Design and build a prototype device capable of rapid precision measurement of aspheric, non-axially symmetric, and conformal optical surface figures to sub-wavelength accuracy without the need for a customized diffractive optical element or any customized reference.

DESCRIPTION: Recent Opticam optics manufacturing technology developed by the Center for Optics Manufacturing (COM) enables economic fabrication of aspheric surfaces in optical glasses and brittle materials as well as conformal optical surfaces of various symmetries or even non-symmetry. Although the figure of conic surfaces can be characterized by conventional interferometer geometries, aspheric surfaces described by up to tenth order polynomial terms in many cases require the fabrication of a diffractive optical element as a reference. Off-axis aspheres and conformal optics comprise a further challenge. Thus, a process which requires negligible setup and does not require special tooling suffers delays, extra cost and limitations due to metrology for acceptance. Touch probe methods are slow, suffer from sampling limitations and require physical contact with the optic. This program will develop an economic, rapid, flexible technique and device for measurement of these surfaces without customized reference elements. Goals are measurement of 100mm diameter surfaces (specular and non-specular) with 500 microns departure from a best fit sphere to an accuracy of 0.1 micron. Capability to make in-process measurements on the Opticam Aspheric Generator, enabling closed loop control, is desirable. Applicability to tangent ogive and off-axis aspheres is desirable. Non-contact methods are preferable.

PHASE I: Coordinate with COM to establish performance and environmental parameters required for metrology system to interface with Opticam Asphere and Opticam Conformal generation and polishing equipment. Design metrology system for measurement of non-spherical surfaces. Demonstrate proof-of-principle of design by measuring aspheres with departures of 50 microns with a brassboard system.

PHASE II: Develop and demonstrate a prototype metrology system. First demonstrate operation with conic aspheric surfaces (500 micron departure) typical of Opticam post-generation and post-polishing stages. Verify accuracy by comparison with conventional interferometry. Demonstrate system by measurement of complex aspheres (500 micron departure) with up to tenth order polynomial descriptions and slope reversal. Apply measurement technology to conformal optical samples from Opticam machinery. As before, this will be performed for surfaces from post-generation and post-polished surfaces.

PHASE III DUAL-USE APPLICATIONS: Aspheric and conformal optics will impact military optical and electro-optical systems (e.g., helmet mounted displays, avionics) by reducing weight and size and improving performance. They will be used in commercial systems for cinematography, medical endoscopy, photolithography, thermographic imaging.

REFERENCES: D. Golini et al., Precision optics fabrication using magnetorheological finishing, Proc. SPIE Vol. CR67, p. 251-274, Advanced Materials for Optics and Precision Structures, Mark A. Ealey; Roger A. Paquin; Thomas B. Parsonage;

Eds. (Sep 97) 2. D. Golini et al., Fabrication of glass aspheres using deterministic microgrinding and magnetorheological finishing, Proc. SPIE Vol. 2536, p. 208-211, Optical Manufacturing and Testing, Victor J. Doherty; H. Philip Stahl; Eds. (Sep 95)

KEYWORDS: Aspheric optics, conformal optics, flexible metrology, electro-optical systems

A99-007 TITLE: Innovative Manufacturing Designs for Energetics

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Generate data and demonstrate the ability to determine the concentrations of ingredients of energetic formulations including gun propellants, explosives, solid rocket fuels, pyrotechniques and their degree of mixedness (spatial distribution) during manufacturing on an on-line or in-line basis and close to real-time so that energetic grains which do not meet specs can be immediately identified and recycled during manufacture.

DESCRIPTION: Most manufacturing operations for energetics are moving towards continuous processing technologies including twin screw extrusion. In continuous processing, multiple ingredients are fed separately and intermixed, molten, pressurized and shaped into grains within the confines of a single extruder. TACOM - ARDEC is one of the leading centers in this area having recently demonstrated live continuous processing of PAXIIA explosives at Picatinny Arsenal, NJ. Continuous processing is ideal for manufacturing flexibility and the ability to process the new generations of extremely viscous, solventless thermoplastic-elastomer-based energetic formulations. However, the continuous processing may suffer from lapses in accurate feeding of various ingredients and occasional migration, stagnation and pipe line effects which may generate variations in concentrations of ingredients in processed grains, which may lead into variations in burn rate. In the era of smart weapons such variations are not acceptable. Currently there are no technologies which can economically, on-line and in real-time determine the variations in concentrations of various ingredients and the statistics of their spatial distributions within each grain. The ability to accomplish this can increase the quality of energetics tremendously while decreasing the testing time, reject rates, costs and environmental impact.

PHASE I: The Phase I will culminate in innovative manufacturing designs which will accurately reveal the spatial distribution and concentration of ingredients on a real-time basis. The capability of the method to being used on-line should also be demonstrated by a design study.

PHASE II: Develop and demonstrate a prototype system to determine the concentrations of various ingredients of live formulations and the statistics of their spatial distributions (degree of mixedness) in a realistic production environment. The Phase II should result in the demonstration of the system on one live formulation as part of the twin screw extrusion facility available at Picatinny Arsenal. PHASE III - Dual Use Applications: The technology of on-line and in near real-time analysis of concentrations of ingredients in a processed suspension or dispersion and their degree of mixedness is of interest to multiple industries including pharmaceutical, food, ceramic, magnetic, construction and composite industries. The technology will find widespread use as a quality control and process sensor device.

REFERENCES:
1."The Kinematics of Mixing: Stretching, Chaos and Transport,"Cambridge University Press, 1989
2. N. M. Trivisonno, Rubber Chem. Technology 58, 469-526 (1985).
3. L. E. Alexander, " x-ray", Krieger Publishing Company, Malabar (1985).
4. T. Allen, "Particle Size Measurement", Chapman and Hall, London (1990).
5. " R. Yazici and D. Kalyon, " Degree of Mixing Analysis of Concentrated Suspensions by Electron Probe and x-ray Diffraction", Rubber Chemistry and Technology, 66, 4, 527-537 (1993).
6. R. Yazici and D. Kalyon, Journal of Energetic Materials, "Quantitative Characterization of Degree of Mixedness of LOVA Grains", Journal of Energetic Materials, 14, 57-73 (1996).

KEYWORDS : Sensing, on-line, real time, concentration, energetics

A99-008 TITLE: Alternative Energy Source for Illumination

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To develop a state of the art, non radioactive , non chemical, self powered illumination system.

DESCRIPTION: This innovative illumination system will provide sufficient energy for low level illumination and it is desired to have a five year service life with enough power for 4 hours of continuous operation. It will be environmentally friendly replacing the current radioluminescent illumination systems used in the U.S. Army's fire control instruments such as the fire control scales, level vials, reticles etc. It is also desired that the system be free of chemical batteries and that the system power source be able to provide low level electrical power for small electronic devices.

PHASE I: Assess state of the art technologies and then develop innovative designs which will result in a long life, non radioactive/chemical, self powered illumination system. The focus will be conducting energy conversion studies to analyze new power source concepts and concepts for low level illumination to produce conceptual designs for the illumination system.

PHASE II: An optimal conceptual , self powered illumination system will be selected based on an analysis of the identified design studies from Phase I. Critical enabling technologies and hardware will be identified to support fabrication of the illumination system. A working model of the selected concept will be fabricated with the goal to demonstrate feasibility of the illumination system.

PHASE III DUAL-USE APPLICATIONS: The AESFI could provide low power illumination for portable electronic devices used with cellular phones, passenger aircraft, arctic and desert installations where chemical battery powered systems don't work for very long and may be unsafe. The AESFI could also provide temporary low light emergency exit illumination, in homes, industry, aircraft etc., where normal power may become interrupted. It could also provide safer, low cost illumination of military fire control devices used with small arms, mortars, artillery and tanks.

KEY WORDS: Fire Control Illumination, Tank, Artillery, Mortars, Non Radioactive, Self-Generating, Self Powered, Small Arms

OPERATING AND SUPPOST COST (OSCR) REDUCTION. Since the AESFI will be designed with no or minimal regulatory requirements or controls, administrative and service requirements, it would have the potential to reduce significantly the current weapon system operating and support costs which accounts for up to 30% of the weapon life cycle costs. The Army is now requiring that its chemical battery costs be reduced by 50% for its weapon systems. The AESFI will contribute to this battery reduction mandate. It will also reduce the costly disposal and regulatory burdens.

A99-009 TITLE: <u>Fragmentation of Energetic Materials via Directed Ultrasonic Energy</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop and demonstrate technology which applies ultrasonic energy to explosives which have been cast-loaded (e.g., TNT, Composition B) in medium and larger caliber ammunition. The objective is to cause in-situ controlled fragmentation. This will enable safe, efficient removal and recovery of the energetic material as well as recovery of the metal parts during demilitarization (demil) operations.

DESCRIPTION: The US stockpile of unserviceable and obsolete munitions currently exceeds 500K tons. A significant portion of this inventory is made up of medium and large caliber ammunition loaded with TNT and Composition B. Historically, demilitarization of this ammunition has been carried out by open detonation although more recently, demil via autoclaving has been employed in order to recover energetic material and metal parts. While autoclaving is effective, the process is labor intensive (and thus costly with operators put at some risk) and also generates pink water that must be processed as a hazardous waste. It is known that when high intensity ultrasound is applied to a liquid medium within the presence of solids, the stress produced by "acoustic cavitation" in the liquid caused fragmentation of the solid. The stress (or pressure) produced by the cavitation of the liquid is a function of the properties of the liquid. High vapor pressure and surface tension are beneficial. It is proposed to use these principles to develop a process to remove and recover cast-loaded explosives from the interior of projectiles. Previous research has demonstrated the feasibility of such an approach through experiments conducted on TNT and Composition B simulants. The proposed project will build on this initial work and use live energetic material to establish a process followed by parametric studies to investigate process performance and develop an optimized pilot process.

PHASE I: Carry out laboratory testing to establish baseline parameters for the fragmentation of energetic material via ultrasonic energy. Experiments will first be conducted in explosive-filled 100 ml beakers and concentrate on the sonication liquid's properties and ultrasonic power effects. Methods to remove the fractured energetic material from the solid/liquid interface and separation from the sonication liquid will also be studied. Where appropriate, computer modeling will be used to study process phenomena and evaluate parameter interactions. The extent of material heating due to input of ultrasonic energy will be assessed . A preliminary process flowsheet and material balance will be developed.

PHASE II: Based on the preliminary process developed in Phase I, a pilot scale process will be developed, evaluated and optimized. Rate of fragmentation, yield of recovered energetic material and recycle of the sonication liquid will be maximized. Actual munitions items (e.g., 60mm, 81mm and 105mm projectiles) will be used in the pilot process demonstration, and design data sufficient to allow scale-up to a prototype demilitarization process will be generated.

PHASE III DUAL-USE APPLICATIONS: In the area of demilitarization, this technology has application to many different munitions. In the private sector, this technology could be used in the process industries to dislodge scale and other foreign material build-up from the interior of process piping.

REFERENCES: 1. Baum, J. and Baum, K., Explosive Removal Using Ultrasonic Energy, Contractor Report ARWEC-CR-97003, US Army Armament Research, Development and Engineering Center, Picatinny Arsenal, NJ, March 1997.

KEYWORDS : Ultrasound, explosives, demilitarize

A99-010 TITLE: Miniaturized Smart Munition Concepts for the Objective Sniper Rifle

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Substantially improved hit probability, miniaturized components, reduced weight and increased effective range for the Objective Sniper Rifle

DESCRIPTION: Current sniper rifles are conventional guns using standard kinetic energy bullets augmented with optical sights and occasionally laser rangefinders. Due to increased lethality and range requirements, it is necessary to seek technology improvements in many areas. These include innovative smart munitions, trajectory correction mechanisms, light weight and miniaturized components, crosswind sensors, control links, laser hardened optics, etc. It is envisioned that through these innovative sensors, lightweight construction, miniaturized components,and innovative trajectory altering mechanisms, the smart munition will be able to detect a target from a set of targets, to lock onto the target if it moves, and to be able to incapacitate the target without hurting innocent bystanders.

PHASE I: Identify promising technologies and processes that will provide for improved performance of these weapons. Conduct modeling and simulation studies of the selected devices/components using an approved set of engagement metrics (range, position, velocity, time). If possible build and test a breadboard.

PHASE II: Provide the design of the device(s)/components from Phase I and test for functionality and verify performance by simulation. Fabricate one or more optimally designed devices/components and test for actual performance.

PHASE III: This technology has commercial applications for law enforcement agencies, the hunting rifle markets and other dual-use applications. Law enforcement agencies can use this smart munition concept to pick out a particular target from a class of targets, lock onto a moving target, and incapacitate without hurting innocent bystanders. Individual components of this Smart Munition will require electrical power and higher energy density batteries which have application to small devices such as radios, cameras, calculators, etc. The envisioned munition sensor must pick out not only a class of targets, but also one particular target from a class of targets. This sensor could be applied to robotic assembly where similar components with minute, distinguishing characteristics can be discerned. The envisioned maneuver mechanism could use materials which can bend when voltages are applied; and this technology could have medical applications for prosthesis. Composite materials which can lighten the munition could have applications to bicycles, automobiles and aircraft, etc. All of these technologies can be adapted to the commercial market for hunters. Modern hunting rifles could be made more accurate and lightweight as well.

KEYWORDS : Smart munitions, sniper rifles, modeling and simulation, trajectories, miniaturized components, hit probabilities

U.S. Army Research Institute (ARI)

A99-011 TITLE: Development and Test of a Conceptual Framework for Critical Thinking Skills within a Military Context

TECHNOLOGY AREAS: Human Systems

OBJECTIVES: Develop a conceptual model to integrate critical thinking skills, knowledge, attitudes, other relevant cognitive variables, battle command tasks, and battle command performance within the context of the military decision making process; Apply the model to the training of selected critical thinking skills.

DESCRIPTION: Increased attention is being paid in the Army to training critical thinking skills to improve performance on military decision making procedures. However, efforts in this area have been theoretically fragmented and characterized by unsubstantiated claims that training specific critical thinking skills will improve battle command performance. If progress is to be made in training such skills, a more systematic approach is needed to define and conduct research. This research will develop and apply a model for conceptualizing the relationships between critical thinking skills, other cognitive variables, and performance.

PHASE I: Military and academic literature will be reviewed to identify a comprehensive list of critical thinking skills, attitudes, other cognitive variables, procedural knowledge, tasks, and performance measures relevant to military decision making. A framework will be developed which models the relationships between critical thinking skills, levels of generality of thinking skills, attitudes, knowledge, subtasks, tasks, and task performance within military decision making processes. Based on interviews with subject matter experts, two or three important critical thinking skills will be selected for further investigation and an explanation for their selection provided. These skills will be ones judged to be trainable and to significantly impact military decision making performance.

PHASE II: Work in Phase II will apply the model developed in Phase I to: (1) develop and evaluate procedures to train the selected critical thinking skills, and (2) conduct research to address questions such as the following: What are the predictors of critical thinking performance? Are the selected critical thinking skills trainable? How should they be trained? How should the critical thinking skills be measured? How much training is needed to effect a significant improvement in the skill? Does improvement in the selected critical thinking skills significantly improve performance on military decision making processes?

PHASE III DUAL USE APPLICATIONS A major commercial market for the products of this SBIR lies in the training programs of large, mid-size and small business and corporations. Corporations have an interest in improving the thinking and decision making skills of their managers and high level decision makers. The procedures developed in this SBIR to train and measure critical thinking skills could be packaged for on-going in-house training programs, vendor training seminars, high-level retreats, and CDs for self study. Another market is the general public. Americans have a well developed interest in self improvement. A video for improving thinking skills for professional advancement could be developed and marketed as self-improvement training

REFERENCES: Chapman, M. (1993). Everyday reasoning and the revision of belief. In J. M. Puckett and H. W. Reese (Eds.) Mechanisms of everyday cognition. Hillsdale, NJ: Erlbaum. Cheng, P. W. & Holyoak, K. J. (1985). Pragmatic reasoning schemas. Cognitive Psychology, 17, 391-416. Cohen, M. S., Adelman, L., Tolcott, M. A., Bresnick, T. A., & Marvin, F. F. (1994). A cognitive framework for battlefield commander's situation assessment. ARI Technical Report 1002. AD A283 631 de Bono, E. (1970). Lateral thinking: Creativity step by step. New York: Harper & Row Ellis, R. D. (1995). Questioning consciousness. The interplay of imagery, cognition, and emotion in the human brain. Amsterdam: John Benjamins Publishing. Ennis, R. H., Millman, J. & Tomko, T. N. (1985). Cornell critical thinking tests level X & level Z manual. (3rd Ed.). Pacific Grove, CA: Midwest Pub. Eysenck, M. W. & Keane, M. T. (1990). Cognitive psychology: A student's handbook. Hove, UK: Erlbaum. Fallesen, J. J. Michel, R. R., Lussier, J. W. & Pounds, J. (1996). Practical thinking: Innovation in battle command instruction. ARI Technical Report 1037. Fischer, S. C. & Geiwetz, J. (1996). Training strategies for tactical pattern recognition. ARI Technical Report 1031. Galotti, K. M. (1989). Approaches to studying formal and everyday reasoning. Psychological Bulletin, 105, 331-351. Gigerenzer, G. & Goldstein, D. G. (1996). Reasoning the fast and frugal way: Models of bounded rationality. Psychological Review, 103, 650-669. Halpern, D. F. (1996). Thought and knowledge: An introduction to critical thinking. Mahwah, NJ: Erlbaum. Langer, E. J. (1989). Mindfulness. Reading, MA: Merloyd Lawrence. Paul, R. (1993). Critical thinking: How to prepare students for a rapidly changing world. Santa Rosa, CA: Foundations for Critical Thinking. Payne, J. W., Bettman, J. R., & Johnson, E. J. (1993). The adaptive decision maker. New York: Cambridge University Press. Pennebaker, J. W. (1993). Stream of consciousness and stress: Levels of thinking. In J. S. Uleman and J. A. Bargh (Eds.) Unintended thought. New York: Guilford Press. Perkins, D. N. (1987). Thinking frames: An integrative perspective on teaching cognitive skills. In J. B. Baron & R. J. Sternberg (Eds.) Teaching thinking skills: Theory and practice. New York: Freeman.

KEYWORDS: critical thinking skills, cognitive skills, military decision making process, training

U.S. Army Research Laboratory (ARL)

A99-012 TITLE: Lightweight Personal Protective Head Gear Communication System for the Dismounted Soldier

TECHNOLOGY AREAS: Human Systems, Materials/Processes

OBJECTIVE: Design and develop a lightweight personal helmet and face shield protective system which does not interfere in detecting auditory signals or localization ability and provides personnel protection for the individual soldier.

DESCRIPTION: The future combat helmet for the dismounted soldier is expected to have multiple capabilities to include visual displays and auditory communication features as well as providing the traditional fragmentation ballistic protection and a possible ballistic enhancement to defeat small arms threats. The purpose of previous helmet designs was limited only to provide personal protection. In recent years, the helmet has undergone an evolution providing not only protection, but also serving as the basis for a personal communication system. The military helmet is often regarded as platform to attach new technology thus increasing weight and changing its purpose. Helmets are beginning to serve as a platform for advanced sensory information communication for the soldier. But current helmet designs and materials, which were not envisioned to support this expanding role for the helmet have not proven to be the ideal candidate platform to reach the AAN goals for the individual soldier. The current PASGT helmet is the standard infantry helmet and was type classified in the late 1970s and fielded in the early 1980s and provides ballistic protection from fragmenting munitions to the head, temple, ear and neck areas and does not provide face protection. During recent experiments with current protective headgear it was revealed that human auditory performance, situational awareness, and speech communication are degraded while wearing the PASGT helmet and future Land Warrior Integrated Helmet Assembly System (IHAS). Additionally, the weight and shape of the helmet limits head movement and exacerbates neck strain while conducting various soldier tasks. Therefore, the challenge of integrating information technology with head and face protection has become significant, making the need to truly begin an effort that covers several areas to include materials science, ballistics, audio signal processing, and human factors engineering. Issues such as lightweight head and face protective materials for ballistic and non-ballistic impact protection, human hearing protection designs, materials and helmet suspension solutions to reduce audio attenuation in the helmet, and sight protection against laser, flash, ballistic/non-ballistic and environmental threats must be addressed. This challenge is a high priority need for both military and commercial users who require a lightweight, ergonomic protective helmet that provides sufficient situational awareness and ballistic and non-ballistic protection. Therefore, the objective of a new reengineered headgear design should provide the requisite ballistic protection without degrading auditory cues critical for the user to maintain situational awareness of the surrounding combat environment. Reengineered design technology capabilities could include active noise cancellation microphones, switching circuitry, digital signal processing, and low detectability of wireless transmissions (i.e., < 50'). This investigation will include the analysis of specific users needs to optimize areas of ballistic coverage based on specifications for threat, weight and conflict scenario. A total redesign of the current helmet and face protective system is envisioned. Additionally, the developed helmet should interface with existing military communication systems and allow open architecture interface capability with future military communication or signal systems. The system should incorporate a speech communication subsystem facilitating binaural radio communication and maintain or enhance (if possible) the ballistic level of the current Personnel Armor System for Ground Troops (PASGT) helmet without an added weight penalty. The effort will address the expanding demands that are being placed on current military helmet designs to meet Army After Next (AAN) individual soldier protective head gear and interface requirements. Current problem areas such as reduced weight, ballistic, eye and face protection, signature reduction and audio signal processing should all be addressed.

PHASE I: Create an innovative advanced personal protective headgear system incorporating a binaural communication interface. Deliver a working prototype demonstrating key capabilities of; (1) lightweight < 4-5 pounds, (2) prototype face shield, (3) acceptable human-helmet communication interface, (4) Eighty percent (80%) speech intelligibility in high noise (> 85-115 dBA) using the helmet system microphone and transducers, (5) undisrupted localization ability to a complex signal compared to the bare-head condition (6) undisrupted auditory detection performance compared to the bare-head condition (7) connectivity with a single COTS radio, (8) integrated head support suspension system for field evaluation. In addition, the contractor must explore and define head and face protective materials for ballistic and non-ballistic impact protection, hearing protection design, materials solutions to reduce audio attenuation in the helmet, and sight protection against laser, flash, ballistic/non-ballistic and environmental threats. This effort must also account for future proposed interfaces between head sub-system components and other such items of equipment to make interfaces as seamless as possible. It is possible that some of the ballistic material end items, such as the face shield and helmet could be Government Furnished Equipment (GFE) if determined by the Government, based on current Army break through technologies in the area. If GFE is furnished, the contractor will be required to modify the GFE as necessary to meet the stated objectives.

PHASE II: Provide a prototype helmet system design that meets the required threat protection levels and area of coverage defined in Phase I. The ballistic protection level of the system must be validated through the use of U.S. defined standards for ballistic performance. This prototype must integrate all the associated suspension and sub-systems for field evaluation and optimize the innovative helmet design and communication interface. The improved working prototype must demonstrate optimized capabilities of the enhanced human-helmet communication transducer interface, and have ninety-two percent (92%) speech intelligibility in extreme noise (115-140 dBA) and (2) plug & play connectivity with various Military and COTS radios.

PHASE III DUAL USE APPLICATIONS: Head and face protection is of prime importance in a number of sports and law-enforcement situations. Enhancing sensory capabilities in a helmet mounted system has numerous commercial applications in the entertainment and game industry and industrial applications associated with advanced human-computer interfaces. Other commercial applications of this technology are likely in fire fighting, disaster relief, chemical, or any high-stress environment in which users must monitor environmental surroundings to maintain situational awareness.

REFERENCES

1. P.G. Dehmer, C.G. Pergantis, T.J. Mulkern, "The Effects of Natural Weathering on the Laser and Ballistic Properties of the HGU-56/P Aircrew Visors, U.S. Army Research Laboratory, Proceedings, "The Design and Integration of Helmet Systems", 2-5 December 1997, Framingham, MA, sponsored by The National Defense Industrial Association, Event #897.

2. D. Lang, P. Neel, "Ballistically Hardened Light Weight Composites Structures for Integrated Helmet Systems, Allied Signal, Inc, Proceedings, "The Design and Integration of Helmet Systems", 2-5 December 1997, Framingham, MA, sponsored by The National Defense Industrial Association, Event #897.

3. J. Mackiewicz, "Low-Cost Fabric Armor Systems for Fragmentation Vests", U.S. Army Materials Technology Laboratory, Report No. MTL TR 90-29, May 1990.

4. National Institute of Justice standard 0101.00 (Ballistic Performance of Body Armor).

5. J. DeNatale, A. Twarowski, L. Warren, "Advanced Materials and Devices for Laser Eye Protection", Rockwell International Science Center, Report No. NAWCADWAR-94002-60, November 1993

6. A.K.Wong and I.Berman, "Lightweight Ceramic Armor - A review", Army Materials and Mechanics Research Center, M3 71-1, April 1971.

7. C.P.Ballard Jr., "A Transparent Ceramic Armor" Sandia Laboratories Report # SAND77-1736, May 1978

8. C.E.Cottenot, "Transparent Ceramic for Lightweight Armors", Lightweight Armor Systems Symposium, 95 Cranfield, England 28th -30th June 1995

9. R.J.Bratton, "Translucent Sintered MgAl2O4", J.Amer.Cer.Soc., 57, 7, 1974, pp 283-287.

10. US Patents #4,930,731 June 5th 1990.

11. #4,983,555, Jan. 8th 1991.

12. #5,001,093, March 19th 1991.

13. #5,082,739, Jan 21st 1992.

14. # 5,244,849, 14th Sept. 1993

15. R.L.Russell, M.J.Paisley, C.L.Carnegie, M.L.Huckabee, S.L.Willing, T.M.Hare and H.Palmour III. "Optical and Mechanical Properties of Trans[arent Fine-Grained Spinel Ceramics", Proc. SPIE Window and Dome Technologies and Materials 1994.

16. M.Shimada, T.Endo, T.Saito and T.Sato, "Fabrication of Transparent Spinel Polycrystalline Materials". Materials Letters V 28, n4-6, Oct. 1996.

17. Ferguson, L.G. and Letowski, T.R. (1997). Two-Loudspeaker Audio Communication System for Helmet Systems. Proceedings: The Design and Integration of Helmet Systems, Event # 897, Natick, MA.

18. Randall, B.R. and Holland, H.H. (1972). The effect of helmet form on hearing: Free field thresholds. Human Engineering Laboratory, Technical Note 5-72.

19. Vause, N.L. and Grantham, D.W., (1996) Effects of Earplugs and Protective Headgear on Auditory Localization Ability in the Horizontal Plane. J. Acoust. Soc., Am., 99(4), Pt 2, 2981A

20. Vause, N.L. and Grantham, D.W., (1998) Effects of Earplugs and Protective Headgear on Auditory Localization Ability in the Horizontal Plane. Human Factors, submitted.

KEYWORDS: Protective headgear, ballistic protection, face and eye protection, transparent armor, audio displays

A99-013 TITLE: Human Communicative Performance in High Noise Environments

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Design and build a hands-free bone conduction transmitter & receiver transducer incorporating wireless connectivity to existing individual portable military or commercial radio systems for use in high noise (115-140 dbA) environments.

DESCRIPTION: Recent experiments with current technology solutions (Air and skull Bone conduction technologies) show that human task performance is severely degraded when executed within high noise environments that rely upon effective two-way communication. A high priority military and commercial need exists for a light weight, user-mounted, hands-free advanced bone conducted communication transmission and receipt with minimum short-distance sound detectability, and maximum speech intelligibility when operated in high noise environments. Currently available air conduction and skull contact bone conduction technology does not allow hands-free communication in extreme noise (double hearing protection) conditions routinely found in combat or civilian adverse environments. Thus, users must communicate via hand and arm signals or attempt to use radio hand sets which seriously hindering human task performance during combat or civilian rescue operations. The objective system should be designed to be compatible with personal protective headgear, and be user friendly. The "plug and play" interface between the advanced bone conduction transmitter and receiver and various personal radio systems must be wireless and highly reliable to maximize user acceptance when operating in these extreme life threatening environments. Additional technology capabilities would include voice activation, active noise cancellation, digital signal processing, and low detectability of wireless transmissions (i.e., < 50').

PHASE I: Create an innovative advanced bone conduction-based wireless communication interface. Deliver a working prototype demonstrating key capabilities of (1) acceptable human-transducer interface, (2) Eighty percent (80%)

speech intelligibility in high noise (> 85-115 dBA), (3) wireless transducer-to-radio transmission, (4) connectivity with a single COTS radio.

PHASE II: Optimize the innovative bone conduction-based wireless communication interface. Deliver an improved working prototype demonstrating optimized capabilities of (1) enhanced human-transducer interface, (2) ninety-two percent (92%) speech intelligibility in extreme noise (115-140 dBA), (3) energy efficient wireless transducer-to-radio transmission, (4) plug & play connectivity with various Military and COTS radios.

PHASE III DUAL USE APPLICATIONS: Commercial applications of this technology are likely in aviation, entertainment, health-care, sports, fire fighting, law enforcement, and disaster relief, chemical, nuclear and biological operations, or any high-stress high-noise environment.

REFERENCES:

1. Pisoni, David B. 1996., "Word Identification in Noise," Language and Cognitive Processes; v11 n6 p681-87.
2. Van Tasell Dianne J; Yanz, Jerry L., 1987. Speech Recognition Threshold in Noise: Effects of Hearing Loss, Frequency Response, and Speech Materials. Journal of Speech and Hearing Research; v30 n3 p377-86
3. Matschke RG . 1994. Communication and noise. Speech intelligibility of airplane pilots with and without active noise compensation, HNO (GERMANY), Aug, 42(8):499-504
4. Payton KL; Uchanski RM; Braida LD., 1994. Intelligibility of conversational and clear speech in noise and reverberation for listeners with normal and impaired hearing. J Acoust Soc Am (UNITED STATES), Mar, 95(3):1581-92

KEYWORDS: Bone conduction communications, wireless communication, human system interface, noise

A99-014 TITLE: Multi-modal Speech Recognition

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Identify alternative speech input devices which have demonstrated in initial research experiments to contribute to speech recognition accuracy when applied to Hidden Markov Model (HMM) based speech systems such as Entropic's HTK research suite. Develop and implement a fusion algorithm to support multiple input streams into the HMM model. These inputs may be voice data or vector data from alternative input devices such as lip readers or data from other articulators such as vocal folds or the tongue. Develop a methodology for evaluating these devices alone or in multiple combinations to determine the viability of multi-modal suites of these devices. The methodology will evaluate Speech Recognition (SR) accuracy and measure the latency produced by fusing multiple input streams. The fusion algorithm(s) will be evaluated to determine the best fusion method based on the particular suite of input devices being tested. The methodology must have the ability to be implemented on one of the generally accepted speech research tools such as (but not limited to) Entropic.

DESCRIPTION: Commercial speech recognition systems have flooded the market. However, these systems are optimized for conventional airborne acoustic microphone input and are not designed for noisy environments or multi-speaker situations. The military must work in high noise with the potential for multi-speaker situations. The use of physiological sensors, conduction microphones, and other devices offer alternatives to the conventional microphone that may provide significant improvement to SR accuracy when used in harsh environments. The problem with alternative input devices is that the data generated by these devices are significantly different in nature to the input delivered from conventional microphones. The filtering requirements and spectrographic nature of these alternative devices must be accounted for by a highly flexible and adaptive speech recognition system and evaluation methodology. When multiple input devices are used, the data streams must be fused in some manner into the HMM model. We seek innovative solutions to this problem. The fusion may occur as a decision based process prior to accession into the HMM model (thus establishing weights for the model) or the data streams may be combined through a to be designed signal processing algorithm. The system must allow for training the HMM model with alternative data and allow for adaptive filtering and anti-aliasing based on the unique requirements for that particular input device or suite of devices. The end result is a system that may evaluate a wide range of potential devices for SR for use in stand-alone or multi-modal SR systems.

PHASE I: A six to twelve month effort should produce deliverables similar to the following: 1. A market survey of commercial and academic alternative SR input devices (only devices that exist as at least functional prototypes should be considered). 2. The procurement of selected input devices for further evaluation. 3. The design of an SR system capable of accepting multiple inputs (at least two channels) with full DSP capability - while specific hardware selections will be based on performance and cost issues, closely matching the government's configuration should result in cost and schedule savings. 4. The development of an evaluation protocol that measures both SR accuracy and computational latency in quiet and harsh environments. 5. Development of one or more fusion algorithms to support multiple input streams into the HMM-based SR system designed under requirement 3. 6. A prototype paper design of the above system.

PHASE II: A two year effort to complete the following requirements: Year One: Implement a stable and functional SR system as designed during Phase-I and perform evaluations on additional devices identified during the market survey plus additional devices identified and/or furnished by the government. One functional SR system (hardware and software) will be delivered to the Army Research Lab as a requirement of this effort. When fully operational, a series of evaluations will be conducted to determine the best input device and fusion algorithm combination for studies to be conducted in the second year. Year Two: Conduct a proof-of-principle demonstration of the "best-of-breed" input suite and fusion algorithm at one of the TRADOC Battle Labs. This demonstration will require delivery, setup, and integration of the SR system and input devices into the Battle Lab's military information system. The scenario for the demonstration will be jointly designed by the SBIR contractor, ARL, and Battle Lab representatives.

PHASE III DUAL USE APPLICATIONS: The use of noise robust SR technology has wide application in the commercial world. From controlling systems in automobiles or other transportation modes to command of industrial operations in factory environments, the ability to utilize new noise robust input devices flexibly will enhance private industry's ability to reliably use SR as a command and control user interface.

REFERENCES:

1. Guan, C.T., Leung, S.H., and Lau, W.H.: "Multi-model approach for noisy speech recognition", IEEE Electronic Letters, 34(1), January 1998.
2. Chen, Tsuhan (editor): "The Past, Present, and Future of Speech Processing", IEEE Signal Processing Magazine, 15(3), May 1998.
3. Koerner, Michael (editor): Speech Recognition: The Future Now, Upper Saddle River, NJ: Prentice Hall PTR, 1997.
4. Rabiner, Lawrence and Juang, Biing-Hwang: Fundamentals of Speech Recognition, Englewood Cliffs, NJ: Prentice Hall PTR, 1993.
5. Jelinek, Frederick: Statistical Methods for Speech Recognition, Cambridge, MA: The MIT Press, 1997.

KEYWORDS: Speech recognition, data fusion, DSP

A99-015 TITLE: Laser Beam Tracking System for Optical Communication Link Between Cross-country Moving Vehicle

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: The recent rapid development of various tools for fast wavefront control [liquid crystal (LC) phase modulators, micro-electro-mechanical systems (MEMS), solid state modulators] has introduced new opportunities for laser beam tracking and control. The objective of this solicitation is to develop a novel fast laser beam tracking and control system that can provide a stable laser communication link between two moving vehicles over the range of 1-5 KM. Laser communication techniques can provide highly secure ground-to-ground wireless data links with high data rates using small light-weight systems. However, the existing laser communication systems can operate effectively only between stationary platforms. This significantly limits potential applications of laser communication systems for military and civilian applications when both transmitter and receiver are located on moving ground platforms (e.g. moving vehicles) at speeds up to 30 mph. In this case, optical communication requires a new type of laser beam automatic tracking system that can maintain real-time focusing and targeting at the moving receiver. The proposed investigation will contribute to the development of laser communication systems that are robust, lightweight, secure, and operate at high data rates for advanced communications and information distribution technologies.

DESCRIPTION: The laser-beam tracking system developed under this program should provide a reliable wireless data link between two cross-country moving vehicles (driving at speed up to 30 mph) with data rates of up to 200 Mbps for distances from 1 - 5 KM using small light-weight systems. The laser communications system supplements other radio frequency communications links to provide high bandwidth, burst oriented secure communications for high data rate transfer requirements such as high-resolution imagery. The laser communication system should be eye safe in accordance with ANSI organization standards.

PHASE I: Demonstrate feasibility, design and develop a prototype laser-beam tracking system for optical communication data link.

PHASE II: Incorporate the developed laser-beam tracking system with a laser communication system. Demonstrate laser communication laser link between two moving vehicles. Develop and demonstrate commercial and military applications, and leverage market opportunities.

PHASE III DUAL USE APPLICATIONS: The laser-beam tracking system should allow the future integration of fiber and wireless communication systems into a communication network that includes both stationary and moving/flying platforms. This will result in wireless, small size, low power, high-performance intelligent devices suitable for a number of military applications. NON-MILITARY: High-speed free-space communication data transfer between automobiles, helicopters and industrial robots.

REFERENCES
1. "Fiber-free laser communication finds niche in commercial market," Optical and Photonics News, VOL. 8, No. 7 (1997)
2. V. I. Tatarskii, "Wave Propagation in a Turbulent Medium," R. A. Silverman, trans. (McGraw-Hill, New York, 1961)

KEYWORDS: Laser communication, high speed data transfer, wavefront control

A99-016 TITLE: Speech Translation for Mobile Environments

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Identify system architectures for speech recognition and translation that can operate between English and multiple other languages on highly portable (e.g., wearable or hand-held) platforms. These architectures should enable robust continuous speech recognition (CSR) and accurate translation between two talkers who do not speak the same language. Software should provide for easy re-targetting to new domains within a language by users who are not experts in the technology. It should also allow new languages to be efficiently trained by software experts, thus enabling rapid extension to the variety of languages encountered in coalition operations, in conflicts, and in peace keeping operations around the globe.

DESCRIPTION: The Information Science and Technology Directorate is leading the ARL Digitization and Communications Science thrust. One aspect of the digitization effort is development of methods for providing data for warfare (and operations other than war) to the soldier in a manner that can be readily assimilated and used. On today's battlefield of multi-national coalition forces as well as multi-lingual adversaries, rapid translation of natural speech is essential. Moreover, in operations other than war and in low-intensity conflicts, conversation with indigenous peoples who do not speak English is key to success for a range of missions, including those of special operations, intelligence, and military police, as well as support services (e.g., chaplains). However, currently depoyable technology is limited to conversion of fixed spoken phrases and does not support flexible, open dialogue needed for realistic missions. Recent research into speech-to-speech translation, however, shows that support for spontaneous dialogues is feasible in constrained domains (Bub, Wahlter, & Waibel, 1997; Frederking, Rudnicky, & Hogan, 1997).

PHASE I: A six-month effort should produce deliverables similar to the following: analysis of approaches to major technical challenges (e.g., accurate interpretation of utterances despite recognition errors); identification of sample dialogues typical of coalition and adversarial communications; definition of efficient language models for task-specific dialogues; identification of methods that naturally constrain expression to accommodate SR boundaries; identification or development of methods of natural language processing/understanding (NLP) that are robust to speech recognizer errors and that exploit pre-existing systems for text translation; exploration of limits of platform size to support CSR and NLP; and concept demonstration of a speech translator between a selected language and English. Target languages may be French or Spanish; however, languages of particular interest include Arabic and Korean.

PHASE II: A two-year effort might address aspects similar to the following: development of software suites for recognizing and translating between 3 different language pairs, each of which includes English and one of which must includes a critical difficult language (e.g., Arabic or Korean); design of prototype wearable platform with human factored, robust channels for speech input and output; demonstration of authoring interface for extending dialogue domains as well as training new languages; coordination with an ARL testbed to further explore speech translation associated with Army systems; development of approaches to evaluation of speech translation systems (e.g., with regard to utility and quality); and initial interface to Army applications (e.g., selected battlefield visualization system products).

PHASE III DUAL USE APPLICATIONS: This work has enormous potential for improving military C3 and analogous civilian systems. In the civilian sector, beneficiaries could include any industry requiring international communications and conferencing. Specific markets that have employed limited speech conversion software but that call for more flexible and extensible translation software on mobile platforms range from law enforcement, emergency relief, and clinical medicine to tourism.

REFERENCES:
1. Bub, T; Wahlter, W.; & Waibel, A. (1997) Verbmobil: The combination of deep and shallow processing for speech translation. In Proceedings of ICASSP-97.
2. Frederking, R. Rudnicky, A. & Hogan, C. (1997) Interactive speech translation in the DIPLOMAT project. In Proceedings of 35th Meeting of the Association for Computational linguistics (ACL-97).

KEYWORDS: Speech translation on wearable computer

A99-017 TITLE: Monolithic Integrable Optoelectronic Devices With Variation of the Bandgap and Strain

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: 1. Develop a technique that can vary the energy bandgap and the strain in a semiconductor optoelectronic waveguide structure within the same wafer as grown (preferably without epitaxial regrowth). Therefore, low-cost monolithic integrated photonic circuits, including both polarization specific active and passive devices, can be made from this wafer.

DESCRIPTION: Currently various optoelectronic (OE) devices (lasers, amplifiers, modulators, splitters, etc) are made from different materials and are integrated into OE circuits/systems. This results in the high cost of fabrication due to the device coupling/integration, regrowth, and packaging. This high cost may prevent the manufacture of large highly integrated OE/photonic systems that can be used to implement new technologies such as photonic phased array antenna and RF photonic signal processing. A monolithic integration technique is critically needed. For monolithic integration, only semiconductor material can be used to make all the types of devices-- from laser to passive waveguides. However, a photonic integrated system may require different devices (active and passive) that have different energy bandgaps. Therefore, the technical goal for the proposed research is to develop an inexpensive method for monolithic integration in which one can vary the bandgap within the same semiconductor wafer. For example, this can be done by selective epitaxial growth on wafers patterned with SiO2 parallel strip masks with an opening gap. By varying the width of the strip or the gap between the strip, the bandgap of a quantum well (QW) waveguide material grown between the strips can be shifted. This technique also allows one to control the strain of the QW, which can be used to control the polarization properties of the material.1,2 Other methods can also be used. However, any method has to meet the following requirements: (1) be capable of 0 to 100 meV bandgap variation, (2) this bandgap variation as well as a strain variation must be artificially controllable in the designate areas with high-quality uniform local material that can be used to fabricate the waveguide devices, and (3) regrowth should be avoided to generate the active layer of the devices.

PHASE I: Design the epitaxial growth/fabrication technique with a regular optical waveguide p-i-n device structure that can be used for both the laser/amplifier and the modulator. Calibrate the growth for each epilayer in the device structure. Grow the device structure, meet the standard specifications in characterizations, and demonstrate the bandgap shift.

PHASE II: Study the effect of the growth condition change (temperature, pressure, etc) on the selective growth rate or composition (bandgap) change rate, and identify the control parameters for the rate change. Calibrate the bandgap variation rate and strain variation with the control parameters. Grow a monolithic integrated waveguide subsystem including at least three types of device materials such as a 1 x 2 splitter, Mach-Zenhder modulator, and amplifier. The amplifier material bandgap should be near 0.8 eV(or 1.55 micro), the modulator's bandgap should be about 0.85 eV, and the passive waveguide's bandgap should be about 0.9 eV. Prototype materials need to be delivered to ARL.

PHASE III: DUAL USE COMMERCIALIZATION: A low-cost monolithic integration technique in optoelectronic materials is needed for many photonic integrated circuits in military and commercial applications such as communications (fiber telecommunication, WDM, optical control of phased-array antenna, RF photonic link, fiber-radio), sensors, guided missile and missile defense (microwave-photonic radar system, optical gyroscope), and information networks (optical signal processing/computing).

COST REDUCTION: Nearly 90 % of the cost for integrated OE systems comes from the integration (testing of individual devices, device-to-device/fiber coupling/interconnect, packagin, etc). This technology is aimed to eliminate this cost!

KEYWORDS: Optoelectronics, monolithic integration, selective area growth, semiconductor, waveguide device.

REFERENCES:
1. L. Silvestre, A. Ougazzaden, D. Delprat, A. Ramdane, C. Daguet and G. Patriarche, J. of Crystal Growth, 170, 639, (1997). 2. Weimin Zhou, J. Pamulapati, and H. Shen, Proceeding of "The 9th Annual DARPA Symposium on Photonic Systems for Antenna Application" (1999).

A99-018 TITLE: Hyper-spectral Terrain Understanding for an Unmanned Ground Vehicle (UGV)

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To develop terrain understanding technology suitable for implementation on a military UGV. Essential components of terrain understanding include the ability to recognize the presence of and classify terrain elements such as the following from sensors on-board the vehicle, at ranges of 50 meters or more (depending on the nature of the feature). Natural features: trees, bushes, grassy areas, areas of marsh grasses, wooded areas, surface water, mud, rocks, stumps, animals. Man-made features: roads, vehicles, buildings, bridges, people.

DESCRIPTION: Current Army After Next (AAN) doctrine projects the use of unmanned ground vehicles (UGV) for a variety of tactical roles: from scout to weapon carrier to mine detector. These vehicles will be capable of autonomous, tactical navigation across terrain mapped only at low resolution, day or night, and in adverse weather. A key pacing technology enabling such performance is the ability of the UGV to create a real-time understanding of its environment. An iconic representation is required over and above the current geometric understanding utilized for obstacle detection and avoidance. One possible solution is the coupling of hyper-spectral imagery with advanced perception algorithms. The analysis of hyper-spectral imagery from satellites is in common use for terrain understanding, and hyper-spectral techniques have been applied to terrestrial problems such as target acquisition and mine detection. There is no record, however, of hyper-spectral terrain understanding techniques having been applied to imagery from a land vehicle in real time. The hyper-spectral signature of terrain elements, fused with related phenomenology, has potential to enable a UGV to understand its environment sufficient to perform the military behaviors essential to its survival on the AAN battlefield. TASK

Develop comprehensive list of terrain elements that must be correctly identified in order to achieve specified military behaviors. Identify phenomenology enabling essential components of terrain understanding for the UGV application. Identify (or modify existing) sensors suitable for sensing these phenomena, with range, field of view, and physical characteristics consistent with the constraints and operating environment of a small UGV traveling cross- country at 30 mph. Establish an architecture for recognizing the presence of classifiable elements in the operating environment, and for classifying them. Develop algorithms which robustly recognize and classify terrain elements. Develop terrain understanding package consisting of sensors, algorithms, software, and processing hardware, using technologies suitable for integration with a UGV. Demonstrate and validate proposed approach in field tests.

PHASE I: Develop comprehensive list of terrain elements that must be correctly identified in order to achieve specified military behaviors. Identify phenomenology enabling essential components of terrain understanding for the UGV application. Identify a representative subset of the terrain elements for initial proof of feasibility (POF), draft test plan, and submit to sponsor for approval. Identify sensors required for POF test and obtain test data. Develop and demonstrate pilot classifier that will demonstrate the feasibility of the chosen approach.

PHASE II: Identify larger and more significant subset of the terrain elements for phase 2 effort. Establish an architecture for recognizing the presence of classifiable elements in the operating environment, and for classifying them. Develop algorithms that robustly recognize and classify terrain elements. Develop prototype terrain understanding package using technologies suitable for integration with a UGV. Demonstrate proposed approach in field tests.

PHASE III DUAL USE APPLICATIONS: Detection and classification of man- made objects are of potential value to commercial vehicle programs for on-road obstacle detection and avoidance. Current DOT programs focus on detection, but not classification. Detection and classification of natural objects may be of use in Agriculture, Forestry, and Construction. Agriculture in particular is on the verge of fielding unmanned equipment, however automated differentiation between healthy and unhealthy crops "on the fly" could benefit manned agricultural vehicles as well.

REFERENCES:

1. "Hyperspectral Signatures (400 to 2500 nm) of Vegetation, Minerals, Soils, Rocks, and Cultural Features: Laboratory and Field Measurements", by Satterwhite, Melvin B., and Henley, J. P., DTIC report ADA239496, presents a characterization and taxonomy of terrain features of interest.
2. "Overview of the Demo III UGV Program", by Charles M. Shoemaker and Jonathan A. Bornstein, Proceedings of SPIE Unmanned Ground Vehicle Technology I, 13-15 April 1998, presents a view of the operating environment and characteristics of a military UGV.

KEYWORDS: Hyper-spectral, Object Classification, Terrain Classification, Unmanned Ground Vehicle, Robotics

A99-019 TITLE: <u>Oil-free Auxiliary Power Unit and Propulsion System Technology</u>

TECHNOLOGY AREAS: Air Platforms, Ground and Sea Vehicles

OBJECTIVE: Develop innovative oil-free compliant foil bearing and seal systems in a size class suitable for application in auxiliary power unit and gas turbine engine turbomachinery systems used in Army vehicles.

DESCRIPTION: This topic seeks innovative oil-free compliant foil bearing and seal technology suitable for use in the development of oil-free auxiliary power units and gas turbine engines for Army vehicle systems. The proposed research must push oil-free turbomachinery rotor support system technology beyond the current state-of-the-art level into larger sizes and high-temperature environment applications relevant to military vehicle systems. The proposal must address anticipated benefits of the technology (such as efficiency, cost, power density, reliability, maintainability) to the vehicle system through complete elimination of the oil lubrication system. The proposal must identify the critical technology barriers that the proposed research effort must overcome to succeed in applying and commercializing the technology. The proposal must discuss the innovation and risk involved in overcoming the critical technology barriers and present a reasonable basis, approach, and timeline for success. The proposal must include information on potential spin-off military applications and commercial dual use applications.

PHASE I: Through experimental testing and/or analytical modeling the proposer must show feasibility of the proposed methodologies to overcome the identified critical technology barriers. Prepare a Phase II research plan.

PHASE II: Demonstrate (in a laboratory setting) the technology at an appropriate scale relevant to the target military vehicle system application and in a relevant operating environment (speeds, loads, temperatures, pressures).

PHASE III DUAL USE APPLICATIONS: This technology is applicable to virtually all military and commercial aircraft/helicopter gas turbine engines, ground vehicle auxiliary power units, and stationary gas turbine power generators.

KEYWORDS: Foil bearings

A99-020 TITLE: <u>Innovative Processing of Multifunctioning Composite Armor for Ground Vehicles</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop novel methods to process multifunctional polymer matrix composite (PMC) materials to be used in ground vehicle applications requiring multiple performance criteria such as ballistic, blast, electromagnetic and fire protection and providing potential for improvements in cost, weight, damage tolerance, and repairability. Utilize emerging technologies which may include but are not limited to density-graded ceramics, controllable fiber-matrix interphase gradients, dissimilar material adhesion through diffuse interfaces, through-thickness reinforcement, alternative reinforcements, and co-cure-enabling technologies such as co-injection resin transfer molding, electron beam curing, and induction bonding.

DESCRIPTION: The Army has a critical need for new multifunctional material solutions for armored combat systems such as armored personnel carriers, self-propelled howitzers, up-armored wheeled vehicles, and tanks. Revolutionary approaches are required to significantly (up to 50%) reduce the mass of these systems and improve their mobility and transportability without sacrificing survivability or maintainability. Current concepts have been developed that begin to meet the multifunctional and reduced weight requirements necessary for the next generation of combat ground vehicles, but these concepts must be improved to realize the full benefit of lightweight multifunctional materials. Recent advances in composite materials science and the development of new processing techniques have not been fully exploited in the production of multifunctional composites for these applications. Furthermore, tailored and/or graded interphases between dissimilar materials have been shown to influence the performance of composite armor, but this approach has not yet been optimized. Hence, there exists a need to devise methods and materials that apply recent technological innovations and scientific understanding to achieve real weight reductions and increased protection from multiple threats. Complex material interactions between PMCs and other materials in multifunctional materials can be tailored to provide an optimized balance of functionality for combined structural, ballistic, electromagnetic, fire, cost, weight, and supportability requirements.

PHASE I: Identify the most promising multifunctional material and materials processing technology for ground-based vehicle applications. Demonstrate feasibility of processing technology by fabricating and evaluating flat test panels of the composite material. Achieving significant improvements in critical parameters such as ratio of areal density-to-level of ballistic protection, fire-protection levels, cost-saving potential, shock wave transmission/reflection mitigation, energy absorption levels, improved damage tolerance (higher ratio of average through-thickness delamination to square of max delamination) will be a factor in determining the success of Phase I. The new technology should represent significant progress toward revolutionary improvements in vehicular armor such as ballistic protection, fire protection, signature reduction, manufacturing costs, and/or damage tolerance.

PHASE II: Design an armor material system incorporating the new material and/or processing technology identified in Phase I. Fabricate full-scale samples of this concept armor for ballistic, fire, damage tolerance and/or EM testing and apply appropriate cost models to demonstrate significant improvements in operational savings and cost reduction using the new material and/or process. Prepare prototype armor materials for field testing in conjunction with TACOM and the Army Research Laboratory. Phase II should also demonstrate the benefits of the material and/or process for large-scale commercial applications and provide a technical data package.

PHASE III DUAL USE APPLICATIONS: There are expected to be a large number of near-term and future Defense and commercial applications of multifunctional composite materials. In addition to a wide range of ground combat vehicles, defense applications include amphibious assault vehicles, aircraft and shelters. Law enforcement and armored security vehicles, fire fighting vehicles, anti-terrorist infrastructure, blast-resistant cargo containers, and damage resistant ship hulls are all potential beneficiaries of the improved multifunctional materials.

REFERENCES:
1. Pike, T., et. al., Proc. 28th SAMPE Technical Conference, Seattle, WA, (1997).
2. Mahfuz, H., et. al., Proc. 11th International Conference on Composite Materials, July (1997).
3. Nayfeh, A.H., "Wave Propagation in Layered Anisotropic Media with Applications to Composites," Elsevier, 1995.

4. Sorathia, U and D. Beck, Proc. 48th International SAMPE Symposium and Exposition, March (1996).
5. Gillio, E.F. "Co-injection Resin Transfer Molding of Hybrid Composites," Master's Thesis, Univ. of Delaware, 1997.
6. Olevsky, F, Metall and Mater. Trans., 27A (1996).
7. Composites Part A. , Special Issue on the Interphase, Volume 28A, No. 1 1997

KEYWORDS: armor, composite materials, ballistic protection, fire-resistant, signature reduction, polymers, ceramics, materials processing and manufacturing technology

U.S Army Research Office (ARO)

A99-021 TITLE: Production of High Energy-absorbing Metallic Foam Structural Components

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To determine the potential of metallic foams to enhance the energy absorbing characteristics of lightweight structural components subjected to dynamic loading and to develop design guidelines and procedures for optimizing their performance.

DESCRIPTION: Structural metallic foams have high specific stiffness and provide excellent energy absorption characteristics at significantly higher strength levels than polymer foams. In addition, they can be used over wider ranges of temperature, are non flamable and can be further processed using numerous secondary operations. Encapsulation of metallic foams in hollow shapes eg. tubes, channels, etc., should lead to the production of structural components that retain their light weight but have improved specific stiffness and greatly enhanced energy absorbing characteristics under conditions where the rate of loading is very high (dynamic). What is required is: (1) the development of the understanding of the synthesis and processing technology involved in the fabrication of foam filled structures; (2) the development of the understanding of the influence of foam morphology on the dynamic mechanical properties of the structures; and, (3) development of the methodology for optimizing the properties that give structures with superior energy absorption characteristics.

PHASE I: Demonstrate the proof of concept for the fabrication of a representative component and optimization of its dynamic mechanical properties to give superior energy absorption in sufficient detail to evaluate the potential for the production of a complex component for a DOD or commercial application. Critical processing steps should be identified and preliminary materials characterization and testing of the component should be performed. A preliminary cost/economic analysis should be performed and a partner identified for commercial scale-up and application.

PHASE II: The structural members envisioned could be integrated into aircraft, rotorcraft, road/rail vehicles and other transportation systems to improve crash worthiness. They could also be an integral part of an armor system to defeat blast or projectile threats. Focus on the fabrication of a full scale component which can be tested in either a current or advanced system. Conduct additional materials characterization and dynamic testing as required. Document expected weight savings, cost savings and/or new capabilities.

PHASE III DUAL USE APPLICATIONS: On Defense-- Lightens the force for enhanced mobility, maneuverability and deployability (airliftable) through decreased overall structural weight. On Commercial-- Provide lighter weight more fuel efficient transportation systems. Overall, provide improved survivability in those senarios where personnel are subjected to the effects of dynamic loading(crash/blast/projectile threats).

REFERENCES:
1. M.F. Ashby, The Mechanical Properties of Cellular Solids", Met. Trans. Vol. A14 (1983), pp 1755
2. L.J. Gibson and M.F. Ashby, "Cellular Solids: Structure and Properties", Cambridge University Press, NY (1997).
3. C.-J. Yu, "Overview: Properties of Metallic Foams", Metal Foams Symposium (ASM), Newark DE

KEYWORDS: Metallic foams, fabrication, dynamic loading, energy absorption, light weight structures

A99-022 TITLE: Tunable Materials for Integrated Adaptive Electronics

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment, Materials/Processes

OBJECTIVE: Develop field-tunable, low-loss thin-film ferroelectric materials for integrated adaptive electronics.

DESCRIPTION: Frequency agility and directional broadcasting are important attributes that the military would like to incorporate into future generations of wireless communications and radar tracking systems. This topic seeks to investigate and develop new, low-loss, thin-film ferroelectric materials with tunable field-dependent properties, e.g. electrical permitivity or magnetic permeability, which will operate above 10 GHz and be appropriate for integration into future generations of adaptive, frequency-agile RF electronics. Specific capabilities being sought include frequency tunable filters and oscillators, and phase shifting elements for directional phased-array antennas. Innovative materials and processing concepts that provide significant performance and cost advantages over current state-of-the-art materials are being sought. The ideal materials should provide tunability over an octave of frequency range (10-20 GHz), afford at least 2-pi of tunable phase range, require relatively low fields for tuning, and have loss tangents below 0.001. Proposals should emphasize the development of new material systems and possibly also propose novel integrated device structures that exploit the specific attributes of the material under development. Possible approaches might include: 1) ferroelectric films with high field-dependent electric permitivities, 2) composite ferroelectric-ferrite films with tunable electric permitivity and magnetic permeability, 3) new material concepts which afford high electrical tunability, and 4) novel device schemes that circumvent critical shortcomings of existing materials.

PHASE I: Investigate and demonstrate the feasibility of an innovative approach to the development of a tunable thin-film materials that will significantly improve communications and radar system performance, and reduce costs in relation to present state-of-the-art materials and approaches. A detailed study of the proposed material / device characteristics should be completed as part of this task.

PHASE II: Implement the innovation, which should include the design and testing of a prototype system. Explore major cost and reliability issues associated with the innovation in the context of commercial viability.

PHASE III DUAL USE APPLICATIONS: Frequency agility and directional broadcasting (via conformal antennas) are important attributes that the military would like to incorporate into its next generation of low-power, broad-band wireless communications and radar tracking systems. This research is in direct support of the Army initiative to digitize the battlefield and develop smart weaponry. At the same time, dual use opportunities exist, since these same materials can be adapted for commercial wireless communications and obstacle avoidance systems. The program is intended to introduce breakthrough technologies (new capabilities, enhanced performance, and reduced system size and weight) that significantly enhance future system performance and reduce costs.

KEY WORDS: Frequency-agile RF electronics, wireless communications, adaptive electronics, phased-array antennas, low-loss tunable materials, frequency tunable filters and oscillators, phase shifters, ferroelectrics, and ferrites

A99-023 TITLE: Full Field Spray Diagnostics

TECHNOLOGY AREAS: Air Platforms, Ground and Sea Vehicles

OBJECTIVE: Develop a particle sizing technique capable of instantaneously sizing all droplets in a liquid spray.

DESCRIPTION: Liquid sprays are encountered in a number of systems of Army interest. The principal focus here is on fuel sprays in diesel and gas turbine engines. Currently there is no accurate technique for the rapid determination of the particle size distribution in such sprays. Full-field techniques, the "Malvern-type" systems, measure moments of the spray, typically the Sauter-mean diameter. The most widely used, and accurate, system for droplet measurement is the phase-doppler particle size analyzer (PDPA). However, it is only able to probe a small region of the liquid spray at any given instant. What is needed is a technique with the accuracy of the PDPA and the capability to interrogate instantaneously the entire spray. That technique should be capable of determining the droplet size statistics without any a-priori assumption about the shape of the particle size distribution. Consideration should be given to performance in both optically thin and optically dense regions of sprays.

PHASE I: Analytically determine the performance of the proposed system for ranges of spray parameters typically encountered in diesel and gas turbine sprays. Analytically determine the accuracy of the technique and potential sources of error. Conduct experiments to verify the performance of the basic concept using controlled droplet sources. Design a brass-board system, controller and associated data reduction software.

PHASE II: Construct a brass-board system, controller, and software and demonstrate its performance using well-characterized droplet streams, diesel and gas turbine fuel injector sprays, with liquids including JP-8. Determine the accuracy of the system and develop data reduction software to provide both droplet statistics (size distribution, surface and volume weighted means) and probable errors.

PHASE III DUAL USE APPLICATIONs: Defense-Enables development of higher performance, lower fuel consumption engines. Commercial-It is anticipated that the resulting measurement system may find wide applicability in commercial engine development programs. It should also be applicable to other areas where fast, accurate measurement of spray properties is desired.

KEY WORDS: Sprays, diagnostics, diesel and gas turbine engines

A99-024 TITLE: Novel Short Wavelength Light Source System for Portable Sensor Application

TECHNOLOGY AREAS: Chemical/Biological Defense and Nuclear

OBJECTIVE: Development of a short wavelength (400 - 200 nm) light source system for portable sensor applications such as Chemical/Biological detection of warfare agents and/or environmental pollutants by photon-interaction techniques.

DESCRIPTION: Present-day methods of chemical/biological warfare agent detection often rely upon some type of photon-molecule interaction method such as fluorescence. This interaction is most sensitive if there is a single-photon source that is available for warfare agent detection. However, almost all applications of photon-molecule sensor processes in this wavelength range have used resonant multi-photon interactions (either fluorescence or ionization) requiring large lab-based photon sources that are not portable. Due to recent advances in solid state technology it is now possible to create several new types of short wavelength lasers or other light sources that should be much more portable and reliable than current commercial sources in this wavelength range. Examples include (I) solid state Gallium-Aluminum Nitride based heterostructure quantum-well lasers or light emitting diode arrays; (ii) small scale diode pumped Ti-sapphire laser sources that are frequency doubled or tripled by new efficient intra-cavity crystal devices; or (iii) conventional compact arc source powered by high efficiency portable power supply. The total portable system should include light source, UV optics and detection schemes for chemical/biological agent detection and identification.

PHASE I: Demonstrate the operation of a short wavelength (200 - 400 nm) light source agent detection system with an average optical power level of 1-2 milliwatts including UV optics and detection schemes for lab-based simulants of chemical/biological agent detection and identification.

PHASE II: Optimize the performance (e. g. 10-20 mW power level) of the short wavelength agent detection system by increasing both the detection efficiency and portability to achieve field-based military applications for chemical/biological sensors and/or humanitarian mine detection.

PHASE III DUAL USE COMMERCIALIZATION: Much of the commercial market place for this detection system will be driven by environmental chemical agent detection systems that are based on the same physical principles as chemical/biological warfare agent detection. In addition, advanced optical storage applications requiring shorter wavelengths may utilize affordable laser technologies based on the sensor technology described above. Thus low cost new laser sources for sensor applications are a realistic outgrowth of this sensor project. Such portable sensor systems should prove useful in environmental monitoring applications and in the food industry for advanced gas sensor detection of defects in fruits and vegetables. Several large industrial labs have already expressed strong interest in these types of commercial applications.

REFERENCES:

1. S. Nakamura, InGaN Light-Emitting Diodes with Quantum-Well Structures in "Gallium Nitride and Related Materials," ed. F. A. Ponce, R. D. Dupuis, S. Nakamura, and J. A. Edmond (Pittsburgh, Materials Research Society, 1996) pp. 879-888.
2. F. A. Ponce and D. P. Bour, Nitride-based semiconductors for blue and green light-emitting devices, Nature 386, 351-359 (1997).

KEY WORDS: Short-wavelength light source, chemical sensor, biological sensor, photon-molecule interactions.

A99-025 TITLE: Application of Recent Algorithm Research to ATRs in Cluttered Environments

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Develop a computer program that will apply recent research on algorithms to recognize the presence or absence of an object in a scene where the object might be partially occluded and may be presented in various poses, where the light shining on the object may be of varying intensity and the image of the scene may be distorted by clutter (noise) introduced either by the sensors producing the image of the scene or by noise present in the scene itself. Although real time processing of an image as it is detected by sensors is desirable and is a long-term goal, the objective here is to process the image after it has been captured and stored in the computer.

DESCRIPTION: Machine vision has long captured the imagination of computer scientists, science fiction writers as well as engineers working on real-world problems. It has, however, continued to be an elusive goal. While optical character recognition programs have been developed that achieve better than 95% accuracy at the word level and machine vision systems are routinely used to inspect products during manufacturing or to enable missiles to lock onto their targets, these systems either operate in tightly constrained situations or offer performance that would be unacceptable if it were not for cost, space or other environmental conditions. Past and current systems fail not only because we lack the hardware that can replicate the human eye and brain, but also because we do not fully understand how a human processes images and we do not have alternative algorithms to use with the available hardware. In this topic, we seek the development of new ATR algorithms. The needs of some applications can be met with brute force approaches that compare an unknown object's image to that of an image stored in a database and then compute an error function. However, to come close to the performance of humans, there appears to be a consensus that the process involves finding the unknown object's edges or contours followed by additional processing. The contour estimation process is likely to involve "perceptual organization," which requires aggregation of contour primitives using a universal (object-independent) visual grammar. Similar to English grammar, which provides rules to aggregate characters into increasingly complex structures, the visual grammar specifies rules to aggregate contour fragments into a hierarchy of increasingly complex contour representations. These rules, which favor aggregations with certain global properties, such as co-linearity, closure, and symmetry are based on the statistical observation that these global properties are more likely to occur if the contour fragments in the aggregate belong to the same object and are used to compute hypotheses and a probability estimate for each hypothesis. To control computational complexity, those hypotheses with low probability are then pruned. Clearly, object dependent rules need to be added to this universal visual grammar in order to create a specific recognition system. The richness and variability of objects in visual scenes are captured by appropriate deformations of object models in an object database. As in language, if subsequent processing affects earlier probability estimates, then the algorithm should return to the earlier step.

PHASE I: Develop a computer program that finds edges in a scene and uses this information to demonstrate the use of a new ATR algorithm to recognize an object such as a tank from aerial photographs (the object database contains only one element) where the target may be partially occluded and the photograph may contain clutter. The technique should be demonstrated at both visible and infrared wavelengths.

PHASE II: Develop a new ATR algorithm (MS Windows or UNIX environment with GUI wraparound) that recognizes whether any of several objects are present/absent in a scene (the object database contains several elements) where the object may be partially occluded and present in various poses, the lighting on the object may be of varying intensity, and the entire image may be distorted by clutter. Demonstrate the algorithm on a testbed application of your choice.

PHASE III DUAL-USE APPLICATIONS: ATR, optical character recognition, product inspection, analyzing satellite data for mineral exploration, automation of hazardous processes such as those encountered in mining, automation of medical tests such as reading X-rays, sonograms or other images.

KEY WORDS: Image processing, machine vision, software algorithms.

A99-026 TITLE: Digital Image Management Capability: Integrated Computer Interfaces for Image-guided Systems

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To develop a software-based digital image management capability, using new image processing algorithms that are based on curvature driven flows for non-invasive diagnostic methods in medical imaging and for efficient processing of military imagery for ATR.

DESCRIPTION: Digital image management is based upon the processing, development, interpretation, archiving, transmission and content-based retrieval and screening of very large volumes of image data without the use of film. In the imaging field, newer imaging modalities use a digital format and can be transmitted electronically throughout a building and/or externally to remote facilities. In 1990, a standard interface protocol was established to enable the integration of multi-brand systems, creating the opportunity for extensive interactive networks. Innovative image processing software is a crucial element in providing superior capabilities for performing primary functions in the acquisition, visualization and analysis and presentation of images. A key rate-limiting step in the fast acquisition, interpretation and diagnosis of images is the image processing software, which typically does not make use of the full potential of the speed achieved by existing hardware. In medicine, imaging systems are used as non-invasive methods for diagnosing diseases and injuries. Two key factors contribute to the emerging importance of the digital image management market: (1) the digitalization of all medical imaging modalities has caused exponential growth in the number of images generated by the radiology sector and has created an urgency to solve the problems of image storage space and (2) due to insurance restrictions, a need is emerging for disseminating image information from the patient source to remotely located consulting professionals, without the necessity of an office visit. Hence, the establishment of Picture Archiving and Communications Systems (PACS) and teleradiology facilities are the fastest growing segments of the medical imaging market. In the military, image processing is of great importance with various applications including enhancement of compressed images for multimedia environments, terrain related imagery, semi-autonomous navigation, fire control, C3I, and denoising and segmentation of SAR, ISAR and IR images in ATR. Such efforts will lead to enhanced man-machine interfaces for interactions with computers and more complicated systems such as remote-controlled weapons and vehicles. In addition, this project is important because of the worldwide deployment of American troops and the necessity to have fast, first rate expertise for the variety of diagnostic tools available to the troops wherever they are stationed.

PHASE I: Develop efficient image processing software code for the digital implementation of curvature based flow methods for image enhancement, compression, and segmentation to demonstrate feasibility of the techniques on SAR, ISAR, and IR images in ATR, and MR, CT, and ultrasound in medical imagery.

PHASE II: Develop a prototype digital image management software package (MS Windows or UNIX environment with GUI wraparound) that concentrates on integration issues. The software tool will process, develop, interpret, archive, transmit and perform content-based retrieval and screening of high volumes of image data. Demonstrate the software on a testbed application of your choice.

PHASE III DUAL USE COMMERCIALIZATION: ATR, HMOs, hospitals, remote medical clinics, health care delivery systems, OEMs in the health care industry.

KEY WORDS: Digital Image Processing, Computer Vision, Control, Man-machine interfaces.

A99-027 TITLE: Engineering Design Software for Military Incinerators

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Software for Incinerator Design using Engineering Process Models

DESCRIPTION: Nerve and mustard agents and many other toxic military materials contain phosphorus, sulfur, and halogens. Until recently, little was known about the combustion chemistry of these materials. Incineration has been shown to transform organic materials into oxides with very high effectiveness; but lack of understanding of the combustion process has forced the over-engineering of units resulting in substantially increased expense. The lack of rational foundation in the design process has also contributed to Army incinerators being under nearly constant legal challenge. This project will produce the first tools for rational engineering design of optimized, economical incinerators for military materials. Using best available data as inputs, the engineering design software will give optimum operating conditions, destruction efficiency as a function of throughput, reactor configuration, product species and concentrations, capital and operating costs, and energy needs. The software will provide information about potential onset of reactor upsets and enable diagnosis of failures. The software must include modules for pyrolysis and gas phase combustion and must include detailed chemical kinetics based on best available reaction mechanisms.

PHASE I: Develop software including all required modules as proof-of-concept

PHASE II: Develop simulator and test against appropriate data set from pilot or full scale plant tests (in literature or new measurements as required). Package simulator must be "user-friendly" for potential DOD and civilian customers.

PHASE III DUAL USE COMMERCIALIZATION: : A wide range of toxic compounds targeted by this program and used by civilians are many pesticides, herbicides, and PCBs. This project will enable rational, optimized design of incinerators for these hazardous materials used in the civilian sector.

KEY WORDS: incineration, combustion, toxic, oxidation, engineering design

A99-028 TITLE: Sensor System for In-situ 3D Soil Stress Analysis

TECHNOLOGY AREAS: Materials/Processes, Ground and Sea Vehicles

OBJECTIVE: To develop a soil stress sensor system for the in-situ measurement of the stress state in three dimensions for application to vehicle-terrain interaction modeling and simulation.

DESCRIPTION: Understanding of vehicle traction element interaction with soil, which is a critical Army need, can be advanced through measuring devices which characterize the in-situ soil stress state. Accurate data of this kind is important both for the definition of constitutive relationships and for physical model development and validation that (a) will lead to an enhancement of the current generation of mobility models, (b) will permit the introduction of dynamic terrain into the synthetic environments used in interactive distributed modeling and simulation, and (c) be utilized in the design and prototype testing of new vehicle systems. The requirement is for a stress sensor system for the in-situ measurement of stresses in three dimensions, with special emphasis on the measurement of lateral forces that develop during steering or turning of a wheel or track. Issues related to coupling of the soil must be addressed. The system should be field portable and designed so that in-situ emplacement can be accomplished with minimal disturbance to the soil. Deployment at various depths, down to a maximum of one meter, is required. Data collection and storage capabilities for multiple data sets also are required, and instrumentation should interface with personal computers. Calibration, noise reliability, and repeatability related to measurements are issues to be addressed in the development, test, and evaluation of the system with the goal being accurate measurements.

PHASE I. The Phase I work will develop, demonstrate, and deliver to the Army an in-situ soil stress monitoring system. The system will have the capability for accurately measuring in-situ stresses in three dimensions within a soil during an application of a vehicle load. Soil coupling will be investigated. Methods for emplacement of the sensor system to minimize soil disturbance will be explored.

PHASE II. This phase will consist of conducting field tests to validate the in-situ stress measurement system. This testing will evaluate the accuracy, reliability, and repeatability of measurements and the performance of the system for vehicle traffic over sensors arrayed in various configurations in different types of soils, the specifics of which will be defined through consultation with USAE Waterways Experiment Station Geotechnical Laboratory.

PHASE III DUAL USE APPLICATIONS: Design and development of an in-situ soil stress sensor system will benefit the manufacturers of off-road vehicles and heavy construction, agricultural, forestry, and mining vehicles.

KEYWORDS: In-situ Soil Stress Measurement

A99-029 TITLE: 4D Remote Measurement of Tracer Concentrations for Atmospheric Dispersion Studies

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To provide a fieldable, low maintenance system to measure the four dimensional field of mass concentration of gases commonly used in atmospheric dispersion field tests at high space and time resolution in the atmospheric boundary layer.

DESCRIPTION: The Army has a critical interest in the atmospheric dispersion of aerosols and gases (chemical and biological agents) affecting soldiers and civilians. It relies on computer models of the dispersion process to estimate local concentrations and their effects on time scales from seconds to days. Griffiths and Megson (1984) note that the lethal dose of some agents is a result of a few instances of very high concentration on the order of seconds rather than longer term (hourly or daily) mean concentration. Current models have large error bars which lead to fatally faulty analyses and predictions of battlefield hazards. Recent recommendations (ARL, 1998) call for (1) new intensive field studies of fluctuating tracer concentrations in evolving plumes as a beginning step in development of better models, and (2) for high resolution measurements of tracer concentrations in space and time using advanced remote sensing techniques. To accomplish that research, instrumentation is needed that has the capability to measure dilute concentrations of tracer material as a function of position and time away from a known source at spatial resolutions of 50 meters or less and on the order of seconds or less within the atmospheric boundary layer The system must operate in day or night, with minimal supervision and be transportable to realistic test conditions. As an example, a proposed system might use differential absorption lidar (DIAL) technology for the detection. Proposals to use other innovative, viable, potential technologies are strongly encouraged

PHASE I: Prepare a proof-of-concept study demonstrating the ability of the proposed approach to measure concentration resulting from a known, single, controlled source of propylene and, secondarily, sulfur hexaflouride, as a function of space and time. (Other potential tracers will be considered with significant justification as meeting current in situ tracer measuring capability.) Figures of merit should include the minimum resolved volume and minimum detectable concentration within that volume at ranges of 100, 500, and 1000 meters from the source; the time required to make those measurements; and the time required to measure the spatial distribution of concentration within a volume from the source to 3000 m downwind by 1000 meters across wind and 300 meters altitude. Such determinations can be expected to depend upon operating capabilities of components of the instrumentation, signal processing, the range of realistic values and assumptions, and the physical principles involved. Assessments of the principal trade-offs in system design should be provided. A reference concentration plume will be provided the selected candidates. Instrumentation design should also consider size, power requirements, and dependability of the system.

PHASE II: A prototype instrument system to make the measurements per the design will be constructed utilizing off-the-shelf equipment insofar as feasible, an approved test plan developed, and field tests conducted in conjunction with Army dispersion experiments.

PHASE III DUAL USE AND COMMERCIALIZATION: The technology developed within this effort is readily adaptable to measure other trace gases within the air. These gases may come from natural or anthropogenic sources. Quantitative measurements of these gases will be possible at the ground level and aloft at time and space scales unattainable using in situ monitors for these gases. Furthermore, the systems are also adaptable to measure the wind components that move the gases. The technology is directly applicable to for stand-off detection of certain toxic or benign trace gases on the battlefield. This capability will invaluably enhance soldier and civilian protection capability in chemical attack. The technology should also be compact, relatively lightweight, and man-transportable, permitting numerous sampling strategies and deployments. This should also permit installation of the systems on airborne vehicles for maximum utilization.

REFERENCES: Griffiths, R.F. and L.C. Megson, 1984, Atmos. Envir. 18, 1195-1206 Army Research Laboratory: Proceedings of the Army After Next Tactical Decision Aids Technical Symposium, El Paso, TX, April 14-16, 1998.

KEY WORDS: Chemical/Biological defense, Atmospheric dispersion models, Concentration fluctuations, Remote sensing of tracer material

U.S Army Aviation Research, Development, and Engineering Center (AVRDEC)

A99-030 TITLE: Innovative Methods for Evaluating and Characterizing Combat Performance using Data from Full Mission Simulation

TECHNOLOGY AREAS: Human Systems, Information Systems Technology

OBJECTIVE: Develop methods and standards for conducting full mission simulation test and evaluation that will provide clear answers to research and development questions, and maximize the risk-reduction benefits of large advanced system simulation.

DESCRIPTION: Classically, simulation studies of soldier performance in combat have gathered and reported traditional data: kills, losses, mission timelines, etc. Seldom have future system benefits been easily and clearly quantified in manned virtual Full Mission Simulation (FMS). Obviously, FMS is a worthwhile cost and risk reduction activity prior to live evaluations of future technology, however success to date in obtaining valid objective data from simulation has been rare. Useful, meaningful human performance data collected during FMS is a valuable source of design feedback, and can often be a reliable indicator of real-world system performance. Phase 1 of this SBIR would explore available FMS literature/reports/data to examine what test designs, metrics, and analysis approaches have been used with what degrees of success in previous simulation studies. Existing data would be examined to identify relationships among gathered data that support pre-existing hypotheses about human performance in simulation. Phase II would apply the methods developed during Phase I to an actual full mission test and evaluation effort.

PHASE I: Analyze existing FMS methodologies and identify the contributing factors to failures of FMS to produce reliable, significant quantitative data and identify contributing factors to successes in gathering reliable data to support FMS tests of future system effectiveness. Develop and evaluate methods to create metrics that report performance as a function of single factors such as sensor performance and as a function of complex combinations of factors such as line of sight by threat system type over time for different soldier experience levels. Develop candidate T&E methodology guidelines for FMS research to enable future simulations to glean the maximum test and evaluation benefit.

PHASE II: Validate the guidelines and metrics methodology developed during the Phase I effort by applying them to a full mission simulation of a human-machine system in complex combat environment as in a Battle Lab Warfighting experiment. Collect data during simulation, and reduce and analyze it using innovative analytical techniques proposed during Phase I. Propose modifications to the approach based on lessons learned during and after the simulation. Design a system architecture and set of software tools that have applicability across many different FMS environments. Publish a guideline handbook documenting validated methodologies.

PHASE III DUAL USE APPLICATIONS: Tools and techniques that can obtimize the use of large-scale system simulation involving humans and advanced technology future systems can applied across a wide range of human-computer system interface environments, including energy control systems, air traffic control, and computer aided design technologies.

REFERENCES: Triggs, T.J. (1996). Some critical human factors issues and challenges in simulation and testing. Proceedings of the First International SimTecT Conference, 25-26 March 1996, Melbourne, Australia. ISBN: 0 646 27402 3

KEYWORDS: full mission simulation, test and evaluation, human performance in combat simulation.

A99-031 TITLE: Predictive and Real-time Visual Assessment System and Tools

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Fabricate and demonstrate predictive and real time Visual Assessment System and Tools (VAST) designed to characterize visual cueing levels for flight and ground crews operating in aided (synthetic) and unaided visual environments.

DESCRIPTION: As the use of Image Intensifiers (I2), Forward Looking Infra Red (FLIR), millimeter-wave radar, low light video and other artificial/synthetic images presented on visual displays are developed for use by crew members in adverse visual environments, the prediction of suitable pilot/operating cueing levels for crew operations has not kept pace. Only predictive technology for the normal human visual spectrum has been provided by weather services, which forecast visibility. In addition real time assessment of the synthetic visual environment are not reliable. Recent advances in sensors, video, meteorology services, display technology, understanding of the human visual system and intelligent systems are now making it possible to provide predictive algorithmic for visual cueing. Gains are being rapidly made in algorithmic advances in pattern analysis, the ability to detect and analyze visual texture, and other cueing technologies essential for the human visual system to efficiently operate within his visual envelope. The VAST would utilize existing technologies to forecast visual cue conditions for crewmembers operating in synthetic visual environments using FLIR, I2, millimeter-wave radar and sensor fusion. In addition the VAST would be able to provide a characterization of the real time visual environment (aided and unaided) to crewmembers. The characterization of the real time visual environment using VAST would also result in a real time methodology for intelligent display control of clutter and for real-time objective determinations of visual cueing conditions for helicopter handling qualities research.

PHASE I: Develop overall system design to include specification of predictive and real-time visual characterization technology. Plans should include possible integration of the real time VAST into a demonstration vehicle and a test plan for the phase II effort.

PHASE II: Develop and demonstrate a prototype VAST in a realistic environment. Conduct testing to prove feasibility over extended operating conditions and several visual environments.

PHASE III: DUAL USE APPLICATIONS: This system can be used by the Federal aviation administration, and numerous other transportation agencies to both predict and measure visual operating conditions.

REFERENCES:

1. Aeronautical Design Standard: Handling Qualities Requirements for Military Rotorcraft, ADS-33D-PRF, May 1996
2. S. W. Baillie and R. H. Hoh, "The Effect of Reduced Useable Cue Environments on Helicopter Handling Qualities," Canadian Aeronautics and Space Journal: 34, 1988, 144-150
3. RH. Hoh, Investigation of Outside Visual Cues Required for Hover, AIM Paper 85-1808, August 1985
4. D. C. Hart, ADS-33C Flight Test Maneuvers Validation In A Degraded Visual Environment," presented at 50th Annual AHS Forum, May 1994
5. A. G. Ledebuhr et at, "WFOV Star Tracker Camera," Sensors and Sensor Systems for Guidance and Navigation, Proceedings SPIE, 1478, April 1991, pp.2-12
6. M. R. Franklin, "Application of an Autonomous Landing Guidance System for Civil and Military Aircraft:" Synthetic Vision for Vehicle Guidance and Control. Proceedings SPIE, 2463, April 1995, pp. 146-153
7. P. K. A. Menon, G. B. Chatterji, and B. Sridhar, "A Fast Algorithm for Image-Based Ranging," Sensors and Sensor Systems for Guidance and Navigation. Proceedings SPIE, 1478, April 1991, pp.190-200
8. R. E. Zelenka, P. N. Smith, A. A. Coppenbarger, C. E. Njaka, and B. Sridhar, "Results from the NASA Automated Nap-of-the-Earth Program, "Journal of the American Helicopter Society: 47,1997,107-115
9. R. L. Newman, Scheme for Automatic Declutter for Helmet-Mounted Displays and Head-Up Displays, Crew Systems TM-96-03 submitted to Aeroflightdynamics Directorate, Moffett Field, February 1996
10. M. J. Wells and M. Haas, "The Human Factors of Helmet-Mounted Displays and Sights," in Electro-Optical Displays, M. A. Karim (ed.), New York: Dekker, 1992, pp.743-785
11. D. F. Kocian and H. L. Task, "Visually Coupled Systems Hardware and the Human Interface," in Virtual Environments and Advanced Interface Design, W. Barfield and T. A. Furness (eds.), New York: Oxford University Press, 1995, pp.175-25.
12. E. T. Davis, "Visual Requirements in HMDs: What We Can See and What Do We Need to See," in Head-Mounted Displays: Designing for the User, J. E. Melzer and K. Moffill (eds.), New York: McGraw-Hill, 1997, pp.207-251
13. C. E. Rash, B. T. Mozo, BC J. McEntire, J. L. Haley, J. R. Licina, and L. W. Richardson, Assessment Methodology for Integrated Helmet and Display Systems in Rotary-wing Aircraft , USAARL 96-16 June 1996
14. R. L. Newman, Head-Mounted Display Design Guide, Army Report TR-(pending), November 1997; Crew Systems TR-97-11
15. R. L. Newman, Helmet-Mounted Display flight Symbology Requirements for Military Rotorcraft, Crew Systems TR-98-1 2, May 1998

KEYWORDS: sensors, cueing, vision, visual environments, FLIR, I2, millimeter wave radar, senor fusion

A99-032 TITLE: Engineering and Information System Environment for Simulation-based Design and Acquisition

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Design of a Simulation Based Acquisition (SBA) Collaborative Environment (CE) for engineering level modeling and simulation to support materiel development and evaluation in a Force XXI mission context. Identify the core components (key models and simulations) of the CE and specify the Engineering and Information System (EIS) environment (key data representations) necessary to support Simulation Based Design (SBD) and SBA of complex Army systems.

DESCRIPTION: Simulation Based Design and Acquisition (SBD&A) is rapidly becoming institutionalized as a means of controlling costs and reducing risk of development of complex systems. The Army requires an Engineering and Information System (EIS) environment or infrastructure to support the "institutionalizing" of the SBA process. The Army Materiel Command's (AMC) Major Subordinate Commands (MSCs) have Research, Development, and Engineering Centers (RDECs) which are responsible for the research and development into new and upgraded materiel solutions. Most of the RDECs have modeling and simulation tools and facilities which are used in the RDT&E process. These facilities often provide a real-time, warfighter-in-the-loop, combined arms synthetic environment to support the model-test-model and "try before you buy" approach for the RDEC's specific commodity. The capabilities include Local Area Networks, Wide Area Networks, DIS and HLA protocol-based virtual, constructive, and live simulations, data collection and analysis, visual systems, Computer Generated Forces (CGFs/SAFs), Virtual Prototyping, C4I interfaces, and others. To fully support SBD&A, and to maximize use of expertise across AMC's MSCs, these capabilities can to be linked together in a common environment, and used as a form of Smart Product Model that will follow the development of the system throughout its life cycle.

PHASE I: Review the AMC MSC engineering level M&S infrastructure and document its capabilities to support SBD&A. Identify common engineering and information system environment components required to support SBD&A. Design a system framework which will link the RDECs M&S capabilities and provide appropriate data interactions for use in the SBD&A process.

PHASE II: Develop a prototype SBA Collaborative Environment (CE) consisting of an HLA-based federation of the RDEC M&S facilities and capabilities that can support SBD&A for materiel development and evaluation in a Force XXI mission context. Demonstrate the capability and functionality of the CE through a real time networked simulation exercise between the RDECs and TRAC-FLVN.

PHASE III: Distributed modeling and simulation environments for research, development, and engineering have immediate application to any commercial industry which could benefit from distributed development environments, e.g. automotives, aircraft, telecommunications, etc.

KEY WORDS: engineering simulation, distributed simulation, simulation based design, simulation based acquisition

A99-033 TITLE: Aerodynamic Design Tools for Advanced Rotor Configurations

TECHNOLOGY AREAS: Air Platforms

OBJECTIVES: To create new aerodynamic design tools for rotorcraft and to investigate passive and active flow-control methods using these tools.

DESCRIPTION: The next generation rotorcraft are required to operate in much more demanding environs than in the past, particularly in areas of nap-of-the-earth (NOE), deep-penetration, and air-to-air combat. These highly maneuverable, agile, and survivable rotorcraft must have performance levels far exceeding those in the current inventory. The most important element of the rotorcraft for meeting these requirements is the rotor itself. It is known that aerodynamic flow control can reduce vibratory loads on rotor blades caused by aerodynamic separation and dynamic stall. This would expand the rotor's stall-boundary and increase the available rotorcraft maneuvering load factor capability in all flight regimes. The rotor is also the major source of rotorcraft noise. Aerodynamic flow control on rotor blades has the potential to significantly reduce rotorcraft noise-levels. The present topic aims at the establishment of effective passive and active aerodynamic flow-control methods to improve rotor performance and to reduce noise. These controls include the use of slat/slot airfoil geometry, airfoil-profile optimization, and flow injection/suction on the blade surface. Blade flows to be controlled all involve vortex dominated regions and strong viscous interaction. In the past, design strategies for advanced rotor blades were heavily dependent on empirical studies, particularly in regimes of high angle of attack for which aerodynamic flow control offers special advantages. In recent years, significant progress has been made in understanding the important relationship between aerodynamics and vorticity dynamics in general viscous flows. The enhanced understanding has brought forth innovative approaches in theoretical aerodynamics as well as highly efficient computational and experimental methods. The Army is seeking proposals for theoretical, computational, and experimental efforts to develop new aerodynamic designs tools for future rotorcraft and to use these tools in investigations of active and passive methods of aerodynamic flow control on rotor blades.

PHASE I. Approaches offering particular advantages for aerodynamic analysis involving vortex-dominated flows will be, developed and refined. New methods capable of identifying major steady and unsteady separation zones in viscous flows will be investigated and the most promising approach will be identified. The ability of this method to provide quantitative information on key factors controlling important aerodynamic characteristics and to evaluate passive and active flow-control methods on rotor blades will be demonstrated. Airfoil profiles and aerodynamic flow control methods for which extensive performance data are presently available will be investigated to demonstrate the validity and practicality of the new method. A framework for creating aerodynamic design tools for future rotorcraft will be investigated.

PHASE II. The new method will be fully established for the investigation of three-dimensional unsteady viscous flows, covering the entire rotorcraft flight envelope and including passive and active aerodynamic flow control methods. Wind-tunnel tests and computations will be carried out to validate theoretical results. Engineering tools for rotorcraft aerodynamic design and performance optimization will be assembled from validated theoretical, computational and experimental components. These tools will be used to develop practical passive and active aerodynamic flow-control methods on rotor blades.

PHASE III - Dual Use Applications. There is a growing market for aerodynamic designs tools in a broad range of applications, including rotorcraft applications, in both the government and the private sector. The tools developed under this project are well-suited for these purposes.

REFERENCES:

1. Ahmed Hassan and Ram JanakiRam, "Effects of Zero-mass 'Synthetic' Jets on the Aerodynamics of the NACA-0012 Airfoil", AIAA 97-2326, 15th AIAA Applied Aerodynamics Conference, June 23-25, 1997, Atlanta, GA
2. Larry Carr, et al, "The Effect of Compressibility on Suppression of Dynamic Stall Using a Slotted Airfoil", Presented at 35th AIAA Aerospace Sciences Meeting Jan. 12-15, 1997, Reno, NV
3. M. Chandrasekhara, et al, "Unsteady Stall Control Using Dynamically Deforming Airfoils", AIAA Journal Vol.36, No. 10, PP1792-1800
4. M. Chandrasekhara, et al, "Compressible Dynamic Stall Control Using a Shape Adaptive Airfoil", AIAA 99-0650, 37th AIAA Aerospace Sciences Meeting Jan. 11-14, 1997, Reno, NV

KEYWORDS: active control, passive control, design tool, aerodynamic design

A99-034 TITLE: Enhanced Symbology for Wide Field-of-View for Helmet-mounted Displays (HMDs)

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop novel symbology tailored for wide FOV HMDs applicable to U.S. Army aviation missions.

DESCRIPTION: Flight at night by mediated vision, e.g., night vision goggles or FLIR sensors, is routinely performed by US Army helicopter pilots. Symbology is usually superimposed over the outside image to assist the pilot in flight, navigation and mission tasks. The aviator's ability to perform night missions will be markedly improved by advances in Helmet Mounted Display (HMD) technology that will provide both greater resolution and a larger field of view (FOV) than currently fielded systems. The symbology used with current systems is largely an extension of Head-Up Display (HUD) technology and is generally placed in and around the center of the display. To minimize obscuring the outside scene, the symbology is frequently quite sparse. Forthcoming displays will offer 80 to 100 degrees horizontal FOV, providing an opportunity for innovative symbols specifically suited to these displays. This topic aims to develop such symbology by considering its function, rendering, and placement.

PHASE I: Determine relevant characteristics of forthcoming HMD display technologies and systems. Develop realistic scenarios and task descriptions for one or two selected Army missions, e.g., transport, reconnaissance, attack, search and rescue. Perform an information requirements analysis for the tasks. Develop descriptions and dynamically prototype one or more candidate sets of symbology for a wide FOV HMD that meets the information requirements for the mission tasks. Produce a plan for simulation-based testing of the symbology, identifying all major design features to be assessed during Phase II.

PHASE II: Implement fully functioning real-time symbology set(s) in a device suitable for part-task and mission-oriented testing. Complete evaluation of the symbology set(s) developed in Phase I. Based on the results, redefine, modify and extend as appropriate the wide FOV symbology by taking into account the availability of new information sources such as GPS, satellite communications, and data link. Extend information requirements analysis to additional Army mission scenarios. Develop and test additional symbology sets consistent with the set(s) defined in Phase I. Based on the evaluations conducted, deliver detailed descriptions of the most promising symbology elements, including all drive functions and input requirements.

PHASE III DUAL USE COMMERCIALIZATION: The wide FOV HMD symbology will be directly useful for helicopter operations performed by the other services as well as in the civil sector. Additionally, it is anticipated that the innovations in flight guidance and navigation symbology will be useful in vision augmentation devices for the visually impaired. Some aspects of the symbology also will be applicable to automotive HUD systems.

REFERENCES:

1. Aeronautical Design Standard: Handling Qualities Requirements for Military Rotorcraft, ADS-33D-PRF, May 1996
2. S. W. Baillie and R. H. Hoh, "The Effect of Reduced Useable Cue Environments on Helicopter Handling Qualities," Canadian Aeronautics and Space Journal: 34, 1988, 144-150

3. RH. Hoh, Investigation of Outside Visual Cues Required for Hover, AIM Paper 85-1808, August 1985
4. D. C. Hart, ADS-33C Flight Test Maneuvers Validation In A Degraded Visual Environment," presented at 50th Annual AHS Forum, May 1994
5. A. G. Ledebuhr et at, "WFOV Star Tracker Camera," Sensors and Sensor Systems for Guidance and Navigation, Proceedings SPIE, 1478, April 1991, pp.2-12
6. M. R. Franklin, "Application of an Autonomous Landing Guidance System for Civil and Military Aircraft:" Synthetic Vision for Vehicle Guidance and Control. Proceedings SPIE, 2463, April 1995, pp. 146-153
7. P. K. A. Menon, G. B. Chatterji, and B. Sridhar, "A Fast Algorithm for Image-Based Ranging," Sensors and Sensor Systems for Guidance and Navigation. Proceedings SPIE, 1478, April 1991, pp.190-200
8. R. E. Zelenka, P. N. Smith, A. A. Coppenbarger, C. E. Njaka, and B. Sridhar, "Results from the NASA Automated Nap-of-the-Earth Program, "Journal of the American Helicopter Society: 47,1997,107-115
9. R. L. Newman, Scheme for Automatic Declutter for Helmet-Mounted Displays and Head-Up Displays, Crew Systems TM-96-03 submitted to Aeroflightdynamics Directorate, Moffett Field, February 1996
10. M. J. Wells and M. Haas, "The Human Factors of Helmet-Mounted Displays and Sights," in Electro-Optical Displays, M. A. Karim (ed.), New York: Dekker, 1992, pp.743-785
11. D. F. Kocian and H. L. Task, "Visually Coupled Systems Hardware and the Human Interface," in Virtual Environments and Advanced Interface Design, W. Barfield and T. A. Furness (eds.), New York: Oxford University Press, 1995, pp.175-25.
12. E. T. Davis, "Visual Requirements in HMDs: What We Can See and What Do We Need to See," in Head-Mounted Displays: Designing for the User, J. E. Melzer and K. Moffill (eds.), New York: McGraw-Hill, 1997, pp.207-251
13. C. E. Rash, B. T. Mozo, BC J. McEntire, J. L. Haley, J. R. Licina, and L. W. Richardson, Assessment Methodology for Integrated Helmet and Display Systems in Rotary-wing Aircraft , USAARL 96-16 June 1996
14. R. L. Newman, Head-Mounted Display Design Guide, Army Report TR-(pending), November 1997; Crew Systems TR-97-11
15. R. L. Newman, Helmet-Mounted Display flight Symbology Requirements for Military Rotorcraft, Crew Systems TR-98-1 2, May 1998

KEYWORDS: helmet mounted displays, flight symbology, flight guidance

U.S. Army Communications and Electronics Command (CECOM)

A99-035 TITLE: Mines/Unexploded Ordnance (UXO) Confirmatory System

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To develop a chemical/biological confirmatory sensor-processing system to detect explosives in buried mines and unexploded ordnance (UXO). High probability of detection, very low probability of false alarm and moderate detection time would characterize this sensor system. This confirmatory system will be used with a set of primary detectors.

DESCRIPTION: Unexploded mines and unexploded ordnance (UXO) pose an enormous hazard both for soldiers and civilians throughout the world. Currently, there is a significant effort underway to develop equipment to detect these hazards. Most of this effort involves developing a system to detect the physical features of landmines. The goal of this research is to develop a confirmatory sensor system capable of detecting the actual explosives that make up the mines/UXO. The ideal system would have the following characteristics: A. Ability to detect femtogram amounts of the explosives; TNT, RDX, PETN, above, on or below the ground's surface. B. High probability of detection. C. Low false alarm rate. D. Real time response. E. Ability to distinguish clutter. F. Ruggedness for field environment. G. Capable of Portability and/or as part of a multi-sensor suite.

PHASE 1: Develop in the laboratory, an integrated chemical/biological sensor-processing system technology capable of detecting the explosives TNT, RDX and PETN at field-level quantities. All research must be directed towards the goals described in the above Description section. All data supporting conclusions must be submitted. Research should also include the following challenges and how they will be addressed: A. Distinguishing clutter B. Response Time C. System Purging D. System Shelf-life

PHASE II: Assemble and test the integrated chemical/biological confirmatory system in the field. The Army can provide appropriate test sites. Test with both surface and buried mines/UXO. Evaluate the following criteria: A. Sensitivity B. Clutter discrimination C. Efficiency D. Detection time E. Shelf life F. Ease of operation G. Lifetime cost.

PHASE III: DUAL USE APPLICATIONS: This technology has a wide range of opportunities. Detection of explosives is vital not only to the Defense Department, but also to the FAA, FBI, ATF and local law enforcement agencies. In addition, this technology can also be adapted for detection of other hazardous materials and be an invaluable tool for Environmental Monitoring/Remediation, NBC detection.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This technology will benefit the Department of Defense by increasing speed, efficiency and ultimately safety in countermine and demining operations. It will also greatly benefit the Demilitarization effort.

REFERENCES:
1. http://www.un.org./Depts/Landmine/
2. http://www.demining.brtrc.com
3. http://www.llnl.gov/landmine_bibliography.html

KEYWORDS: Chemical/Biological confirmatory sensor, detection, explosives, demining.

A99-036 TITLE: Landmine Detection

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To develop effective techniques for the detection of buried landmines from standoff distances.

DESCRIPTION: Although significant progress has been made in recent years, the army is searching for more effective ways to detect buried land mines at standoff distances from both vehicular and airborne platforms. In particular the army is interested in techniques with the potential to meet the following requirements:

A. Airborne Mine and Minefield Detection: Detect surface and buried metallic and low metallic anti tank minefields with the following performance parameters: 1) probabilities of detection (Pd) of: a) 0.80 for surface patterned minefields b) 0.65 for buried patterned minefields c) 0.70 for surface scatterable minefields d) 0.60 for individual nuisance mines on unpaved roads 2) These Pd's should be achieved simultaneously with minefield false alarm rates less than 0.5 per km squared. Approaches which address any one or more of the minefield types are acceptable. The technology employed must have the potential for future configuration and integration on tactical unmanned aerial vehicles with payloads of no more than 65 pounds. Approaches which address the detection of anti personnel mines are also of interest

B. Vehicular Mounted Detectors: Detect surface and buried metallic and low metallic anti tank mines with a probability of detection of at least 0.9 while simultaneously achieving a false alarm rate of no more than 0.01 per meter squared. This detection performance should be achieved at a distance of 15-60 meters in front of the sensor platform. Approaches that address the detection of anti personnel mines are also of interest. Examples of low metallic anti tank mines are M19, TMA-4, VS 2.2, and TM62P. Examples of metallic anti tank mines are M15, M21, TM46, and TM-62M. Buried anti tank mines are typically at depths of 2-15 cm as measured to the top of the mine. Examples of low metal anti personnel mines include M14, VS-50, PMA-3, and the type 72. Examples of metallic cased anti personnel mines areVAL-69 and PROM1. Buried anti personnel mines are typically at depths of 1-5 cm as measured to the top of the mine. Both sensor and processing technologies are of interest.

PHASE I: Concept studies including computational and experimental components are expected. All proposed research should have a clearly articulated connection with the mine detection goals stated in the description. Sensor research should include laboratory investigations with the objective of clarifying the detection phenomenology. The research should also address how the severe clutter/target signal problem will be mitigated. Research in processing should have defined goals and quantitative measures of success.

PHASE II: These investigations must include a configuration of appropriate sensor(s) for laboratory and field experiments. Sensor investigations must include a hardware configuration that can be used in laboratory and field data collection with blind test activities included. Processing investigations must include extensive use of field data. The Army can provide experimentation facilities that meet these data collection needs and would include field emplacement of realistic targets.

PHASE III DUAL USE APPLICATIONS: Sensor hardware and processing configurations will undergo demonstration and testing in a realistic field environment. The Army can provide test sites that meet typical testing and data collection needs taht include field emplacement of realistic targets. Techniques developed under this topic are applicable to both military countermine needs as well as humanitarian demining needs. The commercial aspects of humanitarian demining are considerable. Other applications include detection of buried pipes (utility industry), buried caches, and archeological expeditions.

REFERENCES: Specific detail on each of the above mines and others is available on the "Mine Facts" CD Rom, Commander, National Ground Intelligece Center, ATTN: Tom Reeder, 220 7th Street NE, Charlottesville, VA 22902.

KEYWORDS: Mine detection, ground penetrating, buried object detection

A99-037 TITLE: Low-cost Null-steering Processor for Phased Array Antennas

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop and demonstrate a low cost null steering processor for use in phased array antennas for communications on-the-move.

DESCRIPTION: The Army is developing phased array antennas for communications on-the-move. Currently these antennas are vulnerable to jamming from unwanted signals. Low cost null steering processors are required to place deep nulls in the direction of interfering signals to allow proper communications to be maintained. The overall goal is to develop a low cost null steering processor and integrate it into an existing phased array antenna to demonstrate the technology. The null-steering processor is an add-on to an existing phased array beamforming system. Additional or existing array elements are utilized to detect unwanted signals and are processed to provide modifications to the normal phase shifter settings to steer nulls in the direction of the interfering signals.

PHASE I: This program will investigate viable technologies (optical and electrical) and architectures for low cost null steering processors. The proposal should reflect knowledge of phased array antennas and the close interaction between the null steering processor and antenna. This effort may require developing innovative device technology and system architectures. Proof of concept and preliminary work will be helpful towards a Phase II program. This system should be compatible with developmental phased array antennas. The design should accurately predict expected performance parameters.

PHASE II: This continuing effort will produce a working prototype that will tested and ultimately integrated into an existing phased array for demonstration. The emphasis of this prototype should reflect low cost, producable technologies and compatibility with existing phased array antennas. This prototype should transition very easily into production with minor changes.

PHASE III DUAL USE APPLICATIONS: Both commercial and government systems require phased array antenna systems which are resistant to deliberate or unintended interference. Inherent resistance to jamming, utilizing null steering processing, makes phased array antennas ideal for communications on-the-move.

KEYWORDS: Phased array antennas, Null steering processors, Communications on-the-move

A99-038 TITLE: Low-cost Ethernet Encryption

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Research the timeliness and availability of the extant hardware and software component base to design, develop, fabricate, and demonstrate an Ethernet level (Layer 2, Link) encryption device. This would involve the specification and layout of the required components for the device, component characteristics, electrical interfaces, Human-Machine Interfaces (HMIs), and a security kernel. Expected deliverables are a prototype device, ancillary hardware and software design specifications for the prototype, software source, instruction and maintenance manuals, and demonstration of the device's capabilities to meet the requirements of this topic.

DESCRIPTION: The DoD (and Army) inventory of encryption devices consists of Application (Layer 7), Network (Layer 3) and Link (Layer 2) devices. The Ethernet, which is a pervasive link layer protocol in strategic and tactical DoD as well as commercial applications, has no specific encryption device geared for it. In addition, most "link" layer devices lack built-in Ethernet interfaces, operate at slow speeds, or are dedicated to supporting other communications need lines. Also, Ethernet technology is advancing rapidly, for example, there is quickly developing "FAST Ethernet", a communications protocol designed to operate at 100 MBPS (million bits per second), a ten-fold increase in speed over conventional Ethernet.

PHASE I: Generate conceptual designs for the required encryption device, review extant hardware and software component base to select the best combination of conceptual design and components to initiate design and development of a demonstration laboratory prototype. Focus of this work will be towards an Ethernet (10 Base X; IEEE 802.3)2 encryption device. Commercially available security products will be used by CECOM to test the laboratory prototype delivered at the conclusion of this Phase. A performance description and design specifications for the prototype will be provided. This work can be performed in an unclassified environment.

PHASE II: Build and expand on the Phase I work towards fabricating and demonstrating laboratory prototypes to support newer Ethernet technologies, for example Fast Ethernet (100 Base X) as well as emerging Ethernet standards (IEEE 802.11, wireless E-net)3. Show that these prototypes can be fabricated at reasonable cost. Commercially available products can be used to fabricate a prototype secure E-net to commercial standards. Investigate the feasibility to address Gigabit speed security4 . A performance description or specification would be developed. Expected deliverables are a prototype device (or devices), ancillary hardware and software design specifications for the prototype(s), software source, instruction and maintenance manuals, and demonstration of device capabilities to meet the requirements of this topic. This work can be done in an unclassified environment. Phase III: It is anticipated that there will be ample commercial and military-related Ethernet security applications for the encryption device designs developed here. Caution: Offerors should be aware that the requirements of DoD-grade network security are generally more demanding than for commercial nets. Moreover, certain aspects of DoD-sponsored work may be limited to COMSEC Authorized vendors only, and National Security Agency (NSA) certification of those vendors would be required.

DUAL USE COMMERCIALIZATION: Once a commercial-grade Ethernet encryption device was successfully developed, the only change needed to make it suitable for DoD/Army use would be in the security "chips" which implement the COMSEC algorithm. That is, the initial commercial-grade security algorithm would be replaced by a DOD-grade algorithm.

KEYWORDS: Ethernet security, network security, low cost encryption.

REFERENCES:

1. IEEE 802.3u (FAST Ethernet Protocol)
2. IEEE 802.3 (Ethernet)
3. IEEE 802.11 (Wireless Ethernet)
4. IEEE 802.3z (Gigabit Ethernet)

A99-039 TITLE: Multicast Transport Protocols for Dynamic Wireless Networks

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To design, specify, prototype and characterize a Multicast Transport layer protocol for the dynamic, wireless environment. The protocol must function in the dynamic hostile military environment with a minimum of communications loading, and provide reliable end-to-end, flow controlled data transfer.

DESCRIPTION: The current Internet Transport Protocol, Transmission Control Protocol (TCP), does not support reliable multicast communication. Many military and emerging commercial applications require reliable transmission to several destination machines (ie multicast operation) to properly and efficiently function. The new multicast protocol must to backward compatible with the TCP standard, and provide reliable, flow controlled communication between a set of at least 100 communicating web sites. Multicast message transfer is a critical military problem in that many, if not most data communications are required to be sent reliably to a set of receivers, and not simply point to point (single source to single receiver). The design should be capable of implementation in either a Windows NT/98 or Linux/UNIX environment. The implementation should also be compatible with the emerging DoD security equipment to provide communication in a secure environment.

PHASE I: Design and specify the protocol and provide a simulation to characterize performance in wireless environments. The design must be specified in a formal specification language such as SDL (Specification and Description Language) and clearly identy all processes, procedures, states, message formats and call flows.

PHASE II: Provide a software architecture showing the exact relationships that exist between/among all protocols, a detailed object oriented design (in a tool such as Rational Rose or equivalent) and a prototype implementation in C++ or Java. A demonstration showing proper functional operation between up to 100 communicating sites while the nodes are executing "typical" movement such as road marches, attacking/defending, etc. The demonstration shall include receiving node failure and recovery in addition to automatic retransmission of any data sent while the receiver was inoperative.

PHASE III DUAL USE APPLICATIONS: This protocol design should become an Internet standard for the current Internet or the Next Generation Internet. All architecture and design documentation shall be released in the public domain via RFC's (Request For Comments) technical papers, and journal articles. Implementations may be company marketable.

KEYWORDS: Protocols, networks, packet switching

A99-040 TITLE: Display Management for Command and Control Applications

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To provide enhanced situational awareness through automated, dynamic display management.

DESCRIPTION: As the digital battlefield matures, a new problem facing commanders will be the evaluation of information presented on situational displays. Command and control systems will have to facilitate the process of representing data in a manner which allows the intuitive commander to make rapid and effective use of digital information. Current displays of the Common Tactical Picture (CTP) are overwhelming and do not incorporate any means for the automatic placement of icons, graphics, and labels for the purpose of context sensitive situational understanding. Once digital planning is introduced, the complexity of these displays will increase greatly. Commanders need intuitive displays which incorporate the current situation, the current plan, decision points, predictive information, and more. The objective of this effort will be accomplished through the use of automatic label placement, context and temporal filtering, and customization of tactical displays. While the process of automatically creating overlays has been demonstrated, the problem of display optimization has not yet been addressed. Currently, overlay features are labeled according to static rules which compromise map legibility when multiple overlay features are present. Overlays and features need to be labeled in a manner which minimizes, if not eliminates overlap of labels, and intuitively associates names with the tactical symbols and features they reference.

PHASE I: Phase I will focus on a definition of the areas which automated situational assessment will address. The current situation, current plan, decision points for branch plans, and predictive information will be addressed at a minimum. Techniques for each area of automated situational assessment will be proposed for feasibility demonstration in Phase II.

PHASE II: Phase II efforts will address the development of the techniques identified in Phase I. These generic software applications will be incorporated into the Command and Control Directorate's C2 application prototyping environment. Prototyped software will be tested in Army Warfighting Experiments (AWEs) for soldier feedback.

PHASE III DUAL USE APPLICATIONS: Phase III of this effort will focus on a recommendation and implementation of automated situational awareness which considers appropriate commercial standards and plug and play architectural concepts suitable for insertion into future Army Common Operating Environment (COE). Each capability prototyped will be matched against COE components to identify transition targets. Designs will be developed for the insertion of automated situational awareness into these components, and software will be developed. Display management has many commercial applications including the World Wide Web. Any environment where voluminous data is integrated from a number of different sources onto one display will benefit from this effort.

KEYWORDS: Display management, automated name placement

A99-041 TITLE: Inexpensive, Micro-acoustic Sensor for Future Scout Unmanned Aerial Vehicle (UAV) Battlespace Situational Awareness Missions

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Systems are currently being sought to increase survivability of Future Scouts through the use of acoustical technologies to provide battlespace situational awareness. The objective of this task is to develop a UAV mounted micro-acoustic sensor to provide early warning, as well as enemy location and type information to the Future Scout.

DESCRIPTION: As small UAVs are integrated into the future scout mission and enter the Army inventory, lightweight, inexpensive, potentially expendable sensors will be required to perform certain missions where sensor retrieval will be impossible. One key area for such a sensor will be to provide battlespace situational awareness to the future scout. Acoustics may provide at least part of the answer to this requirement. Acoustics can provide alerting, location and identification of approaching enemy targets of interest and do so passively without degradation from dust, smoke and other visual obscurants. The system developed under this effort must be small, operate automatically and require little power for operation. The anticipated system to achieve this capability will be a device with similar physical volume and cost as a commercial paging device and will have objective ranges out to several kilometers. Placing this acoustic system onboard a UAV may provide significant advantages over a ground based system through the use of innovative location algorithms based upon the synthetically large baseline generated by the UAV movement.

PHASE I: The contractor shall design a Micro-UAV Acoustic system as described above to address alerting/location/identification of enemy ground vehicles for the future scout mission. The system shall make maximal use of existing and emerging state of the art technologies. It shall be easy to operate and require minimal troop involvement. During phase one, additional studies shall be performed to examine the unique problems and advantages of acoustics onboard a UAV including flow noise, self noise, and target sound propagation issues. Sufficient modeling shall be performed during Phase I to determine likely sensor alerting/location/identification performance values under various environmental conditions. The proposed system design shall be further refined with Government inputs during the kickoff meeting.

PHASE II: The contractor will develop, prototype, test, and demonstrate the systems designed in Phase I. The contractor shall provide at least four prototype Micro-UAV Sensor Systems as well as one ground data display for data analysis and any communications equipment required for demonstration. The contractor shall test these systems using a contractor provided UAV surrogate and compare the measured sensor performance against expected sensor performance values resulting from the Phase I modeling efforts.

PHASE III DUAL USE APPLICATIONS: A potential civilian application for this technology could be a noise monitoring system at an airport or acoustical monitoring of inaccessible or noise sensitive remote areas. Such a system would be useful providing input data for environmental impact statements prior to construction or facility expansion. In addition, this system could have application in drug interdiction efforts and may be expanded to explore other targets of interest. Also, at the conclusion of the SBIR program it is possible the hardware/software may be integrated into a government UAV for further testing.

KEYWORDS: Acoustic,UAV,Future Scout,Detection

A99-042 TITLE: Free Space Optical Communications for Ground Tactical Applications

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop and demonstrate a free space optical communication link for on-the-move tactical applications.

DESCRIPTION: The Army is looking at applications of high speed, secure, tactical, free space optical communication links for digital battlefield communication. These systems must be resistant to environmental conditions such as smoke, haze, rain, humidity and other obstructive medium that may impede communication. The overall goal to focus on appropriate device and system technology that will improve the state-of-the-art in laser communication. The emphasis of the program is performance, reliability, distance, and adaptability. Tracking technologies will be considered for on-the-move applications; however, some scenarios may require static positioning. Different laser frequencies and detector technology may be emphasized. Inherent resistance to jamming makes these links ideal for network backbones that may extend several kilometers.

PHASE I: This program will investigate viable architectures for laser communication. The proposal should reflect knowledge of the appropriate laser frequencies with respect to atmospheric absorption and scintillation effects and propose systems based on this selection. This may require developing innovative device technology. Proof of concept and preliminary work may be helpful towards a Phase II program. This design should be ruggedized in a military environment with minimal start-up time and signal acquisition. This system could be compatible with typical network topologies and ideally transparent to network protocols. This design should very accurately predict expected performance parameters.

PHASE II: This continuing effort will produce a working, fieldable prototype. The emphasis of this prototype should reflect advanced state-of-the-art device and systems technology operating at high speed and performance, typical of most optical communication systems. This prototype should transition very easily into production with minor changes. This system would be compatible with desired Army communication parameters as discussed during the Phase I.

PHASE III DUAL USE APPLICATIONS: Both commercial and government systems require links that are secure, high speed, and robust communication links. Situations may require links in which ground installation may be too costly to achieve, especially in application where the remote site is not easily accessible.

KEYWORDS: Laser communication, low to far infrared detectors, quantum cascade lasers, diversity reception, atmospheric propagation, high speed optical communications, free space

A99-043 TITLE: Command, Control, and Communications Infrastructure Situation Awareness

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Provide the commander with insight into his information system performance.

DESCRIPTION: As the Army digitizes to achieve information dominance, information becomes a warfighting resource, just like ammunition, fuel, and personnel. The objective of C2 systems are to provide commanders information and tools to aid in decision making. The information that the commander is provided conveys to him the current strength and capability of his force. The commander and his staff is interested in quantity and positioning of his resources. For example, when planning the next phase of a battle it is imperative for him to know that Company A is currently located at objective alpha, has lost three tanks, and has used 75% of its fuel. By knowing this type of information, the commander and staff can properly make decisions with regard to Company A. Metrics such as fuel levels, ammunition, and vehicle status have traditionally been used by commanders to make tactical decisions. In the age of information dominance the health of a units Information System (IS) is just as important as fuel or ammunition levels. In a force where information dominance acts as a force multiplier, the statue of the IS directly impacts the combat effectiveness of a unit. Thus, it is imperative that a commander considers the level of IS capability within a unit when making tactical decisions. Just as a commander should be reluctant to attack with a unit that only has 10% of its ammunition remaining, a commander should be equally reluctant to attack with a unit that only has a message completion rate of 10%. There is a need to develop tools which can assess the health of the Tactical IS and present this data to the commander in a manner which will properly impact the commander's decision process.

PHASE I: Study Network Measure of Performance to facilitate assessing Situation Awareness. Study effective visualization techniques for displaying C3 situation awareness. Study possible software architectures for C3 infrastructure situation awareness tools which could interface with Army System Architecture. Develop proposal for building a C3 infrastucture situation awareness tool.

PHASE II: Build a prototype C3 infrastructure situation awareness tool based on the Phase I proposal. Demonstrate feasibility of a C3 infrastructure situation awareness tool in a laboratory testbed and/or through field experiments.

PHASE III DUAL USE APPLICATIONS: This system has commercial applications in any industry which depends on distributed Sensor and/or Command and Control Systems linked through a communications network. In this phase the prototype should be commercialized.

KEYWORDS: C3 systems, situational awareness, network management, performance assessment

A99-044 TITLE: Lightweight, High-power, Ground Vehicle-mounted, Gas Turbine Auxiliary Power Unit

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a lightweight, high power, vehicle mounted, gas turbine auxiliary power unit (APU) to provide power to Army fielded systems through maximal integration of Commercial Off the Shelf (COTS) components and technologies. This design goal for the APU system shall be that it weigh less 75 lbs., produce at least 10Kw, 120 VAC, 60 kHz, and 3-phase power. This APU will reduce workload for the troops through more compact and efficient power generation, increase availability of scarce space and weight budgets, and improve productivity through the use of available battlefield fuel (JP8).

DESCRIPTION: Increasing requirements for the support of the more electronic battlefield are placing ever increasing strains on the electrical power generation systems employed on the battlefield. The Army currently uses diesel generators for most of its battlefield power requirements; the diesel generator has several drawbacks to it for small-scale operations, among them size, weight, and logistical concerns. Currently, the Army has need for a high efficiency vehicle mounted gas turbine APU to run on available battlefield fuel. In developing this APU there is potential to reduce size, weight, noise, and fuel consumption through the use of new state-of-the-art technologies. In addition, to power, size and weight considerations in developing an APU for shelters and vehicles, offerors must employ novel starting solutions, state-of-the-art power controllers and develop new housing concepts to ensure troop safety considerations are addressed.

PHASE I: The contractor shall define the preliminary design of the APU, identify key components including all COTS components, and validate their design with computer simulation. In addition, during phase I, the contractor shall develop the mechanical packaging concept considering heat signature, noise, and soldier safety implications and perform thermal design and analysis on the proposed system. A study of critical system integration issues shall be performed.

PHASE II: Phase I design work will be refined and advanced, focusing especially on the fuel usage/housing/control design aspects. Electrical and mechanical design work will be completed and a full power, prototype lightweight, high power, vehicle mounted gas turbine auxiliary power unit will be fabricated. The newly constructed APU will be rigorously tested and its performance and operating characteristics will be evaluated.

PHASE III DUAL USE APPLICATIONS: Power for shelters, such as temporary ones for disaster relief and construction sites. Portable backup power systems for emergency mobile hospitals, temporary field police stations, refrigerated semi-trailer vans, etc. Power for recreational vehicles such as campers, boats, and in any other application that would require a high power to weight electric power generator.

KEYWORDS: auxiliary, power, gas turbine, shelter, vehicle

A99-045 TITLE: Soldier's Antenna

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop and demonstrate an effective rugged and efficient, Very High Frequency (VHF)/Ultra High Frequency (UHF) body borne antenna for the Soldier and commercial applications.

DESCRIPTION: Present VHF/UHF antennas use effective, but high profile designs that in many instances inhibit the ability of the soldier to effectively perform his mission. These antennas when properly deployed (fully extended) tend to get caught in underbrush and tree branches. There is a need to provide the warfighter with a body borne VHF/UHF antenna that will enhance his warfighting capabilities. Efficiency and range of the antenna must be compatible or greater then legacy VHF/UHF antennas currently borne by the soldier. Consideration of emerging materials, coating, and antenna switching technologies, as well as, adaptiveness, efficiency in all warfighter positions, and the ability of the antenna to communicate in rapidly changing warfighter scenarios are critical requirements of the antenna. Successful proposals will explore and develop an innovative VHF/UHF body borne antenna system that will address these objectives and descriptions.

PHASE I: Perform a study of this requirement and develop a set of alternatives, and present to the government. The contractor and the government will make a joint decision on the most promising techniques to pursue in Phase II.

PHASE II: The most promising techniques, emerging from the Phase I study, will be further developed and modeled. A performance description, specification, and antenna prototype will be developed.

PHASE III DUAL USE APPLICATIONS: The performance description and specification will be further refined and optimized for both commercial and military use. A Soldier wearable antenna will be developed that is suitable for field testing.

KEYWORDS: communications, antennas, VHF/UHF

A99-046 TITLE: Unmanned Aerial Vehicle (UAV) Remote Sensor Control and Data Retrieval Operating Suite

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: The objective of this task is to design, develop, prototype, and demonstrate a small, light weight UAV based system which enables control and data retrieval from disposable, inexpensive, forward deployed sensors now under development. This equipment desired shall be made up of 3 subsystems: A universal sensor transmission subsystem(capable of easily operating with all sensor systems), the UAV based control and data collection subsystem, and the data reduction subsystem

DESCRIPTION: As remote sensors move further and further away from the forward line of troops, a range problem has been created for tasking sensors and collecting sensor data. It is cost or resource inefficient to provide many of these sensors with sufficient communication capability to operate continuously and to retrieve their data once it is obtained. UAV's can provide a possible solution to the range and tasking problems associated with deep remote sensors. As UAV platforms are able to be airborne for longer and longer periods of time, their usefulness as a range extension mechanism may be exploited. A PC-based computer system, in a small commercially available form factor could be used as the host for applications software that performs the mission of tasking for, and collecting remote sensor data. The UAV based system then provides the range extension and line of sight needed to retrieve the data from deep remote sensors and send it back to the ground.

PHASE I: The contractor shall design an inexpensive UAV Operating Suite with all required ancillary equipment to address remote sensor data retrieval problem. This design shall be further refined with Government requirements during the kickoff meeting. The contractor shall perform a feasibility analysis of the design and demonstrate its veracity through analysis, simulation, or other means. This analysis shall include but not be limited to: technology issues, operational issues, covert and secure operation, power, size and weight and other pertinent issues. The contractor shall also develop a test plan during phase one that will enable comprehensive testing of the device during phase II.

PHASE II: The contractor will develop, prototype, and demonstrate the UAV Operating Suite per the proposed Phase I system design. The contractor will provide a minimum of two UAV based control and data collection units, four universal sensor transmission units as well as one data reduction station to facilitate testing. The system will then be demonstrated per the proposed Phase I system test plan with surrogate remote sensors in several realistic scenarios. Phase II will be compatible with plug interfaces established under Common MOD UAV Programs.

PHASE III DUAL USE APPLICATIONS: A potential civilian application for this technology could be in the monitoring and control of sensors in inaccessible or sensitive areas such as environmentally fragile or potential danger spots where inaccessibility or line of sight considerations prevent conventional access.

KEYWORDS: UAV, remore sensors, data collection

A99-047 TITLE: Human Computer Understanding

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To create an autonomous human computer interface which integrates multi-modal I/O technologies.

DESCRIPTION: As multi-modal interfaces mature, integration of these technologies into an autonomous human computer interface becomes the next challenge. The goal of this effort is to create a "Star Trek" like computer interface. Technologies integrated will include speech recognition, natural language processing, integrated displays, and more. The result is the application of intelligence to multi-modal technologies to control and coordinate system I/O and applications. Speech recognition software will incorporate speaker identification, and will provide a context sensitive capability. Users will be able to request data, send messages, and control displays through a voice interface. Touch and gesture interfaces, along with user identification and command context, will aid in recognition. Feedback will be provided through both display and voice interfaces.

PHASE I: Phase I efforts should focus on the selection of multi-modal technologies for integration. This selection should identify how each technology will aid in natural human understanding. A technical report should define the role of each technology and a plan for the integration and demonstration of natural human-computer understanding.

PHASE II: Phase II efforts should focus on the design and development of a natural human-computer understanding environment. Experimentation should demonstrate the effectiveness of integrated multi-modal interfaces to achieve natural understanding. A report will be produced which summarizes the results of this experimentation and recommends a design for natural understanding. This design will include when and how technologies should be integrated, as well as the software required to achieve such integration.

PHASE III DUAL USE APPLICATIONS: Phase III efforts will result in the implementation of the Phase II recommendations and design. This implementation should consider appropriate commercial standards and plug and play architectural concepts suitable for insertion into future Army COE. Transition of this implementation itself to COE will then be pursued. Natural human-computer understanding will have applicability to all DOD systems, as well as industrial and residential environments. Such a capability will facilitate the use of computers by all persons in all environments.

KEYWORDS: Human computer interfaces, multi-modal interfaces

A99-048 TITLE: Integrated Circuit and Package Switching Applications Architecture

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Investigate, analyze, design, develop and test an efficient architecture to handle the integration of tactical circuit and package switch intolerability in order to handle the convergence of voice and data networks for the tactical communications system.

DESCRIPTION: The fundamental differences between transmitting voice, video and data over circuit switching and the evolving package switching systems make it difficult for industries to develop efficient algorithms to mediate traffic between circuit and package switching systems. The commercial industries have been trying to find solutions for the problems. However, no efficient products presently exist hat can provide the capability to integrate traffic between circuit and package switch applications. Recently, there are a few major industries announcing the development of new products to provide efficient methods of integrating circuit and package switching applications, however, these new techniques may not be efficiently applicable to the Army tactical networks, because there are fundamentally different network characteristics between the commercial networks and the Army tactical networks. The US Army is using both circuit and packet switched networks in almost all- tactical systems. Integrating the circuit switching systems to work with the package switching systems seamlessly, and ensure the required Quality of Service (QoS) to the users is beyond state-of-the art. Therefore, a necessity exists for the Army to conduct studies, perform tests and develop reliable, efficient, and embedded schemes to enhance system operations thus evolving US Army Communications systems.

PHASE I: Conduct feasibility study and trade of analysis, which will evaluate an efficient architecture to handle the integration of tactical circuit and package switch interoperability in order to handle the convergence of voice and data networks for the tactical communications system. The study will result in an overall design plan that includes specifications of the system architecture to achieve the required objectives.

PHASE II: Develop and demonstrate a prototype system in a realistic environment. Conduct testing to prove feasibility of the system to be developed in the tactical operating conditions.

PHASE III DUAL USE APPLICATIONS: This technology will provide the industries the ability to efficiently integrated the circuit and package switching traffic by efficiently mediating traffic between circuit- and packet-switching systems. The application is critical to the Army's Warfighters Information Network program.

KEYWORDS: circuit switch, package switch, SS7, IP

A99-049 TITLE: Low-cost Attitude and Heading Reference Systems for Phased-array Antennas

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop and demonstrate a low cost attitude and heading reference system for use in phased array antennas for communications on-the-move.

DESCRIPTION: The Army is developing phased array antennas for communications on-the-move. Currently these antennas utilize expensive attitude and heading reference systems (AHRS) initially designed for tanks. (The present systems utilize the Honeywell TALIN (Tactical Advanced Land Inertial Navigator) AHRS.) Currently the thrusts for developing low cost phased array antennas, leaving the AHRS as the single most costly item. Low cost AHRS are required to enable the phased array controller to determine vehicle motion (Roll + 30omin, Pitch + 30omin, and Heading 0o-360o) to allow for proper antenna beam pointing, even in the event of signal blockages during which the vehicle may change roll, pitch and heading. Angular measurement accuracy is TBD. The following dynamic rates are desired: Velocity of 45 degrees/second, Acceleration of 30 degrees/second2. The update rate required is TBD. The overall goal is to develop a low cost AHRS and integrate it into an existing phased array antenna to demonstrate the technology. Antenna beamwidths of 0.5 degree or less will be accommodated.

PHASE I: This program will investigate viable technologies and architectures for low cost attitude and heading reference systems. The proposal should reflect knowledge of phased array antennas and the close interaction between the AHRS and antenna controller. This effort may require developing innovative device technology and system architectures. Proof of concept and preliminary work will be helpful towards a Phase II program. This system should be compatible with developmental phased array antennas. The design should accurately predict expected performance parameters.

PHASE II: This continuing effort will produce a working prototype that will tested and ultimately integrated into an existing phased array for demonstration. The emphasis of this prototype should reflect low cost, producible technologies. This prototype should transition very easily into production with minor changes.

PHASE III DUAL USE APPLICATIONS: Both commercial and government systems require phased array antenna systems for communications on-the-move. Specific applications include mobile satellite reception for truckers and radiotelephone and direct broadcast satellite reception. The development of a low cost attitude and heading reference system is critical to wide deployment of these systems in the commercial arena.

KEYWORDS: phased array antennas, attitude and heading reference systems, communications on the move

A99-050 TITLE: Advanced Intrusion Detection Techniques

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Perform research into advanced intrusion detection techniques that would utilize methods beyond the traditional pattern matching techniques currently in use.

DESCRIPTION: In both the commercial world and military world, network security is being recognized as a major emerging problem. It is vital to protect computer networks from hacker and foreign power threats. There are number of commercially available intrusion detection software packages currently available which make use of pattern matching algorithms to detect known attacks. A basic weakness of pattern matching intrusion detectors is that they cannot detect new attacks. This research will investigate new and innovative approaches to computer network intrusion detection utilizing artificial intelligence and neural networks. Specific uses of artificial intelligence and neural network technology on this project will include the examination of audit logs and the comparison of normal network traffic versus abnormal network traffic.

PHASE I: Perform a study into the application of artificial intelligence and neural networking techniques towards computer network intrusion detection. A set of alternatives would then be presented to the government. The contractor and the government would make a joint decision on the most promising techniques to pursue in Phase II.

PHASE II: The most promising techniques emerging from the Phase II study would be further developed and modeled. A performance description or specification would be developed. A prototype software working model will be delivered.

PHASE III DUAL USE APPLICATIONS: The performance description or specification would be further refined and optimized for both commercial and military use. Depending on findings, the commercial specification may vary in certain ways from the military specification.

KEYWORDS: intrusion detection, artificial intelligence, neural networking

A99-051 TITLE: Hybrid Pixel Miniaturization

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To develop an interconnection (bonding) technique between a detector array and read-out integrated circuit array such that the individual pixel size is less than 12 microns by 12 microns. The goal is a hybridized pixel size approximately the same as a CCD pixel. The technique would normally bond a silicon read-out with an array of MCT detectors and operate in the wavelength region of visible to 2.5 microns.

DESCRIPTION: Modern etching techniques have successfully reduced the size of infrared sensing detector pixels to the point where a substantial barrier in further reduction of pixel size is the size of interconnection bond between the detector element and the read-out circuit. The goal of this effort is to reduce the pixel size of hybridized focal plane array.

PHASE I: Develop and evaluate an electrical interconnection method that results in detector pixels that are less than 12 microns by 12 microns in area.

PHASE II: Assemble a hybridized near infrared focal plane array with pixel pitch of less than 12 microns in a 1280 by 1024 format with a fill factor approaching 100%.

PHASE III DUAL USE APPLICATIONS: Hybridized focal plan arrays are currently the standard in virtually all high performance infrared imaging applications. All surveillance, radiometry, security applications could benefit from smaller pixels as a result of package size reduction, and reduced power consumption.

KEYWORDS: NIR, SWIR, FPA, Uncooled

A99-052 TITLE: Automatic Signal Exploitation

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Research, develop and design practical implementations of automatic modulation classifier and blind demodulators to a set of channel waveform modulations such as quadrature amplitude modulation, in modules of C, C++, and Very high speed integrated circuit Hardware Description Language (VHDL) codes, that enable to be ported to generic computers and commercial hardwares such as Digital Signal Process (DSP) and Field Programmable Gate Arrays (FPGA) chips.

DESCRIPTION: A need exists for the rapid prototyping and implementation of blind demodulators which are robust to a changing tactical environment. A system is needed that facilitates research into high-level algorithm development while simplifying porting of the newly designed algorithm to C code suitable for real-time operation on DSP chips or to HDL/VHDL code for FPGA implementation. The system must support both simulation and system integration.

PHASE I: Identify promising algorithms for blind demodulation from research literature, and conduct research on developing new approaches. Conduct simulations to test the performance of the algorithms.

PHASE II: Design practical implementations of algorithms in C and HDL/VHDL codes. Develop a Graphical User Interface (GUI) platform in PC environment to demonstrate the capability of porting implementation designs onto commercial hardwares.

PHASE III DUAL USE APPLICATIONS: Such development platform and algorithm tools will facilitate both commercial and military users to analyze signal waveforms in diverse unknown environment.

REFERENCES:

1. Treicher, J., Larimore, M., and Harp, J., "Practical Blind Demodulators for High-Order QAM Signals," Preceeding of the IEEE, vol. 80, no. 10, October 1998, pp. 1907-1926.
2. Feldkamp, L. and Puskorius, G., " A Signal Processing Framework Based on Dynamic Neural Networks with Application to Problems in Adaptation, Filterng, and Classification," Proceeding of the IEEE, vol. 86, no. 11, November 1998, pp. 2259-2277.

KEYWORDS: blind demodulation, signal analysis

A99-053 TITLE: Rangefinder/Illuminator Read-Out Integrated Circuit (ROIC)

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To develop a Near Infrared (NIR) detector array readout integrated circuit (ROIC) that will permit gated imaging of a target illuminated with a pulsed laser source at 1.5 to 2 microns. The ROIC shall gate the detector arrays to integrate the received illumination for a time period of 0.1 to 20 microseconds after a variable delay time from the laser pulse. The range to the target will be from 500 meters to 5 kilometers. The NIR detector array (MCT or InGaAs) will be a 1000x1000 array with pixel pitch on the order of 12.5 microns. The ROIC shall also operate in a normal framing mode at a 30 Hz rate.

DESCRIPTION: Currently there is no range gated ROIC operating in the 1.5 to 2 micron range. The goal of this effort is to develop the ROIC for a NIR detector array, which is currently being developed to operate < 2 microns.

PHASE I: Develop and evaluate circuits that result in gated pixels in square area of less than 12.5 microns on a side.

PHASE II: The contractor will assemble and deliver a prototype 1000x1000 ROIC with a 12.5-micron pixel pitch with the center 100x100 pixels on the ROIC having the range gating capability. The ROIC will be suitable for integration with a solid state 1.5 to 2 micron detector array.

PHASE III DUAL USE APPLICATIONS: Techniques developed under this topic are applicable to both military and commercial applications. All surveillance, radiometry, security applications could benefit from an uncooled, NIR camera. Commercial applications for this technology include medical and dental imaging; spectroscopy for atmospheric monitoring; astronomy; active imaging systems for search and rescue operations; police applications and border patrol use to identify ships or vehicles.

REFERENCES:
1. http://cfht.hawaii.edu/~tmca/CCD-world,
2. http://www.sensorsinc.com,
3. http://www.indigosystems.com,
4. http://tcs.thomson-csf.com,
5. http://www.ccd.eev.com,
6. United States Patent #5,793,424, date: August 11, 1998, Inventors: Shepherd,; Orr (Arlington, MA), Assignee: Visidyne, Inc. (Burlington, MA), Title: Syncronously Gated High Speed CCD Imager System

KEYWORDS: NIR, Uncooled, ROIC, Active Imaging

A99-054 TITLE: Laser Protection Device for Near Infrared (IR) Optical Devices

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To develop a concept which will pass low energy light in the near IR, but blocks high energy light. Only self-healing concepts with non focal plane requirements will be considered.

DESCRIPTION: The US Army is seeking concepts which will protect Near IR sensors such as Night Vision goggles and low light televisions against Laser radiation. These devices operate over the wavelength range of 600 to 900 nm and both, out of band and in-band protection are required. Innovation technological approaches are sought for protection against multi-wavelength pulsed Laser devices. Emphasis should be placed on minimizing the impact on the operational capability of the device and on maximizing the transmission in the 600 to 900 nm range, while still giving protection.

PHASE I: Demonstrate proof-of-principle

PHASE II: Fabricate, test, demonstrate and deliver a minimum of ten elements that meet the goals set forth.

PHASE III DUAL USE APPLICATIONS: Protection of the eye from Laser radiation are needed in a wide variety of Laser applications including industrial, medical, dental and communication activities. Dual Use Application of the Laser Protection Device is the goal of Phase III.

REFERENCES: US Patent 5831769.

KEYWORDS: Near IR, Pulsed, Multi-wavelength, laser protection

A99-055 TITLE: Solid State Infrared (IR) Chopper for Uncooled Infrared Camera

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: The objective of this topic is to develop an IR solid-state chopper for pyroelectric/ferroelectric and bolometric (high dynamic scene scenarios) IR uncooled cameras. Presently mechanical choppers add weight, size, input power, and cost to uncooled IR cameras. Also, since the time constant of the chopper and detector are equal; it reduces the signal by a factor of two. The chopper shall be designed such that it operates less than half the frame rate so that as much incoming radiation is absorbed as possible. The time constant of the chopper shall be consistent with the above, so that signal collection is maximized.

DESCRIPTION: The solid state chopper shall be designed for uncooled ferroelectric/pyroelectric and bolometric detectors that are 25 microns in pitch. The chopper shall operate at frame rates from 30-60 Hertz and have a small duty cycle. The chopper shall have a reliability of at least 10,000 hours of camera operation and consume minimal average power. Implementation of the concept should not add to the size or weight of the camera to any measurable degree. The concept should also be capable of withstanding large accelerations (up to 10,000 g's) so that the cameras would be able to be air dropped.

PHASE I: Develop a new concept for chopping radiation with no mechanical parts and analyze camera performance.

PHASE II: Build a small 25-micron uncooled array with the new chopper and demonstrate performance.

PHASE III DUAL USE APPLICATIONS: Techniques developed under this topic are applicable to both military and commercial applications. All surveillance, radiometry, security applications could benefit from uncooled, IR camera.

KEYWORDS: Uncooled, Solid State, Chopper, Pyroelectric/Ferroelectric, bolometrics

U.S. Army Cold Regions Research and Engineering Laboratory (CRREL)

A99-056 TITLE: Preflight Deicing and Anti-icing of Helicopters

TECHNOLOGY AREAS: Air Platforms

OBJECTIVE: Develop capability of preventing or removing ice and snow from helicopter surfaces that must be clean prior to flight including but not limited to rotor head, main rotor blades, tail rotor, engine inlets, windshields, avionics and weapons systems. Snow and ice prevention is preferred, but removal of ice and snow is also of high priority when prevention methods fail or are not available. Prevention or removal systems should require no modification of the helicopter, and it is desirable that systems be portable (preferably flying with the helicopter for continuous availability), compact, lightweight, inexpensive and sufficiently robust for field use with minimal training. Methods should not be mechanical, such as scraping of ice from surfaces, and should not overheat, nor rapidly heat and cool, aircraft composites. Systems are also required that may be transported by helicopter or HMMWV to temporary airfields, assembled, and used for deicing many aircraft, but that do not have to be carried with the aircraft. Fluids must be compatible with military requirements including corrosively and flammability, and must be sufficiently benign environmentally to not require capture or remediation. It is desirable that systems include a wide-area ice imaging system to allow ice to be observed on the aircraft, even at night, and to evaluate the thoroughness of snow and ice removal. Systems should remove ice and snow, or prevent ice and snow, sufficiently to allow an aircraft to safely fly.

DESCRIPTION: Procedures for preflight de-icing of helicopters have not been refined nor standardized as they have been for fixed-wing aircraft. One reason may be because helicopters are typically hangared. In the military, however, helicopters are often exposed to weather when garrisoned in the field allowing freezing precipitation and snow to accumulate on airframe and blade surfaces. Snow and ice often adheres after skies clear, grounding aircraft for hours to days, unless frozen contaminants are manually removed. Modern helicopters are more likely to be damaged by casual ice removal techniques than are fixed wing aircraft because large portions of rotor blades and fuselage surfaces are constructed of composites. Composites are susceptible to damage from physical impact, scraping, high temperatures and thermal cycling. In addition, helicopter rotor heads are vulnerable to corrosion and damage from washing of lubricants from bearings when glycols are used for de-icing. Infrared radiation, hot water and hot air have been used to experimentally de-ice helicopters before flight. Infrared systems are promising and are used operationally to deice fixed-wing aircraft. However, current systems are not transportable on helicopters, and have the potential to overheat composites. Hot air de-icing systems typically draw air from an independent heater through a manually operated hose and nozzle to melt ice. Hot air systems are currently slow, cumbersome for personnel to use, and have the potential for overheating composite blades or causing rapid and potentially damaging thermal cycling of composites. Systems involving covering aircraft with tents or parachutes and filling with hot air are very slow and cumbersome. Commercial fixed-wing aircraft are typically deiced with environmentally-damaging glycol-based fluids. Glycol-based deicers are unacceptable for use on helicopters, especially rotor heads, where lubricants can be washed away and corrosion started. Hot water also can remove lubricants if used under high pressure, and may refreeze on cold surfaces causing larger residual ice problems than did the original ice or snow deposit. Ice prevention has been accomplished using portable covers for aircraft surfaces, such as blades, engine inlets, wind screens and rotor heads. Covers are portable, compact and useful when used before ice or snow is deposited. However, they are also expensive, and require that an aircraft is completely dry before installation, otherwise they may freeze to blades and other structural components. Ice-phobic coatings may assist ice removal. However, coatings do not prevent ice accretion, or alone do they cause ice and snow to be removed. Ice-phobic coatings also erode easily, may complicate decontamination procedures, and typically have required frequent renewal to be effective.

PHASE I: Demonstrate feasibility of developing system for preventing or removing ice and snow from helicopter surfaces sufficient for flight. Systems are desirable that can be easily transported with each helicopter, or transported to, assembled and stationed at temporary airfields by helicopters. The system should be compatible with Army helicopters, preferably all models, present no hazard to aircraft, personnel or the environment, and utilize no mechanical methods, such as scraping, for removing ice. The system should be capable of removing ice and snow of any type or thickness from a helicopter within one hour or less sufficient to make the aircraft safe for flight. The system should be transportable by helicopter or HMMWV, preferably fly with each helicopter, weigh less than 4000 lbs. and occupy a space no larger than 84" wide by 84" long and 72" high. Liquid fuel, if required, must be JP-8. Electrical power cannot be drawn from helicopters, but helicopter APU bleed air may be used. Provision must be made for efficiently capturing and disposing of environmentally-damaging fluids. Expected cost and maintenance should be assessed and should be minimal.

PHASE II: Design and construct prototype deicing/anti-icing system conforming to requirements established in Phase I and demonstrate in field tests representative of battlefield conditions. The developer should be prepared to work with the Army in developing a plan to test and evaluate the system under a wide variety of ice and snow conditions encountered by Army helicopters and crews in battlefield operations. Pending availability of the requisite Army assets, limited testing with Army helicopters and crew personnel might be conducted. Short of this, the testing should approach operational battlefield scenarios as closely as possible. Phase II deliverables will include prototype system hardware and software, prototype design and system performance documentation, available user/maintenance/trouble-shooting documentation, and projected cost data for pilot manufacturing runs.

PHASE III DUAL USE COMMERCIALIZATION: Military and commercial helicopters, and fixed wing aircraft operating in the far north and in areas without support facilities such as servicing offshore oil rigs, need such systems. Systems would extend operating conditions for all-weather helicopters, improve safety and reduce the time required to pre-flight helicopters after ice or snow events. A system would be considerably less expensive than the cost of hangaring aircraft, and would reduce damage to expensive, safety-related helicopter components caused by the use of improper deicing procedures. The system may also be useful for deicing UAVs and fixed-wing military and commercial aircraft.

REFERENCES: Society of Automotive Engineers, 1987, Icing Technology Bibliography. Aerospace Information Report, AIR 4015, SAE, Warrendale, PA, 149 p. Ryerson, C, T. Gilligan and G. Koenig, 1999, Evaluation of Three Helicopter Preflight De-icing Techniques. AIAA Aerospace Sciences meeting, January, Reno, 99-0499, 6 p. Baca, A., and C. Herring, 1996, Minutes of Aircraft/Runway Deicing/Anti-icing Technology Crossfeed. Air Force Materiel Command, Wright-Patterson Air Force Base, AFMC-TM-96-9002, 476 p.

U.S Army Chemical Biological Center of Excellence (CBCOE)

A99-057 TITLE: Synthetic Receptors for Reagentless Biosensors

TECHNOLOGY AREAS: Chemical/Biological Defense and Nuclear

OBJECTIVE: To develop molecular 'imprints' in a polymer matrix which can selectively bind chemicals, toxins and/or bacteria. The development of polymer imprints which exhibit similar antigen binding properties as antibodies offer significant advantages over the latter in their simple and rapid preparation methods, chemical, mechanical and thermal stability and potential for repeated use.

DESCRIPTION: Biodetectors currently rely on biological recognition sites such as monoclonal antibodies, genetic probes, enzymes and other receptors which require an aqueous environment for proper function. This necessitates extensive "plumbing" and environmental controls to maintain stability and function of the biological reagents. Artificial receptors made from synthetic polymers would recognize biological agents (i.e., pathogens and toxins) with high affinity and specificity and would function under extremes of temperature and in a dirty environment.

PHASE I. 1. Develop and test procedures for imprinting large MW compounds. 2. Synthesize and test polymer casts from large MW toxins (Ricin and BoTX).

PHASE II. 1. Assess specificity and affinity of imprinted polymer(s) for toxins. Compare with antibodies. 2. Test feasibility of polymer casting for 'whole cell' imprints. 3. Develop requirements/configurations and test polymer imprints in different sensor formats. 4. Produce gram quantities for use on sensors and test kits.

PHASE III DUAL USE APPLICATIONS: 1. Medical diagnostics 2. Environmental monitoring 3. Industrial process control 4. Drug design 5. Military biological point detection 6. Specific Molecular absorbants

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The use of purely synthetic molecular recognition elements would significantly reduce the logistics in production and storage of reagents derived from biological sources.

REFERENCES: Haupt, K and Mosbach, K. Plastic antibodies: developments and applications. Trends in Biotechnology, Vol. 16, pp 449-489. Aherne et al., J. Am. Chem. Soc., Vol. 118, pp. 8771-8772, 1996.

KEYWORDS: receptors, molecular imprints, polymers, detectors, biosensors

A99-058 TITLE: Microfabrication-based Biodetectors

TECHNOLOGY AREAS: Chemical/Biological Defense and Nuclear

OBJECTIVE: Reduce the size, sample, and power needs of biodetectors using microfabrication.

DESCRIPTION: Microfabrication methods offer the possibility of producing biosensors and biodetector components of unprecedented smallness (i.e. chip based) as well as enabling novel designs, chemistries, and general biosensing approaches not possible in macrofabricated systems. Biological detection goals include deployment of microfabricated sensor systems that are capable of processing and analyzing microliter amounts of sample for a variety of threat bioagents: toxins, viruses, and bacteria. Ideally, such systems would include microfabricated pumps, actuators, sensing platforms,fluidics manifolds, detectors, sample isolators, and sample concentrators; all linked and automated into a continuous process on a hand-held type of system. They would be able to take sample from the macroworld and process and analyze it in their microfabricated environment. Of particular importance for this topic is research and development of microfabricated sensing platforms, sample isolators (from a matrix or interferents), and sample concentrators. Phase I. A successful Phase I effort will be one where the feasibility of applying microfabrication technology to aspects of the biosensing problem are demonstrated. Topics for consideration include the three areas listed at the end of the DESCRIPTION above. The topic calls for more than an engineering effort - concept demonstration must be tied to an actual biochemical system of the proposer's choice, i.e. detecting or isolating a toxin, virus, and/or bacteria sample. The Phase I work does not have to show automation (although desirable) but must show proof-of-principle of the fundamental processes in a microfabricated environment. Specific research objectives are:

a. Develop and test microfabricated sensing platforms that are capable of processing and identifying toxins, viruses, and bacteria in 100ul or less amounts. DNA, antibody, and physical based methods are all candidates for consideration. Detection and identification of multiagent types is desirable but is not a topic criteria.

b. Develop and test microfabricated and rapid (less than 10 minutes) sample isolation systems that are capable of processing 500ul and less amounts of toxins, viruses, and bacteria. Processing functions fall into two areas either or both of which the proposer may address. First, there is bulk isolation of the specific biomaterial from the sample matrix. Second, there is isolation of DNA from its organism and its separation from or neutralization of interferents and inhibitors prior to analysis (i.e. by the polymerase chain reaction). Rapid lysis and DNA extraction from spores is particularly important. Samples will be non-medical and must be taken from or mixed with an actual environment such as soil, polluted water, smog filled air, indoor surfaces, and vegetation. Systems that are capable of processing more than one biomaterial type are desirable but not mandatory for this topic.

c. Develop and test microfabricated and rapid (less than 10 minutes) sample concentration systems that are capable of processing 100ul and less amounts of toxins, viruses, and bacteria. The goal of this work will be to take dilute levels of biomaterial and concentrate it to levels that are orders of magnitude higher in the same 100ul volume. Although not binding, examples are: for bacteria B 10E02 to 10E04 Cfu/ml, for viruses B 10E02 to 10E05 Pfu/ml, and for toxins B pg/ml to ng/ml.

Phase II. Phase II will optimize and expand the technology and methods demonstrated in Phase I and automate them in a modularized microfabricated configuration. A solid and realistic commercialization plan is essential. Continuance of the effort will depend on the proposer's success in this area as well as technically.

PHASE III DUAL USE APPLICATIONS: 1. Medical diagnostics 2. Industrial monitoring and process control 3. Environmental pollution assessment 4. Military biological field detection. 5. Military personnel and area disease monitoring. 6. Domestic preparedness.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Microfabricated sensors which meet the military's sensitivity and specificity goals would be cheap (possibly to the point of being disposable), take up less space, weigh less, and most likely be easier to operate. All this will serve to lower production and training costs.

KEY WORDS: Microfabrication, microsensors, biosensors.

REFERENCES: Review the last two to three years of Analytical Chemistry to start.

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A99-059 TITLE: Small, Low-cost GPS Anti-jam System

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop a small low cost anti-jam system that uses a single element dual frequency antenna for use in small precision guided missiles.

DESCRIPTION: Current GPS anti jam technology utilizes multi-element antenna array with large antenna electronics. The initial tracking and suppression of a jamming signal is currently slow (>50 ms). This slow response is inadequate for use by small high dynamic precision guided missiles and munitions. Missiles such as Guided MLRS and ATACMS need a system must be able to track and suppress the jamming signal within 10 milli-seconds. Small precision guided missile/munitions can only accommodate a single element antenna. The goal of the anti-jam system is to provide greater than 30-dB protection from single and multiple continuous wave, broadband noise (20Mhz), and pulsed jamming signals. All army systems utilizing GPS could benefit from this topic.

PHASE I: Design an anti-jam system. The size goal of the antenna electronics is a 4x4x1 inch card. The antenna must be a dual frequency single element antenna. The goal for the signal acquisition and suppression time is less than 10 milli-seconds.

PHASE II: Build a prototype system of the design from phase I using best commercial practices. The government will conduct all field and laboratory testing.

PHASE III DUAL-USE APPLICATIONS: The use GPS receivers are becoming widespread on many commercial aircraft. The airwaves are being crowded with various transmitters from radio stations, television stations, and cellular phone networks that could cause commercial GPS receivers to be inadvertently jammed. This device could reduce and possibly eliminate the GPS receiver on commercial aircraft from being jammed.

REFERENCE: NAVSTAR GPS Space Segment ICD-GPS-200, GPS Joint Program Office, September 1997

KEYWORDS: GPS receiver, anti-jam, adaptive null antenna

A99-060 TITLE: Liquid Crystal Polymer as a High-density, High-Reliability, Electronic Substrate Material

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop and validate manufacturing processes for Liquid Crystal Polymer as a high density interconnect substrate for electronics applications.

DESCRIPTION: As electronic assemblies increase in density due to advances made in semiconductor fabrication technology, the ability for standard FR-4 printed circuit boards (PCBs) to route all the interconnections between integrated circuits on a printed wiring assembly is approaching significant limitations. Mass production of PCBs with line/space pitches less than .005 inches are needed but are not generally available at reasonable cost. Circuits operating in the GHz regime need a lower dielectric constant than FR-4 to efficiently carry the high frequency signals. In addition, with a glass transition temperature of approximately 150 degrees C, FR-4 is marginal for high temperature applications. In contrast, liquid crystal polymer (LCP), a relatively new material, has excellent electrical and thermal characteristics (approximately 3.0 dielectric constant,350 degrees C glass transition temperature, coefficient of thermal expansion similar to silicon), and appears to be very amenable to mechanical and chemical processing. Of critical importance in achieving widespread acceptance - the material also appears to be nearly as low cost as FR-4. What is needed is processing development, performance verification, and economic analysis to determine if LCP is a valid material for electronic substrate applications.

PHASE I: Survey supplier base and formulations of LCP for availability as an electronic substrate. Characterize material electrically, thermally, and mechanically. Process using standard PWB/flex circuit fabrication techniques.

Document required process changes and material engineering is needed for optimum performance at lowest material and processing cost. Determine limits in terms of signal trace density, number of layers, thickness, and via diameter/aspect ratio. Perform analysis to determine most applicable PWB market segment (ex: chip scale package redistribution layer, ball grid array substrate, Personal Computer Memory Card International Association-type substrate, high density interconnect, etc.) based on performance/cost benefits. Fabricate test vehicles, populate with components, and perform baseline electrical and environmental tests against FR-4 control boards.

PHASE II: Develop and test new process for low cost fabrication of LCP substrates using as much of the electronics fabrication industry infrastructure as possible. Develop test and quality control procedures. Determine costs for installation and start-up of a dedicated fabrication line. Demonstrate the new substrate technology in a test vehicle approved by the Institute for Interconnecting and Packaging Electronic Circuits (IPC) and Interconnect Technology Research Institute (ITRI). Submit 10 substrates (5 populated) to the Government for independent reliability testing. Develop commercialization plan and investigate commercial marketing with industry partner. Present results at an IPC workshop or conference.

PHASE III DUAL-USE APPLICATIONS: This substrate technology is needed in the military for all lightweight, processing intensive applications such as missile seeker target processing/guidance and control, avionics, and manportable weapons/communication systems. Potential commercial markets are much larger and include portable electronics such as cellular phones, laptop computers, camcorders, and personal digital assistants.

REFERENCES:

1. "Liquid Crystal Polymers and Their Role in Electronic Packaging", K. Jayaraj, et al, Advancing Microelectronics journal, July/August 1998, p. 15-18.
2. "A Low-Cost Near Hermetic Multichip Module Based on Liquid Crystal Polymer Dielectrics", Thomas E. Noll, et al, Proceedings from 1996 International Conference on Multichip Modules, Denver, Colorado.
3. "A Low Cost Multichip Packaging Technology for Monolithic Microwave Integrated Circuits", K. Jayaraj, et al, IEEE Transactions on Antennas and Propagation, Vol. 43, No. 9, September 1995.

KEYWORDS: liquid crystal polymer, printed circuit board, chip scale package, high density interconnect

A99-061 TITLE: Alternative Liner Materials for Main Charge Warheads

TECHNOLOGY AREAS: Weapons

OBJECTIVE: The objective of this SBIR is to identify promising alternate liner materials and designs for main charge warheads used in missile and rocket applications. It is known that some liner materials are more efficient at penetrating materials in multilayer, non-homogeneous targets than conventional copper penetrators. Other advantages can include pyrophoric effects, increased spall generation and increased hole diameter. The desire is to be able to integrate this technology into current and future Army missile systems. Dual-use applications for this technology can be found in the oil well, mining, and law enforcement industries.

DESCRIPTION: The US Army uses some conventional metal liners such as copper,tantalum, and molybdenum for use in main charge warheads. This SBIR will look at alternate materials that could be used as a liner for main charge warheads. The intent is to increase the performance of current main charge warheads and to increase understanding on what materials best defeat threat armors.

PHASE I: Identify candidate materials. Perform research and analysis on how to process and manufacture the raw materials to obtain ductility and strength. Model the warhead using analytical and hydrocode models to optimize performance.Develop trade-offs to determine the maximum thickness and contour of the liner,explosive output, etc.

PHASE II: Raw material purchase, metallurgy, and processing. Manufacture liners and press into billets for performance testing. Perform design iterations until the performance of the main charge is maximized. The test data will be analyzed to determine the effectiveness of the main charge compared to a baseline. Tandem warhead applications will be considered in this effort.

PHASE III DUAL-USE APPLICATIONS: Once Phase II is completed and the test data analyzed a decision will be made if the performance is enhanced enough to go into production as an option for lethality enhancement to a missile system.During Pahse II, the oil well logging services, mining industry and law enforcement services would be briefed on the findings for potential use in their applications. The oil well industry is concerned with better perforation of rock and water filled structures. The military role of perforation of multi-layered targets of various materials is a common theme for their performance requirements. Additionally, the mining industry uses shaped charges to create boreholes that are used for cratering charges. Maximizing the diameter and depth of penetration reflects the problems associated with military applications. Law enforcement applications are common to military ones because of the nature of the targets that they wish to breach.

KEYWORDS: Alternate materials, warheads, explosively formed penetrator's, shaped charges, and liner materials.

A99-062 TITLE: Internet Solutions for Information Integration

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Establish the feasibility of satisfying evolving, information integration battlefield functions using government and commercial internet-related technologies.

DESCRIPTION: Recent digitization experiments have demonstrated that fundamental changes to battle staff operations is required to reap the full battlefield effects of long range sensor and weapon system combinations when under the direct command and control of light, tactical force commanders. This is principally due to the fact that tactical control of longer range, real time sensors: (1) extends the battlespace to include a deep battle area, in addition to the traditional, main battle area, thus increasing the overall volume of targeting and damage assessment information to be managed by the battle staff, and (2) provides direct support for indirect fire weapon systems, thus transitioning the sensor management function into a pro-active, time-critical role. This leads to an increased emphasis on information integration battlefield functions that manage critical sensor and weapon information in a manner that allows immediate comprehension, assessment, and resulting force direction. The problem stated above, is not dissimilar to that presented to and solved by large, commercial operations each year, for they also need information integration capabilities that allow them to manage their business information in a way that allows immediate comprehension, assessment and decision-making. However, technical solutions for business have generally required medium to high communications bandwidth and commensurate processing environments. The internet has changed this solution paradigm. Over the past two years, internet related technology companies have increased their investment in low bandwidth, low cost internet solutions that may lend themselves to support information integration battlefield environments. Innovative research is needed to investigate the feasibility of applying evolving internet-related technologies to the tactical battlefield environment. Viable candidates will be demonstrated in a battlefield test environment.

PHASE I: Identify the information integration functions that are in common between the business and battlefield domains. Establish the tactical environment constraints and define the evaluation criteria. Identify government and commercial internet-related technologies that can support these information integration functions. Perform a feasibility assessment. Identify a "tailored" technology solution set(s) that are feasible for the tactical battlefield environment. Identify the specific Battlefield Operating System (BOS) area to which the solution set will be applied in Phase II. Develop the Phase II Plan.

PHASE II: Acquire and integrate the internet technology solution set and integrate with the specific BOS area software/hardware. Identify candidate demonstrations/experiments opportunities and execute the Phase II Plan to include the development of a detailed experiment plan that addresses experiment design, experiments to be executed, data to be collection and analyses to be performed. Execute the experiment, perform analysis on the collected data, and publish the results in a final report.

PHASE III DUAL USE APPLICATIONS: Any low-bandwidth internet technology solution has potential application across all Battlefield Operating System (BOS) areas. Each BOS area may have a commercial counterpart, e.g., "operations" has information integration functions that are common to both domains.

REFERENCES:

1. "Gates Talks About PCs, the Internet, and Globalization at the World Economic Forum"; PRESSPASS: http://www.microsoft.com/presspass/features/1999/02-01davos.htm; 01 FEB 1999.
2. "Moving JAVA to the Factory"; Robert W. Atherton; IEEE Spectrum Magazine, Vol. 25, No. 12; December 1999.
3. "Military Operations Future Operational Capability", TRADOC Pam 525-66; Department of the Army, Headquarters U. S Army Training and Doctrine Command, 01 May 1997.
4. "Army Digitization Master Plan '96"; U.S. Army Digitization Office; March 1996 N/A

KEYWORDS: information integration, internet, browser, web, multi-media, information management, data compression, tactical communications

A99-063 TITLE: Object Tracking through Rapid Sensor Orientation Change

TECHNOLOGY AREAS: Weapons

OBJECTIVE: The objective is to develop an algorithm for tracking an object through rapidly changing sensor orientation. When the sensor is in motion, the background behind the object can change significantly making an object difficult to track. This is particularly difficult when the relative target/background polarity changes (i.e. light object on dark background becomes dark object on light background and vice versa) or the object is difficult to distinguish from the background. This algorithm shall be developed with the potential for future real-time hardware implementation in a missile.

DESCRIPTION: The application of this algorithm will be focused but not limited to Imaging IR missile target tracking for top attack ground target scenarios. Current missile applications frequently use imaging sensors and tracker lock on before launch to destroy their targets. In some cases it is necessary to have a top-attack scenario to insure an appropriate kill ratio. This top-attack scenario requires that the missile climb rapidly after launch to achieve an appropriate altitude. This rapid climb out scenario can cause drastic changes in the perceived target orientation and background. Innovative new ideas are needed to help insure that trackers can maintain target lock through this rapid sensor orientation change.

PHASE I: Develop innovative new algorithmic approaches to object tracking through rapid sensor orientation change. This algorithm is intended for but not limited to use with existing IR imaging sensor hardware for top attack ground targets. A series of IR image sequences from captive flight tests and/or simulation runs will be made available to the contractor for development. The contractor will demonstrate the capability of the new algorithm against a second set of data and provide a report documenting the algorithm and results.

PHASE II: The contractor will implement the algorithm in Cor C++ software for inclusion into simulations for further testing. The contractor will develop a plan for hardware implementation.

PHASE III DUAL-USE APPLICATIONS: This technology will be used to improve target tracking capability for missile target trackers and also has numerous commercial applications. Commercial applications include: Automated Inspection, Autonomous guided vechicles, and Vehicle tracking. Some references in support of commercial applications in these areas can be found at the following web locations: http://www.sees.bangor.ac.uk/users/dewi/otcs_web.htm Documents the need for an automated tracking system to track a stationary object from a plane or helicopter for power line inspection http://www.neuroinformatik.ruhr-uni Documents the need for a system to estimate the positions and danger potential of other objects for an autonomous vehicle http://www.vision.caltech.edu/koller/ModelTracking.html Documents the difficulty of tracking traffic in road scenes. http://vision.caltech.edu/koller/MOU-83.html Documents the need for a vehicle tracking system that runs in real time.

KEYWORDS: imaging, missile target tracking, top-attack, lock-on-before-launch, close combat, polarity reversal

U.S. Army Medical Research and Materiel Command (MRMC)

A99-064 TITLE: Development of a Personal Environmental Recording System for Monitoring Shock, Motion, and Physiology of Soldiers Wearing Head-mounted Devices

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop a miniaturized personal environmental recording system (PERS) to monitor and store electromyographic data, head/torso posture, and head impact response of soldiers participating in military operations. The system will be used to quantify the exposure environment of soldiers wearing full combat gear plus various helmet-mounted devices (HMDs). The collected data will form a basis for estimating head and neck musculoskeletal injury risks and for prediction of fatigue thresholds in operational environments.

DESCRIPTION: The U.S. Army has an urgent need to accurately monitor and record head impact, upper body dynamics, head posture, and physiological signatures from soldiers operating in harsh military environments. These include running, jumping, ingress and egress from air and ground vehicles, unexpected fall, and parachute opening shock. An inexpensive device is needed to record data from different types of sensors attached to the soldier. The device must be small, lightweight, robust, and self powered with no external cabling to allow the system to be worn by soldiers as they conduct field exercises. Potential sensors include EMG electrodes, accelerometers and angular rate transducers, and relative position sensors. Data may be stored on a soldier-worn device or sent via telemetry to a secondary recording unit. Required signal conditioning and data acquisition modes are sensor and application dependent. The requirement for an integrated PERS, which does not interfere with the soldier's activity, and its use in harsh military environments pose unique challenges that require design innovation. An additional technical challenge is presented by the need to sense, condition, collect and store accurate data, simultaneously in different acquisition modes. Because of the technical risks associated with these challenges, no similar system has been commercially developed. It is essential that the data collected allow accurate biodynamic reconstruction and synchronization with the physiological data. Automated analysis software must be developed as an integral part of PERS to allow convenient and timely post processing (filter, unit conversion, synchronization, graph, display, export, etc.) of the data.

PHASE I: Develop a plan to design a PERS (hardware, software, and instrumentation) into an operational miniaturized system and describe the functional requirements of the various sub-systems. The contractor has significant flexibility in system design to meet the desired objectives. A minimum of three innovative approaches (conceptual designs) should be explored, and a working prototype fabricated of the most feasible design. In this phase, the contractor will demonstrate the concept feasibility by fabricating a prototype that can record 6 head impact acceleration signals, 3 head/torso posture angles, and 6 physiological EMG signals. Minimum sampling rates of 100 Hertz per channel are required for all signals except for head impact accelerations, which require as much as 10 kHz per channel. The PERS should allow continuous data acquisitions for up to 4 hours for all signals, except head impacts, which shall be acquired at the higher rate in short bursts of 250 ms, and allows storage of many such bursts. Calibration, diagnostic and data downloading and post processing procedures shall be demonstrated in the prototype. At the end of Phase I, the prototype shall be delivered to the Army for further testing and evaluation.

PHASE II: Based on critical review of the design and performance of the Phase I PERS prototype, refine its capabilities to resolve identified technical problems. Miniaturize the PERS design into a system that is safe and non-interfering with the soldier's movements, reliable and easy to operate, and has sufficient design flexibility to allow the user to accommodate different mission scenarios by selecting the appropriate data acquisition configurations. A minimum of three PERS units shall be fabricated for testing and field demonstrations. All three systems shall be able to operate simultaneously in close proximity. At the end of this phase, two of the PERS prototype units shall be delivered. A final report on the PERS design and operating instructions shall also be delivered at the end of Phase II.

PHASE III DUAL-USE APPLICATION: A safe, lightweight, man-mounted recording system with appropriate sensors would allow the testing and evaluation of human exposure and tolerance in the area of musculo- skeletal fatigue and injury. Medical personnel concerned with biomechanical stress (e.g., orthopedists, physical medicine and occupational medicine specialists, sport medicine, etc.) routinely seek to quantify physical stress in the workplace. If properly miniaturized and fabricated this device would be a non-intrusive method of gathering occupational health and safety data for symptomatic individuals as well as studying whole occupations in a research setting. Professionals from a wide variety of backgrounds who require monitoring of relative motions of various parts of the human body will find the PERS extremely useful. KEY WORDS: data acquisition, signal processing, telemetry, sensors, physiology, biomechanics, mechanical shock, whiplash, repetitive motion syndrome, neck fatigue, musculoskeletal disorders, head injury.

REFERENCES: Bernard, B.P. (Ed.) 1997. Musculoskeletal disorders and workplace factors: A critical review of epidemiologic evidence for work-related musculoskeletal disorders of the neck, upper extremities, and low back. NIOSH Publication No. 97-141. Cincinnati, OH.

A99-065 TITLE: <u>Systems for Improved Manufacture of Human Fibrinogen</u>

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Development of recombinant human fibrinogen

DESCRIPTION: 50% of KIA's and 25% of DOW's die from uncontrolled hemorrhage. These statistics have not changed for over 100 years. Recent developments have suggested that a fibrinogen based hemostatic bandage can reduce blood loss in severe traumatic and life-threatening hemorrhage and can improve survival. Presently, the cost of fibrinogen makes these bandages extremely expensive and precludes wide spread use and easy replacement as envisioned for local hemostatic agents in combat. The low yield of fibrinogen via present methods (Cohn fractionation) drives the cost. A less expensive manufacturing process would reduce the cost of fibrinogen and make field use of a fibrinogen-based local hemostatic agent feasible. Recombinant methodology would reduce concerns of contamination with blood borne pathogens.

PHASE I: Demonstrate cloning of intact DNA for the three subunits (a, b, and g) of human fibrinogen. Identify vector(s) for optimal transfection of human fibrinogen. Identify cell line(s) for optimal production of functional fibrinogen. Demonstrate chemical and functional equivalence of plasma-derived and recombinant human fibrinogen. Define optimal storage conditions for recombinant human fibrinogen. Perform or participate in preclinical testing of recombinant human fibrinogen to include in vitro testing of clot strength and standard clotting tests.

PHASE II: Define a large-scale process for developing recombinant human fibrinogen. Demonstrate longevity of recombinant human fibrinogen through long term storage studies. Introduce recombinant human fibrinogen to present formulations of fibrinogen-based local adhesive bandages. Perform or participate in 1) preclinical testing of the recombinant human fibrinogen-based local adhesive bandage to include in vivo testing using existing animal models and 2) clinical testing. Candidate products must be tested against the fibrinogen (plasma-derived)-based bandages.

PHASE III: Produce and support recombinant human fibrinogen during its introduction into clinical use.

COMMERCIAL POTENTIAL: Significant worldwide commercial potential provided large scale manufacturing cost is lower than present procedures.

KEYWORDS: hemostasis, trauma, adhesive bandage, fibrinogen, recombinant

A99-066 TITLE: Attractant/Insecticide Combination to Eliminate Transmission of Tick- and Chigger-borne Diseases

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Formulate a product which can be sprayed on vegetation or the ground to attract ticks and chiggers to a toxicant, effectively blocking transmission of Lyme disease, ehrlichiosis, scrub typhus, tick borne encephalitis, and other acarine-borne diseases.

DESCRIPTION: Tick and chigger-borne diseases are major threats to deployed and training troops in many parts of the world. In the U.S., ticks are responsible for transmission of Lyme disease, two kinds of ehrlichiosis, and Rocky Mountain spotted fever -- any of which can be fatal or debilitating. Overseas, ticks transmit many kinds of spotted fevers and encephalitis-producing viruses, as well as the diseases in the U.S. Chiggers transmit scrub typhus in Asia, a disease which was a major hindrance to our forces in World War II and Vietnam. Current tick control involves area-wide application of insecticides such as chlorpyrifos which, although legal, are highly toxic and must be used in relatively large quantities. Chiggers are difficult to control with any insecticide, partly because they can remain hidden in the soil. Although no commercial product is available to attract ticks and chiggers, there is abundant evidence that such chemicals exist. Specifically, the secretions of skin glands in deer are highly attractive to ticks and adult chiggers are attracted to their prey, insect eggs. This project would involve the combination of very small quantities of insecticide in a spray or granule which contains chemicals highly attractive to ticks and chiggers. Because the ticks and chiggers would actively seek the formulation, very little toxic insecticide would be necessary to achieve effective control. The spray or granule would have to be formulated to last at least two weeks in the field, eliminating ticks and chiggers from the areas around encampments or along roadsides. Low toxicity would allow the use of the material in environmentally sensitive areas and where there might be much human activity.

PHASE I: Produce a trial formulation that attracts at least one species of tick or chigger to a toxic compound in the laboratory.

PHASE II: Expand tests of effectiveness of formulation to major species of vector ticks and chiggers world-wide, using laboratory tests where appropriate. Perform at least three field trials, showing effectiveness against at least two species of ticks and one species of chigger. Develop data for EPA registration.

PHASE III: The product from this project would have great potential for dual use application. Ticks are responsible for the greatest number of arthropod-borne diseases in the U.S. An effective, environmentally friendly, and safe product for tick and chigger control could be used by literally millions of customers in the U.S. and abroad for control of ticks transmitting Lyme disease, ehrlichiosis, and spotted fevers -- all diseases of major public concern. The environmental safety of such a product would make it suitable for use in national parks, near ponds, and in other sensitive areas where people often encounter ticks and chiggers.

KEYWORDS: tick, chigger, insecticide, attractant, disease, force multiplier

A99-067 TITLE: Biological Agent Sample Preparation for the Detection and Identification of Multiple Agents by Nucleic Acid-based Analysis

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop a rapid and relatively simple method(s) forpreparing nucleic acid from threat agents of biological origin (anthrax, plague, Brucella, Clostridium, Venezuelan equine encephalitis virus, and more) and endemic infectious diseases (malaria, enteric disease, dengue viruses, hantaviruses, Filoviruses and more) with either DNA or RNA genomes from clinical samples including blood, or swabs of potentially contaminated areas. Procedures that minimize labor-intensive steps, maximize automation and interface with portable, integrated detection devices will be given the highest priority.

DESCRIPTION: Modern molecular biology techniques are able to rapidly and accurately detect and identify negligible amounts of pathogen nucleic acid. In vitro amplification procedures such as polymerase chain reaction, are able to detect fewer than 100 copies of agent and can distinguish single base pair differences. This technology could be a powerful weapon against endemic infectious disease agents andbiological warfare agents that threaten troop readiness. However, full implementation and benefit of this technology is hindered by sample preparation procedures. Current sample preparation procedures often employee hazardous materials that require special handling and disposal, and are labor-intensive, requiring many hands-on manipulations that overtime degrade the performance of the assays. This problem is further exacerbated by the variety of agents and sample matrices encountered. Agents can have either DNA or RNA genomes; can exist in different forms, e.g., spore versus vegetative cells; and can be found in sample matrices such as clinical specimens including blood, urine, or saliva; or such as swabs of potentially contaminated areas. The Department of Defense field medical laboratories and counter terrorist response teams need new procedures to rapidly and simply prepare samples for nucleic acid based detection assays. This technology should be compatible with the Department of Defense's goal of developing a portable, integrated nucleic acid detection system.

PHASE I: Initial studies should focus on adapting government requirements to currently working sample preparation procedures. Commercial partner would work closely with government scientists to test procedures and instrument design. Proposed technologies should be able to prepare samples for testing 3-5 biological agents to include at least one agent with an RNA genome in addition to agents with DNA genomes. Preference will be given to procedures that employ a single technology to prepare both types of nucleic acid. Integration of the sample preparation procedure into an amplification/ detection system is desirable. Technologies other than PCR are encouraged. Sample preparation technology should be capable of miniaturization. Approaches will be evaluated for sensitivity, specificity, ruggedness, and ease of use. The government will supply information and selected reagents as appropriate for a demonstration of proof of concept.

PHASE II: After demonstration of a proof of concept in Phase I, the commercial partner would optimize procedures to prepare nucleic acid from samples for testing for 10 different biological agents(TBD) and construct prototype devices for field testing at government facilities.

PHASE III DUAL USE APPLICATIONS: At least 5 working devices to test the 10 different agents would be required as a final deliverable after a performance review of prototype devices. The commercial partner would lead the design and assembly of the system into fieldable kits based upon established government protocols. Reagents, preferably in lyophilized form, must be stable for at least 1 year at ambient temperatures. Kits for at least 1000 specimens will be included as a final deliverable. There are universal applications for the proposed technology. Sample preparation is a major stumbling block to the full implementation of gene amplification technology. Estimated size of the commercial diagnostic device market in the United States is over $5 billion per year. The ability to prepare DNA and RNA for in vitro amplification by a simple, rapid procedure will greatly facilitate the utilization of this technology and increase its benefits. A simplified, sample preparation procedure for both DNA and RNA would be broadly accepted by the research and diagnostic community currently using PCR and other gene amplification procedures.

KEYWORDS: diagnostic assays, nucleic acid amplification, fieldable devices

A99-068 TITLE: Non-invasive Pneumothorax Detection for High-noise Environments

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop a low power, lightweight, hand-held, non-invasive Pneumothorax detector which will allow accurate diagnosis of pneumothorax in environments having high acoustic and electromagnetic noise levels.

DESCRIPTION: A significant fraction of salvageable battlefield casualties die of unrecognized pneumothorax (air in the intra-pleural space) which progresses to cause a tension pneumothorax. This condition compromises cardiac output and oxygenation of the blood. Life-saving treatment is relatively easily implemented by simple introduction of a tube through the chest wall into the air space to allow for relief of the pressure and re-inflation of the lungs. However, diagnosis of this condition is difficult and in fact impossible in high noise environments such as is encountered on the battlefield or even in the back of civilian ambulances. Such a device would assist medics in the early diagnosis of this condition and would save lives.

PHASE I: Identify a methodology for accurately (down to 50 ml) detecting air in the chest cavity which has the potential for producing a lightweight (less than 1 lb.),low power solution and has a minimal electromagnetic signature. Capability to localize the margins of the air embolus is highly desirable to assist the chest tube placement decision. Build a proof-of-principle prototype to establish the feasibility of the approach using studies of animal models. Explore the potential for the method to be "tuned" to also detect fluid accumulation in the abdominal cavity to expand utility of the device.

PHASE II: Adapt proof-of-principle design to one that considers human factors, ease-of-use, size, power and producability issues. Build a prototype which would qualify for human use and clinical evaluation studies. Demonstrate the sensitivity and specificity limits in human studies comparing localization and size of the pneumothorax with current standard evaluations.

PHASE III DUAL USE APPLICATIONS: Pneumothorax detection is not only a problem in the military environment but is also a problem in civilian pre-hospital settings. This technology would be a life-saving asset for civilian paramedics and would be of potential monitoring benefit in the hospital setting where pneumothorax is a risk factor in placement of central venous lines.

KEYWORDS: pneumothorax detection, lungs, non-invasive, noise resistant, computer-assisted diagnosis

A99-069 TITLE: Interrogatable Micro-environmental Sensor Pod for Dismounted Infantry

TECHNOLOGY AREAS: Biomedical, Materials/Processes

OBJECTIVE: Design and build an innovative low cost, low power, radio-interrogatable micro-environmental sensor pod and remote receiver system to evaluate ground level environments relevant to dismounted infantry operations in open, wooded, or urban terrain.

DESCRIPTION: There is a continuing need for an easily deployable autonomous environmental monitoring system to support real-time local/small unit infantry operations. In use, a constellation of sensor pods would be "seeded" or deployed across an operational area in advance of, or during, an operation. Depending on scenario, these pods could be considered recoverable or expendable. Because the relevant environment is generally between the ground surface and man height above ground, system packaging must have provision for hasty attachment to a variety of contingency stand-off supports that might include local vegetation or manmade structures. The pod sensor suite will consist of air temperature, humidity, wind speed, wind direction, mean radiant temperature, barometric pressure, rainfall rate, and geo-location. Total weight for an integrated completely weatherproof pod, containing power supply, radio, and sensor suite must not exceed 12 ounces. Radio interrogation ranges will be at least 2 miles, 5 miles, and 10 miles in urban, wooded, and open terrain respectively. Pod power will be sufficient for 72 hours of operation at 15 minute interval interrogation/download rates. The small unit-level command and control remote receiver component will be a hand-held computer with the appropriate radio interfaces and software to interrogate each pod, receive current data, and automatically create a file archive of all time/location-stamped data. These files would be used in producing a variety of onboard weather/terrain related geospatial informational products and predictive model displays relevant to dismounted infantry. Files on the remote receiver system could also be accessible via wireless battlefield Local Area Network (LAN) resources for real-time aggregation and fusion at higher echelon battlefield command and control systems.

PHASE I: Develop overall system design, to include a high level hardware firmware/software requirements document as well as a weight and power requirements budget specification for integrated sensor pod and remote receiver.

PHASE II: Build and demonstrate a working prototype system of eight integrated sensor pods and two base station receivers. Conduct preliminary wind tunnel and field testing to determine overall accuracy/precision of the sensor suite, radio communications range limits, and data loss rates relevant to establishing system feasibility in battlescale scenarios.

PHASE III DUAL USE APPLICATIONS: The system would have significant potential for use in real-time forestry/fire management applications for predicting firefighter heat stress risks and for tracking fire path, and, in civil defense applications, downwind toxic/smoke hazard prediction. In conjunction with a chemical or biological agent detector and appropriate models, the system could provide a complete, rapidly deployable tool for real-time mapping of vapor or particle diffusion/dispersion patterns as well heat injury risks to encapsulated personnel.

KEYWORDS: Environmental sensor suite, weather effects, models, cold stress, heat stress, infantry

A99-070 TITLE: Portable Oxygen Generators

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To develop a lightweight, compact oxygen generator for use in forward medical treatment areas and casualty transport vehicles.

DESCRIPTION: Develop a lightweight electrically powered oxygen generator capable of producing 99% oxygen by concentrating atmospheric oxygen or decomposing water. The oxygen generator will produce oxygen at a pressure of at least 5-psi and a flow rate of at least 3 standard liters per minute (slpm). The oxygen generator may incorporate demand flow control technology but will have to produce at least 3slpm continuously. The oxygen generator could use pressure swing adsorption , ceramic membrane, electrochemical cell, proton exchange membrane electro-chemical cell.

PHASE I: Investigate feasibility and design constraints necessary to initiate developmental work. Fabricate a prototype oxygen generator that produces oxygen continuously at a pressure of 5-psi. The PHASE I prototype may be a sub scale generator that demonstrates the operating principle at a reduced flow rate.

PHASE II: Continue to develop the generator through a series of improved prototypes until a full performance prototype is ready for Food and Drug Administration approval.

PHASE III DUAL-USE APPLICATIONS: The oxygen generator would be directly applicable to the home oxygen therapy market. Currently this market sells over 100,000 oxygen generators per year.

KEYWORDS: oxygen generators, medical devices, electro-chemistry, ceramics, zeolite

A99-071 TITLE: Systems for Improved Homeostasis

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Improve hemostasis with fibrinogen-free local hemostatic bandage.

DESCRIPTION: 50% of KIA's and 25% of DOW's die from uncontrolled hemorrhage. These statistics have not changed for over 100 years. Local adhesive agents fall into two classes: 1) liquid sealants or glues and 2) bandage type sealants. Only the bandage formulations are appropriate for massive trauma. Recent developments have suggested that a fibrinogen based hemostatic bandage can reduce blood loss in severe traumatic and life-threatening hemorrhage and can improve survival. Presently, the cost of fibrinogen makes these bandages extremely expensive and precludes wide spread use and easy replacement as envisioned for local hemostatic agents in combat. A less expensive bandage, as effective as fibrinogen formulations, would make field use of a local hemostatic agent feasible.

PHASE I: Identify the fundamental components critical for an effective local hemostatic bandage. Identify those agents (cryoprotectants, drying agents), acceptable for human use, to be used in the stabilization of the bandage during processing. Define storage conditions not requiring processing of bandage before use.

PHASE II: Define a large-scale process for developing the bandage. Demonstrate longevity of bandage through long term storage studies. Perform or participate in 1) preclinical testing of the bandage to include in vitro testing of clot strength and in vivo testing using existing animal models and 2) clinical testing. Candidate products must be tested against the fibrinogen-based bandages.

PHASE III: Produce and support such a bandage during its introduction into clinical use.

COMMERCIAL POTENTIAL: Significant worldwide commercial potential provided product demonstrates efficacy in microvascular and severe traumatic hemorrhage.

KEYWORDS: hemostasis, trauma, adhesive bandage

A99-072 TITLE: Development of novel procedures for determination of Immunologic Consequences of Repeated exposures of Homologous Cholinesterases in Nonhuman Primates

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Cholinesterases have been proven to be effective bioscavengers of toxic organophosphates in animals. However, when butyrylcholinesterase from another species (heterologous enzyme) is repeatedly injected into animals, antibodies against the enzymes are elicited. Although these antibodies cause no behavioral consequences, in response to repeated injections of butyrylcholinesterase, the concentration of antibodies gradually increases, neutralizing subsequently administered free enzyme. Such neutralization of free butyrylcholinesterase in circulation negates its properties as a bioscavenger for toxic organophosphates. This immunological response has not been tested with homologous cholinesterases, i.e., with enzyme from the same species. If human butyrylcholinesterase is to be used in battlefield conditions as a prophylactic treatment drug for nerve gas exposure to soldiers, and if the expectation is that the protective enzyme would be used more than once in a soldier, then knowledge of the immunologic consequences, or the lack thereof, is essential. The objective of this proposal is to devise novel ways to test the administration and immunoreactivity of serum butyrylcholinesterase isolated and purified from nonhuman primates and administered to the same species. Proof of the safety and efficacy of a biological product derived from human plasma is required before the biological product can be employed as a treatment drug or vaccine. One of the newer approaches to this proof, which is approved by the FDA, is the testing of such a biological product in nonhuman primates. Results obtained from these studies can be extrapolated for human IND studies in the FDA preproposal process for the use of human serum butyrylcholinesterase in humans as a pretreatment or treatment drug for chemical agent exposure.

DESCRIPTION: Butyrylcholinesterase present in the serum or plasma of nonhuman primates will be collected, isolated, and enriched. When adequate amounts of enzyme have been obtained, animals of the same species will be repeatedly exposed to the enzyme by means that mimic its use in battlefield conditions. Response to repeated exposures will be monitored by devising novel methods to assess circulating levels of free enzyme and anticholinesterase antibodies.

PHASE I: (1) Collect plasma from nonhuman primates. (2) Isolate and enrich butyrylcholinesterase. (3) Expose animals to butyrylcholinesterase and devise methods to monitor appearance in circulation of free enzyme and anticholinesterase antibodies.

PHASE II: Continue (1) collection of plasma and (2) isolation and enrichment of butyrylcholinesterase. (3) Repeat exposures with monitoring of free enzyme and antibody response.

PHASE III DUAL USE APPLICATIONS: Demonstration that single or repeated injection of homologous cholinesterases had no immunological consequences would provide initial data leading to a pretreatment agent not only for soldiers but for any other first responders (civilians) to terrorist nerve gas release/attack or pesticide overexposure. It will also provide treatment for cocaine overdose. Prior to IND studies, the FDA requires that a biological product be tested for lack of immunoreactivity in nonhuman primates. Therefore a need exists to study in monkeys or chimpanzees the immunologic response of repeated injections of homologous butyrylcholinesterase. The data derived from such a study can be submitted as a prerequisite to IND Phase I studies in humans with human butyrylcholinesterase as a bioscavenger for organophosphates. The study will allow development of techniques for pre-IND testing of drugs in primates as well as producing blood products for commercialization. Products arising from this project are (1) development of a procedure which can be used for testing biological products in pre-IND studies, i.e., vaccines, neuroactive enzymes, recombinant proteins, other macromolecules, (2) experience in and guidelines for setting up such studies, and (3) blood products, which have potential commercial value as useful reagents and test materials. Note: We know of at least three small businesses that have the facilities and resources to pursue such a study and are interested in submitting proposals.

KEYWORDS: Cholinesterases, nonhuman primates, anticholinesterase antibodies, chemical agents, pesticides, cocaine.

REFERENCES:

1. Ellman GL, Courtney KD, Andres V Jr., Featherstone RM: A new and rapid colorimetric determination of acetylcholinesterase activity. Biochem. Pharmacol., 7:88-95, 1961.
2. De La Hoz D, Doctor BP, Ralston JS, Rush RS, Wolfe AD: A simplified procedure for the purification of large quantities of fetal bovine serum acetylcholinesterase. Life Sci., 39:195-199, 1986.
3. Gentry MK, Nuwayser ES, Doctor BP: Effect of repeated administration of butyrylcholinesterase on antibody induction in rabbits. Proc. USAMRDC 1993 Medical Defense Bioscience Review, May 1993, pp. 1051-1056.
4. Doctor BP, Blick DW, Caranto G, Castro CA, Gentry MK, Maxwell DM, Murphy MR, Schutz M, Waibel K, Wolfe AD: Cholinesterases as scavengers for organophosphorus compounds: Protection of primate performance against soman toxicity. Chem. Biol. Interact., 87:285-293, 1993.
5. Genovese RF, Lu X-CM, Gentry MK, Larrison R, Doctor BP: Evaluation of purified horse serum butyrylcholinesterase in rats. Proc. USAMRDC 1993 Medical Defense Bioscience Review, May 1993, pp.1035-1042.
6. Gentry MK, Nuwayser ES, Doctor BP: Immunological effect of repeated administration of cholinesterases in rabbits. Proc.1996 Medical Defense Bioscience Review, May 1996, pp. 183-191.
7. Matzke SM, Oubre JL, Caranto GR, Gentry MK, Galbicka G: Behavioral and immunological effects of exogenous butyrylcholinesterase in rhesus monkeys. Pharmacol. Biochem. Behav. In press.

A99-073 **CANCELLED**

A99-074 TITLE: Non-intrusive Lactate Sensor

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To develop a light-weight, rugged, non-invasive sensor which could be worn or applied to the skin to detect tissue serum lactate concentration.

DESCRIPTION: To enable the combat medic to accurately assess the physiological status of an injured soldier, light-weight, rugged, and non-invasive physiological sensors are needed which can be used to continuously monitor the soldier's medical status. Determining which patients require fluid resuscitation based upon metabolic status of the casualty would improve the combat medic's ability to differentiate soldiers with significant blood loss, from those with minimal metabolic derangement. Currently, serum lactate is utilized in the hospital environment to evaluate the not only the effectiveness of resuscitation from hemorrhagic shock, but the level of metabolic derangement secondary to acute blood loss. Recent studies have indicated that serum lactate may be the best indicator not only severity of circulatory shock states, but also of the adequate restoration of intravascular volume status. However, current technology precludes measurement of lactate except by removing a sample of blood, which currently limits this parameter to the hospital setting. This proposal requires the development of a sensor to be used in a non-invasive fashion to measure tissue blood lactate concentration.

PHASE I: Develop system design and demonstrate ability of the sensor to non-invasively measure lactate in relevant physiological ranges of normal and shock states.

PHASE II: Develop and demonstrate a prototype sensor in a realistic environment. Conduct testing to prove accuracy during shock states.

PHASE III: POTENTIAL COMMERCIAL MARKET: This sensor could be used in civilian emergency and critical care medicine to monitor tissue perfusion, severity of shock states, and level of resuscitation.

REFERENCES:
1. Elliott DC. An Evaluation of the Endpoints of Resuscitation. [review] J Amer Coll Surg. 187(5):536-47, 1998.
2. Porter JM, Ivatury RR. In search of the optimal end points of resuscitation in trauma patients: a review. [Review] J Trauma. 44(5):908-14, 1998.
3. Regel G, Grotz M, Weltner T, Sturm JA. Tscherne H. Pattern of organ failure following severe trauma. World J Surg. 20(4):422-9, 1996.
4. Mikulaschek A, Henry SM, Donovan R, Scalea TM. Serum lactate is not predicted by anion gap or base excess after trauma resuscitation. J Trauma. 40(2):218-22; discussion 222-4, 1996.

KEYWORDS: sensors, biomedical device, lactate, non-invasive, shock, resuscitation, injury

A99-075 TITLE: Blast Mitigation Jacket for Training

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop a lightweight jacket that modifies the impulsive noise loading to the thorax so that nonauditory effects can be mitigated.

DESCRIPTION: Soldier training using certain large caliber weapons, shoulder-fired anti-material weapons, and weapons fired from enclosures exceed tolerances for nonauditory injury, in particular injury to the lung from rapid chest wall motion. When these limits are exceeded, occupational safety considerations require that training be restricted or prohibited. Although this is a valid occupational concern, these limitations in training decrease the soldier's effectiveness in actual combat deployment and, therefore, could be detrimental overall. Considerable research has been conducted to determine the biomechanical origin of this injury and some studies have shown that certain aspects of clothing, especially the effects of trapped air and areal mass density, can modify the loading seen by the body and therefore modify the biomechanical response. Other studies have shown that increasing the duration of loading, even if total impulse is not changed, can dramatically reduce traumatic body response.

PHASE I: Demonstrate the feasibility of using clothing materials, combined with control of air spaces, to alter the thoracic loading and to reduce the anticipated nonauditory hazard. Use the prototype tests to estimate the amount of protection in terms of jacket weight and bulk.

PHASE II: Refine and improve promising design concepts. Work with Army materiel developers to identify ways to incorporate these blast mitigation features into standard training clothing, if possible. Demonstrate the increased protection using actual jackets and anthropomorphic dummies.

PHASE III DUAL USE APPLICATIONS: The modification of impulsive loading to the body and subsequent reduction of trauma is a component of the design of ballistic garments worn by law enforcement and by bomb disposal personnel.

REFERENCES:
1. J.H. Stuhmiller, K.H.H. Ho, M.J. Vander Vorst, K.T. Dodd, T. Fitzpatrick, M.A. Mayorga. (1996) A Model of Blast Overpressure Injury to the Lung. J. Biomech., 29:227-234.
2. J.H.Y. Yu, E.J. Vasel, C.J. Choung, J.H. Stuhmiller (1985) Effects of Clothing on Thoracic Response. Final Report Contract DAMD17-82-C-2062. NTIS, Arlington, Virginia.

KEYWORDS: blast injury, explosives, protective clothing, soldier training

A99-076 TITLE: Non-invasive, Lightweight Cardiac Output Detection for Use in the Battlefield and High Noise Environments

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop a low power, lightweight, hand-held, non-invasive cardiac output measurement device which will allow accurate continuous measurement in environments having high acoustic and electromagnetic noise levels

DESCRIPTION: Cardiac output measurement in the hospital setting is currently accomplished by both invasive and non-invasive techniques, however, invasive techniques remain the most reliable standard. Although non-invasive cardiac output measurement using thoracic impedance has found some clinical application, the low level electrical signals used in this technique are very susceptible to electromagnetic interference and motion artifact. Unfortunately, these conditions are commonly encountered in the environments of military field medicine as well as in civilian pre-hospital emergency medical systems. Determination of cardiac output and blood pressure non-invasively and continuously, would give an excellent characterization of the cardiovascular system and would have great value in the management of shock and trauma as well as monitoring soldier physical performance parameters for operational medicine applications.

PHASE I: Identify a methodology suitable for accurately measuring cardiac output non-invasively over the range of 1 to 20 L/min which has the potential for producing a lightweight (less than 1 lb.), low power solution having a minimal electromagnetic emission signature and low susceptibility to electromagnetic environments. Focus on resistance to motion artifact is also important. Two design configurations are desired, one for ambulatory monitoring and one for hand-held use by a medical caregiver. Build a proof-of-principle prototype to establish the feasibility of the approach using studies of large animals and/or humans.

PHASE II: Adapt proof-of-principle design to one that considers human factors, ease-of-use, size, power and producibility issues. Build and deliver a prototype which would qualify for human use and clinical evaluation studies. Demonstrate the sensitivity and accuracy in human studies comparing the technique with accepted methods of cardiac output measurement.

PHASE III DUAL USE APPLICATIONS: A non-invasive, continuous means of assessing cardiac output would find ready application in both the military and civilian acute trauma care settings. Ambulatory monitoring is needed in the military for soldier performance and readiness evaluations and in the civilian home medical care environment for possibly post-operative follow-up or chronic care of the elderly or chronic cardiac cardiovascular

KEYWORDS: pneumothorax detection, lungs, non-invasive, noise resistant, computer-assisted diagnosis

A99-077 TITLE: Stabilization of Critical Reagents

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: To demonstrate technology for stabilization of reagents used in diagnostic assays at or above ambient temperature.

DESCRIPTION: Multiple types of reagents are used in carrying out diagnostic assays. Currently, the long-term stability of these reagents is limited at temperatures above -20 C. Traditional methods of stabilization such as lyophilization offer improvements but may not meet future military requirements. Department of Defense field medical laboratories and counter terrorist response teams use diagnostic assays capable of detecting and identifying a wide array of biological threats. Deployment of these laboratory assets often exposes equipment and reagents to environmental extremes include high temperature and humidity. Because these laboratory assets may be located in inhospitable and remote locations, electrical power may be unreliable or non-existent. Therefore, it is essential that methods for the stabilization of critical reagents be developed such that refrigeration is not required. To meet the demands for reagent stability, a method or methods for preservation must be developed to maintain the specific activity of reagents at or above ambient temperature for one year. Reagents of interest include protein antigens, antibodies, other protein ligands, genomic length nucleic acids (both RNA and DNA), oligonucleotides, enzymes, and enzyme substrates. Procedures for stabilizing reagents in single and multiple use containers and in multi-well plates and reaction tubes should be developed. Technologies that reduce the effort and time associated with reagent reconstitution will be given the highest priority. All technologies being considered must interface seamlessly with standard assay protocols and formats including ELISA and PCR.

PHASE I: Initial studies should focus on the development of a process for stabilizing reagents using prototype technologies. Commercial partners would work closely with government scientists to choose reagents and assay formats for evaluation and for the testing of the final products. Proposed technologies should be able to stabilize reagents of interest at 25-30 C with no loss in activity for up to one year. Accelerated stability testing data are sufficient for this stage of work. A loss in activity will be detected by comparing the activity of reagents stabilized using traditional procedures (lyophilization and/or refrigeration) with those stabilized using the technology being tested. The government will supply selected reagents for a demonstration of proof of concept.

PHASE II: After demonstration of a proof of concept in Phase I, the commercial partner would optimize stabilization procedures to function with diagnostic reagents necessary to complete eight different diagnostic assays (four immunodiagnostic-based and four nucleic acid-based). Full chemistries and protocols for stabilization of all reagents necessary for the eight diagnostic assays will be included as a final deliverable after a performance review of phase II data. For evaluation of the stabilization technology under a variety of environmental conditions, the partner will deliver stabilized reagents necessary to complete 500 each of the eight assays in an appropriate format. Phase III: The commercial partner would lead in the large-scale production of stabilized reagents for use by the military or be willing to license the necessary technologies to other interested manufacturers. Stabilization of diagnostic reagents would be of prime concern to all commercial organizations wishing to increase shelf life especially those producing assays for field and environmental use and could lead to important benefits to the commercial partner.

KEYWORDS: diagnostic assays, reagent stabilization

Natick Soldier Center (NSC)

A99-078 TITLE: Nanotechnology for Ballistic Protection

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop nanocomposite materials to be used in personnel armor for ballistic protection. Utilize emerging nanotechnology to achieve increased protection and/or lighter weight at the same level of protection in small-arms protective vests, plates and helmets.

DESCRIPTION: Recent developments in materials research have shown that it is possible to achieve a non-linear enhancement of material properties in composite systems where the size of the phase domains is in the nanometer range. Examples include the numerous reports of small amounts (5-10%) of silicate nanoparticles (such as montmorillonite clays) giving rise to the same level of mechanical properties in polymers as are typically achieved with loadings of 30-50% of micron-sized fillers. Performance enhancement of this type has not been reported yet in the area of ballistic impact resistance. It may be, however, that fully dispersed nanometer scale reinforcing fillers will be able to enhance the energy absorbing capacity and ballistic impact resistance of polymer matrix composites or other composite materials. One proposed mechanism for realizing such performance is the potential of the interphase region of a particle-filled composite to absorb energy. The relative volume of material residing in the interphase zone of a nanocomposite is significantly larger than in composites of larger domain size. It may also be the case that high aspect ratio nanoparticles with anisotropic orientation will assist in distributing the energy of ballistic impact more effectively through a composite material than an isotropic composite with spherical reinforcing particles. Promising nanocomposite materials might be high-impact polymers modified with nanoparticle or nanofiber reinforcement at low levels of loading, or polymer composites highly loaded with hard ceramic particles which might perform the function of current ceramic armor plates but with enhanced toughness and lighter weight. Other nanoscale architectures, such as nanolaminating of materials with varying hardness may give rise to enhanced impact properties. Inducing anisotropic orientation of nanostructural features via processing methods may also be beneficial to impact properties.

PHASE I: Identify the most promising nanocomposite material or materials for armor applications. Fabricate flat test panels of the nanocomposite material, suitable for ballistic testing at Natick Soldier Center. The ratio of areal density to level of ballistic protection will be a critical factor in determining the success of Phase I. The new technology should represent significant progress toward the current Army goal for personnel armor of an areal density of 3.5 lb/ft2 able to defeat all types of 7.62mm bullet threats.

PHASE II: Design an armor material system incorporating the new nanocomposite material. Fabricate full-scale samples of this concept armor for ballistic testing. Prepare prototype helmets and/or ballistic protective plates and/or vests using the new armor materials for field testing.

PHASE III DUAL USE APPLICATIONS: Law enforcement, security police and armored car personnel are all potential users of lightweight personnel armor.

REFERENCES:

1. Gonsalves, K.E. et al., Mechanistic investigation of the preparation of polymer/ceramic nanocomposites, NanoStructured Materials, vol. 9, pp. 181-184, 1997. Elsevier.
2. Apte, P. et al., Hardness measurements of nanophase Al/Al-Oxide consolidated components. NanoStructured Materials, vol. 9, pp. 501-504, 1997. Elsevier.
3. Niu, C. and Moy, D., Preparation of silicon carbide nanofibrils from vapor grown carbon nanotubes. Mat. Res.Soc. Symp. Proc. 410, pp. 179-184, 1996.
4. Pinnavaia, T. et al., Clay-reinforced epoxy nanocomposites: Synthesis, Properties and Mechanism of Formation. ACS Symposium Series 622 (Nanotechnology) pp. 251-261, 1996.

KEYWORDS: Ballistic protection, armor, bullet resistant, small arms, nanotechnology, composites, nanoparticles, polymers, materials

A99-079 TITLE: Novel Forming Techniques of Complex Shapes in Personnel Armor

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop innovative net/near-net shape forming techniques for complex shapes in textile-based personnel armor to improve performance and comfort.

DESCRIPTION: Current manufacturing techniques for textile-based personnel armor focus on constructing complex shapes from orthogonal woven fabrics or flat sheets of nonwoven materials. In order to minimize potential vulnerabilities, cut surfaces are overlapped thus leading to increased weight and reduced comfort. These techniques can also lead to higher cost through added materials handling and material waste. Research and development are required to establish net or near-net shape forming techniques which maintain the ballistic integrity demonstrated by conventional armor systems but minimizes weight, vulnerability and cost. Performance to weight ratios should be maintained or increased (e.g., 9mm/fragmentation protection at 1.0-1.1 lb/sq ft). The approach should be conducive to forming the compound shapes that are required to cover various areas of the body such as the head, breast, shin and arm. Potential approaches may include weaving technology or any other method such as deep drawing processes that would utilize flat materials without introducing overlap to form curved shapes.

PHASE I: Determine the feasibility of the approach to form the complex shapes by fabricating and testing sample panels. Identify potential weaknesses in terms of ballistic vulnerability.

PHASE II: Refine the approach and demonstrate the application of the technology in final configuration through construction and evaluation of item prototypes (e.g., helmet and/or female vest) which are of similar or lighter areal density and provide levels of protection equal or better than the conventionally formed armor systems. Provide final technical report with technical data package.

PHASE III DUAL USE APPLICATIONS: This technology will be directly transferable to the law enforcement body armor industry as well as to other personnel protective applications such as impact resistant helmet. The recreational sports industry would also benefit from near net shape forming methodology.

REFERENCES:
1. Bottger, Christian (Akzo Noble Faser AG), Comfortable Bullet-proof Vests for Ladies, Personal Armour Systems Symposium 96 Proceedings, 3-6 September 1996, published July 1996.
2. Lastnik, A.L., A Photo Computer Technique for the Design and Analysis of Personnel Protective Equipment. USNRDEC TR76-2, CEMEL Oct 76
3. Cunniff, Philip M., A Semiempirical Model for the Ballistic Impact Performance of Textile-Based Personnel Armor, Textile Research Journal 66(1), 45-59, 1996

KEYWORDS: Personal armor, ballistic protection, textile technology, net shape weaving, draws forming

U.S Army Space and Missile Defense Command (SMDC)

A99-080 TITLE: Common Sense Reasoning to Locate Threats

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Prototype intelligent agent incorporating common sense via a large, multi-contextual knowledge base and inference engine to assist in locating mobile threats soon after detection.

DESCRIPTION: Many warfighters are overwhelmed by the very information they need to master in order to effectively execute their mission. Commanders need state-of-the-art technologies to assist their better understanding and awareness of the battlefield. State-of-the-practice artificial intelligence (AI) methods generally fall short of this goal because they lack the robustness derived from common sense (a basic understanding of physics and the human condition) reasoning. Common sense is required to disambiguate human language, battle situations, information requirements, and battle plans. Unfortunately, common sense is not easily elicited, represented, or automated for reliable human operator performance augmentation. Therefore, a large, multi-contextual knowledge base and inference engine is the ontology for all but the most well bounded problem domains. A knowledge base architecture representation of common sense with associated inferencing capability is required to assist the warfighter in filtering and presenting information about the most likely location and intentions of a mobile threat and associated threat facilities shortly after detection. In addition, the required approach must be flexible and robust enough to cope with emerging battlefield conditions, large quantities of data from disparate sources, missing or corrupt data, and evolving tactics all in real time.

PHASE I: Design and model the most promising method, tool, and/or language containing a large, multi-contextual knowledge base and inference engine for generic common sense and application domain common sense to locate mobile threats and associated facility threats shortly after detection. Demonstrate feasibility of the technology for this application using a simple scenario. The scenario does not have to be military in origin, but must be applicable to the basic problem. Develop a plan for commercial use of the final product.

PHASE II: Develop and test a prototype product that runs in real time on COTS hardware based on the robust intelligent agent proposed in Phase I. Conduct tests to demonstrate military and/or commercial utility and effectiveness in the presence of missing and corrupt data. Demonstrate the commercial utility of the application through simulation and testing. Develop a Phase III commercialization strategy.

PHASE III DUAL-USE APPLICATIONS: Pilots, stockbrokers, design engineers, doctors, lawyers, military commanders, and many other professions now have much more data available to support decisions than can be read or reviewed on a computer. Any AI application that demonstrates common sense in the processing of this information will have many uses in the commercial world.

REFERENCES:

1. http://mitpress.mit.edu/e-books/Hal/chap9.java/nine1.html
2. http://www-formal.stanford.edu/jmc/generality/node7.html
3. http://sunsite.informatik.rwth-aachen.de/dblp/db/conf/kr/kr96.html#McC arthy96

KEYWORDS: common sense, artificial intelligence, information processing, knowledge base, inference engine, expert systems

A99-081 TITLE: Mitigation of Magnetohydrodynamic Electromagnetic Pulse Effects on Long Lines for Missile Defense System and Infrastructure Protection

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Identify, develop, and demonstrate low-cost techniques to protect military and critical infrastructure systems with long power and communication lines from the effects of MHD-EMP.

DESCRIPTION: Ground based missile defense systems and their supporting infrastructures rely on long line cables for power and communications. Solar geomagnetic storms in northern areas have disrupted equipment on the long lines of protected electrical distribution systems [Reference 1]. The response of nuclear MHD-EMP (E3) is similar to that produced by solar geomagnetic storms, but has somewhat greater electric field intensity [Reference 2] and both can induce very high ground currents that can burnout AC transformers and cause other problems. Because defense systems rely heavily on commercial infrastructure, we propose to develop low-cost, widely-applicable mitigation technologies to alleviate the effects of MHD-EMP on military systems and their supporting infrastructure. Mitigation will require safe and effective dissipation of very large currents and energy. Reference 2 provides an unclassified overview of the MHD-EMP environment.

PHASE I: Analyze, design, and conduct proof-of-principle demonstrations of practical techniques to ensure operability of long-line electrical and communication systems in MHD-EMP environments.

PHASE II: Develop prototype protection devices and conduct tests to evaluate the performance of protection devices and protected equipment in MHD-EMP environments. Prepare detailed plans to implement demonstrated capabilities on critical military and commercial applications.

PHASE III DUAL APPLICATIONS: Dual applications exist for MHD-EMP mitigation technologies within the commercial electrical power distribution industry. Commercial power distributors must ensure that critical electrical systems remain operable in the presence of solar geomagnetic storms and post-EMP operability is critical to national recovery efforts. While northern power grids have some protection, severe solar storms in the past have still caused widespread disruption. The protection technologies developed by this effort can be applied worldwide to ensure that long-line power and communication systems will not be disrupted by severe geomagnetic disturbances and nuclear MHD-EMP.

REFERENCES:

1. What Utilities Learn From Disasters. Electrical World, November 1993, pp. 50-51
2. Barnes, P.R., et al.; MHD-EMP Analysis and Protection. Defense Nuclear Agency Document DNA-TR-92-101; September 1993.

KEYWORDS: MHD-EMP, EMP hardening, geomagnetic storms, survivability

A99-082 TITLE: Combine Auditory/Olfactory Sensory Immersion for Decision Support

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop innovative HSI methods and associated device(s) that will combine the human sense of smell with the human sense of hearing to aid human-in-the-loop decision making and analyses of data from disparate sources.

DESCRIPTION: Advances in information systems have made more real-time information available to warfighters. Information must be presented in a manner that will augment the battle commander's decision-making capability, without information overload. A well-designed human-engineered system interface is paramount to minimizing operator decision response times and error rates, to maximizing interaction efficiency and to assuring mission success with advanced weapons systems. Sensory immersion is an emerging science that allows humans to receive and transmit data using all of their senses, i.e., sight, touch, speech, hearing and smell. The objective of sensory immersion research is to improve a human's ability to interact with large amounts of complex data by using more than just sight. Sensory immersion allows a person to interact with data sets the same way they interact with another person. That is through gestures, sound, sight, touch and smell. The objective of the research requested through this SBIR topic is development of HSI methods and associated device(s) that will allow a human to investigate data sets using the sense of hearing combined with the sense of smell. Any proposed research must address both hearing and smell used together to analyze data and support decision making under information overload conditions. Audio cues and audio data have been used effectively to communicate complex data to humans. Olfaction is one of the chemical senses, evolutionarily ancient and capable of recognizing and encoding thousands of different three-dimensional molecular structures with such precision that even molecules that are mirror images of each other can be discriminated. Smell information about our surroundings is acquired, interrupted and stored. Research has shown that odors can be used as stimuli to learning. Odors have also been shown to effect mood and mental alertness. Because of our ability to discriminate between many different odors, odors could also be encoded with information and interpreted directly as data. Device(s) are needed that will take complex data and turn the data into a combination of sounds and smells that can be interpreted by an operator, improving the analyses and decision making capabilities of the operator. The research should also address what types of tasks, under what conditions, are best suited for use of combined auditory and olfactory devices.

PHASE I: Demonstrate the feasibility of constructing and using device(s) that provide data inputs to a human via a combination of sound and smell. Measures of Effectiveness (MOEs) for the HSI methods employed by the device(s) should be defined. Feasibility can be demonstrated through a series of experiments or through simulation, with an emphasis on operator performance (e.g., training time, response time, and number of errors) as measured by defined MOEs. A specific data set addressing specific data to be transmitted should be examined.

PHASE II: Build the device(s) proposed in Phase I and conduct trials of the device(s) to demonstrate the type and amount of information that can be transmitted and understood, with a continued emphasis on analysis and improvement of operator performance.

PHASE III DUAL-USE APPLICATIONS: Humans are faced with huge amounts of data to support their decision-making. Pilots, stockbrokers, design engineers, doctors, lawyers, military commanders, and many other professions now have much more data available to support decisions than can be read or reviewed on a computer. Sensory immersion, using all of the senses to interact with data, can help all of these people make better and quicker decision.

REFERENCES: The following institutes specialize in olfactory research. The Olfactory Research Fund is the world's only non-profit, charitable organization dedicated to supporting research on the psychological benefits of fragrance. The Olfactory Research Fund sponsors numerous research topics each year and has a catalog of published papers.

1. California Institute of Technology Engineering Research Center, Neuromorphic Systems Engineering, http://www.erc.caltech.edu/index2.html
2. The Olfactory Research Fund, Ltd., 145 East 32nd St., New York, NY 10016-6002, http://www.olfactory.org/news.html
   The following University websites contain information on auditory perception research.
3. McGill University, http://www.music.mcgill.ca/auditory/intro.html Auditory Mechanics Lab, http://funsan.biomed.mcgill.ca/
4. University of California Berkeley, Department of Psychology, http://ear.berkeley.edu/ Auditory Perception Lab, http://ear.berkeley.edu/auditory_lab/

KEYWORDS: sensory immersion, human computer interface, ulti-sensory interfaces, olfaction, audio cues, auditory/olfactory devices, decision support

A99-083 TITLE: High-energy Laser Optical and Diagnostic Development

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To create advanced innovative optical materials, technologies, fabrication methods, and equipment, thereby improving the performance of DOD High Energy Lasers and develop new optical and diagnostic technologies.

DESCRIPTION: We at the High Energy Laser Systems Test Facility (HELSTF) propose the creation of specialty optics, sensors, and equipment for use in testing with HF/DF chemical High Energy Lasers (HELs), Free Electron Lasers (FELs) as well as pulsed CO2 HELs. Of specific interest are materials that act as high power frequency converters. Additional specific interests include the use of uncooled reflective optics and beam splitters for extracting low(er) power samples of a HEL beam for a beam diagnostic station or for auxiliary experiments. Advanced polishing and fabrication techniques able to create surface finishes of few (<10) angstroms are also very suitable to this proposal topic as are advanced laser diagnostics which have both low and high power applications. The explicit keys here are innovation, usefulness with high energy laser facilities, and commercial application potential.

PHASE I: Proposers should plan on early experimentation to demonstrate proof of principle for their innovative ideas. A detailed effort to further analyze the new technology proposed will be required as will design for full scale Phase II hardware. Ability to attract Phase III commercial partners for funding is highly regarded.

PHASE II: Second Phase efforts will include innovative developments, hardware fabrication, and demonstration using Army lasers and equipment. Publication of results at all phases is encouraged to attract follow-on interest.

PHASE III DUAL USE COMMERCIALIZATION: The market for specialty optical equipment is very large for several different end use applications. Commercial and civil uses of high energy lasers such as laser welding, laser machining, laser surface treatment, laser assisted surface cleaning, laser power beaming, laser assisted mining, military HEL uses, and laser chemical synthesis will all require robust optical and diagnostic developments. Innovative ideas that address both military HEL needs and established or potential commercial applications are appropriate for this topic. Depending on the maturity of the product and market, the commercial potential ranges from a few million to a few billion dollars per year.

KEYWORDS: High Energy Laser Optics, Optics Fabrication, Laser Diagnostics, Specialty Optics, Advanced Optical Materials, Frequency Doubling Techniques.

U.S. Army Simulation, Training, and Instrumentation Command (STRICOM)

A99-084 TITLE: Distributed Collaborative Java-based Positioning Instrumentation Modules

TECHNOLOGY AREAS: Information System Technology

OBJECTIVE: Develop java-based distributed collaborative Instrumentation modules for tracking dismounted infantry players in a "live" training environment

DESCRIPTION: The problem - Tactical Engagement Simulations (TES) of "live" (ie, actual participants interacting at actual training centers) dismounted infantry engagements need precise soldier positioning information in order to (a) enable the simulation of indirect/area-effect weapons and to (b) enable the generation of high-fidelity after-action reviews (AAR's) using virtual replay mechanisms. The opportunity - leveraging recent advances in embedded java technology, research and develop java-based instrumentation modules that work in a distributed (ie, located on different dismounted infantry participants) collaborative (ie, collective problem solving via exchange of information) manner to more precisely generate positioning information for each of the modules than each module is individually capable of. In other words, apply the principle of sensor array processing --where groups of low-fidelity sensors collectively yield much higher fidelity information.

PHASE I: Develop an oveall design concept for providing accurate positions information in the field. Breadboard, demonstrate, or analyze concepts for monitoring.

PHASE II: Build a prototype system which demonstrates the position tracking and its accuracy to meet the training environment. Demonstrate the approach is not intrustive to the individual's mobility.

PHASE III DUAL USE APPLICATIONS: Cost effective solutions could monitor travelers in national recreation areas. Would be effective for monitoring search party/ rescue operations. Security industry could use a low cost position monitoring for site security. Child security for house exit or "entering pool area" notification.

KEYWORDS: positioning information, embedded java, tactical engagement simulation, distributed sensor array processing, collaborative sensors

A99-085 TITLE: Advancements in Individual Combatant Simulation Technology

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To develop new, innovative and cost effective technological solutions to support immersive simulations for the individual combatant, consistent with the innovative use of entertainment technology and the emerging High Level Architecture (HLA). Uses for the simulations include mission rehearsal, training, analysis and materiel development of soldier systems.

DESCRIPTION: Most of the current virtual environment technologies which support individual combatant virtual simulation suffer from limitations. Some of the key technical challenges in this area include: interoperability, graphics and database complexity, integration into networked simulations, computer generated forces, man-machine interface, individual representation, and instrumentation. There is a current need for technology advancements in the area of voice recognition under stress and gesture recognition to support day / night, open and restricted terrain operations. In addition, there is a need for technology advancements in the area of interaction of Command, Control, Communications, Computer & Intelligence (C4I) systems with IC simulations. Each proposal should clearly identify the area(s) being addressed.

PHASE I: The Phase I effort should focus on developing an overall design concept to (1) integrate voice and/or gesture recognition capabilities or (2) integrate C4I systems to current IC simulations, to include Human-In-The-Loop (HITL) or SemiAutomated Forces (SAF) applications. The product of the Phase I effort should be a technical report and demonstration of the design concept.

PHASE II: The Phase II effort should focus on building a commercial prototype using the results from Phase I. Demonstrate the (1) voice and/or gesture capabilities or (2) C4I system integration with an existing IC simulation using Government approved scenario(s) which include night and day, open and restricted terrain operations.

PHASE III DUAL USE APPLICATIONS: The proposed developments would have application in many commercial markets, including entertainment, communications, and instrumentation. Potential commercial simulation system applications include video games, virtual reality systems, and non-military training systems such as firefighter and emergency managemnt trainers.

REFERENCES:
1. The following web site address may be helpful in providing relevant background information for IC simulation development: www.stricom.army.mil/PRODUCTS/DWN .
2. Jones, T (1995) Individual Combatant Simulation Technology Transfer Plan.

KEYWORDS: individual combatant, dismounted infantry, computer generated forces, military operations in Urban terrain

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A99-086 TITLE: Compression Ignition Engine Technology Insertion

TECHNOLOGY AREAS: Ground and Sea Vehicles, Materials/Processes

OBJECTIVE: Perform feasibility research on and demonstrate potential for advanced technologies, suitable for insertion in compression ignition engines (e.g., up to and including class 8 truck engines) to improve engine performance and assure greater conformity with future system's technologies. Technologies that can more readily be inserted (i.e., improved/intelligent engine controls and/or associated enabling sensor technologies, parasitic load reduction technologies such as might be accomplished through functional integration or elimination approaches (e.g., combined starter alternator) and improved combustion concepts (e.g., stratified combustion approaches) are examples of desired research topics. Proposals that include research collaborations with current engine manufacturers will demonstrate the level of program commitment desired.

DESCRIPTION: Optimal applications of new advanced engine technologies often require alternative (e.g., new) systems' configurations. However, failure to research, develop and apply these new technologies on existing equipment may create future logistics and cost burdens (i.e., dual fuel delivery systems for current and future engines, incompatibilities in lubrication or electrical control systems, etc.). Significant research and development must be performed to address design, both performance and durability, issues related to inserting advanced technologies into engines developed in the 70's and 80's. These legacy engines in the existing military fleet will be maintained in inventory beyond the year 2010 due to budgetary constraints on new systems developments and acquisitions. In contrast, rapid global technology advancements and foreign military R&D investments / hardware acquisitions heighten military needs and threaten U.S. superiority on the future battlefield. Army R&D initiatives, therefore, must research advanced technologies' application potential for improving functional performance of existing equipment during retrograde, while retaining engine systems configurations compatibility (i.e., technology insertion through form and subsystem/component interface).

PHASE I: The contractor shall research specific advanced compression ignition engine technologies as specified in the proposal and develop concepts for integration in existing diesel engine designs. The contractor shall identify and verify technology integration benefits and design issues. The contractor shall perform virtual prototyping and simulation modeling of modified engine design concepts that could be realized through an engine technology insertion program for a specified combined military- & commercial-use engine (e.g., up to and including class 8 truck engines). Technology insertion research/development design plan and cost savings analysis shall be prepared to document optimal technology integration design configuration, performance verification test procedures and expected benefits. In addition to developing preliminary engineering designs for one agreed upon engine, the contractor shall model and evaluate virtual prototype manufacturing processes required to implement the recommended engine technology insertion. Proposals that offer to supply commercial products for government evaluation do not qualify as innovative research and development.

PHASE II: Actual prototype engine modification (e.g., technology insertion) shall be performed in cooperation with the Army overhaul agent (e.g., contractor or depot), manufacturing procedures verified and engine performance tests performed.

PHASE III DUAL USE APPLICATIONS: Commercial bus and truck fleets accumulate significantly greater mileage and undergo more frequent engine rebuild cycles than military ground vehicle power plants. An Army proactive research program would promote commercial engine material adoption by lowering technology insertion risks, providing increased fleet usage data, and defining re-manufacturing procedures/competencies.

OPERATING AND SUPPORT COST REDUCTION (OSCR): The Army has thousands of commercially based engines installed in military vehicles, which will be maintained in inventory beyond the year 2010. Remanufacture programs for these engines will be conducted on a regular, as required, basis. The OEM manufacturer typically guarantees availability of engine parts for 10 years after cessation of production, but component acquisition costs increase 10% to 15% per year due to the lack of a commercial market demand. By initiating the proposed technology insertion effort, the Army can reduce dependence on obsolete commercial components and increase use of state-of-the- art commercial parts and technology, while extending component/system life and improving vehicle performance in three critical areas, fuel economy, noise and exhaust emissions.

KEYWORDS: diesel engine advanced technologies, technology insertion, deisel engine re-manufacture, compression ignition engine technologies

A99-087 TITLE: <u>Smart Lead Acid Batteries for Starting, Lighting, and Ignition Applications</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The objective of this project is to develop an existing cost-effective smart battery electronic controller for use in lead acid batteries in automotive vehicles.

DESCRIPTION: Smart batteries are presently used and widely found in laptop computers. The initial capital investment has been made to bring the component cost to the level favorable for making a smart automotive battery a reality. We wish to modify this controller component to (1) operate with lead acid batteries in automotive applications, (2) communicate with existing or proposed vehicle data bus networks, (3) store and report on demand historical battery usage data, (4) ensure adequate component survivability in the corrosive battery environment and (5) ensure conformance with established military requirements. This could include the development of a programmable flash memory capability. This would allow changes to be made as needed to meet the evolving smart system requirements of existing and future combat and tactical vehicles. This program is an important step for improving an essential vehicle component (i.e., the battery) to provide health and status information to a smart vehicle system by way of a vehicle system data bus. The advantages for having this kind of control over the batteries extend to longer life batteries and improved vehicle system readiness.

PHASE I: Develop overall component design and specification. Provide for and propose a digital communication protocol for this component. Develop a plan for integrating the component into existing lead acid batteries for automotive application.

PHASE II: Build ASIC chips and electronic support sub-structure incorporating the best design capable of meeting the above-mentioned description. Demonstrate performance in prototype batteries. Incorporate the smart controller into a lead acid battery as an integrated component permitting access to the connector for external monitoring.

PHASE III DUAL USE APPLICATIONS: This program applies to commercial as well as the military vehicle applications. Specifically, there presently exists an identified need for this same smart battery capability in trucks for long distance freight service.

REFERENCES: "Smart Batteries, North America Sales Forecasts, Demand Characteristics, Competition and Technology Trends," The Darnell Group, Norco, California, 1995.

KEYWORDS: smart batteries, lead acid batteries, smart systems

A99-088 TITLE: Advanced Opposed-piston 2-stroke Diesel Demonstrator

TECHNOLOGY AREAS: Ground and Sea Vehicles, Materials/Processes

OBJECTIVE: The objective of this topic is to develop an advanced opposed piston 2 stroke diesel research engine able to serve as a demonstrator for advanced technologies including scavenging, fuel injection and combustion, and low heat rejection technology.

DESCRIPTION: The opposed piston 2 stroke format has unique characteristics making it exceptionally well suited for combat vehicle propulsion. The application of advanced technologies to this format has not kept pace with the 4 stroke engine community however, due to the specialized nature of this design. An advanced opposed piston 2 stroke diesel research engine is needed to serve as a technology test bed to demonstrate the full potential of this design for future vehicle programs. The single cylinder research engine envisioned under this topic should provide flexibility to pursue innovative scavenging, fuel injection, combustion and insulative concepts. Access for extensive instrumentation including pressure transducers, thermocouples and gas sampling probes should be provided. The engine should make use of commercially available parts to the greatest possible extent to reduce operating costs. Cylinder displacement is expected to be on the order of 2.5 - 3.0 liters per cylinder to provide 250 hp rated output per cylinder at 2600 rpm.

PHASE I: The contractor shall perform a design study and make detailed drawings for all major engine components.

PHASE II: The contractor shall fabricate the engine and perform operational testing.

PHASE III DUAL USE APPLICATIONS: 2 Stroke diesel engines have found applications ranging from trucks & bus power to large marine and stationary plants. While not all of these are of opposed piston format they will benefit from the development of advanced technology for the 2 stroke engine.

KEYWORDS: opposed piston, 2 stroke, diesel engine

A99-089 TITLE: Surfactant Resistant Fuel Filtration

TECHNOLOGY AREAS: Ground and Sea Vehicles, Materials/Processes

OBJECTIVE: Demonstrate technical feasibility of advanced filtration and water removal technologies that are resistant to disarming by the presence of strong surfactants in fuels, such as JP8+100. Initial investigation will focus on track and wheeled vehicle applications.

DESCRIPTION: Development of advanced engines for use in future military systems, particularly aircraft, are requiring fuels with greater thermal stability. Fuel additive packages that increase thermal stability typically include a strong detergent/dispersant that disarms conventional coalescing elements used to remove undissolved water from the fuel. The technology and process used in the conventional military and commercial fuel filter-separators is well over 30 years old. In terms of operation, the current systems are simple and require no power source of their own, relying on the pumping pressure of the system to push fuel through the filters. In terms of supply, the filter/coalescing elements become clogged and must be replaced periodically, which requires an available resupply in the field, an added logistics expense. It would be desirable for the military, and certainly the commercial sector, if fuel filtration could enter the 21st century with an improved technology. Possible improvements include regenerative filters which are either non-replaceable or offer extended service intervals, or are field cleanable and reusable. The performance of the filters should at least meet API (American Petroleum Institute) 1581 fuel filtration standards. Other improvements may be improved flow rates, flow processes, and less head loss in the system, resulting in lighter weight and smaller volume systems. Potential new areas of investigation include new material applications, change in general process from the physical partitioning type to chemical or electrical potential processes, as well as physical processes such as centrifugal separation. New technologies or applications of technology will only be improvements if the size, weight, efficiency, and/or practicality of system application remains nearly the same or better than the current systems.

PHASE I: Compile research paper detailing the physical and chemical processes supporting a surfactant resistant fuel filtration and water removal system, along with supporting data. Should also include a functional display model to demonstrate feasibility of the concept.

PHASE II: Develop fully functional prototype which meets API 1581 cleanliness standards for filtration and water separation when using JP8+100 fuel.

PHASE III DUAL USE APPLICATIONS: Expansion to full scale bulk fuel handling facility applications, and adaptation to on-vehicle fuel filtration systems. Surfactant resistance would present opportunity for commercial market, both aviation and automotive, to make use of improved fuel additives, and lead to decreased filtration system and fuels costs if commercial market used concurrently.

KEYWORDS: fuel, filtration, separation, coalesce, JP8+100, surfactant, dispersant

A99-090 TITLE: Semiactive Shock Absorber for HMMWV

TECHNOLOGY AREAS: Ground and Sea Vehicles, Materials/Processes

OBJECTIVE: Develop a semiactive shock absorber suitable for application on the Army's fleets of tactical wheeled vehicles; the damping medium will be based on a magnetorheological (MR) or an electrorheological (ER) fluid.

DESCRIPTION: Magnetorheological and electrorheological fluids are both rapidly advancing technologies that hold great promise of providing easily controllable damping devices simply by application of the appropriate voltage or current, respectively, across the device. The project calls for the selection of the most appropriate MR or ER fluid and development of an automotive shock absorber based on this fluid. The shock absorber will be designed to permit the damping force produced to be computer controlled for use in a semiactive suspension system. Voltage or current control to the shocks will control the damping force; computer control of the voltage/current will facilitate dynamic damping control.

PHASE I: The selected fluid capability and properties should be evaluated. The initial shock absorber will be generally sized according to the following data; application to more specific weight class trucks can be extrapolated based on proportionality of forces and suspension component sizes. Size/capability specifications: Use of 12-24 volt electrical system, to generate a minimum of 1500 lbs. damping force, minimum 2 in. stroke, withstand 4000 lbs. static tensile loading

PHASE II: A prototype shock absorber or a vehicle set (sized for HMMWV) will be fabricated and demonstrated (either on a test rig or a Government furnished HMMWV); the corresponding semiactive controller will be fabricated, integrated and demonstrated. HMMWV specification data: 24 volt vehicle electrical, minimum 2000 lbs. damping force capability, 3.5 +/- 0.25 in. stroke, 12.75 in. compressed length, 17 in. extended length

PHASE III: This technology would have application to the majority of truck fleets, both within the Army and commercial fleets; this technology will have a broad range of application, including extensive off-road applications and will be commercially persued for selected off-road vehicles.

KEYWORDS: semiactive, suspension, magnetorheological fluid, electrorheological fluid, shock absorber

A99-091 TITLE: Sensor Technology for Detecting and Monitoring Corrosion of Land-based Vehicles

TECHNOLOGY AREAS: Ground and Sea Vehicles, Materials/Processes

OBJECTIVE: Corrosion sensors are needed to detect, determine the rate and penetration of corrosion on ferrous and non-ferrous metals. Sensors must be durable, small, cheap and either hand carried to a site or mounted/attached directly to the component. They must not adversely interfere with the functionality of the component. The sensors must also be sensitive, free of generating their own by products that can accelerate corrosion and repeatable in their output. Readings/measurements should be downloaded quickly either using RF or some other electronic downloading device. Gravimetric recordings are acceptable but are not the first choice.

DESCRIPTION: Development of sensors for corrosion detection and monitoring of metal components in accelerated test chambers and in field applications for land based vehicles are needed in the automotive community. The sensors are needed to quickly and reliably detect the rate and penetration of corrosion on ferrous and non-ferrous metals during accelerated testing and in a cyclic corrosion chamber, during and outdoor durability Bcorrosion test, and in a fielded fleet. The information gathered must have the capacity to be downloaded quickly with a high degree of confidence and reliability. The data will be used to detect the onset and progress of corrosion on a component and also to correlate data from accelerated testing to actual environments where a customer is using the equipment. Ideally such sensors must be economical, durable and simple in their function. Information retrieval could also be done from remote locations if necessary and fed into a WINDOWS compatible Corrosion Database Management System (CORRDBMS) that will be supplied by the US Army . The sensors will or can fall into the following categories or technologies: Active sensors, passive, imaging, line of sight, acoustic, optical, chemical, magnetic etc. The data or information so gathered will be used to form a basis for developing a model for corrosion deterioration that can ultimately be used in the development and maintenance of the army's fielded fleet. The sensors will also be used to develop simulations that can replace/verify Accelerated Corrosion Testing (ACT) of entire vehicles assemblies or individual components.

PHASE I: Explore and do a search of the various sensors that are in existence, development and research. Select or design at least two approaches in meeting our stated goals. Provide a detailed rationale for the technologies that were not selected but investigated. Perform testing in the lab to confirm the design or approach(s) of the performance goals of the sensors under accelerated corrosion conditions. Write final report with recommendations for Phase II.

PHASE II: Develop and build several sensors that are to be included in accelerated corrosion test (ACT) cyclic chambers and the fielded fleet. The information gathered will be utilized to establish/confirm the correlation with the data obtained from the cyclic corrosion chamber, outdoor accelerated corrosion / durability tests with data inputs gathered from real life deployment in the field. The outputs must be statistically relevant with a desired 2 sigma degree of confidence and repeatability. The sensors must be able to track corrosion rates and level of corrosion such as penetration of the metal substrate, disbondment of surface coatings, fatigue cracking and other forms of corrosion. Upon completion of the field studies which includes downloading directly in the CORRDBMS system a final design of the sensors will be made so that working prototype and production models can be made. A final report will be written.

PHASE III: Dual use application. This technology can be used by the automotive industry to track corrosion and enhance anti corrsion design. General Motors has expressed a desire to support us in this development. The technology can also be used in aerospace, utilities, telecommunication, petrochemical and several other industries.

KEYWORDS: Simulation, Corrosion, Sensors, Accelerated testing, Detection, Vehicles.

REFERENCES: SAE 831820 P 136 "Proving Ground Vehicle Corrosion Testing" SAE 831814 P136 "A Three B Chamber Corrosion Test Method for Passenger Cars"

A99-092 TITLE: Computer Modeling the Corrosion and Durability of Land-based Vehicles

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Take advantage of recent advances in both computer technology & corrosion sensors to accurately and reliably model, simulate, and predict the corrosion, durability, and expected service life of Army vehicles and their major components.

DESCRIPTION: The Army's vehicles often operate in severely corrosive areas and in rugged environments. This coupled with decreasing maintenance funds and a need for increased service life makes corrosion a costly burden to the Army. Thus, being able to accurately & reliably predict corrosion and its combined effects with driving stresses, and associated wear on a vehicle early in its life cycle would be of great benefit to the Army. Decisions early in the design stage could thus be made on how materials, design, and manufacturing plans & process changes affect the service life of vehicles and their major components. This could eventually save $1M & up to 18-24 months of physical testing per vehicle platform once much of the simulation could be done on the computer. Ultimately, the system will require algorithms that give results with a high degree of confidence, accuracy, reliability, and correlation with those found in the field. Corrosion sensors will be utilized and will be an integral part of data collection. The sensors can fall into the following categories: active, passive, imaging sensors, line of site, acoustic, etc. The data, together with existing Army & civilian corrosion databases, would then be used to model corrosion deterioration of vehicle systems and can ultimately be used in the development and maintenance of the Army's fielded fleet.

PHASE I: Perform literature search and explore applicable technologies including vehicle durability, dynamics simulation technologies, corrosion sensors, and corrosion/material degradation simulation & prediction. The information gathered will be used to create a prototype vehicle corrosion & durability simulation & prediction software model. This model will be used to create a final system version in Phase II. Corrosion sensors shall be used to aid in data collection, with the data to be fed into the simulation & prediction model. The model and subsequent system shall be flexibly designed in such a way that it allows for input data collection from future advanced corrosion sensors. Write final report with recommendations for Phase II.

PHASE II: Develop and demonstrate a fully working prototype computer graphical simulation system which utilizes corrosion sensors and available Army & civilian corrosion & durability field data, is easy to use and with 2 sigma reliability simulates and predicts corrosion and durability, and correlates them to actual service life for Army vehicles and their major components. The accuracy and reliability of the simulation system must be proven in Phase II. For the simulation system to be proven valid, it must correlate with the results of Army & civilian proving grounds tests for corrosion and durability. A final report with a fully working, Y2K compliant copy of the software on CD-ROM in the latest Windows compatible format with a user's manual included is required, as well as a business plan for marketing in Phase III.

PHASE III - DUAL USE APPLICATIONS: This technology could be used in many applications where corrosion/material degradation, durability, and service life predictions are needed. The technology could reduce the cost of such real world testing and could shorten product development cycles by over 50%. Potential markets include transportation sectors such as automotive, aerospace, trucking & delivery systems, hovercraft, and off road vehicle markets.

REFERENCES:

1. Murphy, T. "Simulation not a threat for real world testing - for now", Wards Auto World (p. 45), Nov 98.
2. G. Harris, C. Adams, & J Garber, "Use of a Corrosion Prediction Program as an Engineering Tool", NACE Technical Paper 97607 (1997).
3. T. Hakkarainen, "Transferring Corrosion Knowledge to Computers: Models for Predicting Corrosion", NACE Technical Paper 97396 (1997).

KEYWORDS: simulation, corrosion, sensors, durability, computer modeling, vehicles

A99-093 TITLE: Hyperspectral Evaluation of Signature-managed Materials

TECHNOLOGY AREAS: Materials/Processing

OBJECTIVE: The objective of this effort is to create a tool for the evaluation of narrow band optical characteristics of a complex object in backgrounds.

DESCRIPTION: The focus of this effort is to develop an evaluation tool which can accept a hyperspectral image and extract similarity and difference metrics which are useful for conspicuity and detectability. The tools should be capable of evaluation in the optical wavelengths from .35-14.0 microns. The system should also be capable of verifying reference calibration information in each of the spectral regions. A number of hyperspectral systems are in common use today which are capable of collecting necessary engineering data in the field. The problem is that no tools exist to perform these evaluations. The scope of this effort would be to develop an evaluation system based on hyperspectral data cubes of field test data. The spectral bands of interest range from the ultra-violet through the far infrared wavelengths. Determination of conspicuity or detectability for objects has up to this point been a function of systems which collect and integrate large spectral bands of data. New and emerging detection systems are focusing on multi-band data because of the increase in discrimination potential. In order to address these new sensors a better understanding of the characteristics of materials integrated on object in natural environments is required. For cases where more conspicuity in required, the same analysis techniques can be applied. These cases may include automated robotic inspection or automotive collision avoidance systems.

PHASE I: Develop the overall design and specification of the system to include interface specifications with common hyperspectral devices in use of terrestrial applications. Develop a software prototype which demonstrates the feasibility of the proposed concept to extract narrow band spectral conspicuity metrics.

PHASE II: Develop a complete and integrated system for complete spectral and spatial evaluation of field collected hyperspectral data covering visual through thermal spectral bands. This system should include complete sequence analysis, statistical analysis with conspicuity and detectability analysis. In addition the system should demonstrate a calibration function utilizing collected field calibration data.

PHASE III DUAL USE APPLICATIONS: Multi-band and hyperspectral imagery is rapidly becoming main stream in the imaging environment. The reason for this is the ability to produce a robust detection and discrimination system. As additional spectral bands are added, the variations in environment, object rotation and lighting conditions are more reliably handled. Tools like this for object characterization are prime candidates for robotic inspection, automotive collision avoidance and automated medical typing.

KEYWORDS: Hyperspectral, Conspicuity, Spectral Imaging

A99-094 TITLE: Mine-resistant Track Development

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To establish, and document, a set of minimum requirements that a track system and vehicle underbody must be capable of withstanding to be considered mine resistant. Requirements will be used as a basis for a specification. Identify a potential solution to meet these requirements and evaluate it through testing at APG.

DESCRIPTION: Current track systems have no design requirements for a minimum level of protection against mine blasts. The heavier track designs previously used may be better capable of withstanding a mine blast due to the added factor of safety from an over designed system. As the track is optimized for weight reductions, no specific requirements for withstanding a mine blast are imposed, just the basic track durability based on a mission terrain profile. This type of designing leads to an extremely light system, but it may not be able to survive anything other than small anti-personnel mines. A design with sacrificial components, or which would direct the blast in a specific pattern could be used to develop the lightest possible track capable of withstanding these blasts. All bidders will be provided a complete set of drawings for the T154 track system prior to submitting their proposal. These drawings will include roadwheels and the suspension system. It is felt that this information will be sufficient, but requests for additional drawings will be handled on a case by case basis with the potential contractor. Results from recent mine blast testing on both T154 and XT168 track will also be provided as background information during development.

PHASE I: This part of the program would concentrate on determining the requirements that a track would have to meet to be considered mine resistant, and to identify some potential concepts to meeting these requirements. Undercarriage design characteristics to deflect blast away for subsystems and occupants would be investigated to minimize blast damage. Different types of mines along with sizes of the charges would be looked at to determine what would makeup the requirement.

PHASE II: During this part of the program, a track system and undercarriage capable of surviving the requirements identified in Phase I will be produced. This will include a complete finite element analysis (FEA) of each component, as well as advanced computer analysis of the blast itself. Limited quantities of the track system will be produced for testing to the requirements detailed in Phase I.

PHASE III DUAL USE APPLICATIONS: Every track system used by the military and nonmilitary must provide a level of protection to the roads that they are operated on. Materials that the Government develops to increase or prolong this level of protection could also be used by the commercial industries to improve their levels of protection as well. Advances in lighter/stronger track materials and designs could be implemented by the commercial industries to increase the capacities, and performance of their vehicles. The proliferation and use of mines throughout the world and the need to clear them after hostilities cease has increased the exposure of commercial vehicles to mine hazards. This technology would also have applications in force protection, security vehicles, police bomb squads and swat teams, crowd control vehicles and a host of other commercial applications.

KEYWORDS: Track, mine resistance, mine blast, track designs.

A99-095 TITLE: <u>Portable Fuel Analyzers</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The objective of the project would be to develop a portable fuel analyzer and sensors capable of measuring an array of fuel quality parameters.

DESCRIPTION: Currently fuel analysis is performed in mobile laboratories which use time-consuming, manpower-intensive ASTM approved methods. Approximately 17 laboratories are currently fielded. Sensors for determining key fuel quality parameters placed with or mounted on tank trucks, storage tanks or pipelines would provide significant benefit by placing analysis where it is needed most. Before dispensing fuel to any receptacle, personnel could be certain that it met quality guidelines. Various technologies exist which may be applied to fuel quality analysis. Infrared spectroscopy (both near infrared (NIR) and fourier transform infrared (FTIR)) has recently been developed to the point where fuel properties may be measured quickly and somewhat accurately. However, it is not yet at the state where hand held or on-vehicle devices could perform all of the necessary tests. Another technology which has recently seen significant progress is that of particle counting in petroleum products such as fuel. With FTIR to measure fuel density or contamination such as water, and a particle counter to measure solid contamination, the analyzer could be a significant contribution to the Army's petroleum testing arsenal.

PHASE I: The first task as part of this phase would be to collect information regarding fuel analysis technology which is currently available and to determine which fuel quality parameters (e.g., density, viscosity, particulate contamination, etc) are most important. Following this, the field of available technologies would be narrowed to those potential candidates for the hand-held or on-board analyzer. The final task will be to develop a conceptual design for the analyzer. A breadboard model may be constructed to demonstrate feasibility of the concept.

PHASE II: Finalize the design for the analyzer by combining technologies into an integrated, single hand held device for demonstration. The device may collect and interpret data from onboard sensors. Develop mechanism for transferring data from the sensor to a remote location.

PHASE III: Conduct field testing on a military vehicle to demonstrate product performance and operational suitability. Develop a database to incorporate sensor-provided data with fuel quality guidelines. Use of this database would enable soldiers to make decisions regarding fuel use under various situations. This database and sensor system would be extremely useful in numerous military and commercial applications. Airlines could use the sensors for lines carrying fuel from storage tanks to fueling points. Any fuel distribution system would benefit by having remote sensors with the capability of transmitting data concerning its state of quality to a central location for monitoring and control.

KEYWORDS: Sensors, remote sensing, petroleum, petroleum testing, petroleum analysis.

REFERENCES: References for fuel analysis using Fourier Transform Infrared (FTIR) and Near Infrared (NIR) spectroscopy include the following:

1. MIDAC Corporation, Examples of Fox Analysis on Commercial and Military Fuels, 1998. This paper includes correlation plots taken from MIDAC customers who have analyzed various fuels with the Fox FTIR Fuel Analyzer and compared the results with traditional methods.
2. Tack, L.M., J.E. Lyons, C.M. Taylor, Comprehensive Analysis of Reformulated Gasoline and Diesel Fuel Using Portable FTIR Instruments, MIDAC Corporation Application Note 127.
3. Swarin, S.J. and C.A. Drumm, Prediction of Gasoline Properties with Near-Infrared Spectroscopy and Chemometrics, SAE Paper No. 912390, 1991.
4. Fodor, G.E., K.B. Kohl and R.L. Mason, Analysis of Gasolines by FT-IR Spectroscopy, Analytical Chemistry, Vol. 68, No. 1, 1996.
5. Westbrook, S.R., Army Use of Near-Infrared Spectroscopy to Estimate Selected Properties of Compression Ignition Fuels, SAE Paper No. 930734.

A99-096 TITLE: Smart Structures for Combat Ground Vehicles

TECHNOLOGY AREAS: Materials/Processes, Ground and Sea Vehicles

OBJECTIVE: The goal is to apply smart (adaptive) structures concepts to design, develop, and test controllable devices for application in land vehicles. These devices should provide solutions to operational problems occurring in structural vibration suppression, interior noise reduction, suspension system improvement, enhanced steering and maneuverability capabilities, and structural damage detection.

DESCRIPTION: The tactical/operational vision for the Army After Next (AAN) emphasizes operation concepts that stress tactical endurance, thereby driving a set of revolutionary capabilities for ground combat systems, including (1) 50-90 miles per hour cross country, (2) 600 mile range, and (3) ten days of operation capability without resupply. This review requires an integrated systems approach and cost effective tools to understand the interactions between technologies never before considered for combat vehicle use, e.g., complex nestings of technology intensive components, such as composite materials, smart structures, distributed control, active suspension, and active protection. Smart structures consist of incorporated sensing, actuation, signal processing, and control capabilities that can spontaneously respond in real time to external stimuli to compensate for undesirable effects and enhance desirable ones. Research areas include, but are not limited to, sensors and actuators (optical, magnetic, piezoelectric, shape memory alloy, electrostrictive, magnetostrictive, etc., formulation of suitable constitutive relations, modeling and optimal design of smart composite structures, finite element formulations and control algorithms (adaptive, robust, fuzzy logic, neural networks, etc.). Particular emphasis should be placed on improved force, displacement, frequency response capabilities of actuators. Challenges that include constitutive relations, hysteretic and cyclic loading effects, robust controller issues, fabrication techniques, power delivery systems, etc. must be confronted and overcome.

PHASE I: Develop improved sensing and actuation devices for application in combat ground vehicles. Actuation devices, for example, might include magnetorheological dampers to absorb impact in a vehicle suspension system, or structural damping treatments for vibration suppression that possess perhaps both active (piezoceramic, shape memory alloy, shunted electrical circuits, etc.) or passive (viscoelastic layers) elements. Such investigations may require the determination of basic material proprties and the development of suitable constitutive relations, structural models, and control algorithms. Assess those Army vehicles that have the best potential for application and demonstration of smart structures concepts.

PHASE II: Characterize the elastic and dissipative properties of smart composite materials and active/passive damping treatments through modeling and laboratory testing. Conduct optimization studies of smart system designs taking into account both the continuous and discrete aspects of the structures (hybrid optimization procedures will be required). Demonstrate the enhanced performance capabilities of an Army vehicle equipped with smart components (e.g., improved suspension systems, robustly controlled steering system, quieter interior, more accurate performance of vibration prone mounted weapon systems, etc.).

PHASE III DUAL USE APPLICATIONS: Conceive, design, and devise smart structures based components that offer benefits to the improvement of the safety, operation, and maneuverability of both military and commercial vehicles. Improved vehicle suspension and steering systems are obvious candidates for improvement through application of active materials and adaptive structures.

REFERENCES:Toubushi, H., A. Ikai, S. Ymada, K. Tanaka and C. Lexcellent, "Thermomechanical Properties of TiNi Shape Memory Alloy," J. De Physique IV, Vol.6, C1-385 to C1-393, January 1966.

KEYWORDS: smart materials and structures, shape memory alloys, vibration, noise, damage, composite materials, strain, piezoelectric

A99-097 TITLE: Video Compression for Standard Teleoperation Kits

TECHNOLOGY AREAS: Materials/Processes, Ground and Sea Vehicles

OBJECTIVE: Design, build and demonstrate a video compression (VC) module to attach to the DoD Standard Teleoperation Kit. This module will enable the kit to operate in a low bandwidth tactical communication mode. It will also enable the kit to simultaneously send multiple video signals back to the control unit without adding an additional video link. This will enable the kit to operate with stereo vision.

DESCRIPTION: Advances in a variety of VC techniques will facilitate the transmission of one or more video signals over a significantly reduced bandwidth communication system. This is particularly desirable to adapt the teleoperation kit to a standard tactical radio system. The current DoD Standard Teleoperation Kit employs a standard video link operating at significantly higher bandwidth than a tactical radio, e.g. SINCGARS. The integration of the VC technology with the teleoperation kit and a tactical radio will provide a capability for some non-line-of-sight operation not currently available.

The VC module applied to the kit will also provide stereo vision capability to the teleoperator. Simultaneous video signals, from a pair of video cameras mounted on the teleoperated vehicle, will be compressed and transmitted over a single receiver-transmitter pair. The stereo vision will provide the teleoperator with enhanced depth perception. The depth perception will allow the teleoperator to view in much greater detail obstacles such as ditches, craters, fallen trees prior to vehicle negotiation. Specific requests for information on SINCGARS or the Standard Teleoperation Kit by interested contractors should be directed to Jerry Lane USATACOM AMSTA-TR-R MS 205, Warren MI 48397-5000 or Telephonically: 810-574-6683 or E-MAIL: laneg@tacom.army.mil.

PHASE I: The conceptual approach will be developed and initial design modifications formulated to integrate video compression and the tactical radio to the Standard Teleoperation Kit. Phase I will include the selection of video compression algorithms; component selection including processor boards, monitors, and stereo cameras; software flowchart development for the modifications; component placement; stereo vision adaptation of operator control unit; and teleoperation range, mobility & visual obstacle detection performance predictions.

PHASE II: The contractor will complete the design, fabricate the components, adapt the software, integrate the system on a government furnished combat vehicle, perform checkout tests, debug the software modifications, and support government warfighting experiments. Contractor checkout will include developing performance baselines to include the documentation of performance improvements in tactical radio teleoperation range and obstacle negotiation performance based on depth perception improvements from stereo vision. Subsystem checkout will verify the reliability of the software modifications and the durability of the hardware modifications.

PHASE III DUAL USE APPLICATIONS: The system can be used in various hazardous situations where precision driving or manipulation is required e.g. fire extinguishing, mining, construction in soft soil, etc.

KEYWORDS: Stereo Vision, Teleoperation, tactical radios, communication bandwidth, and video compression

REFERENCES: DoD Unmanned Ground Vehicle Master Plan

A99-098 TITLE: Recycling of Discarded Rubber Tires

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop a process that reconstitutes recovered rubber crumb from the Army's discarded rubber tires into a product that approaches the chemical and physical properties of virgin rubber.

DESCRIPTION: The recycling of automotive tires is not new but previous results have not been impressive and the content of recycled rubber in new products has actually diminished. Most of the products have been used for corrosion control, shredded chips as a playground material, low-grade rubber mats or in some cases, clothing and accessories that are more novelty than practical. Recent advancements have resulted in numerous cost effective methods to separate useable rubber crumb from discarded tires. Plastics used to be the environmental scourge of the environmental movement- not so today. Significant emphasis was able to influence the Research and Development of methods and processes to recycle the discarded material into very useful end products. The significant difference between recycling of plastic and rubber is that most plastics (approximately 90%) are thermoplastic in nature while only approximately 6% of rubber is. Pneumatic tires are thermoset with a chemical change that presently is irreversible.

PHASE I: Develop a processing system that reverses the vulcanization inherent in recovered rubber crumb, by adding the appropriate recipes of chemicals, filler material, and temperature control. The resulting raw material will approach the physical and chemical properties of virgin rubber.

PHASE II: Demonstrate the capability of this raw material to be further processed into complex product that exhibits the similar properties of like product made from virgin rubber.

PHASE III DUAL USE APPLICATIONS: Dual Use Science and Technology applications that could provide an enormous market for the millions of Army scrap tires resulting in a cleaner environment and the conservation of a natural resource.

REFERENCES: Charles P. Rader and Marvin A. Lemieux, "The recycle of plastics and rubber-a contrast", RubberWorld, May 1997

KEYWORDS: rubber, rubber crumb, vulcanization, environment, environmental quality, natural resource, thermoset, tires

U.S. Army Topographic Engineering Center (TEC)

A99-099 TITLE: Semantic Mapping Tools

TECHNOLOGY AREAS: Information Technology Systems

OBJECTIVE: Develop tools to support the automation of semantic translation of geospatial data (generated using many different feature dictionaries) to feature dictionaries that are understandable by Army systems that will exploit this data.

DESCRIPTION: Background: Semantic heterogeneity is one of the primary limitations that hamper the widespread ability to share geospatial data. Much of the existing geospatial data contains semantic information that is unique to each database. Software applications that are developed to exploit geospatial data are tailored to these "database specific" or "agency specific" semantics, and are limited to a number of data sets. For example, an application that assesses vehicular mobility across the open terrain is tailored to specific feature and attribute types, and domain values captured in slope, soils, and vegetation information. To use these applications on data with different semantics, it is necessary either to make changes to these applications, or translate the semantics contained in this new geospatial data source into the application's semantics. This is often a very cumbersome (perhaps impossible) process; consequently, new geospatial data sources are rarely used. In addition, queries that rely on semantic information must be tailored to the semantic information contained in a given data set. For example, a query on a database for all "primary, divided highways in Omaha, NE" must query on those exact terms. Therefore, in order to generate a query that uses semantic information contained in a geospatial database, it is necessary either to know, or expose and examine, the semantics of the database. Scope: The focus of this project will be to develop semantic mapping expert tools to automate the laborious process of identification of potentially related terms for semantic mapping. Additionally, this project will develop the capability to export the necessary information to support the capability of spatial data translation tools to translate a dataset from one feature dictionary to one useable by Army application software.

PHASE I: Perform an study and evaluation of existing technology and methods to that could be incorporated into expert semantic mapping tools to automatically identify potentially related terms for semantic mapping. Evaluate existing and developing commercial technology that provide a capability to translate the semantic information contained within spatial databases to a feature/attribute/domain scheme that is common to Army/DOD systems that exploit geospatial data.

PHASE II: Develop and test prototype semantic mapping tools using heterogeneous feature dictionaries and "one of a kind" feature information captured in unique spatial databases. Test the "hand-off" of this semantic mapping information to available spatial database translation tool(s).

PHASE III DUAL USE APPLICATIONS: Applications that provide solutions to semantic mapping of geospatial data are needed by all consumers of spatial data. Semantic heterogeneity is a widespread problem that is found across the multitude of communities that generate and exploit geospatial data since much of the existing geospatial data contains semantic information that is unique to each database. This is especially true of organizations that generate geospatial data for state-, county-, or municipality-level applications, as well as for private industries--such as utility companies. At the Federal level, many of the agencies that generate geospatial data have "agency specific" semantics. These Federal agencies may use the same semantics for a series of geospatial databases (or products). Consumers of geospatial information, especially those that attempt exploit data generate from multiple organizations, are challenged with the task of attempting to analysis each dataset and determine the semantic mapping between what is contain within these datasets and what is encoded in their applications. Therefore the development of tools to identify the semantic mapping that support the translation of spatial databases between feature dictionaries is a commercially viable capability needed by all consumers of geospatial information, e.g., Federal, state, and local governments, and private industry (e.g., utilities, map producers and GIS consulting firms, etc.).

REFERENCES: American National Standards Institute (ANSI). In National Committee for Information Technology Standards. Spatial Data Transfer Standard (ANSI NCITS 321:1999). New York, New York (1998) Kevin Backe, Kevin and Voyadgis, Demetra: The FGDC Feature Registry and its Role in Supporting Semantic Interoperability. To be published paper for INTEROP99. Buehler, K., McKee, L. (ed.): The OpenGIS Guide: Introduction to Interoperable Geoprocessing, OpenGIS Consortium, Inc. Wayland, Massachusetts (1996) Frank, A., Kuhn, W.: A Specification Language for Interoperable GIS. http://bbq.ncgia.ucsb.edu/conf/interop97/program/papers/frank.html Gogolla, M., Hohenstien, U.: Towards a Semantic View of an Extended Entity Relationship Model. ACM Transactions of Database Systems. (1991) 16:369-416 Goodchild, M., Egenhofer, M., Fegeas, R.: Report of a Specialist Meeting Held Under the Auspices of the Varenius Project, Panel on Computational Implementation of Geographic Concepts. http://ncgia.uscb.edu/conf/interop97/interop_toc.html International Organization for Standardization, Technical Committee for Geographic Information/Geomatics, Geographic Information - Part 10: Feature Cataloguing Methodology (ISO/Committee Draft 15046-10), Genève, Switzerland (1998) Sciore, E., Siegel, M., Rosenthal, A.: Using Semantic Values to Facilitate Interoperability Among Heterogeneous Information Systems. ACM Transactions on Database Systems. (1994) 19:254-90 University Consortium for Geographic Information Science: UCGIS Research Priorities, Interoperability of Geographic Information. http://www.ucgis.org (June 1997) Woodsford, P.: Data Conversion and Update in the Object Paradigm. http://www.lsl.co.uk/papers/datacon.htm Yuan, M.: Development of a Global Conceptual Schema for Interoperable Geographic Information. http://bbq.ncgia.uscb.edu/con/interop97/program/papers/yuan/yuan.html

KEYWORDS: Semantic translation, semantic mapping, spatial database,translation

U.S. Army Test and Evaluation Command (TECOM)

A99-100 TITLE: Remote Autonomous Zoned Optical Range

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Design and development of the hardware necessary to provide autonomous remote operation of tracking systems.

DESCRIPTION: Develop fleets of small, high-performance, portable weatherproof optical tracking systems that run remotely and autonomously. This effort will decrease manpower operational requirements. Considerations should include using high-speed digital cameras as sensor sources and differential Global Positioning System for self-locating and automatic range calibration. The desired setup scenario should primarily address setting the unit on the ground, providing and activating a power source, and involve minimum site preparation. This will also allow the units to be precisely located for optimal tracking coverage with minimal environmental effects. Remote control would be established through a radio network to avoid requirements for optical fiber or copper cabling. These units could be located directly under trajectory paths or anywhere a truck or helicopter could set them.

PHASE I: Definition of the design parameters and configuration(s) required to achieve a solution to the problem. Phase I should include a review and analysis of current tracking platforms and operations in order to evaluate their suitability as a solution to the problem.

PHASE II: Develop a prototype tracking platform system that will interface with existing range control systems. Demonstrate the system by tracking dynamic aerial and ground based targets under a variety of conditions.

PHASE II DUAL USE APPLICATIONS: The addition of a small platform that can be placed almost anywhere will enhance the marketing capability of existing tracking systems. Commercial uses are found in dynamic testing environments such as found in the aerospace industry and automobile testing (performance, crash testing, etc), automatic monitoring of ground traffic under adverse conditions with IR sensors (airports, harbors, freeways etc). Suitable applications are also found in work performed by NASA, FAA, other DoD activities and MRTFB ranges.

KEYWORDS: remote autonomous zoned optical range

A99-101 TITLE: Solid State Oxygen Concentration Measurement System

TECHNOLOGY AREAS: Ground and Sea Vehicles

OBJECTIVE: Develop and verify the performance of a portable, multipoint solid-state oxygen sensor system for measuring oxygen concentrations in vehicles and fixtures during fire tests. Continuous oxygen concentration data are essential for evaluating the performance of fire extinguishing agents and/or systems during full scale testing. Failure to account for oxygen depletion within the test volume can result in overestimation of the agent or system performance.

DESCRIPTION: The oxygen measurement system should consist of a data acquisition (DAQ) module with multiple, easily replaceable oxygen sensors having the following characteristics: 1) The sensors shall produce a current or voltage output proportional to the oxygen concentration measured (0 to 25%), and shall be temperature compensated from 0 to 1500oF. Sensor leads, equipped with standardized or commercially available connectors, should be approximately 5-m long, and shall be shielded and insulated as required to prevent signal interference and to withstand temperatures of up to 1000oF for up to 1-minute. Sensor size shall be minimized in Phase I; the Phase II sensor shall not exceed 50-mm diameter by 75-mm length. Sensor response to a step change in oxygen concentration shall be less than 1-second to 90% of full scale 2) The DAQ module shall provide power to the sensors, acquire data, apply temperature compensation and signal linearization, and convert the output to digital format for transmission to a remote computer using a suitable communications protocol (serial, ethernet, etc.) Data acquisition rates shall be a minimum of 10-hz per channel and shall be in a format suitable for direct importation into a spreadsheet such as Excel. The DAQ shall operate on 12 or 24V DC power.

PHASE I: Investigate available solid state sensors (i.e.: automotive sensors) and develop and build a prototype two channel system, test under actual fire conditions, and make changes/improvements as required to achieve the desired performance. The system shall be designed to avoid interferences (positive or negative) from chemical species commonly found in fire situations such as: hydrocarbon fuels, carbon dioxide, carbon monoxide, or hydrofluorocarbon fire extinguishing agents. A calibration procedure shall also be developed.

PHASE II: Implement the design developed in Phase I and build one prototype system to demonstrate performance during hydrocarbon fire test conditions.

PHASE III: Implement the design with modifications demonstrated during Phase II and build two 10-channel systems, with 100% spare sensors (20), that is weatherproof and easy to field. Demonstrate overall system performance, integration and DAQ compatibility.

DUAL USE APPLICATIONS: This system will have applications for fire and combustion research, and possibly for feedback control of fuel burning systems.

KEYWORDS: Oxygen sensors, data acquisition

A99-102 TITLE: Ordnance Detection

TECHNOLOGY AREAS: Materials/Processes; Sensors, Electronics, and Battlespace Environment

OBJECTIVE: New or novel technology is solicited for the detection of concealed or buried unexploded ordnance (UXO). Of specific interest is the UXO that litters the test and training ranges throughout the US and abroad. UXO at such ranges may vary from pre-World War II high explosive (HE) artillery rounds to sub-munitions from today's most modern weapon systems. Also, included in the category of UXO, for this topic, are depleted uranium rounds used for anti-armor applications. The test and training range UXO problem is exacerbated by the fact that the contamination has often been on going for decades and the land areas involved often encompass hundreds even thousands of square miles. Obviously, conventional techniques for locating UXO are not well suited for the test and training range environment. It is expected that any technology developed by this topic will have wide applications, not only on test and training ranges, but also by military and civilian entities reclaiming UXO contaminated areas resulting from war or terrorist activities. Any method or technology developed must provide for maximum personnel safety and minimal disruption to the environment.

DESCRIPTION: Live ordnance litters many former battlefields and test and training ranges throughout the US and abroad. Current techniques for actively locating unexploded ordnance rely heavily on a man in the field approach to physically search for the ordnance. This method is inefficient and presents extreme personnel hazards. Due to the difficulty of this problem, large contaminated areas remain off limits for indefinite periods. Technology is sought that will yield a highly accurate and safe means of locating UXO over large areas. The technology is to be integrated to a Geographic Information System (GIS) to expedite the mapping of UXO for later disposal. This new technology or method will dramatically increase personnel safety and efficiency of UXO detection by allowing operation from standoff vehicles such as helicopters, unmanned aerial vehicles, remotely piloted vehicles, etc. Significant UXO detection research is being performed by the DOD and has had some success. A "fresh" approach to detecting UXO is solicited. No solicitations replicating past research will be accepted.

Additional details on current and past research can be found at the Office of the Secretary for Defense (OSD) UXO web site, http://www.denix.osd.mil/denix/Public/News/UXOCOE/uxocoe.html.

PHASE I: The investigator shall conduct the necessary analysis and research to develop a highly efficient yet environmentally safe technology for the detection of buried ordnance. The analysis and research shall provide the basis for a prototype development in Phase II.

PHASE II: The investigator shall proceed with prototype development and demonstration of the technology proposed in Phase I.

PHASE III DUAL USE APPLICATIONS: There is a tremendous world wide application for a technology that can effectively detect explosive devices. Obvious activities include the reclamation of former battlefields and test ranges. This technology will also be used by anti-terrorist organizations providing building and event security. Additionally, it will be suitable for detection of contraband explosives entering, exiting or being transported within a country. Weapons developers and testers will also be able to use the technology to quickly and efficiently evaluate munition dispersion patterns.

REFERENCES:

1. OSD,Unexplodedordnance Center Of Excellence, http://www.denix.osd.mil/denix/Public/News/UXOCOE/uxocoe.html
2. DARPA, "The Electronic Dog's Nose Program"
http://web-ext2.darpa.mil/DSO/rd/Applied/UXO/programs/uxo/electronic_n ose.html
3. New Mexico Tech, Public Information Office, http://www.nmt.edu/mainpage/news/landmine.html
4. SPIE-AeroSense98, http://www.spie.org/web/meetings/programs/or98/or_confs/3392.tml
5. Lawrence Livermore Landmine Bibliography, http://www.llnl.gov/landmine/landmine_bibliography.html/

KEYWORDS: unexploded ordnance, sensors, minefield

U.S. Army Waterways Experiment Station (WES)

A99-103 TITLE: Device for Measuring Response of Windows and Window Retrofit System

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVES: To design and demonstrate an inexpensive method of measuring dynamic response of blast-loaded windows, including window retrofit systems.

DESCRIPTION: Recent emphasis by the Government on protection of facilities from acts of terrorism has led to the search for building components that are more blast resistant or reduce blast hazard to personnel. Debris hazard from failure of windows is responsible for a major part of the injuries and deaths due to terrorist attack. Window failure and debris transport are reduced by the use of window retrofit systems, including window film and catcher bar systems. Experimental verification of the design of retrofit systems currently includes high-speed photography to document window failure, debris velocity, and retrofit response/performance. Photographic methods are limited by the debris cloud itself and space confinements in the receptor room that limit the viewing angle and viewing extent of the camera. Viewing angles when catcher bar retrofits are used are even more limited. A more desirable approach is a device that can measure initial window velocity; impact velocity, including time of impact of the window/film system onto the catcher bar; catcher bar response; rotational velocity of the window/film system as it wraps around the catcher bar; and debris velocity of any glass fragments that escape the retrofit system.

PHASE I: Provide concept design of the measurement system and demonstrate feasibility in an experiment.

PHASE II: Develop the most promising concept design and build prototypes for use in blast experiments.

PHASE III: This system would have potentially wide use by companies interested in providing building products to increase the blast resistance of windows. These would include various window and glazing manufacturers. In addition, other Government agencies faced with the need for increased blast resistance of facilities may find use for this device.

REFERENCES:

1. Army TM5-1300, Navy NAVFAC P-397, AIR FORCE AFR 88-22, Structures To Resist The Effects of Accidental Explosions, Chapter 6, November1990.
2. Twenty-Sixth Department of Defense Explosive Safety Board Seminar State of the Art of Blast-Resistant Windows, Meyers, G. E., Baldwin, D., Mlakar, P., Miami, Florida; August 1994.
3. Twenty-Seventh Department of Defense Explosive Safety Board Seminar State of the Art of Blast-Resistant Windows in 1996, Meyers, G. E., Las Vegas, Nevada, August 1996.
4. Twenty-Seventh Department of Defense Explosive Safety Board Seminar, Test Program for Enhancing Blast Capacity of Windows, Barker, D. D., Las Vegas, Nevada, August 1996.

KEYWORDS: blast response measurement, windows, windo retrofits

A99-104 TITLE: Bistatic Radar Measurements and Inversion Modeling

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVES: To design, develop, and test a computer model algorithm for inverse microwave scattering capable of reconstructing structural profiles from data collected using a bistatic radar measurement system. The goal is to re-create images of the interiors of man-made structures that possess signature control and structural hardening materials by inverting the data obtained from a controlled, bistatic, microwave, remote sensing system.

DESCRIPTION: Recent developments in high-quality microwave remote sensing systems indicate that it is now possible to invert microwave scattering data to obtain imagery models for man-made structures. Both commercial and military operations often require the deduction of physical properties, such as size, shape, and electromagnetic characteristics, from a structure or object. The source of data for calculating the internal construction structure must be from radar electromagnetic wave since this is the only physical mechanism capable of non-destructive penetration of commercial and military structures for which data are required. This technique is generally known as the inverse scattering problem. Generation of permittivity and conductivity profiles of unknown media can be accomplished through the application of 1-dimensional inverse scattering techniques. In these techniques, information included in the scattering data is utilized to reconstruct 1 and 2 dimensional profiles. Subsequently, several profiles for different transmitter/receiver combinations can be assimilated into a scattering based tomographical image which will cross-sectionally describe the internal material state of the structure. This is accomplished using transmitter/receiver tandems under the constraint of limited angle of access to the structure. An analogy to this process is the use of tomography to measure human internal organs. The measurement techniques involves a multidisciplinary approach to the analysis of electromagnetic wave propagation, the study of wide-band antenna and radar systems, nondestructive testing, subsurface detection, geophysical exploration, signal and image processing, noise reduction, remote sensing and target identification. This research is motivated by high-use commercial and critical DoD requirements for hidden object detection/ identification, damage assessment, and camouflage discrimination. One goal of the work will be to develop an algorithm for a 3-dimensional reconstruction and to verify it using experimental data from scale model test structures. Then, the limited angle scattering based tomography technique will be evaluated and compared with traditional techniques through the transmitted full angle tomographic reconstruction procedure, using both simulation studies and experiments. The proposed effort will involve an equal emphases on equipment preparation, theoretical development, modeling and analysis, and experimental validation.

PHASE I: Design the software and create an applications program interface for the data acquisition using the bistatic measurement facility necessary for the measurements described above. Develop inverse microwave scattering algorithms capable of creating tomographic models of man-made structures from data. Provide a specific set of planned bistatic measurements and software validation techniques to support the algorithm development process.

PHASE II: Develop data acquisition control software, systems components, and user's manuals for implementation on a bistatic microwave measurement system. An experiment design is required for a set of planned measurements necessary to validate the system and the software for displaying the tomographic image reconstruction from the inversion of the microwave scatting data. Conduct measurements for a validation study and provide the results for each algorithmic approach used on a specified structure type. All microwave inversion imagery should correlate with physical measurements of the structures used in the experiments.

PHASE III: DUAL-USE COMMERCIALIZATION: The results of this research will have a broad-based commercial potential for application in sensor and imagery interpretation algorithms development in both civilian non-destructive structural evaluations, and military reconnaissance and surveillance systems. Products from this research would provide new information for multispectral signature control, structural hardening, battle damage assessment, disaster response, non-destructive evaluation of bridges, and rescue from collapsed buildings.

REFERENCES: Ulaby, F. T., Moore, R. K., and Fung, A. K., Microwave Remote Sensing, Addison-Wesley Press, 1982. Ulaby, F. T., Handbook of Radar-Scattering Statistics for Terrain, Artech House, 1988. Ahmad F. H. and Haskins R., "Use of ground penetrating radar in Nondestructive Testing for Voids and Cracks in Concrete," The REMR Bulletin US Army Corps of Engineers-Waterways Experiment Station Publication, Vol. 10, Number 3, Sept. 1993 11-15. Livingston R.A., "Future directions in NDE research for highways," Review for progress in Quantitative Nondestructive Evaluation, Vol. 13, Ed. By D.O. Thompson and D.E. Chimenti, Plenum Press, N.Y., 1994, 2099-2106. Thomas G. et. Al. "Nondestructive Evaluation techniques for enhanced bridge inspection," Review for progress in Quantitative Nondestructive Evaluation, Vol. 13, Ed. By D.O. Thompson and D.E. Chimenti, Plenum Press, N.Y., 1994, 2083-2090. Meaney P. M., Moskowitz M. J., "Finite Element methods in Impedance Tomography and Microwave Imaging" Annual Northeast Bioengineering Conference, 1993, v 19. Ahmad F., "Approximation of Electromagnetic Profiles" Technical Report, U.S. Army Corps of Engineers, 1996 Ahmad F. and Razzaghi,"On the Approximation to the Permittivity Profile of an Inhomogeneous Dielectric Slab," Journal of Electromagnetic Waves and Applications, V. 12, pp. 713-722, 1998.

KEYWORDS: bistatic, RCS, measurement, radar, CCD, radar scattering

A99-105 TITLE: Miniature Blast Sensors for Conventional Weapons Effects Studies

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop miniature air blast and ground shock/motion sensors for use in miniature-scale, precision high-explosive experiments.

DESCRIPTION: The Engineer Research and Development Center, Waterways Experiment Station conducts miniature-scale precision weapons effects experiments and structural response experiments in its laboratory facilities. These miniature-scale of these experiments enable researchers to achieve much greater control of the initial and boundary conditions of experiments, allow for better definition of the blast environments and structural responses created in the experiments, and allows experiments to be conducted several times to define the statistical nature of the data gathered. Miniature-scale experiments save time and money over similar experiments conducted at full- or near-full scale. To better conduct such experiments, very small precision pressure, ground shock, and motion sensors are needed. These sensors must be no more than approximately 1 mm thick in the sensing direction, and no more than 5-6 mm wide normal to the sensing direction, to achieve the desired accuracy at the experiment scales of interest. In addition, the sensors must have a frequency response on the order of 1 MHZ and be able to withstand shock environments of well over 10,000 g's and peak pressures/stresses from 0.7 MPA (100 psi) to 340 MPA (50,000 psi). Innovation will be needed to develop rugged sensors of this size and capability.

PHASE I: Design and predict the performance of prototype gages for use in miniature-scale weapons effects and structural response experiments.

PHASE II: Refine the gage designs and produce working gages for use in miniature-scale weapons effects and structural response experiments.

PHASE III DUAL USE APPLICATIONS: Rugged, small-scale blast gages have an extensive market throughout the R&D community that studies shock physics and structural dynamics. This market includes the automobile and aircraft safety industry, as well as the mining industry.

REFERENCES: Welch, C.R.; Rinehart, E.J.; "The Effect of Experiment Scale On Ground Shock Measurement Error," Proceedings 7th International Symposium on the Interaction of the Effects of Munitions with Structures, Mannheim, Germany 24-28 April 1995.

KEYWORDS: sensors, weapons effects, miniature-scale, shock physics, structural dynamics, blast effects, ground shock, air blast, lethality, survivability, expolsive effects

Topics Addressing U.S. Army Operating and Support Cost Reduction (OSCR) Intiatives

U.S. Army Armaments Research, Development and Engineering Center (ARDEC)

A99-106 TITLE: Innovative Structural Control and Devices using Smart Material Technologies

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop hybrid high performance actuators and devices and associated driving electronics and controllers for integrated or imbedded structural control. The actuators or devices should provide high force/torque and large displacement capabilities with a large dynamic response for precision positioning, vibration isolation and biomimetic applications. The devices should be compact, low cost, have high stroke and load capability and have low power requirements. Ideally, actuators or devices shall be self-contained, imbedded or easily integrated with host systems or structures.

DESCRIPTION: Numerous weapon, biomimetic and commercial applications require high bandwidth (often in the 100-1000Hz range), and large displacement (.1mm - 10mm), structural control systems that can be readily incorporated into the structure or components of the system without major modification. This is particularly critical in structural applications in which even minor change in the component/structure geometry/shape may significantly compromise the performance of the system such as, large caliber tank and artillery guns, 50 caliber machine guns, 30mm B 40mm chain guns and even individual crew served weapons. Additionally, weapon platform mount structures, like the roof of a HMMWV for example, or sensor support mast structures can be improved to minimize platform size and weight burden while improving performance. Ongoing efforts utilizing micro and mesoscale biomimetic systems will directly benefit from this effort. The dynamic requirements of such devices will eventually be dependent on specific applications but for a technology development effort as defined by this topic it is anticipated and acceptable to design hybrid sub-scale actuators and devices and demonstrate these devices on representative surrogate structures. Sensor and actuator technologies can be integrated and embedded to form novel state-of- the-art structural control devices. These designs will most probably be based on smart materials capable of high speed actuation or damping and require specialized drive, mechanisms and control electronics. This project will address issues related to the development of such innovative actuators or devices, including the design concepts and methodology, modeling, simulation, prototyping, and real-time software/hardware implementation for a number of such designs with the greatest potentials.

PHASE I: Develop concepts and configurations, control laws, and implementation ideas. In Phase I, a comprehensive assessment and analysis of possible active material based actuators or device concepts for structural design and control should be conducted. The strength and weaknesses of the different ideas should be evaluated. The best configuration(s) should be identified. Concrete designs of one or more of the best system(s), including the devices, controller, driving electronics and structural members or structural integration are expected. The conclusions should be demonstrated and verified through computer simulations and component level lab tests.

PHASE II: Develop a fully integrated design, test and prototyping environment for development of the selected structural control devices. A prototype system should be developed for a specific military application during this phase of the project that would achieve a higher performance in pointing systems, vibration control or structural optimization. These structural systems or control devices should be prototyped, fully tested, and integrated in existing systems. As part of this effort, modeling and control design of the structure or pointing system should be accomplished in order to demonstrate successful applications of the technology. Production and manufacturing issues shall also be addressed in Phase II.

PHASE III DUAL-USE APPLICATIONS: Smart materials based structural control devices or members have a high demand in both military and commercial applications. A number of commercial systems and machinery also require added low cost actuators or devices for performance enhancement or structural optimization. Such commercial systems are machines such as laser and electron and X-ray beam lithography machines, inspection and probing machines for the electronics industry, automated quality control and metrology related machinery, laser and antenna pointing systems and machinery for the production and testing of ultra-high quality optical components and instruments. Furthermore, such devices may be utilized both for positioning and vibration isolation purposes.

KEYWORDS: smart structures, actuators, dampers, smart materials, vibration isolation, precision pointing, active-passive hybrid actuators, imbedded structural actuators

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The integration of smart material based structural control actuators or devices has demonstrated great potential for the reduction of operating and support costs by improving the accuracy and lethality of weapon systems making them more efficient at meeting mission requirements. These structural control devices can often replace conventional hydraulic or electric actuator systems and over designed/non-robust damper or vibration reduction systems reducing scheduled maintenance, safety and environmental impacts and the cost of spares.

Additionally, the imbedded or integrated design of these devices within host structures or systems can often reduce or minimize the structural weight and platform burden while improving performance capabilities through structural optimization.

A99-107 TITLE: Intelligent Multi-agent Hybrid Systems Control Technology

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop algorithms, design methodology and processing architectures to support implementation of real time muti-agent and hybrid systems control technology for coordinated, rapid response, multi-target/ multi-platform fire control applications. Demonstrate and validate technology for distributed fire mission engagement.

DESCRIPTION: Recently progress has been made (see ref) in developing hybrid/multi-agent processing algorithms, design methodology and architectures to support distributed intelligent decision making, planning and real time control which makes feasible the design and implementation of multi-agent control strategies for coordinated multi-platform weapon engagement. Further development is required to mature this emerging technology, optimize algorithms and hardware/ software implmentation architectures and validate the concept in a realistic scale engagement simulations. Key requirements of the multi-agent architecture are a) real-time performance b) reactive, event driven behavior 3) adaptive/ on-line learning based on sensory data 4) distributed decision making and coordination 5) support for multiple levels of abstraction in reasoning and control 6) distributed reasoning in the presence of uncertainty 7) information fusion 8) target track management and deconfliction and 9) design flexibility for reconfiguration to different platform mixes, mission requirements and sensor configurations. This project will address the broad spectrum of issues associated with the development of prototyping tools and design methodology, hybrid system modeling and multi-agent simulation, real time hardware/software implementation, multi-agent algorithm development, and human-computer interface.

PHASE I: Develop methodology, computational approaches and architectural concepts to support design and implementation of multi-agent hybrid system control laws for distributed multi-platform applications. To demonstrate the generic nature of the multi-agent framework and methodology adapt the problem formulation to the multi-target- multi-platform engagement application and also illustrate applicability to distributed process control and scheduling. Problem formulation should take into account physical constraints and characteristics of sensor/actuator subsystems as well as inter-platform communication and network constraints. In the case of the fire mission application, such constraints would include pointing accurracy, slew rates, rate-of-fire, sensor characteristics, tactics, etc. Phase I will formulate muti-target-multi-platform engagement strategies that optimize use of shared information and resources and maximize hit probability and engagement effectiveness and provide preliminary performance analysis. Phase I will also identify specific software development and design tools, provide preliminary concept definition and specification of implementation environment.

PHASE II: Develop a fully integrated design and prototyping environment to support generic multi-agent control applications. The design environment will include hybrid system modelling and simulation tools, and agent design and prototyping tools to support application development, implementation and testing. Develop detailed agent algorithms, application scenario, and multi-agent software and hardware prototype and and evaluate via simulation. Optimize module hardware/software and algorithm design based on test data and provide complete documentation of algorithms and hardware/software architecture.

PHASE III DUAL USE APPLICATIONS: This work has a very high probability of commercialization. The methodology, design environment, prototyping tools and component technology developed in this SBIR are applicable to manufacturing, machine tool, process control, smart highway systems and distributed robotics. These applications are characterized by the presence of discrete event and continuous time dynamics which are tightly coupled and require hybrid design methods to ensure performance and stability. This technology also has broad DOD applications, particularly in the area of affordable controls; distributed, multi-platform fire control and targeting; intelligent, multi-agent, cooperative systems; defense manufacturing, etc. The impact of the technology is two-fold: increasing performance through improved control software while reducing cost by encouraging reuse and improving reliability, maintainability and fault tolerance.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Multi-agent processing technology will permit optimal utilization and distribution of assets on the battlefield as well as reduce training and personnel requirements by enhansing automation of crew functions.

REFERENCES:
1. Multiple agent Control For Manufacturing Systems, Proc.IEEE International Sym on Intel Control;
2. Scalable Data and Sensor Fusion Via Multiple Agent Hybrid Systems. IEEE Trans on Automatic Control, Spec Issue 1997;
3. Hybrid Knowledge Bases, Trans on Knowledge and Data Eng. 1996;
4. Adaptive Probabalistic Networks With Hidden Variables, Machine Learning, 1997;
5. Conflict Resolution For Air Traffic Management Systems: A Study in Multi-Agent Hybrid Systems, IEEE Transactions on automatic Control, Spec Issue 1997;

6. Learning Controllers For Complex Behavioral Systems, ERL Memo UCB/ERL M96/73, UC-Berkeley, Dec 1996;
7. Lecture Notes in Computer Science, springer-Verlag, 1996.

KEYWORDS : Hybrid control technology, intelligent multi-agent processing architecture, multi-platform, fire control

A99-108 TITLE: Proficient Gun Barrels

TECHNOLOGY AREAS: Weapons

OBJECTIVES: Design and build a proficient gun barrel able to acquire and display unique operational and functional awareness. Introduce the necessary devices, sensors and/or smart materials, etc. with embedded logic into the gun barrel to achieve these aims without resorting to excessive power sources or weight penalties.

DESCRIPTION: In recent years, the past initiatives in the research and development of smart or sensor materials as well as micro-electrical mechanical systems (MEMS) have evolved to the stage where they can now demonstrate unique abilities to respond to external stimuli and provide analog responses. Piezoelectric materials, electrorheological fluids and shape memory alloys are representatives of this class of smart/sensor materials. When incorporated into a structure in an innovative manner they imbue that structure with awareness abilities that can uniquely combine both sensing, control or monitoring features. Gun barrels have not fully taken advantage of these unique materials to improve their operational performance and provide real time functional awareness when they are often subjected to aggressive firing schedules. For example, judicious incorporation of these materials can provide an adjunct level of autonomous operation for specific gun systems that is both cost effective, performance enhancing and safety related. Two areas of functional awareness that can be considered performance enhancements are real time monitoring of barrel wear/erosion and round exiting velocity.

PHASE I: Develop an overall system architecture for gun barrel operational and functional awareness. Incorporate sensor, smart material or MEMS, etc. specifications and modal operational criteria. Address as many aspects of gun barrel performance factors as deemed appropriate to achieve functional awareness levels commensurate with enhanced safety, performance and extended life.

PHASE II: Develop and demonstrate a prototype system in a realistic Army firing schedule with Army supplied gun barrels. Conduct testing to establish proof of principle, fabrication feasibility and system endurance.

PHASE III DUAL-Use Applications: This system would have potential utility in commercial engine monitoring as well as in providing new algorithms to enhance functional awareness with commercial products.

OSCR REDUCTION: Presently the DOD spends a lot of money for premature failure of gun barrels. Developing a cost efficient system that accurately assesses gun barrel performance and available life would facilitate the more accurate projection of inventories

REFERENCES:
1. T. Golnas et al. " Thin film Thermo-Mechanical Sensors Embedded in Metallic Structures" in Material Science Forum Vol. 287/288 pp. 201-204 1998
2.Embedded Temperature-Change Sensors, NASA Tech Briefs, Vol. 19 :9 pp. 48 1995
3. Appropriate articles in the following technical journals: Sensor Review; Smart Materials & Structures; Journal of Intelligent Material Systems and Structures
4. N. Tien "Silicon Micromachined Thermal Sensors and Actuators" in Microscale Thermophysical Engineering , Taylor & Francis, Publishers 1997.

KEYWORDS : Gun barrel, sensors, smart materials, functional awareness

A99-109 TITLE: Acoustic Mine Detection and Neutralization

TECHNOLOGY AREAS: Sensors, Electronics and Battlespace Environment

OBJECTIVE: Develop a state-of-the-art acoustic mine detection system capable of detecting and neutralizing existing and next generation land mines.

DESCRIPTION: Based upon the growing concern over the number of existing land mines which have been left in place during conflicts, and the number of civilian casualties as a result of these uncleared areas, there is a growing need for the ability to efficiently and effectively detect and dispose of land mines. This problem is compounded by the fact that as a function of time, the sophistication of land mines has increased, and the ability to be detected has been significantly diminished due to the utilization of new materials. Current systems either cannot detect new land mines, or the detection times are too long and not reliable, and thereby are virtually prohibitive. Although the basic focus of the effort is toward Anti- personnel Landmines which are typically buried near the surface, this technique could be utilized for other types of mines such as antiarmor mines which are typically buried about five inches below ground. The intent of this system is to acquire and disable both existing and new systems in a fraction of the time currently achievable with a relatively small rate of false alarms. For those detected cases of initial false alarms, the system would be used with more resolution to interrogate and confirm the validity of the false alarm to ensure that once an area has been cleared no active landmines remain.

PHASE I:

A. Detection: Identify existing state-of-the-art mine acoustic detection systems which are potential candidates to identify land mines. This could include the combination of detection techniques, which will provide both high resolution and high scan rates, with low rates of false positives. It is envisioned that the resultant concepts would utilize a fusion of acoustic sensor and acoustic source technologies with the combination of advanced visualization comparison technologies. During operations, initial soil calibrations would be done and potentially referenced to an existing "look-up" table which would contain pertinent information about known soil conditions. In addition, "look-up" table could be utilized to minimize processor times, and hence scan times for pertinent mine information. It is envisioned that the first stage, the scanning phase, would utilize a low power acoustic source to excite the surrounding air and ground. This would provide an initial signal to the sensor as well as excite the ground which the mines would be buried in and provide a reflection back to the sensors. The scanning phase would provide a high scan rate with relatively low resolution. The output from these series of sensors would utilized state-of-the- art logic and would ensure that if the system detected a potential mine, a positive result would register. This portion would error on the side of identifying false positives as potential positives to ensure that any and all potential mines would be detected. At this point, once a potential positive was denoted, the determination/validation mode would become the dominant function of the system. This portion of the detection process would be of a slower scan rate, but significantly higher resolution. This stage of the process would clearly determine the potential positive(s) as denoted in the scanning phase. Once again, if the determination/validation phase of the detection process would always error on the side of a false positive, it would ensure any and all potential land mines would be denoted for neutralization.

B. Neutralization: This phase will determine the sensitivity of the mine initiation process to acoustics and determine the vulnerable thresholds for various components, subsystems, and the total system of various surrogate mines. This will utilize the output information such as location, and type of mine, etc., as previously determined in the detection mode. The landmine initiation sensitivity information obtained during this phase will ensure that the acoustic energy utilized during the detection mode does not inadvertently initiate the mines, and to also ensure that once a mine is located, it is subjected to sufficient acoustic energy to ensure detonation. During the neutralization phase the mine should be subjected to an excess of 1 to 2 orders of magnitude higher acoustic energy density (flux) than is required to detect the landmine. This approach will ensure that the landmine will be neutralized.

C. Demonstration: Experimentally confirm/verify the sensitivity analysis for both Detection and Neutralization by utilizing surrogate mines or representative components for different classes of mines. A series of parallel approaches will be utilized, i.e., Phase IA and IB would be performed in parallel to minimize development time. The Demonstration portion, Phase IC could be done either independently or congruently

PHASE II: Combine the two (2) systems developed independently during Phase I and combine the units into a single brassboard system. In addition, experimentally confirm/verify the capability to detect and neutralize several surrogate, representative, mines.

PHASE III DUAL USE APPLICATIONS: This technology has numerous applications in the law enforcement as well as counter terrorism areas. This tool could be utilized either in the joint mode of detection and neutralization or independently. For buildings or areas which would require constant monitoring for munitions activities, this device could store an acoustic footprint of the building/area, and via comparison of the current trace to the baseline data, a proactive counter terrorist effort could be maintained. In addition, in the area of countering drugs, during raids on manufacturing and storage facilities, this tool could provide "real time" entrance into these safeguarded areas.

KEYWORDS: Landmine technologies, sensors, acoustics, neutralization, lethal mechanisms

OPERATING AND SUPPORT COST REDUCTIONS: By providing the Unit Commander and the operator with "real time" detection and neutralization of land mines, the vulnerability of the forces is significantly reduced as compared to previous systems, and the ability to detect and neutralize occurs in seconds as opposed to minutes, if at all. This will allow the Commander the ability to accomplish not only his mission faster, but also with significantly fewer personnel. This will result in the overall reduction of operational cost.

U.S. Army Research Institute (ARI)

A99-110 TITLE: Training Adaptability in Digital Skills

TECHNOLOGY AREAS: Human Sytems

OBJECTIVE: Develop an innovative package of training strategies and practical techniques to facilitate the retention and transfer of "old-system" digital skills and acquisition of "new-system" digital skills during major and/or rapid equipment and software upgrades or other changes, assuming limited formal training support.

DESCRIPTION: The Army is going digital. Currently, digitization is focused on a few units, such as the 4 ID, or in a few career fields, such as Intelligence. Digitization is being carried out through Advanced Warfighting Experiments (AWE) and equipment upgrades. Things are not always going smoothly. By 2010, the Army Experimentation Campaign Plan would field fully digitized light infantry, strike force, and heavy units. A lot of money will be put into a lot of digital systems to bring the transformation of the Army about. Equipment will be fielded, at times, with advance notice, with mobile training teams, and at a measured pace. At other times, digital equipment, software, and doctrine changes may come in rapid bursts, with little formal training support for them. The Army needs soldiers to be able to adapt readily to maintain and upgrade their digital skills, when the equipment and software they use change or other aspects of their jobs change such that they can no longer fully utilize their digital systems. For example, soldiers may be assigned to environments such as peacekeeping deployments in which their normal equipment and software may not be available or useable, or only different digital versions of the equipment and software are available. Therefore, it is difficult to retain or update their digital skills in a standard or orderly manner. These kinds of problems are particularly acute in branches such as Intelligence that are at the forefront of digitization. Strategies and techniques are needed that reduce the period of decrement in performance resulting from the introduction of new equipment and/or software, including when there has been a gap in use by a soldier of the previous "old system." Soldiers need strategies and techniques to help them adapt quickly to the constant changes and move forward. One dimension of interest is the generality-specificity of the digital skill training. This dimension can be reflected in a training emphasis on general digital skill building compared to an emphasis on particular digital tasks or equipment/software skills. The dimension can also be reflected in its sequencing; for example, it may be optimal in the early stages of training to focus on general principles and analytic components of jobs and then later focus on procedures specific to the current digital equipment and software, or it may be more effective to focus on both at the same time. Another dimension is the location for training the digital skills. Training can take place in Army schools, on-the-job, on a soldier's own time, as an embedded feature of new equipment/software, or in combinations, although this dimension is complicated by the extremely high optempo and long duty hours in some units, which would prevent some training sites or means from being effective. Finally, there is an interest in the dimension of learning strategy. For example, adaptability may be enhanced by allowing soldiers the time to play with their new equipment/software (exploratory learning). Alternately, adaptability may be enhanced through the use of mentors or master trainers that can provide a holistic perspective that facilitates adaptability. Or adaptability may best be gained by some special structuring of how the digital system changes are presented. It is expected that the winner of this project will determine how to facilitate the adaptability of digital skills, and verify recommended strategies and techniques in a training and/or operational situation.

PHASE I: Identify an innovative package of strategies and techniques that should prove effective for training adaptability in digital skills. Develop a method(s) to determine how to minimize interim performance decrements while digital skills are being upgraded. Describe and design research for verifying the strategies and techniques for the optimal training of adaptability and the criteria for assessing training success.

PHASE II: Verify the training strategies and techniques in a training and/or operational situation(s). Incorporate results into a written set of training techniques, strategies, guidelines, and recommendations, in a format easy to include in appropriate Army training material.

PHASE III DUAL USE APPLICATIONS: The same difficulties that soldiers are encountering due to frequent changes in equipment and/or software, including possible discontinuities in usage of old systems, are found with civilian workers in the many environments that now routinely depend on digital equipment. Most validated principles, strategies, technologies, and techniques that work in the Army are likely to be easily transformed for commercial use in the civilian sector and would be readily received.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The successful application of research results should save direct costs by decreasing the amount of time and training support needed in training a specific set of skills for a specific set of tasks and equipment as well as costs of refresher training.

REFERENCES:

1. Goodman, B., Sollar, A., Linton, F., & Gaimari, R. (1997). Encouraging student reflection and articulation using a learning companion. In Proceedings of the 8th World Conference on Artificial Intelligence in Education (AI-ED 97), Kobe, Japan, 151-158.

2. Salter, M. S. & Black, B. A. (1998). Back-up training requirements for the digitized battlefield: An overview (Study Report 98-05). Fort Knox, KY: U.S. Army Research Institute for the Behavioral and Social Sciences.
3. Throne, M. H. & Lickteig, C. W. (1997). Training computer skills for the future battlefield: A review and annotated bibliography (Research Product 97-15). Fort Knox, KY: U.S. Army Research Institute for the Behavioral and Social Sciences.

KEYWORDS : digital skills training, computer skills, skills retention, skill transfer, adaptability

U.S. Army Research Laboratory (ARL)

A99-111 TITLE: Micromagnetic Sensor Technology

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop technology for networks of magnetic microsensors

DESCRIPTION: We are seeking to develop technology for small, low-power, low-cost sensors to detect magnetic fields in the battlefield generated by the presence and movement of armed troops, tracked and wheeled vehicles. It is anticipated that these sensors may be part of a network of battlefield microsensors which employ a variety of sensor technologies (which may also include, but are not limited to: acoustic, seismic, IR, etc.). Such networks, when linked to indirect fire (e.g., from artillery) may help obviate the need for conventional landmines, although other conceivable roles also exist. The focus is on sensors that can be fabricated by micro-electronics and micro-electromechanics (MEMS) techniques. This will allow integration of sensors with signal processing and transmission circuitry to allow rapid prototyping with very little capital investment by using the existing industrial base.

PHASE I: Research is needed in one or more of the following areas: (a) novel magnetic sensor concepts leading to quantification of detection distance(s) for various classes of targets; (b) filtering and/or signal processing techniques which are expected to improve the detectability of targets in a battlefield environment; and (c) computer-based modeling of targets and sensors that can provide a capability to perform trade-off analyses of sensor concepts during prototype design. The resulting sensor and signal processing circuitry in (a) and (b) must be capable of fabrication by microelectronics/MEMS techniques. The modeling in (c) must apply to these microsensors and associated circuitry.

PHASE II: Development of prototype hardware corresponding to the research conducted in Phase I; e.g.: (a) prototype sensors suitable for testing; (b) prototype filtering hardware demonstrating improved performance and/or micro-power requirements; (c) detailed modeling and analysis to support trade-off decisions during prototype development. PHASE III: Dual-use applications: It is anticipated that the research described above could also be applied to commercial networks of magnetic microsensors used to monitor urban or highway traffic, automated warehouses, and secure installations, perimeters, and borders.

OPERATING AND SUPPORT COST REDUCTION (OSCR): The "networked microsensors" concept represents a fundamental shift in the way we can view the battlefield, as compared to the high-cost, high-resolution, fixed sensors which are often employed today. By definition, these sensors must have very low cost, to the point that they can be remotely deployed in large networks and never recovered. They will require no external power, no spare parts, and no maintenance.

REFERENCES:
1. James E. Lenz, "A Review of Magnetic Sensors", Proceedings of the IEEE, Vol. 78, No. 6, pp. 973-978, June 1990.
2. M. N. Deeter, A. H. Rose, and G. W. Day, "Fast, sensitive magnetic- field sensors based on the Faraday effect in YIG", IEEE Journal of Lightwave Technology, Vol. 8, No. 12, pp. 1838-1842, December, 1990.
3. John C. Peterson et al., "Sensor Technology Assessment for Ordnance and Explosive Waste Detection and Location", Jet Propulsion Laboratory report D-11367 Revision B, (available through the JPL Archives and Records Group, Mail Stop: 512-110, 4800 Oak Grove Drive, Pasedena, CA 91109-8909, phone: 626-449-1593), 1 March 1995.
4. Jay L. Brown, "High Sensitivity Magnetic Field Sensor Using GMR Materials with Integrated Electronics", 1995 IEEE International Symposium on Circuits and Systems (ISCAS '95), Vol. 3, pp. 1864-1867, 1995.
5. R. B. Givens, J. C. Murphy, R. Oslander, T. J. Kistenmacher, and D. K. Wickenden, "A high sensitivity, wide dynamic range magnetometer designed on a xylophone resonator", Applied Physics Letters, Vol. 69, No. 18, pp. 2755-2757, 28 October 1996.
6. Thomas T. Liu and Antony C. Fraser-Smith, "Identification and Removal of Man-Made Transitents from Geomagnetic Array Time Series: a Wavelet Transform Based Approach", to appear in the Proceedings of the IEEE 32nd Asilomar Conference on Signals, Systems, and Computers, 1998.

KEYWORDS: Magnetic,Microsensors, Anomoly Detection, Unattended Ground Sensors

A99-112 TITLE: Logistics Site Planning and Operation Tool (LOGSPOT)

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Design and program an inexpensive PC based software package that logistics commanders and their staffs at all levels can intuitively use to optimize the layout of their logistics sites and plan daily operations.

DESCRIPTION: At the tactical level, the Army currently has no planning tool to assist logistics commanders and their staffs in site planning, layout, and logistics and tactical operations. Logistics commanders and their staffs at all tactical levels must rely on paper maps, plastic overlays and grease pencils to plan and display the physical location and layout of their units. This process is man-hour intensive and prone to inefficiencies and errors, causing delays and loses in supplies and logistics support. Logistics planners and operators need a tool that will aid them in optimizing the layout and operation of their logistics units. This Logistics Site Planning and Operations Tool (LOGSPOT) would allow logistics planners to optimally place logistics support equipment, defensive weapons and supply locations into the positions based on terrain considerations, customers requirements, logistics operating rules, safety and enemy threat. LOGSPOT would be networkable allowing logistics data to be transmitted, integrated and displayed on LOGSPOT systems at higher levels of command. Networking would allow shipping and transportation data to be transmitted for use in daily unit operations planning. LOGSPOT would use this information to optimize the storage and transloading of supplies based on supply arrival times and customer demands. LOGSPOT would be intuitive for operators (Sergeants to Captains) to use. LOGSPOT would be used on any Pentium based laptop with a modem. Maps, logistics information and unit displays would be easy to understand by intended users.

PHASE I Develop a detailed system design that specifies the tool's conceptual design, human computer interface design, logistics data import and export methods, and logistics and tactical data and display representation. The contractor's design should demonstrate how commanders and their staffs would use LOGSPOT in a field environment. Designs must cover: (1) Entering and displaying unit equipment and defensive positions on a computer generated map. (2) Use of map terrain information and logistics rule sets in planning and optimizing unit set-up and operations and (3) Passing logistics and defensive set-up information to higher and lower command levels. Contractors should concentrate on delivering a design that is easy to use without extensive training. Interfaces should be intuitive to use for both military and commercial logisticians.

PHASE II Develops and demonstrates a prototype system based on Phase I approved designs. Demonstrations will be conducted in a realistic environment. Conduct testing to prove feasibility and usefulness and potential benefits of LOGPSOT.

PHASE III DUAL USE APPLICATIONS: Automated commercial logistics tools have concentrated on the speeding up the logistics pipelines. LOGSPOT is unique in that it concentrates on optimizing the nodes along the logistics pipeline. Commercial uses of the LOGSPOT would focus on logistics site operations and the benefits of an optimized site for conducting daily logistics operations. Commercial interest would come from the potential cost savings from increased optimization of these storage sites, transportation hubs, manufacturing sites and construction projects.

OPERATING AND SUPPORT COST REDUCTION (OSCR): LOGSPOT seeks to aid in OSCR by reducing lost and frustrated supplies, reducing delays inside logistics nodes, and reducing the number of man-hours needed to plan logistics operations.

KEYWORDS: Logistics, operations planning, site layout, Combat Service Support.

A99-113 TITLE: Novel Wear Resistant and Thermally Insulative Materials

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVES: Development of a novel functionally graded material (FGM) that is both wear resistant and thermally insulating.

DESCRIPTION: Anticipated future diesel engines will require higher power output and reduced engine volume while simultaneously increasing fuel efficiency and decreasing emissions. Since the 1970's efforts to develop low heat rejection adiabatic and minimum friction engines for military use have been underway.1-3 The objectives for these engines was to reduce combat failures associated with the loss of engine coolants or liquid lubricants. Monolithic ceramics and ceramic-based thermal barrier coatings (TBCs) have been the candidate materials to achieve these objectives.4-6 Functionally graded materials (FGMs) have been studied in recent years with the focus of optimizing thermal or wear resistant properties, but not both. Only lately, has the "science" of FGMs and the development of manufacturing processes for the production of FGMs reached a mature stage where this novel concept might be possible. Two factors have been particularly significant in advancement of FGMs: (1) development of higher purity and quality starting materials, (2) development of new processing techniques. This novel FGM would allow engineers to design engine componentry (i.e. pistons, piston rings, valves and cylinder liners) that would be both insulating and wear resistant, thus increasing overall engine performance and efficiency to meet the needs of Crusader, Future Combat Systems and AAN requirements.

PHASE I: Identify and demonstrate the feasibility of FGM material(s) to meet or exceed the wear resistance properties of 4140 steel, and have a thermal conductivity $<= 12$ W/m°K. Also this material must meet a minimum thermal shock resistance of 25 cycles of RT to 600°C, at 30-minute intervals between cycles, without material delamination or spallation.

PHASE II: Exploit and improve the wear and thermal properties of the Phase I material, and demonstrate the feasibility of the material processing by applying it to geometrical configurations which are representative of the appropriate reciprocating engine components.

PHASE III: Dual-Use Applications: The performance of the material shall be demonstrated by applying the material to appropriate reciprocating engine components and testing these components using a single- or multi-cylinder engine with operating conditions similar to high output military engines. Army and automotive industry requirements for increased power density, efficiency, and lower heat rejection would benefit from the material developed in this program.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Any development of a novel materials and associated processing, that could produce a wear resistant, thermally insulating material will extend the service life of diesel engines and enhance combat force survivability. Experimental confirmation that a wear resistant and thermal insulating material results in improve engine performance may lead to reductions in engine size and weight with an associated reduction in armor. This would also, improve logistics (materiel deployability, increased range, reduced maintenance) and improve survivability (increases in speed, range and maneuverability).

REFERENCES:

1. Katz, R.N., "Applications of High Performance Ceramics in Heat Engine Design," in Engineering Ceramics, Eds., M. Ish-Shalom and D.G. Brandon, Elsevier Applied Science Publishers, NY, 227-249 (1984).
2. Woods, M.E., Mandler, Jr., W.F. and Scofield, T.L., "Designing Ceramic Insulated Components for the Adiabatic Engine," Am. Ceram. Bull., 64 [2] 287-293 (1985).
3. Mandler, W.F., "Ceramic Successes in Diesel Engines." 6th International Symposium on Ceramic Materials and Components for Engines, Niihara, K., Kanzaki, S., Komeya, K., Hirano, S., and Morimaga, K., 137-141 (1998).
4. Larson, H.J., "Development of High Temperature In-Cylinder Components and Tribological Systems for Advanced Diesel Engines," Proceedings of the Annual Automotive Technology Development Contractors Coordination Meeting, Conf. #17207, SAE Warrendale, PA, 653-656 (1992).
5. Kalish, Y. "Engine Testing of Ceramic Cam-Roller Followers" Final Report for Oak Ridge National Laboratory, ORNL/Sub/90-SF985/1, April 1992.
6. McEntire, B.J., Willis, R.W., and Southam, R.E., "The Development and Testing of Ceramic Components in Piston Engines," Final Report for Oak Ridge National Laboratory, ORNL/Sub/90-SG151/1, October 1994.

KEYWORDS: Thermal barrier coating, functionally graded materials, wear resistance, thermal insulation

A99-114 TITLE: Smart Materials for Collapsible Fuel and Water Storage Tanks

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Design, synthesize and manufacture new and improved materials capable of being used as collapsible fuel and water storage tanks. The material must have excellent thermal, oxidative, UV and hydrolytic stability, resistant to water, solvents and various fuel types as well as possess the necessary mechanical strength to hold up to 210,000 gallons of fuel or water. Additionally, the material must possess the ability to sense and alert personnel as to the onset of material failure.

DESCRIPTION: The need for the new, smart materials was facilitated by events occurring in Saudi Arabia, where collapsible fuel storage tanks failed while in service. The fuel tanks were normally exposed to intense sunlight as well as air temperatures exceeding 130 F, this caused catastrophic failure due to seam splitting, where bond lines could not withstand the unique climate conditions and leakage occurred. All the failed fuel tanks were constructed of nylon fabric coated with polyurethane where the tank seams were heat sealed and were only in service for as little as 2 months. The Army is interested in the development of new smart materials that will meet and, if possible, exceed the requirements set forth above. In addition, the materials should withstand a variety of temperatures from -60 F to 160 F and remain stable to UV degradation. The material of interest should be a smart material; i.e., have the capability to detect material/bond line deterioration from hydrolysis by release of a chemical dye or other sensor to alert personnel of possible problems.

PHASE I: Demonstrate the feasibility of developing new materials with improved mechanical strength, excellent bond line strength and excellent thermal and oxidative stability with the capability of being used as a collapsible storage tank for fuel and water under all climate conditions. The material should incorporate some sensing capability to determine the onset of possible failure.

PHASE II: Design, synthesize and manufacture as optomized collapsible fuel storage tank prototype based on material(s) developed under Phase I effort. Demonstrate the scale-up capability of the proposed material for fabricating end item collapsible fuel and water storage tanks.

PHASE III DUAL USE APPLICATIONS: Successful completion of this work would have several applications in the commercial marketplace. The areas of tarps and tents, baggage, service station gas tank liners, oil recycling containers and water storage containers. Chemical storage and transport, spill recovery, commercial airline refueling stations would be affected.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Potential life cycle cost savings for the Army will be acheived due to enhanced durability and reliablility of end product storage tanks. Currently, these fuel tanks are used by the Air Force,the Army and the Marines who all have exhibited seam failure in the past. The enhanced material will increase the service life of the tank, thus affording a reduction in the quantities required. The dual use characteristic will increase the militaries response to surge demands while still allowing a reduction in inventory and reduced logistics of managing multiple NSNs, specifications and technical publications. Decrease in procurement cost by structuring a single contract for dual use tanks instead multiple contracts for fuel and water tanks. Potential for increased cost avoidance in the area of environmental clean-up and adverse legal action.

REFERENCES:

A. Specifications of Collapsible Tanks that could use this technology:

1. MIL-T-53066 Tank, Fabric, Collapsible, 5,000 Barrel, Fuel
2. MIL-T-52943 Tank Fabric, Collapsible, Pillow, For Potable Water
3. MIL-T-52983 Tank Fabric, Collapsible, 3,000, 10,000, 20,000 and 50,000 Gallon,Petroleum

B. Reports & Papers on Fuel Tank Materials & Deterioration

1. "Failure Mechanism of Urethane Elastomer Coated Fabric Collapsible Fuel Tanks", Henry O. Feuer and Paul Touchet; US Army Belvoir RD&E Center Technical Report No. 2488, dated March, 1990.
2. "Extending The Service Life of Urethane Tanks", P. Touchet, P. E. Gatza, H. O. Feuer and A. R. Teets, US ArmyBelvoir RD&E Center Technical Report No. 2519 dated March 1992
3. "Effects of Extracting Hydrolytic Stabilizers on Urethane Performance", paper presented at 138th at ACS Rubber Division Meeting in Washington DC, Oct 1990 and also published in the April, 1991 issue of Coated Fabrics magazine.

KEYWORDS: Collapsible storage tank, polyurethane

A99-115 TITLE: Low-cost, Adhesiveless Method for Assembling Fibrous Preforms

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Preform assembly is the single most costly step in the fabrication of fiber-reinforced polymer composites. The objective is to develop and demonstrate an inherently inexpensive and effective means for connecting the individual preform plies so that a desired preform shape is achieved without the use of tacifiers or expensive stitching.

DESCRIPTION: Making composites more affordable is not only an Army need but a pervasive DoD technical goal. The Army, for example, is aggressively pursuing these objectives in the "Rotary Wing Structures Technology Demonstration" Program (RWSTD) and the "Knowledge and Process Tools for Manufacturing of Affordable Composite Structures" Program (a MANTECH-sponsored Manufacturing Technology Objective (MTO)). Similarly, the Composites Affordability Initiative (CAI) is a Defense Technology Objective (DTO) with Air Force, Navy, and Army participation [1]. Preform technology is fundamental to the development of advanced composite structures, particularly those capitalizing on recent advances in resin infusion processes such as VARTM (Vacuum Assisted Resin Transfer Molding) [2,3]. Nevertheless, preform fabrication procedures remain by far the single most expensive and labor intensive element of a given composite manufacturing operation [4]. While advances in stitching and automation have begun to address this issue, relatively little innovation has been applied to the fundamental problem of connecting one ply to another in the "build up" of the preform geometry and part thickness. Currently manufacturers use polymer-based adhesive tacifiers, but recent evidence indicates adhesives interfere with both the resin flow and ultimate mechanical properties [5]. Traditional stitching is expensive and difficult to justify in many applications. A novel, inexpensive, easy to implement method for connecting successive plies is required which is amenable to both manual and automated implementation. The manual use of the method is emphasized given that, in some cases, hand lay up is still the preferred and more economical method for producing a composite system [4,6,7]. The technical goal is to develop a generalized means for mechanically fastening one ply to another, and ensuring that both the material and technique used to accomplish this assembly do not appreciably interfere with either the resin flow or mechanical properties developed in the composite.

PHASE I: Design and develop a novel method for inexpensively and effectively connecting successive woven fibrous plies to fabricate a preform that does not use adhesives or tacifying agents. The method should be amenable to either manual (i.e., hand held) or automated (e.g., robotic) implementation. Demonstrate the ability to "build up" a complex preform geometry that does not distort or allow excessive ply slippage prior to or during impregnation and/or curing.

PHASE II: Refine and scale up the novel assembly technique developed during in Phase I. Particular emphasis should be on producing thick (e.g., >1") glass laminates for use in Army ground vehicle, shelter, and armor materiel. Scale up will successfully demonstrate a minimum 30% reduction in preform assembly cycle time. Integrate method with automated preform fabrication system.

PHASE III DUAL USE APPLICATIONS: The successful development of a low cost preform assembly method has vast and significant implications, both in the commercial and DoD sectors, given that affordability issues are currently limiting more pervasive adoption of polymer composite materials. Preform technology has been cited as the largest source of cost in the overall production of both commercial and military compoiste products [ref. 4]. Successful and innovative preform assembly techniques would directly impact these issues, accelerating a host of improved composite applications including infrastructure, commerical transportation, building materials, and storage systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The significant weight reduction offered by polymer composites translates directly into reduced operation coss through increased fuel efficiency and/or operational range. Furthermore, polymer composites exhibit dramatic corrosion and environmental integrity, reducing the need for frequent replacement and maintenance during the service life of a given structure, component or vehicle. Finally, a more economic and cost effective preform assembly technique will require less material and supplies during repair operations.

REFERENCES:

1. Composites Affordability Initiative, Wright Patterson AFB Technology Program Office, Dayton, Ohio, 1998
2. J. Ni, S. Li, and L.J. Lee, "Analysis of Vacuum Infusion Resin Transfer Molding with Resin Distribution System," ANTEC Proceedings, Vol. II, 1997, pp. 2406-2410
3. A. W. Chan and R.J. Morgan, SAMPE Quarterly, October 1992, pg. 45.
4. C.E. Kim, "Composite Cost Modeling: Complexity," M. Eng. Thesis, Dept. of Mech. Eng., MIT, 1991.
5. W.O. Ballata et al., "XM194 Gun Mount Shield: Processing in a Female Tool Utilizing Embedded Sensors for Process Control," Army Research Laboratory Technical Report No. 1710, July 1998.
6. A Comparison of Materials and Processes for Fiber Glass Composites, Owings-Corning Fiberglas Corp, Toledo, OH, 1986.
7. B. H. Hull, "Hybrid Molding Processes Can Break the "Economics vs. Requirements" Barrier for Structural Composites," 41st International SAMPE Proceedings, March, 1996, pp. 1563-1572.

KEYWORDS: Preform,preform assembly, polymer composites, thick section laminants

A99-116 TITLE: <u>High-mobility Trailer</u>

TECHNOLOGY AREAS: Ground and Sea Vehicles

OBJECTIVE: Develop and validate the technology for future high- mobility trailers compatible with the mobility requirements of Army After Next (AAN).

DESCRIPTION: The efficient movement of materiel in war is increasingly important for AAN. Future military wheel vehicles will traverse rough terrain in excess of 50 mph with an occupant absorbed power of less than 4 watts for terrain having a surface roughness of 3 in. rms. These vehicles will have highway dash speeds approaching 100 mph. Conventional trailers mechanically linked to tow vehicles are incompatible with the high-speed rough-terrain mobility needs of AAN and could cause serious accidents when operated under these extreme mobility conditions. It is anticipated future trailers will have onboard propulsion, active suspension, and energy storage systems as well as vehicle speed and directional controls. The self-propelled trailer is electrically linked through an umbilical(s) to the tow vehicle creating a convoy like arrangement. It is anticipated that future trailers will not have mechanical connections between the trailer and the "tow" vehicle. Future AAN wheel vehicles will probably have hybrid electric drives. Excess electrical power from the "tow" vehicle as well as terrain information is passed between the tow vehicle and the trailer. This umbilical attachment between vehicles affords considerable flexibility in transporting materiel. For example, multiple small tow vehicles could be linked together to supply power to a much larger trailer or multiple trailers. Only the lead tow vehicle needs to be manned because the subsequent tow vehicles would be operating in a trailer mode except for their power generation. Because the tow vehicles are hybrid electric drives and makes extensive use of computers for controls, virtually any AAN wheel vehicle could be a tow vehicle. The size of the trailer for this project should be approximately 180 inches in length by 84 inches wide. The trailer should be a flat bed configuration that will accommodate either a container for solid cargo or a tank for liquid cargo. The height of the container/tank exclusive of the trailer should not exceed 60 inches. For demonstration purposes the center of gravity of the container/tank and cargo shall be approximately 50 percent of the container/tank's height. Cargo weight including the weight of the container/tank should be approximately 4000 pounds. The trailer shall have 4, 6 or 8 suspension-wheel assemblies. All of the suspension-wheel assemblies shall be identical. Suspension systems will be actively controlled to reduce the dynamic automotive loads and facilitate mobility across rough terrain. Inwheel electric motors shall be used throughout for propulsion. When driven across rough terrain at 50 mph the cargo shall not experience more than 8 watts of absorbed power. This trailer shall not have a conventional mechanical link to the tow vehicle. Furthermore, the trailer shall have an umbilical cable(s) to the tow vehicle to transfer power and terrain information.

PHASE I: Develop a high-mobility trailer concept compatible with future AAN mobility requirements. Develop a preliminary design of the trailer that will be built in Phase II. Demonstrate the trailer concept using kinematics simulation software such as CADSI's DADS computer code or a similar kinematics simulation software package. Through simulation define the operational limits of the trailer. Describe in depth the logic used to convoy the tow and trailer vehicles.

PHASE II: Design, fabricate and conduct a 200 hour endurance test of the high-mobility trailer with high center of gravity solid and liquid cargo. The trailer, all design information, test results, and simulation will be deliverables in this program.

PHASE III DUAL USE APPLICATIONS: There is an expanding market for high mobility recreational and commercial vehicles. Oil exploration, electrical power, fire fighting and search and rescue, to name a few, require the movement of men and equipment to remote locations that frequently utilizes helicopters. Frequently, this movement of men and equipment requires speed such as experienced in the fighting of forest fires in California and Florida. Helicopter lease costs are between $600 and $2000 per hour and their availability can be limited in times of emergencies. Also, helicopters are frequently ineffective in the delivery of men and equipment to dense forest or mountainous regions. Once men and equipment are delivered local transportation is still needed requiring additional expensive helicopter time. High mobility trailers will greatly lessen the dependence on helicopters and will facilitate the movement of more material to remote locations in less time having a positive affect on operational costs. Mobility of sport utility vehicles have also caused an increased interest in vacationing in areas other than the trailer parks we call camp grounds. Families are willing to spend more of their discretionary dollars to "get away from it". When they get away from it they will need a trailer with high mobility. The only off road excursion that today's family trailers are designed for is the trip from the driveway to the backyard. Therefore, the technology developed in this program should be equally applicable to commercial, recreational and military interests. Once matured the commercial and recreational markets should drive future technology advancements for the military further reducing the cost of mobility for the military.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The development of high mobility vehicles will result in quicker response at a lower operating cost by the Army to the movement of men and materiel and is consistent with the needs of AAN. Without this capability the soldier >s movement could be severely constrained by the slowest element of ground vehicles, the conventional trailer.

KEYWORDS: High-mobility, trailer, active suspension, hybrid electric drive, Army After Next.

A99-117 TITLE: Energetic Materials for Batteries and Electrochemical Capacitors

TECHNOLOGY AREAS: Information Systems Technology; Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Synthesize/identify new materials and chemistries for electrochemical power sources for communications, munitions, vehicles and other Army applications

DESCRIPTION: 1) Primary Batteries are needed to power a large variety of electronic and small electrical equipment over the full military temperature range (-40o to 70o C) with a minimum of performance degradation after storage for one year at 30o C or after one month at 70o C. The baseline technology for this purpose is Li/S02, which provides specific energy and power greater than 160 Wh/kg and 40 W/kg, respectively. A more energetic and benign lithium battery chemistry with higher potential for dual use is desired. Possibilities include the synthesis and use of novel high-energy positive plate materials (e.g., various forms of manganese dioxide) and of compatible liquid, polymeric or polymer-matrix electrolytes. Particularly of interest, is the development of a battery chemistry, which would allow soft packaging, thereby increasing energy density by as much as 50%. This implies a cathode material that is not chemically aggressive to organic electrolytes, an electrolyte which is highly resistant to oxidation and reduction and/or an internal mechanism for eliminating gases produced during cell storage. 2) Rechargeable Batteries - Improved Li-Ion or Li battery chemistries are being sought for applications similar to those mentioned above. The baseline chemistry is now Li-Ion/liquid electrolyte/LixCoO2, which can provide specific energy and power of approximately 100 Wh/kg and 40 W/kg respectively and over 100 deep cycles. Improvements are needed in low temperature performance (present limit is approximately -10o C), energy and power densities. Improvements might be gained through the synthesis of more energetic electrode materials and new liquid, polymeric or polymer-matrix electrolytes. Concepts to allow soft packaging (as discussed in section 1, above) are also being sought here. 3) Reserve Batteries are needed for munition applications where battery shelf life of up to 20 years is required. Both thermal and liquid reserve batteries are in use today. These provide only a small fraction of the intrinsic energy of the battery couples, because of the space allotted to caloric materials/insulation (thermal batteries) or to mechanical parts which serve to contain the electrolyte and release/distribute it under impact-spin conditions (liquid reserve batteries). Power density requirements are greater than 100 W/l. Reserve batteries are overly expensive because of their mechanical complexity. That complexity also causes great difficulty in developing smaller batteries for newly emerging applications. Approaches to achieving improved specific energy and reduced cost/complexity might include: a) The development of an "active" battery chemistry with a shelf life greater than 10 years. The use of relatively expensive, high purity materials is permissible. b) The development of novel activation methods. Such methods would release a highly conducting electrolyte within milliseconds after gun launch with 15,000 to 30,000 g's setback and 45-500 rps spin. The methods could include phase change, the use of a container material which pulverizes on impact, the use of frangible microencapsulated electrolyte, etc. The activation method must not operate if the battery is dropped from a height of 2 meters to a hard surface. 4) Electrochemical Capacitors are required for burst communications and for vehicular applications. Low cost, high cycle life, high power and high energy densities and operation over most of the military temperature range are requirements. The baseline low-cost chemistry utilizes carbon electrodes and a liquid organic electrolyte. Energy and power densities of approximately 4Wh/kg and 1 kW/kg appear to be at hand. Even higher energy densities are required and could result from the discovery of more capacitive (including pseudocapacitive) electrode materials, higher voltage electrolytes and improved methods for preparing electrodes with high electronic conduction and more effective electrolyte/electrode interfaces.

PHASE I: Phase I should result in the identification/synthesis of at least one of the major cell components for a chemistry which could provide performance exceeding the present stare-of-art.

PHASE II: Phase II will provide for further exploration of cell components and for the formulation and demonstration of a complete prototype cell or battery.

PHASE III DUAL-USE APPLICATIONS: The energy storage components under consideration here are of great potential value for use with cellular phones, laptop computers, camcorders, many other commercial electronic equipment and for civilian electric-drive vehicles.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The new primary batteries (for use in combat) being sought are to be "dual use" as compared with present Li/SO2 primaries which are not. The commercial base is expected to foster competition and reduced costs. The new rechargeable batteries (to be used mainly for training) could provide power for a fraction of the operating cost of primary batteries. The substitution of active for reserve batteries could provide power for smart munitions applications at a fraction of the cost of the latter power source.

REFERENCES:

1. Proceedings of the 38th Power Sources Conference, 8-11, 1998 (also previous years)
2. R. Koksbang, J. Barker, H. Shi and M.Y. Saidi, "Cathode Materials for Rechargeable Lithium Batteries", Solid State Ionics 84, 1-21 (1996)
3. R.A. Huggins, "Lithium Alloy Negative Electrodes Formed from Convertible Oxides" Solid State Ionics , p.113-115 and 57-67 (1998)
4. S.P. Ding, K. Xu and T.R. Jow, "Comparison of Properties of a Symmetric and Asymmetric Tetraalkylammonium Salt and Their Nonaqueous Electrolytes", Proc. Of the 194th Electrochemical Society Meeting, Boston, MA. 1998

KEYWORDS: Batteries, capacitors, reserve batteries, anodes, cathodes, elctrolytes

A99-118 TITLE: Lightweight, Inexpensive, and Reusable Personal Sampling Sensors for Real-time Monitoring of Hazardous Gaseous Combustion/Pyrolysis Chemicals

TECHNOLOGY AREAS: Biomedical

OBJECTIVE: Develop lightweight, inexpensive, and reusable personal sampling sensors for real-time or quasi-real-time monitoring of hazardous gaseous combustion/pyrolysis chemicals for use in a fire/thermal/smoke environment. New and innovative technologies are sought, such as optical system-on-a-chip technology, but any viable technology is acceptable. Such personal sampling sensors should collect desired information rapidly and reliably, and interface easily with both real-time display devices and data storage devices. Described sensors must be able to be easily placed on clothing or protective clothing items. Personal monitoring sensors should have chemical specific selectivity detection capability on the order of parts per billion by volume (ppbv), should exhibit rapid detection, should be fire/thermal/smoke resistant in their construction and must be capable of sampling effectively in a fire/thermal/smoke complex chemical gaseous environment. Additionally, the sensor should be reusable (a reversible system). Sampling parameters should include chemical species identification, peak concentration, and time-concentration history output. We are interested in both retrievable and remotely monitored personal monitoring sensors.

DESCRIPTION: There is a growing need for sophisticated lightweight, inexpensive, reusable personal sampling sensors for real-time or quasi-real-time monitoring of toxic parent chemicals and their pyrolysis products in hazardous or potentially hazardous environments. Personal sampling monitoring of this type will enhance our current capabilities to characterize hazardous environments and support the Army's critical mission of soldier survivability. Specifically, such sensors would enable the acquisition of critical research data needed to identify and quantify chemical insult hazards, under various combat conditions and circumstances; and directly foster the development of algorithms, models, and methodologies involving development of injury criteria and resulting estimates of injury impairment, performance degradation and soldier survivability, both in terms of potential operational and medical causalities. Successful development of these chemical sensors will enable exploitation of current Army vulnerability/lethality testing and associated controlled laboratory experiments, as well as make possible use of tri-service research efforts. For example, such sensors may enhance our capabilities to support analyses related to crew casualty assessment conducted as part of congressionally-mandated Army Live-Fire Testing to assess the vulnerability and lethality of weapon systems (combat ground vehicles and air system vehicles). Army Live-Fire testing directly promotes the development of improved military platform engineering designs that minimize crew member vulnerability and increase soldier survivability. Toxic gas combustion products and other fire-related gaseous chemicals of military interest, such as oxygen to investigate oxygen depletion, include: CO, CO2, O2, O3, NO, NO2, NH3, HCL, HFl, HBr ,HCN, SO, SO2, acrolein, formaldehyde and acetaldehyde, and benzene.

PHASE I: Produce and demonstrate the capability of prototype components for such Personal sampling sensors for several of the chemicals of military interest (listed above) from existing or novel materials, capable of demonstrating the proof-of-principle.

PHASE II: Demonstrate the features and capabilities of pre-production prototype shirt pocket size personal monitoring sampling sensor system for all seventeen chemicals/combustion/pyrolysis products of military interest (listed above). Conduct, present and document sound scientific testing on personal monitoring sampling sensors for each chemical of interest, including testing in fire/thermal/smoke environments, while simultaneously characterizing the test environment and identification of concentration of chemicals present using other standard and accepted practice methods and procedures to evaluate personal monitor sampling sensor effectiveness and utility.

PHASE III DUAL-USE APPLICATIONS: The use of such sampling sensors is anticipated not only in basic and applied research involving development of algorithms, model, methodologies, and criteria supporting Army soldier survivability, but also in Army Test & Evaluation, such as in Department of Army Live Fire Testing of full-up combat ready vehicle systems, or related controlled experiments or laboratory testing, and in other DOD Live Fire Testing and Evaluation. For example, such sensors may be of interest and have practical application to other Army test and evaluation agencies, such as the U.S. Army Test and Evaluation Command (TECOM), the Aberdeen Test Center (ATC), and the U.S. Army Operational Test & Evaluation Command (OPTEC). Such sensors may have utility in important projects involving the study of fire and combustion gases and their control, such as the HALON 1301 replacement projects. Other DOD and Non-DOD agencies involved with fire and combustion chemicals prevention and control may have applications for such sensors in their research, and test & evaluation (e.g., Walter Reed Army Institute of Research (WRAIR)- toxicology of parent and combustion gases and respiratory research; U>S> Air Force-air crew protection and survivability research; U.S. Navy-ship and submarine onboard fires; and National Aeronautic and Space Administration (NASA)- flight and space vehicle fire prevention and control). Personal monitoring sensors for combustion gases would have both occupational and environmental applications. Foe example, although combustion gases are known to be a serious threat in several civilian occupations (i.e.,firefighting), there is a paucity of useful exposure data. Such personal monitoring sampling sensors would have immediate applications in a variety of civilian emergency response and occupational environment monitoring or related research, including: firefighting, hazardous material response, hazardous material workers, industrial safety workers (e.g., coal miners, steel workers, etc.), and industrial confined space monitoring associated with many occupations (e.g., industrial chemical manufacturing). Environmental applications would include both qualitative and quantitative indoor and outdoor air sampling and monitoring, regulatory standard compliance, and epidemiological exposure assessment in environmental hygiene studies.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This technology area has the potential to improve OSCR in several areas. For example, development of improved algorithms, models, and methodologies involving development of injury criteria and resulting estimates of injury impairment, performance degradation, and soldier survivability potential may lead to development of improved soldier protection systems, improved crew safety, improved/better survivability of combat systems and reduction in combat crew operational causalities, as well as potential reduction of medical causalities. The use of reusable personal monitoring sampling sensors will result in significant cost savings in the area of research, test and evaluation.

REFERENCES:
1. United States Code (USC) of Federal Regulation. Title 10 USC, Section 2366, Washington DC - Conduct of Live Fire Test and Evaluation within DOD
2. Deitz, P.H.; Baker, W.E.; Bely, DC; et al., Evaluation Strategies for Live Fire Planning, Analysis and Testing. US Army Research Laboratory (ARL) Technical Report Number ARL-TR-1273 December 1996.
3. Lees, PSJ, Combustion Products and Other Firefighter Exposures. In Orris, P; Melius, J; and Duffy, RM (editor). Occupational Medicine: State of the Art Reviews - Firefighters Safety and Health Vol 10, No 4 October-December 1995. Hanely & Belfus, Inc. Philadelphia.

KEYWORDS: Toxic chemicals, Pyrolysis/combustion products, personal sampling monitor, chemical sensors

A99-119 TITLE: Low-cost Fabrication Technologies to Produce Transparent Armor Ceramics

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To develop a cost effective method of producing transparent armor ceramics that will enable the weight of the transparent armor systems to be reduced by at least 35% against armor piercing (AP) threats relative to present glass plastic transparent armor systems.

DESCRIPTION: There is a critical need to reduce the weight and thickness of armor on current and future military ground and air vehicles. Future requirements call for increased levels of protection; lighter weight, reduced thickness, and increased survivability. Transparent armors currently in use consist of soda-lime glass or borosilicate glass laminated to polycarbonate. It has been demonstrated that by using advanced transparent ceramics such as aluminum oxynitride spinel (ALON), Mg spinel, or single crystal sapphire in transparent armor systems, the areal density required to defeat small caliber AP projectiles can be reduced by 35 % to 60 % compared to traditional glass-plastic systems. Two factors have kept these materials from being used in transparent armor systems. The cost of the materials is too high and they cannot be produced in the large sizes needed. The purpose of this SBIR is to develop substantially lower cost processing routes for producing transparent armor ceramics that will reduce the weight of transparent armor systems by at least 35 %. The processes developed must be capable of producing ceramic plates at least 36" in diameter, between 0.25 inch and 1.00 inch.

PHASE I: The submitted proposal will include the selection of a armor material and a single fabrication technique to be investigated. In phase I, the proposer will demonstrate the feasibility of producing the material, as specified in the proposal. The technical and economic advantages of the fabrication route, material chosen and ability to be scaled up to produce (24" x 24" x 0.5") will establish the basis for the Phase II proposal.

PHASE II: Scale up of the production method developed in Phase I to demonstrate cost effective fabrication of panels 24 in. x 24 in. x 0.5 in. thick. Evaluate and optimize the ballistic performance of the material developed against a specified AP threat. Measure the strength, thermal expansion, thermal conductivity as well as the transmittance in the visual and Infra-red spectrums. Perform a cost analysis to determine the production costs for 100 panels per annum via the chosen fabrication route.

PHASE III DUAL USE APPLICATIONS: The successful development of a low-cost fabrication technology for a transparent ceramic that increases the performance of transparent armor systems would be of great benefit to both military and commercial armor/security systems. Many of the transparent ceramics that have demonstrated they can greatly improve the performance of transparent armor systems are also of interest for Infra-Red, and dual band windows and domes that transmit wavelengths between 3 microns and 5.5 microns. The next generation of dome materials for high speed missiles will require high strength, thermal conductivity, and low thermal expansion up to 1000EC. The ideal material will be transparent to electromagnetic radiation of 3 micron to 5.5 micron wavelengths, exhibit low emissivity, scattering and birefringence, and should be resistant to rain erosion at supersonic speeds. If a material can be used both for transparent armor and IR window and domes, it is expected that the economies of scale will drive down the costs of the material and benefit both armor and IR domes. Non military uses include protection for law enforcement personnel, armored cars and bank security.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: A lighter weight armor will reduce operating costs through better fuel mileage and increase the usable payload for armored vehicles.

REFERENCES:
1. A.K.Wong and I.Berman, "Lightweight Ceramic Armor - A review", Army Materials and Mechanics Research Center, M3 71-1, April 1971.
2. C.P.Ballard Jr., "A Transparent Ceramic Armor" Sandia Laboratories Report # SAND77-1736, May 1978
3. C.E.Cottenot, "Transparent Ceramic for Lightweight Armors", Lightweight Armor Systems Symposium, 95 Cranfield, England 28th -30th June 1995

4. R.J.Bratton, "Translucent Sintered MgAl2O4", J.Amer.Cer.Soc., 57, 7, 1974, pp 283-287. 5. US Patents #4,930,731 June 5th 1990. #4,983,555, Jan. 8th 1991. #5,001,093, March 19th 1991. #5,082,739, Jan 21st 1992. # 5,244,849, 14th Sept. 1993
5. R.L.Russell, M.J.Paisley, C.L.Carnegie, M.L.Huckabee, S.L.Willing, T.M.Hare and H.Palmour III. "Optical and Mechanical Properties of Trans[arent Fine-Grained Spinel Ceramics", Proc. SPIE Window and Dome Technologies and Materials 1994.
6. M.Shimada, T.Endo, T.Saito and T.Sato, "Fabrication of Transparent Spinel Polycrystalline Materials". Materials Letters V 28, n4-6, Oct. 1996.

KEYWORDS: Armor, Transparent Armor, Ceramic armor, spinel, ALON, sapphire

A99-120 TITLE: Compact, High-power Microwave Antenna

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: The objective is the development of a high power microwave antenna with reduced size and weight for tactical radio frequency directed energy (RF DEW) applications. The desired characteristics are:

Weight:	<250kg
Cross-sectional Area:	<7 square meters deployed
Largest side dimension:	<1.2m deployed
Gain:	>30dB.
Frequency:	L-band
Bandwidth:	>10%
Power:	>100MW
Pulse Width:	>5 microseconds
Pulse rep-rate:	> 100 hertz

The antenna will be fielded on standard Army land vehicles (e.g., HMMV) and air platforms (e.g., Blackhawk).

DESCRIPTION: The Army has a requirement for a mobile (air/land) high power microwave antenna system for RF Directed Energy Weapon applications. The antenna system must be low weight, highly portable, and be able to handle high pulsed power levels. The objectives are stated above. With recent advances in dielectric materials, ferroelectric materials, semiconductors and plasmas, coupled with advances in numerical and analytic prediction techniques, the Army is looking for a leap ahead in antenna technology to support the survivability and lethality requirements of the Army After Next (AAN).

PHASE I: The contractor will design an antenna using the state-of-the-art in component, material and plasma technology to meet the above objectives. Feasibility will be demonstrated through numerical and analytic studies supplemented by piece-part experiments.

PHASE II: The contractor will construct at least two prototypes for evaluation. The government will provide the L-band sources and the antenna range facilities. The contractor will characterize the prototypes. He will provide antenna gain patterns and experimentally determine power handling capabilities. The contractor will also supply preliminary designs for tactical field applications to include land and air applications.

PHASE III DUAL USE APPLICATIONS: The contractor will explore applications of the technology and features of his design for military and commercial fixed and mobile/transportable radar systems. He will also explore potential use in satelite and microwave line-of-sight communications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: If successful the designs developed under this SBIR would be incorporated into a new suite of weapon systems. Cost advantages will be achieved by replacement or augmentation of existing weapon systems. Cost reduction is not quantifiable at this time.

REFERENCES: Jasik, H., Ed., Antenna Engineering Handbook, New York, McGraw-Hill, 1961

KEYWORDS: HPM,RF DEW,microwave,antenna,radar, information warefare

A99-121 TITLE: Wavelength Division Multiplexing Fiber Optic Microwave Delay System

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Research and develop a fiber optic system using wavelength division multiplexing techniques to delay pulsed and continuous wave microwave signals by intervals ranging from 0.5 to 30 milliseconds.

DESCRIPTION: Current fiber optic microwave delay systems are capable of delaying pulsed and continuous wave microwave signals up to about 0.5 milliseconds. In these systems, a microwave signal modulates a laser beam that is delayed in a programmable length fiber optic network and demodulated by an optical detector. A means of achieving much longer delays is required for advanced radar target simulation and electronic countermeasure generation. Wavelength division multiplexing makes it possible to establish several optical paths simultaneously at different light wavelengths through a single fiber optic path. Very long delays can then be realized by chaining multiple paths together. Technical goals for the proposed system are as follows: [1] Microwave signal delay: (a) Range: 0.5 to 30 milliseconds, digitally programmable in steps of 0.5 milliseconds; (b) Variation over operating frequency and temperature ranges: 10 nanoseconds; (c) Switching speed: <1 microsecond for any delay change; [2] Microwave signal characteristics: (a) Instantaneous operating frequency bandwidth: 8 GHz; (b) Input center frequency: 8 GHz; (c) Input signal level: 0 dbm: (d) System gain: 0 db nominal; (e) System gain variation over operating frequency and temperature range: less than +/- 3 db over entire operating frequency band and less than +/- 1 db over any 1 GHz segment of the operating frequency band; (f) Spurious products: -35 dbc or lower; [3] Built-in test functions: capable of assuring proper system functioning and identifying the source of major component malfunctions; [4] Operating temperature range: 0 to +50 C; [5] Operating power requirements: 115 VAC, 60Hz; [6] Physical: Mountable in a standard half-height rack and operable at 15,000 ft. above mean sea level.

PHASE I: Research, develop and propose a system design with the potential of realizing the goals in the description above, favoring proven technologies to minimize technical risk. Develop technical specifications for all system components and identify them as commercially available or to be developed. Conduct detailed theoretical and/or laboratory investigations on the design and performance of critical components to demonstrate the feasibility and practicality of the proposed system design, including mitigation of risks associated with factors limiting system performance. Deliver a report documenting the research and development effort along with a description of the proposed system and specifications for all system components.

PHASE II: Procure or develop the system component specified in Phase I. Fabricate the system proposed in Phase I. Characterize and refine the system performance in accordance with the goals stated in the description above. Deliver the prototype system along with a report documenting the system theory, design, component specifications, performance characterization and recommendations for system performance.

PHASE III DUAL-USE APPLICATIONS: The proposed research and development effort has wide commercial application to microwave signal processing functions in military and commercial radar sensors and communication systems. Military applications include radar target simulation and electronic countermeasure. Commercial applications include telecommunications, airborne and space systems, and sensor signal processing.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Cost savings of millions of dollars have been demonstrated using radar target simulators with microwave delay technology instead of targets. Development of the proposed system will be instrumental in extending these cost savings to other air and missile defense systems.

REFERENCES: Several articles related to the topic are found in the December 1998 issue of IEEE Communications Magazine, Vol. 36, No. 12. The whole issue is devoted to Multi-Wavelength Fiber Optic Communication. Titles of interest include: "Multi-Frequency Lasers and Applications in WDM Networks", Multi-Wavelength Receivers for WDM Systems", and "Tunable Optical Filters for Dense WDM".

KEYWORDS: Laser,fiber optic,microwave,delay,wavelength division multiplexing

A99-122 TITLE: <u>Time-efficient, Economical, High Rate Production and Manufacturing Methods for Nanoparticulates</u>

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Conceive and develop processing and consolidation methods for nanoparticulates at large scale.

DESCRIPTION: The application of nanomaterials to structural applications requires that methods be developed to consolidate particulates to very high densities while preserving the nanoscale grain structure. In efforts to-date, attempts to consolidate nanoparticulates have been moderately successful. In research efforts, the sizes of consolidated nanoparticulate materials are limited to a few millimeters in extent while more commercial-like efforts have been limited to a few centimeters. These successes, although world leading, are modest when compared with the shape forming capability commonly found in other particulate fabrication sectors. Commercial development of structural components with nanomaterials as their basis will require the development of methods, equipment and techniques that greatly increase the scale at which consolidation is accomplished.

PHASE I: Identify the critical consolidation variables for the production of structural items utilizing nanomaterials. Identify fabrication methods that consolidate nanoparticulate materials to full density while maintaining the nanograin structure and controlling oxygen content. Demonstrate the processing method using a variety of materials to fabricate structural components no smaller than 500 cubic centimeters in volume. Methods developed shall be readily adaptable to production environments. Demonstrate the appropriateness of the materials and processing methods for the application(s). Deliver demonstration items produced with the materials, techniques, methods or procedures developed.

PHASE II: Work in Phase II should exploit the Phase I success, expand the range of materials and processes and begin to apply the methods developed to production-like situations. This work should highlight the generic nature of the developed process or method and deliver prototype or demonstration components. Process automation should be incorporated into this phase of the work. Demonstration parts should be fabricated that exceed 1500 cubic centimeters in volume. A fully functional prototype of equipment developed should be delivered. Testing in phase II should be suitable to demonstrate the benefits of the material or process developed and should include quasi-static and dynamic materials testing.

PHASE III DUAL USE APPLICATIONS: There are expected to be many near-term commercial applications for nanomaterials in densified form including tungsten-copper composites for thermal management, cermets and ceramics as cutting tools, bulk erosion resistant applications, and new transparent armors. Additional uses may be found in non-consolidated applications such as in the paint, drug, cosmetic and food industries. Reliable and accurate particle analysis is an important part of furthering and commercializing nanomaterial applications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Cost reduction due to the use of more efficient materials for critical applications in survivability and lethality and reduced logistical burden.

REFERENCES:

1. Nanoparticulate Materials Densification, J.R. Groza and R.J. Dowding, Journal of Nanostructured Materials, vol.7, 1996.
2. Synthesis and Consolidation of Nanoparticles, J.J. Stiglich, T.S. Sudarshan and R.J. Dowding, Proceedings of PM2TEC, Toronto, Canada, May 1994, MPIF, Princeton, NJ.
3. Materials and Manufacturing Processes: Special Issue on Consolidation, vol. 11, no. 6, 1996.
4. Ultrahigh Pressure Consolidation (UHPC) of W-Cu Composites, S. Yoo, M.S. Krupashankara, T.S. Sudarshan and R.J. Dowding, Materials Science and Technology, February 1998, vol.14.

KEYWORDS: Nanomaterials,processing,automation,consolidation,scale-up

A99-123 TITLE: Direct Digital Synthesis Technology

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: The Army has a documented need for the development of enabling RF technologies that are both affordable and flexible with regard to their ability to address the Army's many radar and communication requirements. Transmitter architecture is one such technology area. For example, transmitter architecture could be reduced in terms of size, weight, power requirements, and cost if digital, highly complex wide-bandwidth waveforms were generated at the highest possible frequency instead of near baseband. These waveforms could be used for high-range resolution radar communication applications to sort targets from clutter that has a low probability of intercept.

DESCRIPTION: This topic seeks a direct digital synthesis (DDS) approach to reducing transmitter architecture complexity while improving the opportunity to pursue more multipurpose RF sensors. Goals of this work might be to operate at carrier frequencies of greater than 10 GHz and bandwidths of greater than 1 GHz. Another issue to be addressed is the spectral purity of the signals; a goal of greater than 60 dB over the modulation bandwidth is suggested. Waveform configurations should include chirp, step-frequency, phase-modulation, limited-impulse, pulsed-RF, and other hybrid modulations. Current limitations to achieving an optimal DDS technology include the following: > Low bandwidth clocks between 1 and 2 GHz limit ultimate bandwidths to the Nyquist criteria. > Alternative materials (e.g., Si-based) are needed to replace the high-power GaAs architectures. > Low intermediate frequency output (due to clock rates and architecture limitations) requires extensive hardware for microwave and millimeter-wave operations. > High spurious and phase-noise levels are such that they degrade system performance. > Lack of an integrated control for complex radar and high data rate communication functions.

PHASE I: This work should address emerging technologies that can meet the above goals with consideration of the stated limitations. A quality proposal would discuss a company's approach toward highly linear, ultra-fast digital/analog converters; integrated control and memory; and modularized construction (e.g., VME/VXI/PCI).

PHASE II: Design, build, test, deliver, and report on the chosen DDS approach. Performance and affordability should be the major emphasis of this effort.

PHASE III DUAL-USE COMMERCIALIZATION: A considerable commercial potential exists in both DoD and private-sector RF system applications: satellite-tranmitted high-definition television, air traffic control and weather radar, as well many other wireless communication networks.

KEYWORDS: Direct Digital Synthesis, Digital Waveform Modulation, D/A Converters

REFERENCES:

1. "Direct Digital Synthesis Applications for Radar Development," E. Adler, E. Viveiros, T. Ton, J. Kurtz, and M. Bartlett, 1995 IEEE International Radar Conference.
2. Government Microelectronics Applications Conference (GOMAC) 1999, "Frequency Synthesis for Future Manportable MILSATCOM Terminals, " L. J. Kusher, R .J. Parr, R. G. Dragmeister, M. T. Ainsworth, J. Murphy from MIT Lincoln Laboratory, C. E. Hastings, G. V. Andrews, M. P. Harris, P. Garner, C. Perry from Ratheon TI Systems, J. B. DeLancy, and M. A. Vernon from TriQuint Semiconductor. This document describes an interesting DDS serrodyne modulation approach.

A99-124 TITLE: Real-time Image Restoration Processor

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop an inexpensive video processor capable of restoring distorted imagery (both visible and IR) that is often associated with "long-range" viewing, i.e., usually in excess of 1 km. The proposed restoration processor should be based on an algorithm that can accurately correct for atmospherically induced aberrations that are primarily due to optical turbulence and aerosol scattering.

DESCRIPTION: The amount of information conveyed by a highly magnified image of a distant object is often limited by adverse atmospheric conditions that serve to reduce both spatial resolution and image contrast. This is particularly true for optical paths close to the ground where refractive turbulence and light scattering due to haze is most severe. Although atmospheric aberrations effect all light either reflected or emitted, it is especially troublesome in the IR. Advanced IR imaging systems currently under development will not be limited by sensor characteristics, but by atmospheric degradation. It will be necessary to restore the original information content of the imagery to take full advantage of these "next-generation" sensors. Various post-processing algorithms are needed that are capable of restoring atmospheric degraded imagery. As an example, one such technique is based on a linear systems approach in which a predetermined atmospheric modulation transfer function (AMTF) is deconvolved, resulting in an enhanced "seeing" ability. Currently, there is a great deal of debate within the scientific community on which post-processing algorithm is of greatest value. In order to resolve this important issue, the authors would like prospective candidates to propose an optimal post-processing algorithm designed to mitigate atmospheric effects (based on cited research) and to develop a unique programmable video processing device that could be used to implement the necessary image restoration. The algorithm/device should have the following features; 1) be capable of restoring degraded video imagery in real time, 2) the device should be compact and relatively inexpensive to manufacture, and 3) the device should be easy to incorporate into existing visible and IR imaging systems, e.g., simply connect in-line between the video-out of the imager and the video-in of the display. The development of such a device should greatly improve the ability to resolve distant objects when viewed through the atmosphere and would likely represent a welcomed enhancement for both military and civilian applications. Such applications might include, but are not limited to, remote sensing, surveillance/security observations, search and rescue operations, and conventional recreational videotography.

PHASE I: Propose and design the image restoration algorithm/hardware including schematics that fully describe and identify all electrical circuits including the types of processors used for both mathematical computations and analog-to-digital conversion. Included should be a reasonable prediction of the anticipated performance characteristics of the device. The development of a prototype is desirable.

PHASE II: Assemble, test, and demonstrate a prototype device that should include all hardware and software necessary. An evaluation procedure will be conducted using degraded video imagery where various objective figures of merit are to be determined, e.g., point and line-spread functions will me measured before and after restoration.

PHASE III DUAL USE APPLICATIONS: Demonstration/evaluation of the final product will take place at an appropriate U.S. Army field test facility, and will include integration of the device with a third generation FLIR system currently under development. This device will be directly applicable to any long-range imaging system, e.g., visible, infrared, and millimeter-wave. Applications of this technology are numerous and include high resolution remote sensing, commercial videotography, long-range surveillance along boarder regions, and environmental monitoring of remote locations.

COST/BENEFIT ANALYSIS: This technique will provide a cost-effective means of improving the ability to detect and identify targets far beyond current adversarial observation distances. Commercial applications will receive equivalent benefits. Since the proposed device can be completely assembled with commercial off-the-shelf integrated circuits, a cost-per-unit of less than a thousand dollars is achievable.

OPERATING AND SUPPORT COST REDUCTION: Technologies which result in effiecient power sources will have a very positive effect on Operating and Support (O&S) costs.

KEYWORDS: Image processing, video processing, image enhancement, FLIR, target acquisition.

REFERENCES:
1. D. Sadot, G. Lorman, R. Lapardon, N. Kopeika, "High-resolution restoration of images distorted by the atmosphere, based on an predicted atmospheric MTF", Infrared Phys. Technology, vol 36, pp. 565-576 (1995).
2. M. Belen'ki, "Effect of the inner scale of turbulence on the atmospheric MTF", J. Opt. Soc. Am., vol. 13, p. 1078 (1996).
3. D. Sadot, A. Dvir, I. Bergel, N. Kopeika, "Restoration of thermal images distorted by the atmosphere, based on measured and theoretical atmospheric modulation transfer function", Opt. Eng., vol. 33, no.1, p. 44, (1994).
4. I. Dror, N. Kopeika, "Aerosol and turbulence modulation transfer functions: comparison measurements in the open atmosphere", Opt. Lett., vol. 17, no. 21, p.1532, (1992).

U.S Army Research Office (ARO)

A99-125 TITLE: Hybrid Power Systems in the 10-50 Watt Power Range

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop the required system and control strategy for a hybrid power system which could provide a dismounted soldier with up to 50 W for 30 minutes, peak pulses on the order of several hundred watts, and a total energy budget of 1000 Whr in a package weighing less than 3 kg. Sustained (duration of the fuel supply) power levels of 15 W are desired.

DESCRIPTION: The Army, and particularly the Dismounted Soldier, has need for high energy, lightweight power sources. Battery technology is relatively mature, so dramatic improvements in energy density are highly unlikely. However, batteries have many desirable characteristics such as low signature, air-independent operation, instant startup, etc. Fueled systems consisting of very lightweight energy converters have energy densities limited by the energy density of the fuel. However, the systems typically require a source of air, may be difficult to start at low temperatures, and often have signature problems. The ideal system for supplying the electrical power required by the modern soldier appears to be a hybrid system consisting of a high density fuel supply, a lightweight energy converter, a battery charger, a high rate battery and perhaps a supercapacitor to handle pulse loads. A control system would sense when the battery is in need of charging, and turn on the primary energy converter to recharge the battery. Small fuel cells are among the most advanced new technologies which might provide the desired lightweight energy converter. Since the ideal fuel supply for small hydrogen/air fuel cells has not yet been developed, this solicitation will consider proposals for 'partial' hybrid systems using hydrogen/air fuel cells but not including the hydrogen supply. Proposals for complete systems will be given preference. Proposals containing energy conversion technologies other than fuel cells will be considered. The system to be developed will be in close contact with soldiers; proposals which do not show rational consideration of the safety factors involved will be declined.

PHASE I: Identify and demonstrate a system which could lead to a hybrid power source that would satisfy the power/energy profile given in the objective statement. System models may be considered for the demonstration, but hardware systems will be given preference. The target volume for these power sources is 2000 cc. Safety, ruggedness, and performance (eg, operating temperature range) issues will be identified.

PHASE II: Reduce the Phase I 'benchtop' demonstration to practice in a fashion suitable for field testing. All safety issues will be addressed, and ruggedness and performance issues will be addressed where practical in a prototype, and quantified if they cannot be fully addressed. One complete system with six fuel cannisters will be delivered to the Army for test/demonstration. Prospective commercial users will be contacted.

PHASE III DUAL USE COMMERCIALIZATION: Developments in hybrid power sources will have immediate impact on a wide range of commercial power sources from computer power to emergency medical power supplies to recreational power uses.

OPERATING AND SUPPORT COST REDUCTION: Technologies which result in effiecient power sources will have a very positive effect on Operating and Support (O&S) costs.

REFERENCES: ARO Workshop on Hybrid Power Systems, March 1998.

KEYWORDS: hybrid power, supercapacitor, fuel cells, control systems, soldier power

A99-126 TITLE: Enhancements to Hand-held Electromagnetic Induction Metal Detectors for Unexploded Ordnance and Landmine Detection

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: To investigate and demonstrate affordable enhancements for handheld active Electromagnetic Induction (EMI) Unexploded Ordinance (UXO) or landmine detectors.

DESCRIPTION: Handheld mine detectors based on the principle of electromagnetic induction are effective in detecting metal mines and pieces of metal used in the firing mechanisms of non-metallic mines, however these detectors can have a very high false alarm rate due to an inability to discriminate targets, particularly the types and shapes of small metal firing mechanism parts, and they are not effective at localizing small metallic targets within their electromagnetic footprint. Techniques to improve discrimination, such as utilizing time or frequency response signal information or spatial signal distribution and statistical signal processing, have been reported in research articles. An effective technique for common mode rejection is the use of mechanically balanced bucking coils. Novel techniques such as electronically adaptive bucking coils, gradiometric measurements, or phase locked loops may provide cost or stability (mechanical and thermal) advantages. Techniques to improve localization using balanced coils have been effective, but reliable systems have been expensive due to fabrication costs. Innovative circuit techniques, using advanced methods such as MEMS adaptive circuitry or high temperature superconducting components, and advanced signal processing to take advantage of all signature information, have the potential for enhancements in detector performance at reasonable costs. New techniques for detecting the induced magnetic field in targets may provide better sensitivity and larger signal to noise ratios, which may enable the use of more sophisticated signal processing techniques. Automatic navigational and small computational components may allow the conversion of data from the imprecise sweeps of the handheld detector into accurate local spatial signal maps. Novel, innovative ideas are encouraged, they should not be limited to the previous examples. The baseline for comparison of enhanced performance is the AN/PSS-12 handheld detector, currently standard issue for US Army troops in the field.

PHASE I: Demonstrate feasibility of concepts as separate laboratory experiments or simulations. Demonstrate enhanced performance via analysis and experimental data (it is recognized that some performance parameters may require reasonable estimation from physical principles where measured data is unavailable). Perform preliminary cost analysis to demonstrate affordability of overall system concept.

PHASE II: Develop and demonstrate a prototype against metallic and low metal content antitank and antipersonnel landmines under realistic field conditions. Perform detailed cost analysis to demonstrate affordability of detector system.

PHASE III DUAL USE APPLICATIONS: Field trials at a specified Army location. EMI metal detectors are the primary detector for landmines for military countermine and civilian humanitarian demining operations. Affordable detectors with enhanced performance would have a large potential commercial market.

OPERATING AND SUPPORT COSTS REDUCTION: This capability could speed demilitarization of former ordnance impact zones on land to be returned to private use and shorten the time and risks involved in humanitarian demining operations.

REFERENCES: Detection and Remediation Technologies for Mines and Minelike Targets III, A.C. Dubey, J.F. Harvey, and J.T. Broach, Editors, Proceedings of SPIE Vol. 3392.

KEYWORDS: landmine detection, electromagnetic induction, magnetic induction, metal detector

A99-127 TITLE: Ammonia-based Hydrogen Sources for Small Fuel Cells

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop the required chemistry, catalysts, storage cannisters, and reactors to convert ammonia to hydrogen fuel for small (<500 W) hydrogen/air fuel cells (H/AFC). Sizes of particular interest are 10-50 W, 150 W and 500 W. Ammonia storage units should contain the equivalent of 500 to 1000 Whr.

DESCRIPTION: The Army, and particularly the Dismounted Soldier, has need for high energy, lightweight power sources. H/AFCs have been developed to the point where these energy converters can meaningfully augment the soldier's batteries, either as part of a hybrid system or as lightweight battery chargers. A primary obstacle to widespread use of small H/AFCs is lack of a convenient, inexpensive, safe source of hydrogen. Ammonia has high hydrogen content and is stable under most conditions, but can be decomposed to hydrogen and nitrogen. It can be stored as a liquid under modest pressure, and is a commodity chemical used worldwide. In addition to direct cracking to H2 and N2, ammonia can be reacted with many compounds to generate hydrogen. Ammonia seriously degrades the performance of most H/AFCs, therefore, an ammonia-based hydrogen source must ensure an ammonia-free fuel stream.

PHASE I: Identify and demonstrate a process/system which could lead to a hydrogen source that would produce 1 Whr/g in the size range of 500 to 1000 g. The target volume for these sources is 500 - 1000 cc. Use a value of 1 g hydrogen = 17 Whr for estimating system performance. Safety, ruggedness, and performance (eg, operating temperature range) issues will be identified.

PHASE II: Reduce the Phase I 'benchtop' demonstration to practice in a fashion suitable for field testing. All safety issues will be addressed, and ruggedness and performance issues will be addressed where practical in a prototype, and quantified if they cannot be fully addressed. One complete system with six fuel cannisters will be delivered to the Army for test/demonstration. Prospective commercial users will be contacted.

PHASE III DUAL USE COMMERCIALIZATION: Developments in improved hydrogen sources will have immediate impact on utilization of small fuel cells as convenient, quiet, long-lasting power sources with low life cycle costs.

OPERATING AND SUPPORT COST REDUCTION: Technologies which result in effiecient power sources will have a very positive effect on Operating and Support (O&S) costs.

KEY WORDS: Ammonia, hydrogen, cracking, fuel cell, fuel processing, microreactors

U.S Army Aviation Research, Development, and Engineering Center (AVRDEC)

A99-128 TITLE: Dual-alloy Technology for Turboshaft Engines

TECHNOLOGY AREAS: Air Platforms

OBJECTIVE: Develop affordable, dual alloy bonding technology applicable to future gas turbine engine components to extend their operating temperature range.

DESCRIPTION: A significant opportunity exists in the application of advanced materials to many components of industry/Government gas turbine engines. The use of advanced materials will enable significant increases in power-to-weight ratios and reductions in specific fuel consumption. The advanced technology trend for future engines towards higher temperatures, and fewer stages, requires advancements in materials, processes and design concepts. Dual alloy components permit the best materials at the critical locations. Considerable design flexibility can be provided with the dual alloy concept. Bonding technology development is required for such a dual alloy component to be successful in an engine environment. Mechanical needs for the advanced, high performance impellers have identified the need for alloys to have strength and temperature capabilities superior to the titanium alloy's used in today's engines. To minimize compressor weight while making high tip speeds and stage pressure ratios possible, new alloys and processes have been developed. Advanced titanium alloys, enhanced in strength by unique processing to achieve optimal microstructure, have been developed to extend the useful temperature range for the compressor. Thus, utilizing the dual alloy concept the impeller can be made using gamma titanium aluminide where creep resistance is needed and super alpha 2 or orthorombic aluminide where high strength is needed. Mechanical limits on turbine components often limit cycle temperatures and blade loadings, and set cooling air requirements. Turbine disks are limited primarily by dovetail creep, bore LCF and overspeed capability. Disk envelope and weight can also be a limiting factor. Dual alloy turbine disks could use high creep strength alloys for the rim and high LCF strength materials for the bore. This technique would extend the useful temperature range over conventional superalloy disk materials.

PHASE I: Working with a gas turbine engine manufacturer identify bonding concepts for a dual alloy system applicable to a turboshaft engine component. Define both component and joint operational requirements. Evaluate the most promising bonding method in terms of strength and stability of the bond interface.

PHASE II: In conjunction with a gas turbine engine manufacturer and utilizing results of Phase I, apply the joining technology to a full scale turbine engine disk or impeller. Establish the physical, thermal, and structural properties of the dual alloy component. Verify the dual alloy concept through gas turbine rig and/or engine testing.

PHASE III: Focus on the commercialization of the bonding technology demonstrated in Phase II.

DUAL USE APPLICATIONS: The resulting technology will facilitate achievement of engine components having reduced weight, higher temperature capability, and/or increased durability. This technology will prove very beneficial to both the military and commercial sectors, being applicable to a wide variety of applications such as tank, automobile and aircraft primary power, heat exchangers, auxiliary power units, etc. The resulting product has a large potential market with enormous cost savings potential.

OPERATING AND SUPPORT COST REDUCTION: Technologies which result in increased power-to-weight and reduced specific fuel consumption while maintaining or increasing durability have a positive impact on Operating and Support (O&S) costs for future helicopters.

KEYWORDS: Gas Turbine Engine,Dual alloy disks, Dual alloy impeller,High Temperature Materials High strength materials

A99-129 TITLE: Aircraft Engine and Transmission Wear Monitoring Sensor

TECHNOLOGY AREAS: Air Platforms

OBJECTIVE: The objective of this effort is to develop and demonstrate an on-board sensor capable of detecting wear materials, contaminants, and lubrication properties of oil used in aircraft engines and transmissions. The sensor will be used in conjunction with on-board, vibration monitoring systems to trend wear in rotating components used in engines and transmissions. The trending data will be used by aircraft Health and Usage Monitoring Systems (HUMS) to project maintenance requirements and provide early detection of impending failures.

DESCRIPTION: The health of transmissions is currently evaluated by periodic vibration test flights and oil samples sent to a laboratory for analysis. Based on the results of the vibration test flight and oil analysis, the maintenance officer assesses the health of transmissions. HUMS is under development to monitor the health and usage of engines and transmissions in military helicopters. The HUMS resides on the aircraft and collects vibration data for analysis by the HUMS ground station. On-board sensors to evaluate wear materials, contaminants, and lubrication properties of the oil will increase the reliability of HUMS trending, as well as, early detection of impending failures that can be catastrophic. Safety studies indicate that as much as 25 percent of all helicopter losses could be avoided by early detection of impending failures.

PHASE I: The objective of Phase I is to demonstrate, in a controlled environment, the accuracy and reliability of a sensor capable of detecting wear materials, contaminants, and oil properties. The sensor must prove to be accurate, reliable, lightweight, and adaptable for aircraft applications.

PHASE II: The Phase II objectives are to demonstrate the effectiveness of the sensor in seeded fault tests using a gearbox on a test stand and adapt the sensor for aircraft use.

PHASE III: The Phase III objectives are to qualify the sensor for flight; test the sensor on a test aircraft; and integrate the sensor data into a HUMS.

DUAL USE APPLICATIONS: The resulting technology will be applicable to both military and commercial aircraft, automotive, trucking, and marine markets, as well as, any other market using engines and transmissions.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Various HUMS cost benefit analyses show a reduction in O&S costs and a return on investment at 1-3 years.1,2 An on-board wear monitoring sensor is an enabling technology for maximizing the HUMS potential.

KEYWORDS: Wear Materials, lubrication, HUMS, Engines, Transmissions

REFERENCES:

(1) "Cost/Benefits Analysis for Integrated Mechanical Diagnostics," prepared by the Charles Stark Draper Laboratory for Naval Air Systems Command, April 1997.
(2) "HUMS/ADR Benefit Assessment," by Stewart Hughes Limited, October 1994.

A99-130 TITLE: Lightweight Double Helical Gears for Aerospace Applications

TECHNOLOGY AREAS: Air Platforms

OBJECTIVE: The objective of this effort is to develop a manufacturing process that can significantly reduce or eliminate the gap currently required to produce hardened and ground, aerospace quality double helical gears and thus reduce their weight.

DESCRIPTION: Double Helical (DH) gears are desirable due to their low noise characteristics, damage tolerance due to high contact ratio, and zero net thrust loads. DH gears are starting to find their way into more and more performance critical aerospace applications, especially ones where low noise is a prime consideration. The Army's Comanche Helicopter utilizes a large DH gear in the final stage of its main rotor transmission. It is anticipated that future designs will follow this trend. Aerospace quality power gears are typically case hardened for maximum load capacity and durability. Grinding of the teeth is required to obtain the final finished dimensions. A gap between the left and right hand sides of the DH gear is currently required in order to allow the grinding wheel access to the full tooth surfaces without interference with the adjacent teeth. The presence of this gap increases the weight of this type of gear. The use of shaper cutters and small grinding wheels has reduced this gap over the years. Currently, helicopter gears with a whole tooth depth of 0.30 inches require a gap between the left and right hand of not less than 0.7 inches. A manufacturing technique that can greatly reduce or eliminate this gap is desired.

PHASE I: The effort in Phase I will focus on the development and demonstration of the key technical challenge(s) associated with the proposed approach. Small scale trials of the manufacturing technique shall be conducted to prove the feasibility of the process. The trials shall utilize representative materials and tooth geometries and be evaluated for their capability to produce the desired tooth profile, surface finish and minimum gap size.

PHASE II: The Phase II effort shall focus on the scale up of the process to allow large size DH gears to be fabricated. The Phase II effort shall conclude with the demonstration of the capability to fabricate a hardened and ground DH gear with dimensions similar to those of the Army's Comanche helicopter with the gap significantly reduced or eliminated.

PHASE III DUAL USE APPLICATIONS: This technology has the potential to be applied in all types of aerospace applications including commercial rotorcraft and fixed wing passenger aircraft. It would also be attractive to the automotive industry due to the low noise characteristics and reduced size.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This effort will impact the operating and support costs of the Army' rotorcraft by reducing empty weight and thus reducing the amount of fuel required to perform a given mission.

REFERENCES: Sikorsky Aircraft Advanced rotorcraft Transmission (ART) Program - Final Report, March 1993, NASA Contractor Report 191079, Army Research Laboratory contractor Report ARL-CR-49

KEYWORDS: gears, grinding, double helical

A99-131 TITLE: Battle Damage/Fault-tolerant Reconfigurable Open Systems Avionics Architecture

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: This research and development effort will demonstrate a reconfigureable open systems avionics architecture designed for an inherently high degree of battle damage and fault tolerance.

DESCRIPTION: Modern fielded rotorcraft avionics systems suffer very high acquisition, operating, and support costs. This is due not only to their levels of sophistication but also to the fact that most, if not all, consist of custom hardware built to military specifications. Moreover, these avionics systems are difficult and expensive to upgrade due to the wide proliferation of closed proprietary interfaces and to the rapid obsolescence of critical computer architectural elements. As a result, open systems architectures are being investigated for application to many weapon systems (ground, sea, and airborne). Open systems will enable the military to use commercial and industrial grade components thereby capitalizing on the "economy of scale" and reducing acquisition, operating, and support costs. However, commercial and industrial grade equipment is frequently not suitable for demanding military operational environments and reliability requirements. Two key attributes for Army aviation weapons systems are that they must be battle damage and fault tolerant. In general, redundant systems are employed for these purposes; however, this solution comes at the expense of adding black boxes. Computer processor functional reconfiguration techniques may make it possible to reduce component count and retain expected levels of fault tolerance within the constraints of an open systems design. This work will enhance the Army's understanding of battle damage and fault tolerance issues associated with the use of commercial off-the-shelf equipment and enable fielding in a more expeditious manner.

PHASE I: The contractor will analyze Army aviation battle damage and fault tolerance requirements and develop an overall system design to meet these requirements for a highly integrated open systems avionics architecture. The design will be comprehensive in nature considering all aspects of the architecture. The contractor will develop guidance, specifications, and design strategies that contribute to a battle damage and fault tolerant design. These designs and specifications will be consistent with the Joint Technical Architecture - Army (JTA-A) and with open systems specifications, standards, products, and processes.

PHASE II: The contractor will fabricate and integrate a prototype battle damage/fault tolerant open systems avionics architecture and demonstrate it in a bench test environment. The avionics architecture will use market driven commercial-off-the-shelf equipment and components to the maximum possible extent. The contractor will host mission systems software on the selected processing platform and demonstrate reliable operation and reconfigureability under simulated fault inducing and battle damage conditions. This demonstration will be conducted within a simulation based avionics integration environment.

PHASE III DUAL USE APPLICATIONS: This system could be tailored for use by both commercial and military helicopters and fixed wing aircraft. It might also be applied to various ground vehicles. The results of this research will be used to support Army Science and Technology work in the area of open systems avionics architectures and integration. If successful it may also be applied to the RAH-66 Comanche and AH-64D Longbow helicopters and to civilian rotorcraft.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Open systems computer architectures will enable the Army to use commercial and/or industrial grade equipment for the integration of avionics systems on manned and unmanned rotorcraft. This directly reduces acquisition costs, enables more affordable upgrades as new capabilities are developed, and increases the useful life of the weapons system.

KEYWORDS: Open Systems, Avionics Architectures, Battle Damage Tolerance, Fault Tolerance

A99-132 TITLE: Graphics Display Systems for Night Vision Goggles (NVG)

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: The objective of this SBIR is to reduce the cost of installing graphic (symbology) display systems which are used on rotorcraft night vision goggles (NVGs). A number of manufacturers make NVG displays, graphics generators, and associated sensors. However, each type of helicopter has a different design for the installation of the sensors and the graphics generator. For this SBIR, a single, integrated package of sensors and associated graphics generator is developed which can be bolted onto a number of different types of rotorcraft airframes, with minimal modification to the airframes.

DESCRIPTION: Night vision goggles are used by military and civil rotorcraft operators to increase the usable operating hours of the aircraft. To increase safety while flying low level at night, graphic information (symbology) is added to the NVG display to provide critical flight information to the pilot. This information includes aircraft altitude above the ground, aircraft attitude, direction and magnitude of aircraft velocity in three dimensions, direction and magnitude of aircraft acceleration in three dimensions, and direction to navigation waypoints. Data accuracy, update rates and lags must be taken into account in order for the information to be usable by the pilot to control the aircraft for extended periods of time. Typical, current installations of graphic displays for NVGs include inertial sensors, radar/laser altimeter, heading reference sensor, global position system (GPS) receiver, graphics generator, NVG display, and possibly a head tracker. The components are typically distributed throughout the airframe, which increases the cost of installation. Additional cost usually occurs when installing into a new airframe, since the system design typically varies with the airframe. For this SBIR topic, an integrated, bolt-on, sensor and graphics generator package will be developed to make installation into any rotorcraft easier and less costly. The package will be designed to work with different off-the-shelf displays and head trackers. The graphics generator should detect sensor failures in flight, and blank out incorrect information. The package should also perform self-calibration checks of the sensors during the preflight or start-up. In order to accommodate different displays and recorders, the graphics generator should have programmable video output to include composite video (RS-170) as well as RGB video (640 x 480, 1280x1024). The graphics generated should be user programmable using the C language, with OpenGL libraries. Proposing companies have complete flexibility in formulating the approach to this topic. Innovative approaches should be developed. SBIR proposals that meet the general goals of the solicitation topic, but do not meet specific goals or approaches will be considered.

PHASE I: Proposals should include a concept level design for the packaging and installation of the system described in this topic as well as a list of the expected types of sensors. Phase I proposals should also include human-factors based targets for data accuracy, update rates and lags. For the Phase I effort, a preliminary design of the NVG graphics generator system detailed in this topic should be completed up to the point that cost and performance can be estimated to within a target of plus or minus 20%.

PHASE II: Design, fabricate, test, and deliver to the US government one complete NVG graphics display package. This package will include the sensor and graphics generator system described in the topic, an AN/AVS-6 night vision goggle (or superior replacement), a graphics display for the night vision goggle, and a head tracker that can be operated inside the cabin of a helicopter. Demonstrate during a helicopter flight that all system components work together to provide critical flight information to the pilot. The list of critical flight information is detailed in this topic. For the demonstration, the contractor should expect to rent time on a civilian helicopter, since the Government cannot guarantee that a helicopter will be available for this test. Deliver two sets of documentation including specification sheets, quality test reports, electrical schematics, software documentation, operator's manuals and maintenance manuals.

PHASE III DUAL-USE APPLICATIONS: This device has the military benefit of improving NVG helicopter operations. In addition, this device is very useful to civilian medical evacuation helicopters, law enforcement helicopters, and offshore transport helicopters.

OPERATING AND SUPPORT COST REDUCTION (OSCR): Reducing helicopter accidents while operating at night is the goal of this SBIR topic. Besides the more important goal of saving lives, there is also the potential for a significant cost savings associated with reducing helicopter accidents during routine night operations.

REFERENCES:
1.http://www.monmouth.army.mil/peoiew/pmnvrsta1/anvishud.htm
2.http://vislab-www.nps.navy.mil/~avsafety/research/nvddemo.htm
3.http://www.monmouth.army.mil/peoiew/pmnvrsta1/anvis.htm
4.Helmet- and Head-Mounted Displays III, SPIE Proceedings, Vol. 3362, 1998
5.Head-Mounted Displays II, SPIE Proceedings, Vol. 3058, 1997 (1) Aeronautical Design Standard: Handling Qualities Requirements for Military Rotorcraft, ADS-33D-PRF, May 1996 (2) S. W. Baillie and R. H. Hoh, "The Effect of Reduced Useable Cue Environments on Helicopter Handling Qualities," Canadian Aeronautics and Space Journal: 34, 1988, 144-150 (3) RH. Hoh, Investigation of Outside Visual Cues Required for Hover, AIM Paper 85-1808, August 1985 (4) D. C. Hart, ADS-33C Flight Test Maneuvers Validation In A Degraded Visual Environment," presented at 50th Annual AHS Forum, May 1994 (5) A. G. Ledebuhr et at, "WFOV Star Tracker Camera," Sensors and Sensor Systems for Guidance and Navigation, Proceedings SPIE, 1478, April 1991, pp.2-12 (6) M. R. Franklin, "Application of an Autonomous Landing Guidance System for Civil and Military Aircraft:" Synthetic Vision for Vehicle Guidance and Control. Proceedings SPIE, 2463, April 1995, pp. 146-153 (7) P. K. A. Menon, G. B. Chatterji, and B. Sridhar, "A Fast Algorithm for Image-Based Ranging," Sensors and Sensor Systems for Guidance and Navigation. Proceedings SPIE, 1478, April 1991, pp.190-200 (8) R. E. Zelenka, P. N. Smith, A. A. Coppenbarger, C. E. Njaka, and B. Sridhar, "Results from the NASA Automated Nap-of-the-Earth Program, "Journal of the American Helicopter Society: 47,1997,107-115 (9) R. L. Newman, Scheme for Automatic Declutter for Helmet-Mounted Displays and Head-Up Displays, Crew Systems TM-96-03 submitted to Aeroflightdynamics Directorate, Moffett Field, February 1996 (10) M. J. Wells and M. Haas, "The Human Factors of Helmet-Mounted Displays and Sights," in Electro-Optical Displays, M. A. Karim (ed.), New York: Dekker, 1992, pp.743-785 (11) D. F. Kocian and H. L. Task, "Visually Coupled Systems Hardware and the Human Interface," in Virtual Environments and Advanced Interface Design, W. Barfield and T. A. Furness (eds.), New York: Oxford University Press, 1995, pp.175-25. (12) E. T. Davis, "Visual Requirements in HMDs: What We Can See and What Do We Need to See," in Head-Mounted Displays: Designing for the User, J. E. Melzer and K. Moffill (eds.), New York: McGraw-Hill, 1997, pp.207-251 (13) C. E. Rash, B. T. Mozo, BC J. McEntire, J. L. Haley, J. R. Licina, and L. W. Richardson, Assessment Methodology for Integrated Helmet and Display Systems in Rotary-wing Aircraft , USAARL 96-16 June 1996 (14) R. L. Newman, Head-Mounted Display Design Guide, Army Report TR-(pending), November 1997; Crew Systems TR-97-11 (15) R. L. Newman, Helmet-Mounted Display flight Symbology Requirements for Military Rotorcraft, Crew Systems TR-98-1 2, May 1998

KEYWORDS: night vision goggles, graphics display

A99-133 TITLE: Affordable Fuel System Computer

TECHNOLOGY AREAS: Air Platforms, Materials/Processes

OBJECTIVE: To develop a low cost, fuel system computer to monitor fuel flow, quantity, endurance and system health. This project addresses goals of the Air Vehicle Technology Area Plan to achieve a 25% reduction in crew workload, a doubling of decision making accuracy, and a quadrupling of situation awareness. The project will enhance pilot situation awareness and reduce workload by automating routine but potentially error prone fuel management tasks. It will provide the crew up-to-date, accurate information for aeronautical decision making. It will also provide timely alerts.

DESCRIPTION: Modern aircraft carry advanced fuel systems to improve engine performance and fuel efficiency. Yet the information provided to the crew by the fuel system has changed little from the earliest, mechanical gauges. The hardware and software technology exists for precise monitoring of fuel usage and quantity on board. This technology can provide the crew with timely and accurate fuel status information both under normal operating conditions and under conditions when manual accuracy might be poor. A major obstacle to placing this technology in aircraft is the high cost of developing and certifying a flight worthy device. This project will develop a low cost flight worthy device that will monitor fuel status, work with navigational systems to compute endurance, and alert the crew in case of a hazardous fuel status.

PHASE I: Identify a low cost, technical approach and design for the project. The design will include sensors for fuel flow and pressure as well as software and display format/presentation concepts. A proof of concept demonstration at the end of Phase I will include operating a brass board monitoring system and simulating the crew interface.

PHASE II: Develop a low cost fuel monitoring system and install it on an Army aircraft at Ames Research Center, Moffett Field, CA. The contractor will flight test monitoring hardware, software, and display formats/presentations. The demonstration system will be evaluated for usability and effectiveness as well as for cost and suitability for existing rotorcraft.

PHASE III DUAL USE APPLICATIONS: This system can have a great impact on civilian safety. Recent safety studies by NASA have analyzed civil rotary wing aircraft accidents listed in the NTSB data base. These studies have shown fuel starvation to be one of the most common factors in civil accidents. In many cases fuel starvation is the result of a sequence of crew errors that lead to an underestimate of endurance. Timely, accurate fuel status information and appropriate alerts could greatly reduce the number of fuel starvation accidents. Since a major stumbling block for the widespread use of fuel management computing systems is the high cost, the development of a low cost system should do very well in the civil market, both for rotary wing and fixed wing aircraft.

OPERATING AND SUPPORT COST REDUCTION: Operating cost reductions will be obtained mainly from enhanced combat performance due to better fuel management. Combat performance will be enhanced through the pilot's improved situation awareness of fuel status close to the limit of the endurance envelope. The system will also provide a great benefit in actual combat, where maximum endurance can be critical. The system can both enhance combat effectiveness and reduce losses. Although the system's potential to impact safety of military training is smaller, because training missions are less likely to push the endurance envelope, it could allow more realistic training by simulating performance near the edge of the endurance envelop.

REFERENCES:

1. "ASRS Rotorcraft Incident Study, Data Summary," January, 1999.
2. Hart, S. G., "Results of Safety Analysis Workshop," invited paper at The AHS Forum, May 1998, Washington.
3. Hart, S. G., "Analysis of Civil Helicopter Accidents," HeliExpo '98, February, 1998.
4. Schwirzke, M. F. J., Workshop on Near Term Gains in Rotorcraft Safety Strategies for Investment, NASA Ames Research Center, July 1998, Mountain View, CA.

KEYWORDS: fuel, fuel monitoring, crew alerting

U.S. Army Communications and Electronics Command (CECOM)

A99-134 TITLE: Low-cost Helicopter Collision Warning System

TECHNOLOGY AREAS: Air Platforms

OBJECTIVE: To provide helicopter pilots early warning of developing collision (contact) situations.

DESCRIPTION: Damage, destruction and fatalities result when helicopters contact aerial (other helos and wires) and ground objects (towers, buildings, standpipes, trees, hills, cliffs, guy-wires, etc.) in both extra-ordinary and routine situations. A relatively small and inexpensive stand-alone/retro-fittable system is needed to warn pilots in a timely yet unobtrusive manner of developing dangerous contact situations. This means sensing, tracking and evaluating objects in roughly the lower hemisphere out to around 100 meters (600 m or more in the forward direction). Only combined approach speeds less than 100 m/sec need be considered. The system must not significantly impact or endanger current helicopter operations. Proposals should also provide a preliminary estimate of power, size, weight, and cost.

PHASE I: A tradeoff study will be conducted to determine a limited set of radar sensors which will satisfy the goals. These will then be used to define an operational system configuration for the targeted UH-1 Huey test helo. (The design must be extensible to other helo categories with only minor modifications.) A detailed design will be prepared, and the bench functionality of one key sensor will be demonstrated.

PHASE II: The detailed design and sensor set determined in phase I will be used to construct and demonstrate one full mounted system, including a non-interference test. (This may require multiple units on two helos, depending on design.) The tests will be run using Army helos at Lakehurst Naval Air Station in New Jersey.

PHASE III DUAL USE APPLICATIONS: The proposed configuration will have an almost identical use in the commercial helo transport fleet, which encounters the same situations as the military fleet. Depending on the design, it might also be applicable to some small fixed wing aircraft.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Even minor contacts can result in structural damage to helicopter blades and fuselage. This occurs quite often and involves considerable cost to satisfy air safety regulations. Saving lives in peacetime training is a high priority.

KEYWORDS: Helicopters, collision avoidance, sensors

A99-135 TITLE: Radio Frequency Communications Modeling and Simulation using Distributed Simulation

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: The proposed effort will develop and model the distribution of RF communications equipment associated with specified deployed battlefield entities and organizational units in a simulated environment. Further, the deployed Semi-Automated Forces (SAFOR) will produce simulated communications traffic for a variety of tactical battlefield situations. The resulting communications simulation and modeling products will be integrated into an existing, off-the-shelf,tactical battlefield simulation system with Distributed Interactive Simulation (DIS) and High Level Architecture (HLA) compliant protocols.

DESCRIPTION: In current Distributed Interactive Simulation (DIS) environments, there exists a limited capability to model RF communications equipment accurately. Further, the modeled communications devices must correlate with battlefield entities or units, for DIS/HLA exercises. This type of representation on the electronic battlefield is required in the Intelligence and Electronic Warfare community to describe tactical situations accurately. There exists in the IEW community, systems that exploit information gained through the interception of communication traffic such as GUARDRAIL and Rivet Joint. Therefore, an accurate portrayal of potential target system is necessary in determining the performance of these collection systems under a variety of battlefield scenarios. The ability of such systems to perform missions in a DIS/HLA exercise environment is considered a highly desirable goal since these systems are expensive high value assets to deploy.

PHASE I: An initial investigation in determining the organizational makeup of forces that can be represented as Semi-Automated Forces (SAFOR), distributed on the battlefield and the communications devices deployed with these forces will be performed. From this initial analysis, a sub-set that provides a spectrum of RF Communications models is developed. The development of software models that accurately describes the parameters of the selected systems is then constructed. Typical parameters would include power, frequency, bandwidth, beam characteristics and other salient characteristics. After model development, next is tethering or attaching the communications model to an entity that has a representation or known model in the DIS/HLA environment. As the model is exercised through various scenarios, data will be collected on the performance of a communication collection system. The performance of multiple scenarios will generate a range of data sets that provide system sensitivity analysis.

PHASE II: This phase of the effort will address the development of an automated deployment system for larger forces a Distributed Simulation of tactical battlefield operation. On a simulated battlefield, the rapid and efficient deployment of numerous forces using a wide range of equipment associated with each entity is required. It is proposed that an Expert Systems and/or several AI techniques can be utilized in defining these deployment patterns, strategies and equipment distributions on the synthetic battlefield. Target areas for these technologies are as follows: - Use of templates or expert systems software in defining deployments. - Tactical situation deployment of forces based on preset rules. - Varying deployment patterns based on tactical situations or opponent type. In determining the organizational makeup of the Semi-Automated Forces (SAFOR) distributed on the battlefield, several factors comprising the characteristics of specific entities or units on the battlefield with associated communication capabilities require investigation.

PHASE III DUAL USE APPLICATIONS: The developed models and simulation techniques possess practical application for other than DoD agencies. An example of this extends to modeling communication devices on transportation vehicles such as trucks and trains. Utilizing Global Positioning System (GPS) along with a database of communication relays, mobile systems can determine potential link and loss of link using these tools. When the communications link is lost, the tool would direct the operator toward locations along its general direction or route where reacquiring the link is possible. Further, this tool would alert a operators as to when a unit would lose communication during a delivery or voyage.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Utilization of these modeling and simulation techniques will provide enhanced operator training on sensor and INTEL collection systems such as Guardrail, Joint STARS and ASAS at reduced cost to train. The ability to train operators without the deployment of high value assets is highly desirable and cost effective.

KEYWORDS: Distributed Interactive Simulation (DIS), High Level Architecture (HLA), Guardrail, Joint STARS, Communication Modeling

A99-136 TITLE: Near Real-time Radio Frequency Emitter Mapping

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Demonstrate significantly enhanced capability to provide a near-real time map of RF emitter locations in the tactical commander's battlespace. Improvements are sought in both system performance and system SWAP (size, weight, and power).

DESCRIPTION: The tactical commander requires a near-real time map of RF emitter locations, including emitter type identification, in the battlespace. This map contributes directly to the all-source intelligence picture of the disposition of both friendly and enemy forces, and is critical to force protection/situation awareness, situation development, and targeting. Currently, the Army relies on a mix of ground, air, and national assets to provide this picture. However, the performance of each of these assets is limited in some particular aspect. Limitations include line-of-sight, field of field-of-view, sensitivity, dynamic range, geolocation accuracy, size, weight, power, etc. In particular, operational trade-offs must be made between system performance and system range to target (i.e., large, sophisticated systems operating at stand-off ranges versus attritable systems operating at stand-in ranges). Opportunities for performance improvements exist in several areas. Vehicular applications require compact, mechanically robust, high-gain or reconfigurable antennas capable of acquiring data for on-the-move direction finding. Operation in dense environments requires enhanced spatial signal separation techniques. Operation against modern, low-power commercial emitters requires high-dynamic range and low-noise broadband digital receivers. Tracking of specific emitters within a communications net places particular emphasis on techniques and hardware for reliable, high-confidence electronic fingerprinting. Opportunities for SWAP improvements include the application of low-power electronics, advanced packaging techniques, and advanced hardware/software configurations.

PHASE I: Identify candidate improvements, develop initial designs with analysis of return-on-investment in the area of improvement, and demonstrate technical feasibility of the recommended approach.

PHASE II: Develop and demonstrate a prototype version of the improvement. Hardware should provide maximum possible compatibility with the Joint Airborne SIGINT Architecture (JASA) and other relevant standards. Hardware will be delivered for test and evaluation in concert with existing SIGINT systems at CECOM.

PHASE III DUAL USE APPLICATIONS: Hardware developed under this topic will have potential application to RF site-survey activities for the planning and construction of cellular communications networks.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Improvements in SWAP will have collateral impact on logistics and support costs associated with transportation, fuel supply and storage, etc.

REFERENCES: Further details on Army requirements for near-real time RF emitter mapping may be found at the TRADOC System Manager - Ground Based Common Sensor (TSM-GBCS) website at http:/huachuca-dcd.army.mil/tsmgbcs/tsm.htm . Interested parties may request the Operational Requirements Document (ORD) for the Prophet System from TSM-GBCS by following the instructions as noted on the website. The JASA Standards Handbook is available via the JASA Standards Working Group (JSWG) website at http:/www.jswg.org .

KEYWORDS: situation awareness, signals intelligence

A99-137 TITLE: Low-cost Modular Intelligence System

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Design and develop a low cost, scalable, intelligence analysis system.

DESCRIPTION: Current Army intelligence analysis systems require bulky, expensive hardware and are not designed to support multiple intelligence disciplines. Additionally, they require the purchase of expensive commercial off-the-shelf (COTS) software licenses, further increasing the cost of ownership and making them too expensive to be widely deployed. The objective of this effort is to develop an intelligence analysis system that has: 1) reduced hardware cost; 2) reduced cost of ownership; 3) reduced size and weight; 4) Defense Information Infrastructure/Common Operating Environment (DII/COE) compliance; and 5) functional modularity. Functional modularity will allow the user to select each individual intelligence discipiline [e.g., Communications Intelligence (COMINT), Electronics Intelligence (ELINT), Human Intelligence (HUMINT), etc.] and install only the functionality required to perform the current mission. The system must allow the user to configure the software to interface with existing intelligence sources and systems. Potential offerors shall ensure that product design accommodates segmented, multi-level security as required to interface with existing intelligence sources and systems.

PHASE I: The contractor shall design the hardware and software architecture of the system incorporating the concepts and requirements of the description above. The system shall be designed to be implemented on a Window 95, Windows 98, or Windows NT platform. The software shall be designed for implementation in C++. Deliverables shall consist of a final report that addresses the issues of cost, size and weight savings over current Army analysis systems, includes the system design architecture, addresses dual-use prospects of the system, and a feasibility assessment of the system. Evaluation factors shall include compliance with the solicitation, innovative merit, relevant experience and dual-use.

PHASE II: The contractor shall implement the Phase I design of the system. The contractor shall test and demonstrate that the system implements and complies with the requirements of the description above. Deliverables shall consist of five complete systems, a test & demonstration plan, a final report of the test & demonstration results, and the C++

source code and makefilies used to compile the software. The C++ source code shall not invoke any executable user files, unless the C++ source code for such files is also delivered to the Government.

PHASE III DUAL USE APPLICATIONS: The resulting system will provide a low-cost intelligence analysis capability for law enforcement (FBI, DEA, CIA, Customs) operations and counter-drug operations. For example, this system may be used by these agencies to correlate and track electronic emissions from sources such as radio transmitters and cellular phones against other sensor data, such as ground vehicle movement data, in real time and on the move. Additionally, this system could be used by the FCC as a low cost, backup, tracking system for air traffic control systems by taking advantage of multi- sensor correlation of radar and communications information.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This topic will support reduced up-front costs for hardware and software as well as reduced support costs for the system's lifecycle in terms of repair and software licensing.

REFERENCES: Product Manager, Intelligence Fusion, All Source Analysis System Homepage: http://www.asaspmo.belvoir.army.mil/asas/asas.htm

KEYWORDS: Intelligence analysis, surveillance, fusion, correlation

A99-138 TITLE: Physically Small, Very High-frequency/Ultra-high Frequency Conformal Antennas

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: The proposed effort will develop and construct a VHF/UHF antenna which is both lightweight and small and can be mounted on a tactical Unmanned Aerial Vehicle (UAV) such as Outrider.

DESCRIPTION: A need exists for an antenna that can be used on tactical UAVs. At VHF/UHF frequencies, current technology requires an antenna be either large, or have inadequate electrical performance. It is desired that the developed antenna will work from 20 MHz to 2GHz, with a directivity greater than 3dB, and a VSWR across band of better than 3.0:1. These goals should be met with the antenna mounted on a UAV and not only in a lab type environment. Two antennae that meets this requirement needs to be mounted on each UAV. Meeting the electrical goals fully is not required, though it is highly encouraged. The use of new architectures, such as fractal designs and or the use of new materials is encouraged. If full electrical performance can not be met from one antenna, a possible solution can be the combination of a number of antennae.

PHASE I: This initial phase should include extensive modeling of the desired antenna or antennae and if possible, the development of proof of concept models for verification. The antenna should be designed to mount on a small tactical UAV such as Outrider. Modeling should include the problems encountered from mounting the antennae on a UAV. Phase I should include a detailed plan for constructing the antenna or antennae in Phase II.

PHASE II: This phase will include design, fabrication and testing of the final antenna or antennae. Final testing should be done in an anechoic chamber and if possible also mounted on a structure similar to a small tactical UAV. Two each of every antenna should be constructed and delivered upon completion of this phase.

PHASE III DUAL USE APPLICATIONS: Possible dual use applications include the use of this technology in the commercial communications field. Successful completion of this project will allow antennae used in cellular base stations, short wave communications and other VHF/UHF applications to be smaller and/or have improved electrical performance, potentially decreasing the costs and increasing the utility of these systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Utilization of these antenna(e) on a UAV for reconaissance purposes will allow a significant reduction in cost over what can be accomplished with present day technology, i.e. piloted aircraft.

REFERENCES: http://roselott.gsfc.nasa.gov/html/valvidia/fractal_antenna/node1.html
http://www.neci.nj.nec.com/pomepages/vlasov/photonic.html

KEYWORDS: antenna, UHF, VHF, conformal

A99-139 TITLE: Tactical Vehicle Inverter System

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop a new electrical inverter system which provides tactical vehicles with sufficient usable, onboard electric power to meet mission requirements.

DESCRIPTION: The Army has a need to process power from the 28 volt DC electrical system onboard tactical vehicles into usable 120/240 volt, 60 Hz, single phase AC power to support a variety of mission functions, i.e. Signal, Communications, Contact Maintenance, Mobile TOCs, etc. The Light and Medium families of tactical vehicles are available with DC systems up to 400 amperes (11.2 kilowatts). Armored vehicles have even higher DC system capabilities. The maximum capabilities of these systems are not always necessary to perform vehicle operations, and, therefore, this surplus power can be applied to a conversion unit to produce AC power. These units will be capable of producing 2.5 kilowatts (kW) of 120/240 volt AC power each. The units will be selectable between 120 volt AC Single Phase and 240 volt AC Single Phase via a switch, or by having separate output connectors for the respective voltages. The units will physically secure to one another and electrically interface as to parallel the outputs to produce 120/240 volt AC Single Phase power in multiples of 2.5 kW (2.5 kW, 5 kW, 7.5 kW, ...etc.). The only vehicle interface required will be to plug into the NATO battery slave receptacle. This allows the power converter to be generic and adaptable to all tactical vehicles. These converters must operate in the critical ambient temperature conditions required for tactical equipment (-32 Degrees C to +52 Degrees C). The power produced by these units is required to meet Mil-Standard 1332B, Utility Class 2C, for power quality.

PHASE I: Explore the technologies and components available to determine the approach best suited to meet the Army's need for a generic vehicle power conversion system, employing the latest technologies in power electronics, and develop a design which meets these criteria.

PHASE II: From the design developed under the Phase I effort, fabricate and deliver four operational prototype vehicle power conversion systems. Multiple units are necessary to confirm the paralleling capabilities. The paralleling of the conversion units provide them with the unique capability of producing multiples of the individual unit power rating. This will allow adaptability to virtually any military or commercial application requiring 120/140 VAC power originating from the vehicle electrical system.

PHASE III: Providing dual voltage input capability to the power conversion unit, allowing either 12 or 24 VDC, will permit this technology to meet military and civilian commercial applications. This technology under Phase III would transition to production to provide power conversion systems which are adaptable to all military tactical vehicles and a large segment of commercial vehicles as well, i.e., Fire & Rescue, Forestry, Utility Power Maintenance, Disaster Relief, Commercial Trucking, Recreational Vehicles, etc.

OPERATING AND SUPPORT COST REDUCTION (OSCR): These inverter systems will provide the necessary electrical power to meet critical mission requirements while eliminating the need for many Diesel Engine Driven (DED) Generator Sets or Auxiliary Power Units (APUs). Using these inverters, when suitable, will not only reduce initial equipment costs over generator sets and APUs, but will also reduce, operational and maintenance costs, and transportability and logistics. Each inverter will weigh but a few kilograms and be less than .03 cubic meters in size. These units can be easily transported in their host vehicle without a significant increase in size or weight. The Generator Set or APU, which these inverters can replace, range in size from .5 to 11 cubic meters and weigh between 100 and 2,000 kilograms. Generator sets and APUs require routine maintenance, therefore, maintenance and repair parts and trained personnel must be available in the field to support them. These inverter systems will not only eliminate the initial cost of the Generator Set or APU, they will also reduce the logistics burden by, decreasing the volume and weight of deployed equipment, and reducing the necessary maintenance and repair parts and personnel which support this equipment.

KEYWORDS: Inverter, converter, 28VDC, 120/240VAC, Vehicle Interface

A99-140 TITLE: Lightweight Integrated Navigation and Communications Radio System

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To design, build, and demonstrate an affordable, anti-jam, LPI integrated navigation and secure communications system that offers precision relative navigation and rendezvous capability to Army mobile platforms, including the soldier.

DESCRIPTION: In order to make future multi-function radios affordable on many Army platforms it is highly desirable to utilize the same frequency spectrum for both navigation and communication functions, thereby eliminating the requirement for additional antennas and RF front-ends. Innovative concepts are required that facilitate realization of this objective by addressing problems of: susceptibility to enemy jamming threat, detection by the adversary, self interference, and interference to friendly users not equipped with the proposed system.

PHASE I: The purpose of Phase I is to conduct research and risk reduction through trade studies. The contractor will develop the system architecture and concept of operation.

PHASE II: The objective of Phase II is to demonstrate key technology areas through laboratory tests. Completely define their system specification and prepare a final report.

PHASE III DUAL USE APPLICATIONS: The proposed system will benefit manned and unmanned aircraft guidance, command and control, search and rescue, surveillance and reconnaissance, precision approach and landing systems to suit the needs of commercial users. Military applications include situation awareness and precision relative navigation between non line-of-sight mobile platform.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This topic increases and improves the commander's situation awareness, and provides the capability to issue short commands, without resorting to high power transmitters which give away force location. This capability minimizes the need for more expensive antenna and RF components, thus reducing logistic support expenditure.

REFERENCES: Small Unit Operations Situation Awareness System, System Capabilities Document Version 2.0 March 10, 1998

KEYWORDS: communication, radio, navigation, low probability interception, RF

A99-141 TITLE: Application of Distance Learning to Training Cost Reduction for Logisticians and Command Post XXI Staff

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To develop, demonstrate, and transition innovative Distance Learning technologies for training cost reduction for logistics and command post staff.

DESCRIPTION: The need exists for major improvements in training and knowledge acquisition in the area of logistics and command post operations. As the battlefield becomes faster-paced and more complex,and as budgets decrease, the need for cost reduction/enhancements in training and knowledge acquisition is becoming increasingly critical. Distance Learning (also called Distributed Learning or Learning Technology) offers great potential for meeting these needs. While this topic is open to any new technologies addressing this field,offerors should consider focusing their proposals on one of the four emerging Learning Technology standards recently adopted by The Joint Technical Architecture-Army (JTA-Army) [1. Learner Model; 2. Learning Technology Systems Architecture; 3. Learning Objects; and 4. Computer Managed Instruction]. For example, the Learner Model (a person-centered database that can potentially track and manage everything an individual learns, knows, and does) offers fertile ground for innovation and extended functionality. The technical standard defines the data interchange format, a critical first step, but the potential functionality offers many good opportunities for innovation, especially dealing with improved learning and human knowledge acquisition. Proposals should be for new technology, not merely the application of existing technology.

PHASE I: Conduct extensive study and/or develop early prototype software of proposed technology for purposes of demonstrating technical feasibility, user benefits, and commercial marketability.

PHASE II: Complete development of proposed innovation, technology or system.

PHASE III DUAL USE APPLICATIONS: Product sales to commercial logistics market. Product sales to education, training, and performance-support markets. License agreement with DII COE for segmented products. Follow-on R&D contracts from government and industrial customers. Technical Demonstrations as part of military R&D programs.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Training is a major portion of O&S costs.

KEYWORDS: distance learning, distributed learning, learning technology, logistics, C2, learner model, student model, knowledge management, learning object, computer managed instruction, soldier

A99-142 TITLE: Electrooptic Active Ambient Attenuator

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop and demonstrate a smart, video-rate response, electro-optic active ambient attenuator (EA3) for use in see-through head mounted display (HMD) systems. The attenuator material technology will improve the human systems interface of HMD systems by ameliorating the conditions which increase power consumption and reduce image contrast and quality. No existing material/device structure currently exists which can provide this capability.

DESCRIPTION: Current HMD electro-optic designs require high transmittance for see-through channel optics during low scene ambient conditions. This conflicts with the need for high display luminance/contrast during high scene ambient conditions (<10 kfc). Introduction of a video rate attenuator which incorporates scene/display luminance feedback controls will permit see-through HMD designs which do not depend on high display luminance to provide adequate image contrast under high ambient illumination environments (this is currently the case for Comanche, and other HMD systems). The ability to switch between high transmittance and low transmittance at both the pixel and bulk addressed level will establish a new capability for compensation of dynamic ambient illumination conditions. The resultant lower power display luminance requirements will reduce the HMD power consumption, and will also reduce the thermal signature and the users head borne heat load. Localized, small area bright source attenuation will improve threat and hazard detection in urban and battlefield environments.

PHASE I: Perform comparative study of candidate EA3 device materials and structures. The study shall, as a minimum, provide physical test data obtained from bulk material test cells. Functional samples of the of the candidate structures will be submitted to the Government for electro-optic characterization. These materials demonstration test cells will be capable of being driven at 60 Hz video rates, in order to define the material electro-optic performance suitability for HMD applications. The study will address such parameters as maximum transmittance state, maximum achievable attenuation level, temporal characteristics (t-on/t-off), and operating temperature range. Integrate Contractor and Government generated findings into final report of comparative device study, and deliver final report to Government.

PHASE II: Design, develop and deliver to the Government a functional EA3 demonstration unit which can be driven in both bulk (HMD field of view) & small (pixel & pixel block) area luminance attenuation modes. Ambient attenuation will be established via a closed feedback system between the ambient channel and the display and will provide for both manually regulated and auto-sensing/controlled attenuation. The electro-optic attenuator demonstrator will be integrated with a representative see-through/display channel which incorporates a functional miniature, high resolution display (640x480 monochrome, minimum). The demonstration unit will incorporate the required electro-optical control mechanisms, algorithms and feedback architectures required to modulate the attenuator material. The Phase II unit will serve to determine the ability of the material and device structure to meet the electro-optic performance requirements relative to military, see-through HMD systems applications. Delivery shall include any ancillary support equipment required to operate the EA3 demonstration unit such that the Government can operate the demonstration unit to perform an independent electro-optic performance evaluation of the device characteristics Ancillary equipment not specifically funded under this effort will be returned to Offeror NLT 30 days after delivery to Government.

PHASE III DUAL USE APPLICATIONS: EA3 technology has strong commercial and Tri-Service potential for aviation HMD applications. To date, no see-through HMD systems meet the desired operational performance levels. This device technology can ameliorate the luminance and power conditions such that realistic HMD designs may be realized. Availability of this device technology will greatly increase the manufacturability of HMD systems which are capable of meeting military operational requirements. Further military and commercial use of this technology approach is possible as larger area devices become available for direct view applications. Potential military program beneficiaries include Land Warrior, Mounted Warrior, Air Warrior, Comanche, and Apache vision systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Ambient attenuation will result in lower display luminance requirements. Lower luminance translates directly into longer life for the displays & longer battery life for untethered systems. These factors result in lower system life cycle cost, and reduced operating cost. Thes cost savings are applicable to all see-through HMD systems.

KEYWORDS: Head Mounted Display, HMD, Electro-optics, Attenuator

A99-143 TITLE: Innovative Backlight Technologies for Miniature Active Matrix Liquid Crystal Display

TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop and demonstrate innovative backlight technologies for miniature Active Matrix Liquid Crystal Display (AMLCD) panels for use on military Head Mounted Displays (HMDs) and weapon sights. These technologies should produce a more efficient, lower power backlight for both low and high brightness applications. To date, little research has been performed to produce an efficient and optimized miniature AMCLD backlight.

DESCRIPTION: The military is currently in the process of inserting flat panel displays such as AMLCDs into military HMDs and weapon sites. These applications require miniature (<1.5" diagonal) high resolution (> 320 x 240) displays with a nominal LCD pixel pitch of 12 to 15 micro-meters. Some aviation see-thru HMDs require AMLCDs with a resolution of 1280 x 1024 and output luminances on the order of 1,500 to 2,000 ft-L. Current backlight sources such as remote arc-lamps are bulky and require high power consumption in order to produce enough light. High power backlights also possess a larger heat load and require complicated heat dissipation techniques. To date, no backlight has been fabricated to meet the luminance, size, power and heat goals. Innovative research is required to examine new techniques for meeting all of these goals. AMLCD displays intended for dismounted soldiers require lower luminance (approximately 100-200 ft-L) and also require low power consumption (including backlight). Low efficiency backlights require the soldier to carry more batteries and thus more weight. More efficient, lower power backlights could solve both the aviation and the dismounted soldier display backlight problems.

PHASE I: Perform comparative study of candidate backlight technologies. This study should examine source and coupling technologies for both the low and high brightness applications. The study shall as a minimum, include physical test data obtained from measurements of candidate approaches. Functional samples of the candidate approaches shall be submitted to the Government for evaluation.

PHASE II: Develop and demonstrate mutilple functional backlight technologies and integrate them onto a monochrome or color AMLCD display with a minimum resolution of 640 x 480 active pixels. Functional samples of the candidate devices (backlight, AMLCD display, drive electronics) shall be submitted to the government for evaluations. The candidate devices should be capable of being driven by a computer or video generator via standard VESA 60 Hz or 72 Hz video signals using a 15-pin VGA analog signal connector. Candidate backlight technologies will be characterized by performance criteria such as power consumption, heat dissipation, power efficiency, luminance uniformity, and motion video artifacts of the AMLCD caused by the backlight.

PHASE III DUAL USE APPLICATIONS: An innovative power efficient backlight has both commercial and military applications. The candidate backlight could be integrated to a military miniature AMLCD and be demonstrated on a military aviation or dismounted soldier HMD or weapon sight. Commercial demonstration could be performed by utilizing the backlight in low power, high performance, AMLCD display applications such as on cellular phones, video cameras, and portable televisions.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Innovative backlight technologies will lower the military operating costs for military systems in several ways. The more efficient/lower power backlight will require less power and allow the dismounted soldier to operate longer and require fewer batteries during operational use. Innovative backlights should be smaller in size, possess fewer parts then current backlights, and increase the display system's reliability.

KEYWORDS: AMLCD, Head Mounted Display, HMD, Backlight

A99-144 TITLE: Dual-voltage, Multiconfigurable Nonrechargeable Battery Design with Adapter

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Increase the ability of existing Army lithium prismatic shaped battery types to meet future equipment battery footprints and decrease the chances for future battery type proliferation in the logistics system.

DESCRIPTION: Dual voltage, multi-configurable battery design concept that can be retrofitted to existing prismatic Army Lithium batteries and allow the design (with proper adapter) to mimic original battery and without the adapter, form four additional dual voltage prismatic shaped batteries. Successful design will allow the Army to replace one original battery with one that can form four physically distinct battery types, each capable of providing two electrical configurations and with an adapter, the design can mimic the original battery.

PHASE I: Propose a dual voltage, multiconfigurable battery design concept that can be inserted into a BA-5847/U lithium battery configuration. The design with a proper adapter will mimic the BA-5847/U battery (6 VDC, 50 watt-hour and 3 ampere capable) and without the adapter will fold to form four distinct prismatic shapes and each shape can operate at a 6 VDC or 12 VDC electrically. The proposed design must account for mechanical issues such as ruggedization, water resistance, electrical and mechanical connections between modules, optimal packaging of electrochemical cells to maximize battery energy and power capability within the size and weight constraints of a BA-5847/U type battery. Produce 15 prototype mock ups of concept.

PHASE II: Set up and manufacture 400 dual voltage multiconfigurable batteries with proper adapter to mimic the BA-5847/U type battery. The batteries shall meet the performance and safety requirements of MIL-PRF-49471(ER).

PHASE III DUAL USE APPLICATIONS: Apply design and manufacturing techniques for military and commercial nonrechargeable and rechargeable batteries.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The dual voltage multiconfigurable battery design concepts will help simplify future battlefield logistics and decrease the chances for future battery type proliferation by making existing Standard Army prismatic batteries multiconfigurable to meet future equipment battery needs and still retain the ability to operate in legacy equipments.

KEYWORDS: battery, dual voltage, multiconfigurable

A99-145 TITLE: Speech Intercept Intelligibility for Spectrum Supremacy

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Improve the intelligibility of intercepted speech communications over tactical radios for spectrum supremacy situation intelligence processing.

DESCRIPTION: The intelligence community is interested in extracting tactical situation knowledge of current and planned enemy activities from automated monitoring of battlefield radio communications. Natural language understanding, language identification, language translation, and key words spotting are emerging technologies, which can be applied in this quest for relevant information. The limiting factor in the successful application of these emerging language based interpreters is the poor quality of the speech captured from these tactical radio emissions in a battlefield environment. An innovative method for improving the speech quality of these tactical radio intercepted transmissions is the underlying research needed. This research should lead to dramatic improvement in pre-processed "clean speech" for subsequent language algorithm application. The key is to develop a concept for accurately extracting the captured speech from the severely degraded transmission intercept in a way that is the most beneficial for natural language algorithm performance.

PHASE I: Develop an innovative methodology to improve the performance of natural language algorithms for degraded tactical radio transmitted speech. Continue progress in the research of speech intelligibility algorithms that can accurately extract speech in the presence of signal to noise ratios of minus 10 dB or less. Demonstrate and quantify the improvement in speech intelligibility for degraded tactical radio intercepted communication and the natural language algorithm(s) post processing success. Show the feasibility of applying the low signal to noise ratio speech extraction remedies to low power and processing limited mobile tactical radio receivers.

PHASE II: Demonstrate the successful natural language identification and context understanding post processing for degraded tactical speech intercepts. The natural language identification and context understanding algorithms are to be integrated with next generation tactical radio speech processing schema to effect a processing efficient and low power consumption solution. The effectiveness of the real-time speech intelligibility enhancement shall be demonstrated using only the single tactical radio processor resource, to show power consumption savings obtained by merging duplicative speech processing and memory requirements. These prototypes will use recorded and live intercept voice transmissions containing typical fading and multi-path phenomena.

PHASE III DUAL USE APPLICATIONS: Automated natural language interpretation and understanding processing represents the preferred next generation interface between humans and their supporting electronic devices. Applications for this natural language interface include personal data assistants, computers, controls and an intuitive interface for appliances, radio, cell-phones, vendor kiosks, web-site browsers, information fusion and decision aids. Improved speech intelligibility processing for degraded speech transmission will provide wider user acceptability of the automated natural language technology in a wide range of consumer products and services.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Automated intelligence monitoring and language understanding represents a significant breakthrough in this human labor intensive task. Reductions in required personnel of 10 to 1 are predicted as a result of the technology implementation for electronic warfare and intelligence warfare missions. This automated technology represents a practical solution to the surveillance of the ever increasing bandwidth use which necessitates innovative and automated solutions to achieve spectrum supremacy.

REFERENCES: IEEE 1997 International Frequency Control Symposium, "New Prospects for Acoustic Sensors". Experimental Psychology,Oct 1998, "The Role of Lexical Information in Syntactic Ambiguity Resolution. Architectural Acoustic Principles and Practices, Cavanaugh; Wilkes,Oct 1998. DRA Laboratories, Sarasota, FL,"MLSSA Speech Intelligibility Measurements. Speech Technology "Detecting the Goats",June 1998, "How Speech Can Be Used for Multi Language Applications",Aug 1998, "Beyond recognition to Understanding" Oct 1998.

KEYWORDS: natural language identification, speech intelligibility, tactical radio communication

U.S. Army Construction Engineering Research Laboratory (CERL)

A99-146 TITLE: Asbestos Neutralization by In-situ Chemical Digestion

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: The objective is to develop and test innovative in situ chemical digestion of asbestos in asbestos containing materials (ACM), using acids such as fluorosulfonic acid, which have been used in Army/DOD buildings and structures.

DESCRIPTION: In the past, asbestos containing materials have been used in DOD buildings and structures for pipe insulation, boiler/tank insulation, spray on fireproofing, plasters, vinyl asbestos floor tiles, roofing felts, and in transite boards. Currently, in place management is recommended since removal is not affordable. However, this merely postpones the abatement until major rehabilitation or demolition takes place. The cost of asbestos removal is prohibitive and cheaper technology for abatement is needed. Current techniques for removing asbestos containing materials (ACM) require the construction of airtight barriers, labor intensive scraping of the ACM and costly environmental and worker protection. Development and testing of an in situ chemical digestion process for ACM will greatly reduce the cost of asbestos abatement. The United States Environmental Protection Agency (EPA) introduced regulations to minimize building occupants' exposure to asbestos dust derived from building materials. On November 28,1990, the Asbestos School Hazard Abatement Reauthorization Act (ASHARA) was enacted to amend certain portions of Asbestos Hazard Emergency Response Act (AHERA) to extend certain elements of the school program to public and commercial buildings. From the earliest days of this technology, most field engineers have defined asbestos abatement to include one or a combination of: removal, enclosure, encapsulation, and management in place. Basic concepts, which employ fluoro acid decomposing agents, have been demonstrated by the Brookhaven National Laboratory. However, further development of this chemical digestion technology is needed for neutralization of ACM in insulation in Army/DoD buildings and structures.

PHASE I: Explore and establish the feasibility of developing innovative chemicals for in situ digestion of ACM. Previous technology (as shown in references) has used fluorosulfonic acid to digest asbestos containing materials in spray on fireproofing for steel structural components of buildings. The process should be applicable to ACM used for insulation in Army buildings. The methodology will include formulating and testing chemicals that are known to digest asbestos minerals in the serpentine group. It is expected that when the treatment is done, it will no longer be a regulated material and will contain less than 1 percent fibers, which is the EPA's definition of non-asbestos materials. The methodology shall meet the following criteria: (1) Develop ACM digestion chemicals that will dissociate chrysotile asbestos into non-regulated components, (2) Develop binding agents that will bind the non- regulated components to form an environmentally benign solid, (3) Develop process to increase reaction rate ACM digestion chemicals, (4) Develop method of in situ application of digestion chemicals to chrysotile in ACM in typical geometric configurations where ACM has been used in the past, e.g., pipe insulation, (5) Develop process by which binding agents are applied in situ to typical geometric configurations in which the ACM has been used in the past, e.g., pipe insulation, (6) Develop process for safe removal of environmentally benign solid product, and remaining chemical digestion and binding agents from the point of application.

PHASE II: Perform development of the process and testing in the field.

PHASE III DUAL USE APPLICATIONS: This technology represents a high payoff potential for DOD buildings and structures as well as commercial buildings, schools and hospitals. Basic concepts have been demonstrated by the Brookhaven National Laboratory. There is excellent potential for commercialization.

OPERATIONS AND SUPPORT COST REDUCTION (OSCR): The DoD owns more than 2 billion square feet of buildings and structures which have some ACM. It is estimated that the cost to the DoD for asbestos inspection, training, in place management, and abatement will exceed $ 1 billion. In situ digestion by chemicals has the potential of cost avoidance of 20 percent, or $200 million.

KEYWORDS: asbestos, digestion, buildings, chrysotile, gypsum

REFERENCES: T. Sugama, R. Sabatini, L. Petrakis, "Decomposition of Chrysotile Asbestos by Fluoro-sulfonic Acid", Industrial and Engineering Chemistry Research, Vol. 37, p. 79-88, 1998. J. A. Hriljac, C. Eylem, Q. Zhu, R. Sabatini, L. Petrakis, R. Hu, J. Block "Use of X-ray Powder Diffraction for Determining Low Levels of Chrysotile Asbestos in Gypsum-Based Bulk Material: Use of a Synchrotron Source", Analytica Chimica Acta, Vol.350, p.221-229, 1997. R. Hu, J. Block, J. A. Hriljac, C. Eylem, L. Petrakis, "Use of X-ray Powder Diffraction for determining Low Levels of Chrysotile Asbestos in Gypsum-Based Bulk Material: Sample Preparation", Analytical Chemistry, Vol. 68, p.3112-3120, 1996.

A99-147 TITLE: Magnetic Fluxgate Micro-electromechanical Systems (MEMS) Sensor for Structural Integrity Monitoring Capabilities

TECHNOLOGY AREAS: Materials/Processes

OBECTIVE: Develop a sensor for measuring magnetic flux on the surface of structural components using micro electromechanical systems (MEMS) technologies. The sensor must be small (< 5 mm length) and easily attached to the surface of a structural component by an adhesive bond. The sensor must be capable of detecting flux readings of 0.0001 Gauss or less. The technology should be developed such that an array of sensors can be manufactured in a sensing "grid" or "patch" that can be attached to the surface of a structural component.

DESCRIPTION: Recent work shows that tagging of structural components with a magnetostrictive phase yields a structural material that emits a magnetic flux proportional to the applied loading on the structure. Locally elevated stresses around cracks and other forms of damage produce locally elevated readings in magnetic flux for these materials. As such, the magnetic flux on the surface of tagged structural components can be used to monitor the structural integrity of these components. Development of micro fluxgate sensors based on MEMS technology provides the capability to obtain continuous monitoring of surface and/or subsurface magnetic flux, detailed spatial resolution in order to locate precisely the structural damage, and the capability to utilize a host of low cost magnetostrictive tagging materials. MEMS technology is based on photolithographic patterning. It is therefore capable of generating fine geometric features and precise control of device characteristics. In addition, the fabrication process is mass predicable, making it suitable for realizing arrayed devices. Electroplated Permalloy material (with 80% Ni and 20% Fe contents) has been under development at research institutes. It offers material properties desirable for the application in flux gate sensors (e.g. high permeability on the order of 4500).

PHASE I: Develop and demonstrate the manufacturing techniques to fabricate a micro fluxgate sensor capable of detecting magnetic flux readings on a laboratory specimen of magnetostrictive tagged polyester composite structural material. Direct comparisons with a Hall-effect sensor will be made. A simplified fabrication process based on electroplated Permalloy material and evaporated metallization will be developed. The process is expected to require reduced processing time and complexity compared with state of art.

PHASE II: Develop sensor "grids" of micro fluxgate sensors to be bonded to laboratory and prototype tagged structural materials. Direct comparisons with existing magnetic flux measuring systems will be made.

PHASE III DUAL-USE APPLICATIONS: Because the technology is applied to basic structural materials, it is directly transferable to all other branches of the federal government and to the entire civilian sector as well. Facilitating the use of composite materials in infrastructure applications has the potential for major cost savings in U.S. construction and maintenance industries. For example, the technology developed for the fluxgate sensor will enable high-density array of magnetic leakage (ML) sensors for non-destructive evaluation (NDE) of structures. Current ML NDE units contain only single units and are bulky. It is impossible to detect small defects with high precision. The project under development is expected to yield technology that will enable this and other revolutionary devices with broad applications. The magnetic MEMS is generally useful for a number of sensor and actuator applications. Examples include micro actuators for active optical fiber alignment in advanced communication systems, and magnetic systems for controlling biological entities in micro fluidic systems. This program is expected to provide the principal researchers with an opportunity to develop basic understanding and practical technologies for realizing high-performance magnetic sensors and actuators.

OPERATIONS AND SUPPORT COST REDUCTION (OSCR): The DOD owns more than 2 billion square feet of buildings, most of which have inadequate structural integrity monitoring. Self-monitoring structural systems offering the potential for assuring the structural adequacy of a facility with less on-site inspections can save millions of dollars in annual inspection costs. Additionally, lightweight, self monitoring, composite systems offer the field Army the potential to fabricate self assessing gap crossing systems to insure safe gap crossings.

REFERENCES:

1. S.R. White, R. G. Albers and R. Quattrone, "Tagging of Composite Materials with Terfenol-D Magnetostrictive Particles for Structural Health Monitoring," 1996 Joint ASME Applied Mechanics and Materials Summer Meeting, June 12-14, 1996, Johns Hopkins, Baltimore, MD, p. 162.
2. S.R. White and R.G. Albers, "Magnetostrictive Tagging of Composite Materials for Structural Health Monitoring," USACERL Final Technical Report, Feb., 1996. R.
3. Quattrone, J. Berman, and S.R. White, "Self-Monitoring Structures Containing Magnetostrictive Composites," 21st Army Science Conference, Norfolk, VA, June 15-17, 1998.
4. S.R. White and F. Brouwers, "Smart Materials for Infrastructure Applications," USACERL Final Technical Report, June, 1998.
5. C. Liu, T. Tsao, Y.C. Tai, J. Leu, C.M. Ho, W.L. Tang and D.K. Miu, "Out-Of-Plane Permalloy Magnetic Actuators,"Proceedings, IEEE Workshop on Micro-Electro-Mechanical Systems, MEMS '95, the Netherlands, pp. 7-12, 1995.

KEYWORDS: sensor, structural integrity monitoring

A99-148 TITLE: Artificial Intelligence (AI) Technology for Identifying Pavement Defects From Visual Image Data

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Develop and test Artificial Intelligence (AI) algorithms capable of identifying pavement distresses and severity levels from digital image data as per the Micro PAVER manual.

DESCRIPTION: Infrastructure management, especially in the area of pavements, is gaining higher priority in an area of sustainable systems. Manual pavement surveying techniques are often prohibitive in terms of time and cost. The ability to quickly gather and analyze pavement inspection data would enormously reduce the costs of pavement surveys. The use of video technology is becoming accepted for use in pavement distress inspection. Video inspection data, in the form of 35mm film, can be transformed into digital image data. The digital image data is the basis for distress identification algorithms. The U.S. Army Construction Engineering Research Laboratories (CERL) has conducted a limited amount of research in which AI algorithms have been developed for identifying cracks in asphalt pavements. First, the image is converted into a photographic negative. The algorithms manipulate the image format to separate the crack footprint from the general image. Pixels are evaluated based on a number from 0-255, representing 256 shades of gray. The pixels in the image are adjusted based on three types of algorithms: point processes, area processes, and geometric processes. Point processes scan the image and use the pixel value at each point to compute a new value at that point. The area process uses information from neighboring pixels to modify pixel values or assert the existence of some property of the neighborhood. A geometric process changes the arrangement of the pixels. The patterns of pixel values in the filtered image can be identified as objects representing crack types. The distress information is automatically catalogued and entered into a database compatible with the Micro PAVER for Windows program developed by CERL.

PHASE I: Develop and test the ability of current or state of the art algorithms to correctly identify different crack types in pavement. The algorithms should be consistent with the technology developed in the AutoPAVER program outlined in CERL Technical Report M-90/15. The algorithms will improve the current method of manipulating pixel data and identifying crack types in single or multiple frames. Expand the capabilities of the algorithms to accurately establish the severity levels and quantities of the individual cracks. Classification for image elements must be consistent with current PCI distress measures. No technical risk exists for identifying crack types, however a risk does exist with determining severity levels.

PHASE II: Develop and test algorithms capable of identifying additional surface distress types and their respective severity levels and quantities. These include, but are not limited to patching, bleeding, weathering, potholes, bumps, and depressions. Develop software that will integrate individual algorithms for the different distresses. The software will enable the algorithms to operate independently of one another to determine distress information from digital image data. However, the software will examine the type and location of the distresses, and eliminate any duplication of distress information. The software will build and manage the information database. The software must operate as both a module of the current Micro PAVER program or as a stand-alone program that can be launched from within Micro PAVER. In addition, software should be designed to enable the simple integration of analysis algorithms for other infrastructure systems.

PHASE III DUAL USE APPLICATIONS: The technology developed here can be applied to a variety of inspection-oriented management areas. The current development of an automated inspection interface and the investigation of video inspection techniques for use in Micro PAVER will complement the artificial distress identification technology. Additional infrastructure systems, such as sewers, can benefit from the developed technology. The technology is applicable to the civilian infrastructure management sector. The technology could account for a potentially significant cost saving for military installation managers, municipal infrastructure managers, while boosting the competitiveness of the U.S. civil engineering consulting industry.

OPERATIONS AND SUPPORT COST REDUCTION (OSCR): With a Plant Replacement Value of over $200 billion for Army installations, it is clearly evident that the life of current facilities needs to be extended through careful and comprehensive maintenance and repair. Engineered Management Systems (EMS), such as Micro PAVER, help achieve this goal. A controlled test of PAVER realized a cost avoidance of nearly 50%. However, manual pavement inspections are lengthy and costly, often taking several months. Video inspection technology enables several hundred lane-miles of road to be inspected in just a few days. The addition of the technology described here would reduce the analysis time of the video data from weeks to days. The true savings have not been accurately measured, but are clearly substantial.

KEYWORDS: Artificial Intelligence, Micro PAVER, automated inspection

REFERENCES: Ginsberg, Mark D., Shahin, M.Y., Walther, Jeannette A., "AutoPAVER, A Software Package for Automated Pavement Evaluation," USACERL Technical Report M-90/15, USACERL, 1990. Shahin, M.Y., Pavement Management for Airports, Roads, and Parking Lots, Chapman & Hall, New York, NY, 1994.

U.S. Army Chemical Biological Center of Excellence (CBCOE)

A99-149 TITLE: Self-contained Surface Bio-sampling Apparatus

TECHNOLOGY AREAS: Chemical/Biological Defense and Nuclear

OBJECTIVE: Design and construct a self contained surface biosampling device for swabbing surfaces and delivering bacteria, virus, and toxin in a 20 ml liquid sample.

DESCRIPTION: Biodetection systems require a liquid sample containing biothreat agent for analysis. Field deployed systems utilize large air impactors to force aerosolized bioagents into liquid phase. A need exists for a self-contained device which can be rubbed against a surface to remove deposited biologicals and transfer it to a sealed collection vial with minimal exposure of personnel during sampling. GENERAL DESCRIPTION OF THE CURRENT SITUATION: Packages of biological surface sampling sponges exist that were developed for the food industry and medical swabbing devices immersed in saline solutions are also available. Because it is necessary to swab an area of at least 1 meter square to extract enough bioagent these objects do not deliver enough fluid to precipitate effective swabbing and the stick swabs do not posses enough surface area to efficiently pick up biologicals. The current systems may also contain many parts and bags, which are difficult to handle in a hostile environment. Protective garb also makes manipulation of tiny pieces, tearing of bags, and handling of vials difficult. The construction of a device which contains a universal biological surface sampling material coupled with a sterile pre-measured liquid sample (such as a liquid filled ampule) would be the best solution for this need.

PHASE I: Design a strategy for the construction of a device capable of sampling biologicals from 1 square meter of benches, machinery, and other similar surfaces. The device should be easily opened and implemented by personnel in chem/bio protective garb. The design should enable the transfer of the maximum amount of surface biologicals into a twenty milliliter solution of buffer free of debris larger than ten microns. The final liquid sample should be transferred into a sealed collection vial for delivery to a biodetection device without exposure of soldiers. Deliverables for phase I include detailed design drawings, estimated costs, and documented studies on swab selection. Swab studies should involve testing the effectiveness of the swab material in transferring known amounts of the simulants ovalbumin, MS2, and Erwinia herbicula. Substitutions for these simulants are acceptable as long as a simulant is chosen for a toxin, a virus, and a bacterium. Accommodations should be included so that the devices can be marked and transported without contamination of personnel and adherence to chain of custody doctrines.

PHASE II: During phase II proto-types should be constructed and tested in-house. The testing should involve simulants at various known concentrations on three different surfaces. Data should analyzed by how much bioagent was removed and transferred, ease of use, and should be coupled to a corroborating biodetection scheme such as ELISA or colony plate counting. ECBC may be approached to coordinate the biodetection aspects if the SBIR facility is not capable of testing at this level. The results should be used to modify the device to correct any deficiencies discovered during the first part of phase II. Following these studies the contractor should produce a small number of units for field testing with ECBC and the technical escort units. Data will be shared with the SBIR company and used for further improvements.

PHASE III DUAL-USE APLICATIONS: Develop and commercialize this technology for application in the food industry and medical environments. There are additional commercial markets in domestic preparedness and overseas efforts in biological verification. Key words: biodetection, surface sampling, biological sampling, swab

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The need to couple biodetection assets to surface sampled objects is a pressing need. Air impactors are not readily available and may not always be the best choice for some scenarios. This field hardy, single use device will fill a vital gap in biodetection.

U.S. Army Missile Research, Development, and Engineering Center (MRDEC)

A99-150 TITLE: Novel Imaging Techniques for Compact Aerial Vehicles

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: The objective of this topic is the development and application of novel imaging sensors in space/weight critical environments such as that of a compact aerial vehicle. In addition to military uses, such technology would be applicable to many commercial uses such as law enforcement and property protection systems.

DESCRIPTION: This topic seeks innovative solutions to imaging sensors which can be carried aboard a compact, disposable aerial vehicle. Such a vehicle is a small (14"-24" wingspan), lightweight (1/2-3/4 lb. total payload), low cost, disposable (i.e. non-recoverable) vehicle capable of flying autonomously/near-autonomously for sustained durations (.5-1 hour). To preserve size, weight, cost, and power, all subsystems on the aircraft will typically perform multiple functions. The functional requirements envisioned for this imaging sensor system are: a) Vehicle navigation to a potential target area without reliance on GPS or other jammable navigation aids. b) Target search with a resolution of 6.0 line pairs or better on a tank sized (3 meter by 3 meter) target at an altitude of 300 meters. A single pass over the target area searches an area 1 km wide (i.e. field of view of approximately 120 degrees). Datalink the imagery to an operator on the ground using at most 2 megabits/second data rate. c) Perform target location to an accuracy of 80 meters CEP. d) Perform vehicle orientation (pitch, roll) (eliminates need for pitch, roll gyros). e) Perform the above operations during day and night (1/4 moon) conditions. f) Total airborne system weight of 150 grams and total power of <2 watts for all imaging system components and airborne image processing required to meet the above functional requirements. Traditional imaging sensor systems cannot meet the above requirements within the constraints of a compact aerial vehicle. This topic seeks to develop novel imaging sensors and associated novel processing algorithms/hardware achieve the above requirements.

PHASE I: The contractor shall perform a technology search for components which could be combined into a highly integrated/miniaturized imaging sensor system which meets the above functions and requirements. The search shall consider all system components such as lenses, mirrors, scanning mechanizations, image processing/compression algorithms, light sensors, etc. The contractor shall propose an implementation concept for integrating the components together into a compact aerial vehicle imaging sensor system which meets the above functions and requirements.

PHASE II: The contractor shall implement the imaging sensor design proposed in Phase I.

PHASE III DUAL-USE APPLICATIONS: Commercial applications for this technology might be found in the surveillance and law enforcement industries. The miniature, low power imaging sensor developed under this topic would provide an ideal covert imaging sensor that could operate remotely for extended periods of time.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Increased reliability brought about by this technology would fit within OSCR by reducing the number of spare parts required for system upkeep. This would also reduce maintenance costs over the system life.

KEYWORDS: Infrared, Charge Coupled Device (CCD), Imaging sensors, low light level

A99-151 TITLE: Alternative Communications for Nonline-of-sight Applications

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Wide bandwidth communication systems employing traditional RF methods are limited by multipath propagation effects and time dependent fading. The objective is to advance the state-of-the-art of a modulation scheme which spreads narrow pulses over an extremely broad bandwidth known as impulse radio. This technique is covert, jam resistant, utilizes low power, is immune to multipath effects (excellent clutter rejection), and will not interfere with or degrade the performance of another narrowband user in the electromagnetic spectrum. While the primary MRDEC application will be to transmit digital video to enable steering a teleoperated ground platform for delivery of weapons payloads, other potential application areas include missile guidance links for non line-of-sight environments (low altitude trajectories), and transmission of sensor data from autonomous platforms. Impulse radios are predicated on the ability to generate very narrow pulses with extreme precision and low jitter. However, breakthroughs in SiGe heterojunction transistors (SiGe HBTs) may lower the cost of the time delay generator to enable commercialization of impulse radios.

DESCRIPTION: Although ground robotic platforms have enormous potential for remote delivery of weapons payloads, ordnance disposal, logistics resupply and surveillance and reconnaissance, current communications to steer the vehicle are limited primarily to RF transmission of analog video over at most a few kilometers (km). Proponents of ground robotics within the Army have expressed a desire (through Operational Requirements Documents) to increase the communications range, i.e., the separation distance between the operator and the vehicle, to at least 10km, with 40km desirable. This technology would enable digital video to be transmitted to an airborne relay such as mini-UAV and downlinked to an operator at a ground station. In addition to steering the vehicle, freeze frames of the video could be annotated at the ground processing station for transmission to a rear-based tactical operations center along the tactical internet.

PHASE I: Explore the feasibility of transmitting digital video in free space (10 to 40 km) using impulse radio by examining the tradeoffs between bit error rate (BER) as a function of noise, power requirements, and modulation. Consideration must be given to how the receiver will be synchronized with the transmitter for transmission in the free-space environment. In order to address these issues, some research into digital communication theory may be included that focuses on but is not limited to synchronization aspects such as chaotic pulse encoding and appropriate analytic bit error probability expressions.

PHASE II: The deliverable prototype will be a set of digital video cameras with impulse radio transceivers mounted on the ground robotic platform, airborne relay, and operator control unit (ground processing station). The airborne relay is necessary because the impulse radio is a line-of-sight technology. Several digital video cameras will need to be multiplexed to achieve remote guidance of the ground robotic platform along with surveillance video, telemetry, and precise acquisition and tracking of the airborne relay. The Phase II effort should include a demonstration of this technology, with the SBIR contractor choosing the demonstration site. A helicopter may be used as the airborne communications node with an impulse radio transceiver mounted on it to relay the digital video signals from the ground robotic platform to the operator control unit(OCU). The separation distance between the robotic platform and the OCU will depend on test area restrictions. Note that digital video is preferred over analog video to be consistent with the vision of the future battlefield. Digital compression methods must also be utilized. This effort will directly support the MRDEC technology base program known as "Robotic Applications for Modular Payloads".

PHASE III DUAL-USE APPLICATIONS: Hand held impulse radios for voice applications have been successfully demonstrated for military use at Battle Command Battle Lab - Ft. Gordon, GA. The characteristics of impulse radios such as immunity from multipath, efficient use of the spectrum to overcome frequency management problems, low power, and extreme covertness (receivers synchronized to receive pulses generated in picosecond timeframe) are attractive to both the military and law enforcement agencies. Another military application might be the transmission of sensor data from an autonomous robotic platform to a tactical operations center for situational awareness and reconnaissance purposes. Research and development from this effort (waveforms, application specific integrated circuits) might influence developments in impulse radar such as motion-sensing radar to image through obstacles (law enforcement, firefighters) and the development of weather radar able to instantaneously image storms. The potential commercial market of the digital video system is law enforcement for surveillance.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Accurate long range target acquisition decreases maneuver time and also conserves fuel and batteries. Also, acquiring accurate battle damage assessment saves ordnance.

REFERENCES:

1. MZ Win and RA Scholtz, "On the Energy Capture of Ultrawide Bandwidth Signals in Dense Multipath Environments," IEEE Communications Letters, Vol. 2, No. 9, pp. 245-247, Sep. 1998.
2. KM Walter, B Ebersman, DA Sunderland, GD Berg, GG Freeman, RA Groves, DK Jadus, and DL Harame, "A Scaleable, Statistical SPICE Gummel-Poon Model for SiGe HBTs," IEEE Journal of Solid-State Circuits, Vol. 33, No. 9, pp. 1439-1444, Sep. 1998.
3. MZ Win and RA Scholtz, "Comparisons of Analog and Digital Impulse Radio for Wireless Multiple-Access Communications," Proc. IEEE International Conference on Communications, Montreal, Canada, pp. 91-95, June 1997.
4. D. Nguyen-Ngoc, et. al., "A 200 mm SiGe-HBT BiCMOS Technology for Mixed Signal Applications," Proc. IEEE Bipolar/BiCMOS Circuits and Technology Meeting 1995, pp. 89-92.
5. MZ Win, RA Scholtz, and LW Fullerton, "Time-Hopping SSMA Techniques for Impulse Radio with an Analog Modulated Data Carrier," Proc. IEEE Fourth International Symposium on Spread Spectrum Techniques and Applications, Sep. 1996
6. F Anderson, W Christensen, L Fullerton, and B Kortegaard, "Ultra-wideband beamforming in sparse arrays," IEE Proc.-H, Vol. 138, No. 4, Aug. 1991
7. Airborne Reconnaissance Information Technical Architecture. Defense Airborne Reconnaissance Office, Draft Version 1.0, 30 Sep. 1996, www.acq.osd.mil/daro/homepage/arita/arita.html

KEYWORDS: impulse radio, ultrawide bandwidth signals,radio frequency communications, ultrawide RF, silicon germanium heterojunction transistor, spread spectrum technology

A99-152 TITLE: 2D High-speed Bipolar Optical Modulator Array

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environments

OBJECTIVE: The Objective of this task is to investigate the utility and feasibility of encoding bipolar data in optical image processing systems. While there are devices that can meet some of the design criteria, there is none currently available that can meet the high resolution, high frame rates with bipolar modulation. A device that could meet all the required specifications would improve the speed and accuracy of image processing systems. These improvements would have applications in imagery analysis and in machine vision for quality control and manufacturing processes.

DESCRIPTION: Current optical image processing systems require a spatial light modulator (SLM) to write information onto the light. The characteristics of the SLM are a limiting factor in the system performance. A modulator with scalar bipolar modulation characteristics would allow implementation of more powerful filtering techniques; improving overall system performance. To be truly useful, a Bipolar SLM should have the following characteristics. Each sub-region or pixel should modulate the amplitude of the optical wavefront according to the following equation: t = m A exp(iq). where; A is maximum transmittance (or reflectance) of the device; 0 < A<= 1. m is the modulation factor; -1 <= m <= 1. q is the modulation phase angle; a constant. Each pixel is individually controlled by a signal, represented by m, which determines the transmission (or reflection) of that pixel. Optical active area must be greater than 80%. Modulation resolution, delta-m < 1/125. Frame rate of operation is a minimum of 4 kilohertz. Spatial resolution in each dimension must be at least 10 line pairs per millimeter. Also, the array must have acceptable uniformity of the following parameters, across all pixels: A, q, and delta-m.

PHASE I: The goal of Phase I would be to design a device to perform bipolar scalar modulation on an individual pixel basis as described above. The design should be for a two-dimensional (2D) array with 128 X 128 sub-regions or pixels. The design should also be scalable up to 1024 X 1024 sub-regions or pixels. If starting with a new design, detailed plans would be made available for review. If the design leverages off existing hardware, a small-scale demonstration would be required.

PHASE II: The goal of Phase II would be to fully demonstrate the device designed in Phase I. This would include the manufacturing and delivering of a 128 X 128 prototype device for testing and evaluation. Support hardware and software needed to operate the device would also be included in the deliverables.

PHASE III DUAL-USE APPLICATIONS: The goal of Phase III would be to demonstrate the two-dimensional high speed bipolar optical modulator array for use in machine vision and manufacturing applications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Military systems which incorporate image processing hardware serve as an aid to the soldier by reducing his workload and improving his efficiency. Not only will the improved speed and accuracy of these systems further reduces the demands on the soldier, but it would open doors to new applications which may serve him in the future.

REFERENCES: J. Kirsch, B.K. Jones, J.J. Booth, J.N. Duffey and J. A. Loudin, "Optical aided target recognition system," Materials, Devices, and Systems for Optoelectronic Processing, Bahram Javidi and John Neff, ed., Proc. Soc. Photo-Opt. Instrum. Eng. 2848, August 1996.

KEYWORDS: bipolar filters, spatial light modulator, optical signal processing, electro-optical devices

A99-153 TITLE: <u>Enhanced Scramjet Combustion</u>

TECHNOLOGY AREAS: Space Platforms

OBJECTIVE: To develop innovative models for the basic physical and thermochemical processes coupling acoustics and combustion in multi-phase, chemically reacting, supersonic flows.

DESCRIPTION: All too often the theoretical potential of airbreathing missiles - scramjets, ramjets, and ducted rockets - are not realized because of the inherent failure to fully mix fuel and oxidizer streams within the geometric limits of these vehicles. Practical designs to date for ramjets and ducted rockets have required compromises in operating conditions (e.g. air-fuel ratios far greater than stochiometric) and hardware (e.g. flame holders) which greatly increase the complexity of the vehicles while adding significantly to the performance penalties. Scramjets remain beyond the reach of practicality largely because of the extreme difficulty in mixing, reacting, and maintaining supersonic flows. One innovative and as yet unexplored technique to remedy this inherent short-coming is through acoustic resonance, i.e. to acoustically enhance multi-stream mixing and, therefore, combustion with high frequency waves. However, the design, development, and validation process for acoustic drivers to enhance mixing and combustion has a very low probability of success without a comprehensive first principles based physical and thermochemical model which can couple acoustics and combustion for multi-phase, chemically reacting flows. State-of-the-art computational fluid dynamics models for multi-phase, chemically reacting flows could serve as the foundation to build such a design tool for acoustic enhancement devices; however, significant advances must be achieved. For example, the computational fluid dynamics, that is solution of the time-dependent Navier-Stokes equations on unstructured grids, must be fully coupled with the aero-acoustics to adequately resolve the high frequency phenomena. Also, the chemistry must be turbulent, not laminar as is currently the state-of-the-art, and the turbulence/chemistry interactions must be integral to an advanced nonlinear turbulence framework with compressibility and temperature/species fluctuation capabilities. Clearly, new, innovative, and improved approaches are needed.

PHASE I: Phase I proposals must demonstrate (1) a thorough understanding of the Topic area, (2) technical comprehension of key acoustic-combustion interaction problem areas, and (3) previous computational fluid dynamics experience in modeling multi-phase, nonequilibrium gas-particle, chemically reacting flows with a computational fluid dynamics code possessing those capabilities. Technical approaches will be formulated in Phase I to address each of the key problem areas for inclusion into computational fluid dynamic models. At least one innovative, meaningful demonstration of acoustic-combustion interactions will be proposed and a flowfield solution produced with the advance computational model during Phase I to assess the potential for Phase II success.

PHASE II: The model improvements formulated in Phase I will be finalized, documented, coded, and incorporated into an existing Government computational fluid dynamics code. The improved computational fluid dynamics model will be run blind for a hypersonic scramjet test case for which detailed flowfield and body force/moment data will be available to demonstrate the advanced capabilities for analyzing and modeling acoustic-combustion interactions.

PHASE III DUAL-USE APPLICATIONS: This technology is directly applicable to advanced propulsion techniques for commercial applications such as high speed supersonic transports and single stage to orbit launch systems.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The SBIR research topic entitled "Enhanced Scramjet Combustion" is oriented toward fundamental research of basic physical phenomena with direct application to mission objectives and any association with OSCR issues will be incidental.

REFERENCES:

1. Ishiguro, T., et. al., Proceedings of the 8th NAL Symposium on Aircraft Computational Aerodynamics, 1 November 1990.
2. Kenzakowski, D.C., et. al., "Analysis of Ducted Rocket Flowfields," Proceedings of the 1996 JANNAF Combustion Subcommittee and Propulsion Systems Hazards Subcommittee Joint Meetings, Naval Post-Graduate School, Monterey, California, 4-8 November 1996.
3. Gerlinger, P., et.al., "Numerical Investigation of Hydrogen Strut Injections into Supersonic Air Flows," 34th AIAA/ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 12-15 July 1998, Paper No. AIAA-98-3424.
4. Kanda, T., "Simulation of an Airframe-Integrated Scramjet Engine," 34th AIAA/ ASME/SAE/ASEE Joint Propulsion Conference and Exhibit, 12-15 July 1998, Paper No. AIAA-98-3427.

KEYWORDS: accoustics, combustion, scramjet, ducted rocket, ramjet, computational fluid dynamics, propulsion, modeling

A99-154 TITLE: Demonstration of Steerable Array Antenna using Micro Electro Mechanical Switches (MEMS) Technology

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: MicroElectroMechanical Switches (MEMS) have recently begun to show great promise in the area of true time delay steerable array antennas. This work appears to be reaching the critical mass necessary to begin experimental development/demonstration outside the laboratory. The objective of this topic is to acquire a MEMS based beam steering system capable of controlling the true time delay array antennas currently proposed for the next generation Army air defense radars, Federal Aviation Administration (FAA) air traffic control radars, commercial weather radars, and wide bandwidth military communication systems.

DESCRIPTION: The goal of this effort shall be to design fabricate, and test a two dimensional, steerable array including the beam steering equipment. The array shall be steerable in both azimuth and elevation. The beam steering architecture shall be MEMS based, true time delay steering capable of supporting waveforms with instantaneous bandwidths of 2 GHz at an 18 GHz center frequency. The steering system shall be capable of steering from -20o to +60o in the elevation plane and from -45o to +45o in the azimuth plane without the development of real space grating lobes. The main beam of the antenna system shall be a 2o x 5o pencil beam.

PHASE I: The goal during Phase I is to create a producible design for the above described antenna. This effort will include computer modeling to predict the antenna's expected performance.

PHASE II: Phase II will have two goals. The first goal will be to fabricate the antenna designed in Phase I. The second goal will be to test the antenna on a Government antenna range.

PHASE III DUAL-USE APPLICATIONS: This technology has potential commercial and military use for all applications involving non-mechanically steerable antennas. From a military perspective, the applications for this technology in air defense radars and wide bandwidth communications systems would be quite broad. In the commercial world, FAA air traffic control radars and commercial weather radars are just two of many areas in which this technology could be applied.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: A MEMS based array antenna offers several operating and support cost reduction opportunities. The devices currently used in electronically controlled array antennas are a cost driving item. Current projections indicate the MEMS devices that will replace them will be significantly less expensive, thereby, reducing both purchase and repair costs. In addition, MEMS based array antennas will be lighter in weight than their electronic counterparts. This will result in both lower transportation costs per unit as well as increasing the number of units that can be transported per transport. Also, MEMS based systems typically require less prime power than their electronic counterparts which will reduce their basic operating cost.

REFERENCES: N. S. Barker and G. M. Rebeiz, "Distributed MEMS True-Time Delay Phase Shifters and Wideband Switches", IEEE Transactions on Microwave Theory and Techniques, April 1998.

KEYWORDS: MEMS switches, array antennas, radar, beam steering, wide bandwidth

A99-155 TITLE: An Effective Mixing Process for Gelled Propellants

TECHNOLOGY AREAS: Weapons

OBJECTIVE: Develop an innovative, variable-volume, closed-batch process for making gelled propellants. Liquids that are toxic, corrosive, and volatile are to be gelled with sub-micron particulates that may have a very low bulk-density and/or may be chemically reactive with the liquids. This novel process will include the design, fabrication, and demonstration of lab-scale, prototype mixing hardware. The process design should also be able to scale-up directly for future manufacturing. Batches will meet or exceed current Army propellant gel specifications.

DESCRIPTION: An innovative process will be developed to disperse homogeneously sub-micron solids within liquids that are toxic, corrosive, and volatile. The process must comply with all of the following mixing requirements: - any ingredient additions throughout the process must not allow exposure to the environment - the system must fully retain any volatile fuel or oxidizer components but allow pressure-relief of any reaction gases - the process must be able to handle effectively batch volumes from two to eight liters - the process and mixing vessel must accommodate solids with very low bulk densities, i.e. fumed silica - the process must not retain any kind of gas within the completed gel, including air or purge gases, reaction gases, or vaporized volatiles - the process must wet all solids and complete any gassing before gellation viscosities preclude escape of the bubbles - the mixing system must control batch temperatures between -40 and +60 EC with "1EC precision - the completed gel must be able to expel directly into an attachable receiving tank (the completed batch must not be exposed to the environment) - all processes must be suitable for volatile flammable liquids.

PHASE I: Perform processing and system analyses to determine the most effective approach for this innovative mixing process. Design the prototype system, identified in the analyses, that complies with all of the process and mixing specifications.

PHASE II: Fabricate, demonstrate, and deliver two prototype gel processing systems, for fuels and oxidizers, that will meet laboratory installation and operational specifications. Verify the functionality of the systems and their ability to make batches that will comply with all of the Army gel characterization specifications.

PHASE III DUAL-USE APPLICATIONS: Improvements in mixing technology and industrial processes are directly applicable to any commercial operation that blends or disperses solids into liquids. Some examples might be: CloroxÔ Gel, pharmaceutical processing, cosmetics, gelled toothpaste, etc. The closed-batch, environmentally safe approach required by AMCOM could also apply to various areas of sanitary processing or commercial processes involving toxic materials.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Direct savings would be recognized by reducing the number of out-of-spec gel batches for R&D testing, by reducing the processing time, and by increasing the safety of operators, facilities, and the environment. Gelled bipropellants have lower cradle-to-grave costs than traditional solid propellants. The development of an effective process to gel fuels and oxidizers will accelerate R&D capabilities in gelled bipropulsion. This will indirectly enhance the development of a single advanced missile that could replace several single-use systems currently deployed. Such a system would greatly reduce logistics and training costs. The variability and precision of bipropulsion thrust control increase kill probability and multi-mission flexibility, thereby reducing the number of missiles needed in the arsenal. The savings to the government could exceed $1B if a single missile replaces several existing systems. If multiple systems are to be retained, common hardware could be horizontally integrated into TOW, Dragon, Hellfire, and possibly Stinger missile systems.

REFERENCES:

1. Higashitani, K. In Powder Technology Handbook; Gotoh, K. et al., eds., 2nd ed., Marcel Dekker: New York, 1997; pp. 475-484.
2. McDonough, R. J. Mixing for the Process Industries; Van Nostrand Reinhold: New York, 1992; pp. 135-137.
3. Schramm, L. L., ed. Suspensions: Fundamentals and Applications in the Petroleum Industry, Advances in Chemistry Series 251; American Chemical Society: Washington D.C., 1996.
4. Perry, R. H. and D. W. Green, eds. Perry's Chemical Engineers' Handbook, 7th ed.; McGraw-Hill: New York, 1997. Shamlou, P. A. Processing of Solid-Liquid Suspensions; Butterworth-Heinemann: Boston, 1993.

KEYWORDS: mixers, dispersing equipment, particle dipersion, deflocculation, colloidal suspension, gel propellant,

A99-156 TITLE: Application of Spatial Antenna Arrays/Processing for Command, Control, and Communications with Unmanned Ground Vehicles (UGV)

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To demonstrate a capability to achieve high quality command /communications and imagery transmission with an RF data link during a non-line-of-sight scenario at ranges of up to 10 kilometers in a Unmanned Ground Vehicle (UGV) application (i.e.: ground to ground communications without relay or elevated antennas).

DESCRIPTION: The control of UGVs and UAVs is often compounded by the problem of multiple signal reception caused by multipath and signal diffraction. For UGVs this problem limits the effective range for which a UGV can be controlled. For a UAV this problem creates a safety risk in situations where the landing site is in close proximity to terrain structures (i.e. on a ship or in a field site where trees are close). A partial solution is to use multiple antennas on the vehicle, which by means of proper wavelength spacing can overcome this situation. However, this creates the reception of multiple signals, which can be both interfering as well as constructive. This creates increased noise problems and increased errors in data decoding. The purpose of this SBIR is to develop and apply signal processing algorithms and antenna arrays using the techniques of spatial antenna arrays to allow the objective control of a UGV. Current commercial efforts for cellular telephony, vehicular communications, and satellite communications are examining the problem of multiple signal reception and addressed hardware and software techniques to overcome the signal errors associated with such. These 'spatial array' or 'spatial processing' techniques are addressed chiefly for the area of narrow bandwidth signals (typically 3 kHz bandwidth), which are directly applicable to the UGV/UAV command/control problem. These processes have not been addressed for wide bandwidth imagery signals, which constitute a critical element for the UGV and UAV applications due to the need for remote driving or landing and takeoff.

PHASE I: Phase I will consist of identification of spatial processing algorithms and antenna arrays for use in the UGV application. A search of algorithms would be compiled and examined for application to the wideband imagery transmission. For UGV application, the wideband imagery requirement is for dual stream (i.e. stereo vision), real-time video to accomplish driving of the UGV. Differentiation for digital transmission processes shall be based on frequency selection, error reduction, timeliness of throughput, and adaptability as a minimum set of critical factors. An algorithm will be selected as a best approach candidate for each solution, and a study performed to estimate the performance in terms of signal error rates, projected range, and antenna array spacing. Frequency considerations should be examined based on typical UGV data links (L, S, or C bands). The results of the analysis will be used to design a system to demonstrate the effectiveness of the candidate algorithms and arrays.

PHASE II: Phase II will consist of development and demonstration of the spatial processing algorithm and antenna array selected in a real world scenario. This phase will consist of algorithm coding and building of RF hardware to model and demonstrate the algorithm's/array's effectiveness in reduction of transmission errors occurring in the transmission path, and to demonstrate improved range performance. The system developed would be evaluated for the improvement of both signal transmission and reception. The system developed should be capable of operating on a computer operating with a Windows 95 or NT operating system. Demonstration of any resultant hardware system can be arranged at Redstone Arsenal, AL on test ranges utilized for development of UGV systems. Delivery of the model shall be made to AMSAM-RD-MG-IP at Redstone Arsenal for evaluation.

PHASE III DUAL-USE APPLICATIONS: The signals transmitted for a UGV or UAV application are of two types, the first being command and status telemetry, and the second being sensor imagery. The application of the spatial array processing technology to non-military use exists in several commercial markets. These include the cellular telephone and digital broadcast (television) markets, as well as the robotic vehicles market (typically for police surveillance but also for heavy industry (transportation, energy). The application of the spatial array techniques developed under this effort will assist in providing transmission with reduced signal losses and signal noise in urban or high clutter environments where these markets are predominant. These applications include the use of point to point direct communication or network relayed communications.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The chief benefit in cost reduction by the use of this technology, for UGV applications, is in the elimination of the need for fiber optic communications for ground vehicles. The use of RF transmission for extended range (up to 10 km) for UGVs eliminates the weight, volume, and storage requirements for the fiber. Further the vulnerability and restrictions of fiber to vehicle movement are eliminated. The cost benefit for UAV type applications is the improved signals during critical flight functions (landing and takeoff) which reduce the risk of flight, and therefore of loss of hardware.

KEYWORDS: Antenna arrays, wideband coherence, spatial error correction algorithms, multiple signal reception.

REFERENCES: V. M. DaSilva and E. S. Sousa, "Fading-Resistant Modulation Using Several Transmitter Antennas", IEEE Transactions on Communications, Vol. 45, October 1997. Proceedings of the 47th Annual Vehicular Technology Conference, IEEE.

Natick Soldier Center (NSC)

A99-157 TITLE: Onsite Packaging and Food Waste Disposal (Safe Incineration)

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To demonstrate the ability to reduce packaging and food waste to nonhazardous byproducts through combustion.

DESCRIPTION: Field feeding produces tons of packaging and food wastes that must be back hauled to landfills at great expense. An onsite packaging and food waste disposal method is needed that unequivocally reduces waste to nonhazardous byproducts to reduce or eliminate this enormous logistic burden. Municipal and light industrial incineration/treatment technology shows the promise of processing wastes with a variety of approaches that are intended to meet EPA clean air standards. However, municipal wastes can include a wide range of products, and industrial wastes can include very dangerous chemicals. In addition, municipal and light industrial applications are stationary with relatively large amounts of electric power available for processing. Field feeding waste reduction is a simpler problem because it only includes a narrow spectrum of plastic, paper, and food products. However, the equipment must be robust, portable, and of minimum power. A prototype shall be designed to fit within a pallet envelope, that is capable of reducing battalion level wastes (63 cubic feet) to non hazardous products. The waste disposal system may operate with diesel fuel, but it is desired that the system use little or no electric power.

PHASE I: Establish the basic operating concept through the design and development of a proof-of-principle prototype, demonstrate operation and reliability, and provide strategies to meet all described requirements with minimal risk. Address EPA clean air act, safety, and human factors.

PHASE II: Refine the design to meet all requirements and fabricate 2 prototypes for technical and operational tests. Address manufacturability issues related to full-scale production for military and commercial utilization

PHASE III DUAL USE APPLICATIONS: This basic waste disposal technology targeted for food and packaging waste has application for outdoor events such as fairs, carnivals, and camps, as well as indoor food service such as lunch rooms, cafeterias, and all types of institutional or consolidated food service, both commercial and military.

REFERENCES: Army Food Service Operations Manual: FM 10-23, Marine Food Service Doctrine, Navy Galley Sanitation Doctrine

OPERATING AND SUPPORT COST (OSCR) REDUCTION: This topic supports Operational and Support Cost Reduction (OSCR). In addition to the cost and effort required to transport wastes, and the fees associated with municipal incinerators and landfills, there are other less quantifiable but equally important benefits to onsite disposal. Wastes can be disposed of as they are produced eliminating the mountainous piles of hazardous garbage that accumulate. These wastes are an eyesore and can blow around the site during mission exercises. The garbage piles attract vermin that can acerbate health hazards. An onsite incinerator that produces only water vapor and carbon dioxide will have global acceptance. This global acceptance will eliminate the negotiation process that occurs whenever an "outside" military force requests disposal of wastes at local facilities, subject to local discretion, and local interpretation of environmental impact and associated fees.

KEYWORDS: waste, disposal, incineration, food, packaging

A99-158 TITLE: Portable Rapid Analytical Technology for Food Safety

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: Exploit biosensor technology to provide military food inspectors with a rapid, simple, objective early detection system of microbial safety for military feeding scenarios.

DESCRIPTION: Biosensors are a special class of sensors that associate a biological component with some type of transducer to provide a mechanism for detecting changes in the biological/chemical component. Recent breakthroughs in molecular recognition, fiber optics, sensitive luminescent reagents and instruments make this a particularly promising technology to apply to food systems. The concept consist of molecular recognition compounds of biological origin (enzymes, antibodies, etc.) immobilized on a platform, and the interaction between the recognition compound and substrate is monitored by their attenuation of electrical, magnetic, optical signals, etc. This effort will lead to the fabrication of a lightweight packaged portable prototype biosensor. The device will result in fast detection of potential safety risk from pathogenic bacteria in fresh, prepared or exposed foods that are brought with the troops or obtained through host nation procurement. FDA scientists have indicated that up to 2 percent of all fresh produce, both foreign and domestic, are contaminated with disease causing organism, some discovered only in the last few years. Benefits envisioned include improvements in logistical handling of rations, improved health and performance of the soldier by preventing potential food borne type illnesses and increased rations quality/acceptability.

PHASE I: Identify a biosensor technology suitable for the detection of one of the following pathogens: Campylobacter jejuni, salmonella spp, E coli O157:H7 or Lysteria monocytogeneis. Investigate miniaturization of instrumental detection systems for design of a portable biosensor system that would sensitively detect the selected pathogen. Demonstrate potential application of this technology to food systems with emphasis placed on the need to accurately identify the pathogen from a complex mixture of interferents/competing pathogens.

PHASE II: Incorporate any design refinements indicated in Phase I to include improvements in instrument sensitivity, and develop a prototype packaged unit for field test applications selected from the biosensor system of Phase I. Prototype design should include probe/platform development for one microbiological pathogen. Demonstrate prototype in selected ration systems.

PHASE III DUAL USE APPLICATIONS: Biosensors have a wide potential application in the food industry, environmental testing, industrial processing and the military. The proposed instrument can further be adapted to the detection of any food pathogen. Recent outbreaks of food borne illnesses and disposal of potentially contaminated foods demonstrate the need for this technology and its application to the commercial food industry.

OPERATORING AND SUPPORT COST (OSCR) REDUCTION: This topic supports Operational and Support Cost Reduction (OSCR). Portable biosensors will not only ensure the safety of the military food supply but also will allow food inspectors to make rapid, objective decisions regarding the quality of prepositioned military rations for logistic distribution. This technology will allow the real-time determination of typical food deterioration processes, from early to late stages of the process, that will result in virtual decisions regarding the logistical handling of ration items. Rations will then be supplied based on actual quality and not on predetermined shelf life requirements. This will reduce logistical waste from military TISAs, as well as, reduce the cost in labor for removing uneaten rations (waste) from the field.

REFERENCES:

1. Blum, L.J., Gautier, S.M. and Coulet, P.R. 1995. Fiber-optic biosensors based on luminometric detection in Food Biosensor Analysis (Ed.), Gabrielle Wagner and George E. Guilbault. Marcel Dekker, Inc. N.Y.
2. Deshpande, S. S. 1994. Immunodiagnostics in agriculture, food, and environmental quality control. Food Technol. 48(6): 136-141.
3. Oh, S. 1993. Immunosensors for food safety. Trends Food Sci. Technol.
4. 98-103. 4. Brown, C.W., Li, Y., Seelenbinder, J.A., Pivarnik, P., Rand, A.G., Letcher, S.V., Gregory, O.J., and Platek, M.J. 1998. Immunoassays Based on Surface-Enhanced Infrared Absorption Spectroscopy. Analytical Chemistry 70:2991-2996.

KEYWORDS: Biosensor, rapid microbial test, portable instrumentation, immunosensor, food pathogens

A99-159 TITLE: High-speed/Low-cost Impermeable Seaming for Synthetic Tentage and Collective Protection Shelters

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To explore methods of seaming synthetic fabrics to produce a water and vapor proof seam suitable for high speed manufacturing of tents and collective protection structures. This will reduce the fabrication cost and increase the quality of finished tentage and Chemical/Biological resistant soft shelters that require water and or vapor proof seams.

DESCRIPTION: Military and commercial clothing, equipage and soft shelters are currently fabricated using a number of techniques, the most common of which are sewing or some type of heat sealing such as thermal, ultrasonic or Radio Frequency (RF). In some cases a combination of methods are used. Each of these techniques has both desirable and undesirable qualities. Sewing operates at high production rates, can be easily stopped and started during the seaming operation and can be visually inspected to insure a quality seam has been formed. The drawback to sewing synthetic fabric is that the hot needle creates a stitch hole that becomes a leakage point for water or vapor. Heat sealing creates a water and vapor proof seam but is substantially slower and less forgiving to starting and stopping during the seaming process. It also requires destructive testing of random end items or coupons that are created during the manufacturing process to insure a quality seam. The combination of sewing and thermal tape sealing seams eliminates some of the problems but doubles the manufacturing process since the sewn seam which is created at relatively high speeds must then be processed through a hot taping machine that operates at speeds slower than a sewing machine. One potential technology to be explored is a composite sewing thread that expands after sewing (possibly by application of heat) to fill and seal needle holes. Laser technology may also have potential as a means of creating the energy required to weld synthetic fabrics together. The application for a high speed, low cost method of seaming synthetic fabrics is extensive. Water and vapor proof seams are required for tents, tarps, truck covers, convertible car tops, shoes, boots, gloves, Chemical Biological (CB) resistant garments and shelters, packs, pouches and equipage in general as well as many other applications.

PHASE I: Determine minimum strength requirements and water and vapor resistance required for a sampling of end items. Suggest innovative methods for reducing the cost and speeding the processes associated with creating structural water/vapor proof seams. Determine the feasibility of each method and a trade-off analysis discussing all performance parameters including production rates, hydrostatic resistance, physical properties and costs. Demonstrate the effectiveness of methods by creating seams from a minimum of five different synthetic fabrics.

PHASE II: Refine the most promising concept(s) discovered in Phase I. Fabricate full-scale prototypes of several types of end items and perform performance, manufacturability and durability testing to determine overall performance.

PHASE III DUAL USE APPLICATIONS: The US imports and internally manufacturers a wide range of military and commercial products that require water/vapor proof seams. These include shoes, gloves, Hazardous Material (HazMat) suits, tents, equipage, truck covers, tarps, CB resistant shelter and clothing, pond liners, dump liners, marine products and many others.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: High speed, low cost manufacturing techniques and or equipment will reduce the initial purchase cost of tentage, equipage and collective protection equipment. Studies have shown that 20 to 30 percent of the labor involved with producing water proof or CB resistant tentage involves the seaming process. Defense Logistics Agency (DLA) bought more than 110 million dollars worth of water proof clothing and tentage in FY98. Water proofing General Purpose (GP) Medium tents after the initial deployment into Bosnia cost several million dollars in terms of providing and implementing field fixes. Reduced morale and quality of life from living in tents that leaked at the seams was an issue that reached the highest levels of the Pentagon. It is important to make synthetic fabrics work on current tentage as it is an improvement in terms of the reducing the burden of having to retreat old cotton tents with environmentally hazardous chemicals.

KEYWORDS: Seam, sewing, sealing, impermeable, clothing, tentage, chemical, biological

A99-160 TITLE: <u>Human Performance Modeling of Paratrooper Landings</u>

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Improve and apply currently available biomechanical models (e.g. JACK, ADAM, SIMM, etc.) to simulate the landing motion of a parachutist, to analyze the impact forces on the parachutist, and to develop new concepts for minimizing landing injuries.

DESCRIPTION: Statistics from the US Army Safety Center1 show that the leading cause of tactical parachuting injuries is improper parachute landing fall. Currently there is a lack of understanding of the various independent factors, such as total weight, landing velocity, body position, etc., that affect the impact forces on the lower limb, and cause ankle/knee injuries. 2-6 A proper biomechanical analysis and model of landing impact along with physiological data are needed to understand this critical process during personnel airdrop, to provide guidance on new protection design and methods, and ultimately to decrease body injuries. Two SBIRs on human dynamics modeling of walking motion are currently being supported by the U. S. Army Research Office (ARO).

PHASE I: This phase will concentrate on obtaining available physical properties of the human foot, leg, trunk, ankle joint, knee joint, and hip joint as related to analysis. A biomechanical model of the human body will be developed based on currently available models. This model will then be used to investigate the impact forces on the body as a function of landing velocity, total weight, and body position prior to impact. Based on the analytical results, guidelines for proper landing fall and new concepts for minimizing landing injuries will be developed.

PHASE II: This phase will be an experimental investigation of the landing dynamics to provide a database to check the adequacy of the computer model developed in Phase I. The computer model will be further refined to accurately predict the impact forces on the body. Proper landing fall and technique will be developed. New concepts will be developed and tested in a laboratory to show their benefits and protection.

PHASE III DUAL USE APPLICATIONS: The computer model, the generated guidelines and the protection system will be very useful for training and combat of the airborne soldiers, and design of advanced parachute systems, such as the Advanced Tactical Parachute System (ATPS), for safe personnel landing. Through proper training and external support methods, the current leading injuries caused by improper landing fall will be greatly reduced. These applications and benefits should be able to extend to the commercial market in recreational sport jumping using ram-air canopies or hang-gliders, foot injuries in sports (gymnastics, track and field, hiking, etc.), and smoke jumpers for fire fighting.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Ankle injuries account for 30%-60% of military jump-related injuries. It is anticipated that proper landing fall and effective limb support systems will significantly reduce ankle injuries. A cost benefit analysis performed by the U.S. Army Research Institute of Environmental Medicine, Natick, MA8 has shown that a 50% reduction in ankle injuries during parachute landing would result in more than 2 million dollars in savings per year.

REFERENCES:

1. "Tactical Parachuting Incidents FY1997", General Officer Airborne In-Process Review. XVIII Airborne Corps, US Army Safety Center, Ft. Rucker, AL, Sep 24, 1997, (available from Ms. Rose Scott (508) 233-4268).
2. "Parachuting injury Surveillance, Fort Bragg, North Carolina, May 1993 to December 1994", LTC S.C. Craig, and SFC J. Morgan, Military Medicine, Vol. 162, 1997, p.162.
3. "The Biomechanics of the Knee during the Parachute Landing Fall", J.M. Henerson, S.C. Hunter, and W. Jefferson, Military Medicine, Vol. 158, 1993, p 810.
4. "A Study of Some Factor influencing Military Parachute Landing Injuries", J. Pirson and E. Verbiest, Aviation, Space and Environmental Medicine, June, 1985, p564.
5. "Kinematics and Impulse Characteristics of Drop Landings from Three Heights", J.L. NcNitt-Gray, International Journal of Sport Biomechanics, Vol. 7, 1991, p.201.
6. "Lower Extremity Assistance for Parachutist (LEAP) Program: Quantification of the Biomechanics of the Parachute Landing Fall and Implications for a Device to Prevent Injuries", H.P. Crowell III et al, Army Research Laboratory Technical Report No. ARL-TR-926, Nov. 1995.
7. Referenced SBIR abstracts are available from Ms. Rose Scott at (508) 233-4268.
8. "Braced for Impact: Reducing Military Paratroopers' Ankle Sprains Using Outside the Boot Braces, " P. Amoroso, et al, Journal of Trauma: Injury, Infection, and Critical Care, Vol. 45, No. 3, P. 575, Sep. 1998.

KEYWORDS: Biochemical modeling, jumper landing impact, impact modeling parachute safety

U.S. Army Space and Missile Defense Command (SMDC)

A99-161 TITLE: Fluorine and other Extremely Hazardous Chemicals Gas-handling Equipment

TECHNOLOGY AREAS: Materials/Processes

OBJECTIVE: To create an advanced innovative fluorine and/or other extremely hazardous chemical gas handling equipment for use with military HF/DF chemical lasers and/or other industrial hazardous chemical handling applications.

DESCRIPTION: We at the High Energy Laser Systems Test Facility (HELSTF) operate very high power HF/DF chemical lasers for the U.S. Army. These laser operations involve the combustion of many pounds of extremely reactive and toxic gaseous Fluorine and Nitrogen Trifluoride. Fluorine gas handling is one of the primary safety concerns at the HELSTF. The focus for this topic is innovative new approaches to Fluorine gas handling. Current Fluorine gas handling is accomplished using K-bottle, material, and valve designs dating from the uses of chlorine early in this century. Specific possible innovations include the optimization of materials (material cost and machining costs vs. compatibility with Fluorine), valve designs, coupling designs, regulator designs, pipe fitting designs, fluorine pump designs, storage container designs, high sensitivity sensors, electrolysis systems designs and innovative designs for trapping systems that are made to consume excess fluorine. Fundamental chemical, material science, and engineering understanding of issues such as reliability, safety, mean time between failure, ease of use, ppm to ppb exposure levels, and risk management are the explicit keys to success in this topic area.

PHASE I: Proposers should plan on early experimentation to demonstrate proof of principle for their innovative ideas. A detailed effort to further identify the usefulness of the proposed equipment for the broader classes of high power lasers and for uses in similarly dangerous hardware applications in military/commercial/industrial settings will be required. Detailed design for a Phase II hardware product demonstrations is also required. The ability to attract Phase III commercial partners for funding is highly regarded.

PHASE II: Second Phase efforts will include hardware fabrication, and demonstration at HELSTF using the Army LDD and MIRACL lasers. Army contractor personnel will be necessarily involved in any actual modifications to fluorine systems. Publication of results at all phases is encouraged to attract follow-on interest. Success in Phase II may lead to a follow-on effort completely upgrading the MIRACL (Megawatt class) laser fluorine gas handling sub-systems.

POTENTIAL COMMERCIAL MARKET: The market for advanced hazardous gas handling equipment may be very large because it could lead to the creation of new industrial applications for chemicals now rightly viewed as too dangerous to routinely handle. By inventing and developing new hazardous chemical equipment/components new material synthesis can be opened up therefore leading to an industrial demand for the equipment itself.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Improved hazardous gas handling will lower operating and support costs. Improvements will improve safety, lower storage costs and make operations more reliable.

REFERENCES:

1. "Fluorine Systems Handbook, Section VI, Dynamic Compatibility of Fluorine with Metals", R.E. Anderson, AFRPL-TR-72-119, October, 1972.
2. "Handling and Use of Fluorine and Fluorine-Oxygen Mixtures in Rocket Systems", H. Schmidt, NASA SP-3037, 1967.

KEYWORDS: chemical handling equipment, flourine compatible materials, advanced flourine gas handling, HF/DF chemical lasers

U.S. Army Simulation, Training, and Instrumentation Command (STRICOM)

A99-162 TITLE: Robust, Low-cost Target System Data Link

TECHNOLOGY AREAS: Sensors, Electronics, and Battlespace Environment

OBJECTIVE: Develop and demonstrate a low cost target system data link using an innovative implementation of commercial technology to transmit data between target control stations and ground and air targets. The system may apply emerging commercial telecommunications data link capabilities to allow the elimination of unique, dedicated target control systems for existing and future targets.

DESCRIPTION: Current and projected military target systems employ a control station to allow control inputs from operators and receive data from targets, a dedicated data link, and a transceiver in the target to receive control inputs and transmit data. Current target systems employ relatively low data rates of approximately four Kilobits/second. Continuous connectivity between the target and the control station is essential to insure safe operation of the target. Range configurations and training/test scenarios often require operation of targets when direct line of sight between the target and the operator are not possible. Technical advances like the low earth orbit satellite based commercial telecommunications are beginning to provide reliable worldwide linkages between users. While each system uses different telecommunications techniques, all are focused on reliable, high volume, and low cost applications. The goal of this research will be to develop a capability to provide a continuous data link between a target control station and a maneuvering target vehicle. If sufficient reliability can be demonstrated using a commercial telecommunications data link for target system control, the dedicated data link could be eliminated from current and future target systems.

PHASE I: Analyze a sample of existing target-control station data link requirements and develop a method to provide a continuous, economical data link which is not impeded by data transmission latency or transmission routing shifts inherent in commercial telecommunications networks.

PHASE II: Build a prototype of the target control data link system established in the Phase I effort and demonstrate its capability to provide continuous control of a target using commercial telecommunications circuits. The demonstration area, target, and personnel to support target operation will be provided by the Government to support the prototype demonstration. The effort will provide a detailed analysis of the demonstrated technical capabilities of the prototype and its ability to meet this operational requirement.

PHASE III DUAL USE APPLICATIONS: This technology implementation could have impact for commercial area security systems, and has potential for operations in natural disaster team support. If telecommunication networks, demonstrating the more complex functions required to control a maneuvering target system over telephone circuits could facilitate the investigation of more complex, positive control, applications of these communication networks. OPERATING AND SUPPORT COST REDUCTION (OSCR): If this research can be effectively used to provide target control data link connectivity, military unique receivers and transmitters currently in use could be replaced with commercial equipment reducing the organic maintenance and spare part cost associated with these items.

REFERENCES: Additional information on the Targets Management Office (TMO) and some of the target systems they employ can be found at the Project Manager for Instrumentation, Targets & Threat Simulators world wide web page at "http:www.stricom.army.mil/STRICOM/PMITTS".

KEYWORDS: telecommunications systems, low earth orbit satellite communications system, data link system, positive control network system

A99-163 TITLE: Software Tools for Visualization of Terrain Databases

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: To develop and demonstrate tools, processes, and standards for rapid prototyping, dissemination, and collaborative visualization of terrain databases.

DESCRIPTION: Disparate applications of modeling and simulation frequently require that teams of individuals, separated by long distances, collaboratively visualize terrain databases. Generally, these individuals will have different computer platforms, a range of download capabilities, and different display and navigation devices. These disparities can make it very difficult for each viewer to exchange meaningful information about the terrain. This topic addresses processes and software tools for collaborative visualization of terrain databases. Target applications for this development include as a minimum: 1) subject matter experts, at diverse locations, collaborating in the development of a geospecific terrain database for simulation, 2) members of a task force responsible for collaborative mission planning, 3) collaborative mission rehearsal, and 4) distance learning.

PHASE I: Develop and demonstrate a process and prototype tool set for converting terrain databases in the Synthetic Environment Data Representation & Interchange Specification (SEDRIS) standard transmittal format for dissemination over the Internet. This process and tool set shall address key issues of collaborative visualization: compression (with no loss or minimal loss of information) to reduce download times and storage, enforcement of similar appearance on diverse platforms, and scalability of content.

PHASE II: Develop software that automates the process of planning, formatting, and compressing terrain databases for collaborative, Internet-based viewing. Develop downloadable navigation aids that allow multiple viewers to accurately identify points of interest, paths, etc.

PHASE III DUAL USE APPLICATIONS: Internet gaming, distance learning for K-12 and university students as well life-long learners, and emergency management.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Terrain Database development for M&S applications currently costs from $1M to $5M depending on the complexity of the simulation and size of the terrain database. Software tools to support database development and evaluation could significantly reduce database development costs.

REFERENCES: www.sedris.org

KEYWORDS: terrain databases, simulation, SEDRIS, software tools

A99-164 TITLE: Multi-resolution Modeling

TECHNOLOGY AREAS: Information Systems Technology

OBJECTIVE: Develop the technology for using one simulation model set in multiple applications. One option is to maintain a consistent set of interface objects (i.e., entity location and state) that are fed by one branch of an underlying model set tree. The underlying models would consist of two or more models with different resolutions (i.e., an platform level movement model and an aggregrated movement model with a set of formation templates). The active model being used during simulation execution could be switched within the model set without requiring additional software to be loaded or the exercise to be paused.

DESCRIPTION: The Advanced Concepts and Requirements (ACR) will use OneSAF for analysis, the Research, Development and Acquisition (RDA), and the Training, Exercises and Military Operations (TEMO) for battalion and below training and mission rehearsal. Even though these uses have somewhat different requirements (i.e., real time vs fast as possible, after action review vs data analysis, Y), the Army's desire is to use the same model set to support these different uses. The Army currently has many different models and simulations, each with their own specific purpose. The simulations operate on different platforms, with different operating systems and different simulation infrastructures. The Army's desire is to develop future models and simulations that will be usable for many different applications. For example, the Warfighter's Simulation 2000 (WARSIM 2000) is currently under development as a replacement for the Corps Battle Simulation (CBS), the Tactical Simulation (TACSIM) and the Combat Service Support Training Simulation System (CSSTSS). The primary use for WARSIM 2000 will be to train the commanders and staffs of battalion through echelon above corps units. In this role, WARSIM will provide a detailed simulation of the combat activities with less detail in the combat service support representation. However, in its role as the driver for Combat Service Support training, the WARSIM system will need to switch its processing focus to more detailed modeling of the logistical representation and less detail in the representation of combat activities. Similarly, WARSIM will need to support an intelligence-focused exercise as the replacement for TACSIM. The Army's desire is to use one model set that supports all of these applications.

PHASE I: The Phase I effort should focus on investigation of current research efforts of methodologies for developing multi-resolution models and an analysis of which are appropriate for Army simulation systems. The product of the Phase I effort should be a technical report.

PHASE II: The Phase II effort focus on development of a prototype model using the results from Phase I. The products of the phase II effort should include; a report describing the contractor's choice of an area to model, a conceptual model of the area chosen, object oriented software models (both static and dynamic models from an established object oriented methodology of the contractor's choice), and an operating implementation of the model set. The implementation model can be demonstrated in either a contractor provided testbed or a freely available simulation framework (such as OSim or SPEEDES).

PHASE III DUAL USE APPLICATIONS: Successful completion of this effort will put the offering contractor in an position to either develop or participate in the development of commercial simulation systems. Potential commercial application areas include video games (i.e, PC games, TV based game systems, etc.), virtual reality rides, and non-military training systems (such as truck driver trainers).

OPERATING AND SUPPORT COST (OSCR) REDUCTION: Successful development of multi-resolution models would reduce the Army's overall simulation operating costs by; reducing the software that needs to be developed (and supported), reducing the number of hardware platforms that need to be supported, and increasing the application areas for simulation systems under development.

REFERENCES:

Text book: Gamma, Erich, Richard Helm, Ralph Johnson, John Vlisides. Design Patterns - Elements of Reusable Software. Addison-Wesley, Reading, MA, 1995. (ISBN #:0-201-63361-2)

World Wide Web sites: US Army Simulation Training & Instrumentation Command (http://www.stricom.army.mil)

WARSIM (http://www.stricom.army.mil/PRODUCTS/WARSIM/)

US Army National Simulation Center WARSIM Directorate - (http://www-leav.army.mil/nsc/warsim/index.htm)

OneSAF - (http://www-leav.army.mil/nsc/stow/saf/onesaf/index.htm)

KEYWORDS: multi-resolution modeling, simulation systems, conceptual modeling, object oriented software development

U.S. Army Tank, Automotive, and Armament Research Development and Engineering Center (TARDEC)

A99-165 TITLE: Unique Hardkill Active Protection Countermeasures Mechanisms

TECHNOLOGY AREAS: Ground and Sea Vehicles

OBJECTIVE: In support of our future Defense Technology Objective (DTO) and Science Technology Objective (STO) efforts, the objective this SBIR is innovative research to devise, develop and test/demo close-in sense and detection concepts/technology for use in triggering active protection (AP) defeat mechanism countermeasures (CM) that can physically disrupt and defeat large caliber anti-tank threats while they are in flight. This effort shall investigate close-in detection electronics, with adaptive response methods, that will trigger an AP countermeasure to defeat the threat projectile. This combined close-in AP-Sensor/CM system should be potentially effective against all classes of large caliber threats, including large caliber kinetic energy threat projectiles. This sensor/CM system should use technologies that can be eventually miniaturized and packaged into a small deliverable size. Such an advanced AP-Sensor/CM system is desired for use in improving vehicle survivability.

DESCRIPTION: Currently AP systems concepts/designs use command or time detonated blast effects, fragments and high velocity/mass impact methods and mechanisms without the use of a close-in final triggering sensor. None of these approaches are very unique, innovative or very "high-tech". This SBIR effort shell research, development and use advanced electronic methods to detect the close-in presence of threat objects and help to focus and direct the defect mechanism. New innovative concepts and methods for selecting and triggering the proper response mechanism shell be investigated. This combined sensor/CM response mechanism would be useful for respond against the full range of different threat objects since it would be "smart" enough to respond differently and appropriately. Selected parts of this "smart" device will have applications to a very wide range of applications requiring quick detection and response electronics.

PHASE I: The contractor shall research advanced technologies and components required for low cost close-in sensing of threat projectiles to trigger the quick directed response defeat mechanism needed to defeat the threat. The contractor shall identify and verify the technologies available for use can eventually be miniaturized and packaged in to a small deliverable package, ideally about 4" in diameter and 6" long, and have a detection range of several meters. The contractor shall devise and design the concept development program outline. The contractor shall also identify and devise their concept for use in commercial applications.

PHASE II: The contractor shall design, assemble and test concept field testing hardware. The contractor shall test/demo their concept system against select threat devices. The contractor shall develop advanced development plans for their system. The contractor shall develop a plan for the commercial use and applications of selected and appropriate parts of the concept.

PHASE III DUAL USE APPLICATIONS: The advanced electronics and concepts that will be used for this effort will have direct applications for various police forces, airport security applications, bank facilities security. This will have applications in many military and non-military vehicles in future collision avoidance and convoying systems. The sensing and electronics components of this effort will/should have direct applications to security force applications in the form of weapons detection devices of one form or another. Even home and parking lot security systems could apply the advance electronics devices that would be used in this effort.

OPERATING AND SUPPORT COST REDUCTION (OSCR): The Army has thousands of combat vehicles and facilities on which these technologies will support and provide improved survivability and security. This effort will support the advancement of facility security equipment through out Army and anywhere else needing protection. The basic design and development will not have to be repeated every time, resulting in cost savings.

KEYWORDS: vehicle survivability, countermeasures, close-in sensing

U.S. Army Topographic Engineering Center (TEC)

A99-166 TITLE: Methods for Achieving Improved Position and Orientation Performance from Small, Low-cost Sensors

TECHNOLOGY AREAS: Ground and Sea Vehicles; Sensors, Electronics, and Battlespace Environment

OBJECTIVE: The objective is to identify emerging, small, low-cost Position/Navigation (POS/NAV) hardware whose individual performances yield moderately accurate position and orientation data but when integrated together into a system yield highly accurate information. Once the POS/NAV sensors are identified, algorithms and hardware arrangements are developed and tested.

DESCRIPTION: Today high accuracy for position and orientation determining systems equates to high cost, large size and heavy weight. New sensors with application to POS/NAV are emerging from advanced solid-state technology and from micro-electro-mechanical system (MEMS) technology. These sensors are small, lightweight and low-cost. Advancements are also being made in the techniques for integrating several stand-alone POS/NAV systems together to form robust, full time, accurate POS/NAV systems. This effort would identify currently available solid-state and MEMS sensors, which are at the stage where integrate offers the potential for improved POS/NAV performance. Using the identified characteristics of these sensors, a concept integration algorithm would be developed. Using modeling and simulation, the interaction of sensors, the type of sensors, and the integration algorithm would be used to establish the potential performance goal. The potential for a single system or the need for a family of systems which meet the Army POS/NAV requirements would also be determined. A system or a family of systems would be developed, tested and shown to potential users.

PHASE I: Identify emerging sensors which support determining position and orientation and lists their strengths and weaknesses when used to determine position and orientation. Select those sensors whose integration offers the potential for improved accuracy in determining position and orientation. Develop a proof-of-concept integration algorithm and demonstrate by modeling and simulation techniques the potential for improved performance. Establish the need for a single system or need for a family of systems to meet the Army' POS/NAV requirements.

PHASE II: Develop a hardware design for the integration of the sensors identified in Phase I. If it is determined in Phase I that a single system can not be developed, a family of systems will be developed. Improve the algorithm developed in Phase I and test with the hardware. Demonstrate by operating the system in non-integrated mode and in integrated mode that the system or systems work with high accuracy on platform or platforms for which it was designed.

PHASE III DUAL-USE APPLICATIONS: The system would have utility by the civil side of government and the commercial community. The system would be an affordable accurate navigator which would support manned or unmanned hazardous waste clean-up vehicles, navigation for the general public, navigation and location for the transportation industry and many other uses.

OPERATING AND SUPPORT COST (OSCR) REDUCTION: The reduced cost of the system, parts and potential ease of maintenance contribute to OSCR. Adding a navigation capability to Army resupply and support vehicles may reduce the transportation time and the associated man-hours. If the location of resupply and maintenance vehicles is know, redirection is possible and allows the efficient redirection of supplies, spare parts and maintainers to critical locations.

REFERENCES: (1) Future Operational Requirements for TRADOC and Battle Labs (2) Future Positioning and Navigation Technologies Study, Prof. Klaus-Peter Schwarz and Dr. Naser El-Sheimy, University of Calgary, to be published

KEYWORDS: positioning, navigation, orientation, sensors, low cost, integrated

U.S. Army Test and Evaluation Command (TECOM)

A99-167 TITLE: Marrying Commercial-off-the-shelf (COTS) and Government-off-the-shelf (GOTS) Equipment for Tracking Chemical Releases

TECHNOLOGY AREAS: Chemical/Biological Defense and Nuclear

OBJECTIVE: Augmenting the current abilities of deployed M21 Chemical Agent Automatic Alarms (M21) to perform cloud tracking and determine cloud distance using commercial-off-the-self (COTS) equipment. To do this, a new spectral manipulation approach must be developed to eliminate spectral background problems attributed to scanning.

DESCRIPTION: Currently fielded M21s are designed for passive stand-off chemical agent detection with a limited scanning range (seven positions), and no cloud tracking or range finding capabilities. Currently fielded M21s can not distinguish between a 600 x 100 m cloud at 5 km or a 300 x 50 m cloud at 2.5 km. These limitations can be corrected by merging data from multiple M21s mounted on COTS scanning stands (one M21 per stand). For example, two scanning M21s placed approximately 500 m apart (on mobile, stationary and shipboard platforms) can track, determine cloud diameter, and determine accurate distances and estimate concentrations for clouds up to 5 km away. The M21 is ideal for COTS integration, because collection of wavelength-resolved intensity data can be externally controlled using personal computer (PC) with no modification to fielded M21s for chemical agent detection. A single PC could control four scanning M21 assemblies, merge cloud mapping data from each assembly, rapidly determine agent identity, and provide the user with relevant real-time cloud threat information. The critical developmental component will be completely eliminating spectral background problems by applying a new spectral manipulation approach that will utilize the M21 interferometer as a wavelength- resolved radiometer.

PHASE I: Develop a new spectral manipulation approach needed to solve background problems associated with scanning. Build, evaluate, and refine the interface between M21s and commercial scanning stands. Evaluate data merging to produce multi-dimensional mapping.

PHASE II: Develop or integrate proper tracking and identification algorithms of which most will need to be developed. Build a deployable system and develop procedures to facilitate the rapid upgrade of currently deployed M21s.

PHASE III DUAL USE APPLICATIONS: Support anti-terrorist efforts at national and international events (Olympic games, super bowl, etc.). Track releases and supply real-time data from environmental disasters such as toxic releases from chemical plant explosions.

REFERENCES:
Grim, L., Gruber, T. C., Ditillo, J. Evaluation of Passive FTIR Algorithms, Proceedings of the Third Workshop on Stand-Off Detection for Chemical and Biological Defense, p. 251, 1994.

KEWORDS: Chemical warfare, tracking, detection, infrared, M21

NAVY
PROPOSAL SUBMISSION
INTRODUCTION

The responsibility for the implementation, administration and management of the Navy SBIR program is with the Office of Naval Research (ONR). The Navy SBIR Program Manager is Mr. Vincent D. Schaper ((703) 696-8528). The Deputy SBIR Program Manager is Mr. John Williams ((703) 696-0342). If you have any questions, problems following the submission directions, or inquiries of a general nature, contact one of the above persons. Phase I proposals must be received by **11 August 1999**. All Phase I proposals and subsequent Phase II Appendices A, B, and E must be submitted to:

Office of Naval Research

ONR 362 SBIR
800 North Quincy Street, RM 633
Arlington, VA 22217-5660

The Navy's SBIR program is a mission-oriented program, which integrates the needs and requirements of the Navy through R&D topics, which have dual-use potential. All Navy SBIR topics fall within the DOD Science and Technology areas and the Navy Science areas, listed in Table 1. Navy topics will be funded from these areas according to a priority it has established to meet its mission goals and responsibilities. Information on the Navy SBIR Program can be found at **(http://www.onr.navy.mil/sbir)**. Additional information pertaining to the Department of Navy mission can be obtained by viewing various Navy World Wide Web sites at http://www.navy.mil

UNIQUE NAVY REQUIREMENTS:

1. Navy requires Appendix A, B and E to be submitted electronically through the Navy SBIR/STTR Website. The company must print out the forms directly from the Website, sign the forms and submit them with their proposal.
2. All Phase I award winners must electronically submit Phase I summary report through the website at the end of their Phase I.
3. Phase II award winners must also submit Phase II Summary reports through this same website.
4. The Navy requires that all Phase II proposers submit Appendix A, B & E through the Navy SBIR/STTR Website and mail only the appendices to the Navy SBIR Program Office listed above.
5. The requirements and time frames for Navy Fast Track submission have been modified and are described below.
6. The Navy only accepts proposals with a base effort less than $70,000 with an option less than $30,000.

NEW IN FY 1999:

The Navy will allow firms to include with their proposals, success stories that have been submitted through the Navy SBIR/STTR Website at **(http://www.onr.navy.mil/sbir)**. A Navy Success Story is any follow-on funds that a firm has received from past Phase II Navy SBIR or STTR awards. To qualify the firm must submit these success stories no later than **23 July 1999,** through the Navy SBIR Website. The success story should then be printed and included as appendices to the proposal. These pages will not be counted towards the 25-page limit.

The success story information will be used in the evaluation of the third criteria Commercial Potential, (listed in Section 4.2 of this solicitation) which includes Companies Commercialization Report (Appendix E) and the strategy described to commercialize the technology discussed in the proposal. Commercialization is viewed as any follow-on funds, from the DOD, DOD contractors or the private sector, used to further develop the technology or from sales of a product. The Navy is very interested in companies that transition SBIR efforts directly into Navy and DOD programs and/or weapon systems. The proposing company should make reference to the attached success stories in the Commercialization Strategy section of their proposal so the evaluator knows to look for them. If a firm has never received any Navy SBIR Phase II it will not count against them, and they will be evaluated on the other evaluation criteria listed in Section 4.2 Phase I Evaluation Criteria.

Effective with the fiscal year (FY) 2000, no Navy activity will issue a Navy SBIR Phase II award to a company where the elapsed time between the completion of the Phase I award and the actual Phase II award date is eight (8) months or greater; unless the process and the award has been formally reviewed and approved by the Navy SBIR Program Office. Also, any SBIR Phase I contract that has been extended by 'no cost extensions' beyond one (1) year will be ineligible for a Navy SBIR Phase II award using SBIR funds.

The Navy has adopted a New Phase II Enhancement Plan to encourage transition of Navy SBIR funded technology to the Fleet. Since the Law (PL102-564) permits Phase III awards during Phase II work, the Navy will provide a 1 to 4 match of Phase II to Phase III funds that a company obtains from an acquisition program up to $250,000 in additional SBIR funds.

PROPOSAL SUBMISSION CHECKLIST:

SUBMIT YOUR PROPOSAL(S) WELL BEFORE THE DEADLINE.

All of the following criteria must be met or your proposal will be REJECTED.

1. You must use the electronic format described in the section <u>Electronic Submission</u> described below. The Navy will not accept any proposals that do not have electronic forms of Appendix A, B, and E. The electronic appendices submitted must match the paper copies submitted via mail/express delivery.

2. An electronic version of Company Commercialization Report (Appendix E) must be submitted with all proposals. Even if you have no Phase II or Phase III information to report.

3. Your Phase I proposed cost for the base effort can not exceed $70,000. Your Phase I Option proposed cost can not exceed $30,000. The costs for the base and option should be clearly separate and identified on Appendix A, the cost proposal and in the work plan section of the proposal.

4. Your proposal must be received on or before the deadline date. The Navy will not accept late proposals, or incomplete proposals. If you have any questions or problems with submission of your proposal allow yourself time to contact the Navy and get an answer to your question. Submit Appendices early, as computer traffic increases, computer speed slows down. <u>Do not wait until the last minute.</u>

ELECTRONIC SUBMISSION OF APPENDICES:

Submit your SBIR proposal to the Navy using the online submission. This site allows your company to come in any time (prior to the closing of the solicitation) to edit or print out your appendices. **The Navy <u>WILL NOT</u> accept any form from this book or any electronic download version except those from the Navy SBIR Website as valid proposal submission forms for the Appendix A, B and E.** <u>Proposers must use the following procedures</u>.

A. Go to <u>http://www.onr.navy.mil/sbir</u> and click on SBIR Phase I box, click on "Submission", then click on "Submit" or Edit Phase I Appendix A and B and follow instructions.

B. Fill out all the information requested. The screen format will look different then the forms in the solicitation. Once you have filled in the data, follow the instructions to electronically save/submit appendices. That is, make sure you click on the Save/Submit button, which will save your appendix to the Navy server. You will still be able to return and edit this text up to solicitation closing, at which time the Navy will close down the site. Your electronically submitted version should match the signed paper appendices submitted with your proposal.

C. After you click on the Save/Submit button, follow instructions to print out the appendices and sign them. The printed forms from the website may look different than the forms in book and the signature block may appear on the second page. The Navy requires you to include these forms with the mailed hard copy of your proposal. Do not use any other version of the signed forms.

D. Mail the signed Appendix A/B and E forms along with one original and four copies of your entire proposal (the copies should include four copies of the signed Appendix A, B and E forms) to the Navy SBIR Program Office at the above address.

ELECTRONIC SUBMISSION OF PROJECT REPORTS:

The submission of an electronic Phase I Summary Report will now be required at the end of Phase I. The Phase I Summary Report is a summary of Phase I results, includes potential applications and benefits, and should not exceed 750 words. It should require minimal work from the contractor because most of this information is required in the final report. The summary of the final report will be submitted through the Navy SBIR/STTR Website at: http://www.onr.navy.mil/sbir, click on "Submission", then click on "Submit a Phase I or II Summary Report". If your company does not have access to the Internet on your computer consult your local library or local computer service store.

The Navy is initiating this new program to help increase the awareness and implementation of SBIR funded efforts. The goal is to increase the market potential and transition of SBIR projects by increasing the visibility and ease in accessing information about SBIR projects to DOD, government and DOD industry contacts. This should facilitate the transition of these projects into follow-on efforts and bring additional revenue to the SBIR Company.

To do this the Navy is asking companies to provide information on the status and benefits of their technology developments so that this information can be put into a media that others can easily access and review. The Navy plans to redistribute this information to a wide audience using such tools as the Navy Webpage, Accomplishment Book and a new interactive Navy SBIR Website. This will help provide parties with technical challenges or those with the need to implement new technology, with a user-friendly mechanism to access and identify SBIR companies that can provide them with solutions. This information should be **non-proprietary** yet detailed enough to provide the interested transition partner with enough knowledge to understand the potential use and benefit to their program.

NAVY FAST TRACK DATES AND REQUIREMENTS:

All Fast Track Applications and required information must be sent to the Navy SBIR Program Manager at the address listed above and to the designated Contracting Officers Technical Monitor (the Technical Point of Contact (TPOC) for the contract and the appropriate Point of Contact at the end of this Introduction). The dates and information required by the Navy are the same as the dates and information required under the DOD Fast Track described in the front part of this solicitation.

ARE YOU A SUPPORT CONTRACTOR FOR A NAVY ACTIVITY ?

Do you have employees occupying space in a Navy activity? Or do you have a support contract to provide services outside of an SBIR Phase I, II or III contract award? Then you must indicate so on the Appendix A form. The Navy is concerned with potential conflict of interest and if you reply yes to either of the above you may be precluded from participation in the navy's SBIR Program.

YOUR SUBMISSION TO THE NAVY SBIR PROGRAM:

This solicitation contains a mix of topics. When preparing your proposal keep in mind that Phase I should address the feasibility of the solution to the topic. Be sure that you clearly identify the topic your proposal is addressing. The Phase I option should address the transition into the Phase II effort. The Phase II is the demonstration of the technology that was found feasible in Phase I. Only those Phase I awardees which have been invited to submit a Phase II proposal by the Navy technical point of contact (TPOC) during or at the end of a successful Phase I effort will be eligible to participate for a Phase II award (with the exception of Fast Track Phase II proposals). If you have been invited to submit a Phase II proposal to the Navy by the TPOC, obtain a copy of the Phase II instructions from the Navy SBIR Webpage or request the instructions from the Navy SBIR Program officer. Phase III efforts should also be reported to the SBIR program office noted above.

The Navy will provide potential awardees the opportunity to reduce the gap between Phases I and Phase II if they provide a $70,000 maximum feasibility Phase I proposal and a fully costed, well defined ($30,000 maximum) Phase I Option to the Phase I. **The Navy will not accept Phase I proposals in excess of $70,000 (exclusive of the Phase I option).** The technical period of performance for the Phase I should be 6 months and for the Phase I option should be 3 months. The Phase I Option should be the initiation of the next phase of the SBIR project (i.e. initial part of Phase II). The Navy will also offer a "fast track" into Phase II to those companies that successfully obtain third party cash partnership funds ("fast track" is described in Section 4.5 of this solicitation). When you submit a Phase II proposal it should consist of three elements: 1) a $600,000 maximum demonstration phase of the SBIR project (i.e. Phase II)(Phase II efforts are for two (2) years no more, no less....Phase II options are for an additional six (6) months...a waiver may be granted only from the NAVY SBIR Program Office); 2) a transition or marketing plan (formally called a "commercialization plan") describing how, to whom and at what stage you will market your technology to the government and private sector; 3) a Phase II Option ($150,000 maximum) which would be a fully costed and well defined section describing a test and evaluation plan or further R&D if the transition plan is evaluated as being successful. You must also submit your Phase II appendix A, B & E electronically to the Navy SBIR Program Office at the address above. While Phase I proposals with the option will adhere to the 25 page limit (section 3.3), Phase II proposals together with the Phase II Option will be limited to 40 pages (unless otherwise directed by the TPOC or contract). The transition plan should be in a separate document.

The Navy will evaluate and select Phase I proposals using scientific review criteria based upon technical merit and other criteria as discussed in this solicitation document. Due to limited funding, the Navy reserves the right to limit awards under any topic and only proposals considered to be of superior quality will be funded.

TABLE 1. NAVY MISSION CRITICAL SCIENCE AND TECHNOLOGY AREAS

TECHNOLOGY AREAS	SCIENCE AREAS
Aerospace Propulsion and Power	Atmospheric and Space
Aerospace Vehicles	Biology and Medicine
Battlespace Environment	Chemistry
Chemical and Biological Defense	Cognitive and Neural
Clothing, Textiles and Food	Computer Sciences
Command, Control and Communications	Electronics
Computers, Software	Environmental Science
Conventional Weapons	Manufacturing Science
Electron Devices	Materials
Electronic Warfare	Mathematics
Environmental Quality and Civil Engineering	Mechanics
Human-System Interfaces	Ocean Science
Manpower, Personnel and Training Systems	Physics
Manufacturing Technology	Terrestrial Sciences
Materials, Processes and Structures	
Medical	
Sensors	
Surface/Undersurface Vehicles/Ground Vehicles	
Modeling and Simulation	

NAVY 99.2 SBIR WORD/PHRASE INDEX

NAVY 99.2 SBIR TITLE INDEX

N99-174 TITLE: Develop Low-Weight/Low-Cost AC/DC Regulated Converter for V-22 Applications

N99-175 TITLE: Failure Detection System for Composite Joints

N99-176 TITLE: Selective Depainting and Precision Cleaning

N99-177 TITLE: Innovative Protective Coating Systems for Aircraft

N99-178 TITLE: Non-Chromated Flexible Primer

N99-179 TITLE: Innovative Thermal Barrier Technology for Exterior Aircraft Structures

N99-180 TITLE: Design Assistant and Software Tools for System Identification and Adaptive Fault-Tolerant Control

N99-181 TITLE: Weight Efficient Corrosion Resistant Composite Heat Exchangers

N99-182 TITLE: Low Cost Turbojet Engine for Expendable Target Applications

N99-183 TITLE: Motion Coupling in a Deployable Virtual Environment Trainer

N99-184 TITLE: Alternate Time Management Schemes for Use in High Level Architecture (HLA) Federate Simulation

N99-185 TITLE: Client/Server Part Task Trainer Interface

N99-186 TITLE: Shallow Water Directional Noise Measurement Sensors

N99-187 TITLE: High-Bandwidth Scene Projector Drive Electronics

N99-188 TITLE: Novel Signal Processing Algorithms to Exploit and Classify Active Sonobuoy Returns

N99-189 TITLE: Small GPS Controlled Reception Pattern Antenna for Aircraft

N99-190 TITLE: Expendable Broadband Projectors for Undersea Warfare

N99-191 TITLE: Compact Mid-Infrared Laser for IRCM

N99-192 TITLE: EO/IR Sensor Applications on Supersonic Vehicles

N99-193 TITLE: GPS Ground Plane Nulling Antenna

N99-194 TITLE: Low Cost GPS Oscillator

N99-195 TITLE: Real-Time Pattern Recognition Algorithms for High Density Commercial and Military Applications

N99-196 TITLE: Geometric Patterning of Radar Absorptive and Reflective Materials (RARM) and Selective Combining of RARM materials to Achieve Improved Electromagnetic Interference (EMI) Protection and Significantly Reduced Radar Cross Sections (RCS)

N99-197 TITLE: Handheld Remote Fuel Quality Sensor

N99-198 TITLE: Ray-tracing Tool for directly interrogating Pro-Engineer Geometry

N99-199 TITLE: Real Time Motion Capture for Virtual Reality

N99-200 TITLE: Non-Lethal Clearing Facilities of Personnel

N99-201 TITLE: Armored Vehicle Internal Noise Reduction System

N99-202 TITLE: Remote Meteorological Sensor Package

N99-203 TITLE: Fiber Optic Multi-pin Connector for Towed Arrays

N99-204 TITLE: Water Based Hydraulic System

N99-205 TITLE: Search and Rescue (SAR) Using Active Light Detections and Ranging (lidar) Technology

N99-206 TITLE: Fault Diagnostics For Waterfront Construction

N99-207 TITLE: Scriptable Human Animation Figures in an Open Environmental Framework

N99-208 TITLE: Lightweight and Inexpensive Rigid Construction Paneling Material

N99-209 TITLE: Constructed Wetland System for Treatment of Washrack Effluent

N99-210 TITLE: Carbon Composite Reinforcement For Concrete Waterfront Construction

N99-211 TITLE: Automated Electromagnetic Optimization for Advanced Antenna Design

N99-212 TITLE: SMART Damage Control Boundary Opening System

N99-213 TITLE: Non-Cooperative Moving Target Recognition Using ISAR

N99-214 TITLE: Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation

N99-215 TITLE: Pressure-Tolerant Batteries for Undersea Applications

N99-216 TITLE: Improve the Performance and Reduce the Cost of Central Components of Ocean Sampling Systems

N99-217 TITLE: Identification of Shallow Water Acoustic Environmental Parameters

N99-218 TITLE: Simulation Based Acquisition Development Environment

N99-219 TITLE: In-Situ Device for the Measurement of Gas in Shallow Sea Floor Sediments

N99-220 TITLE: Bright Ultra-cold Positron Beam Source for Chemical and Materials Analysis

N99-221 TITLE: Extended Torso Garment for Tactile Transduction

N99-222 TITLE: Self Regenerating Controller for High Power Magnetostrictive Devices

N99-223 TITLE: Mine Blast Seat Attenuation System

N99-224 TITLE: Advanced Concepts for Hull Array Beamforming Technology

N99-174 TITLE: Develop Low-Weight/Low-Cost AC/DC Regulated Converter for V-22 Applications

TECHNOLOGY AREAS: Aerospace

OBJECTIVE: Demonstrate the advantages of novel power electronic and thermal designs in cost (less than $23K), weight (less than 30 lbs.), reliability (2 time increase in mean time between failure(MTBF)) and performance improvements for AC/DC regulated converter app'ications for V-22 electrical power distribution system.

DESCRIPTION: Three regulated converters (CVs) are installed on the V-22 aircraft. The CVs convert aircraft 115/200 VAC, 360-457 Hz, 3-phase power into a regulated 28.7 +/-0.3 VDC output. The CV also control, protect and monitor the DC system which includes charging the main aircraft battery and configuring the system's seven contactors and one remote controlled circuit breaker. The CVs are rated at 200 amps DC continuous; provide up to 450 amps following a 9 kW power curve for transient overloads and fault clearing conditions; and provide up to 450 amps for auxiliary power unit (APU) starting following a minimum 6 kW power curve (and maximum of 10 KVA input during APU start). An innovative design will be required to meet the 30-lb maximum weight while achieving the stringent power quality, electromagnetic interference (EMI) and thermal requirements for an aerospace application. The power quality requirements are defined in MIL-STD-704D (30 Sep 80), titled, "Aircraft Electric Power Characteristics." The EMI requirements are defined in MIL-STD-461B (01 Apr 80) and MIL-STD-462. Their respective titles are "Electromagnetic Emission and Susceptibility Requirements for the Control of Electromagnetic Interference" and "Electromagnetic Interference Characteristics, Measurement of." Thermally, the CV should operate its components in safe operating temperatures for a high reliable and long life operation (MTBF 6,000 hrs) at altitudes from sea level to 30,000 feet and at temperature extremes from +71°C maximum to -54°C minimum. The APU start function is required only up to 17,500 feet. Innovative thermal technologies may be considered. However, the aircraft ECS system will provide cooling air. The total pressure drop through the CV should not be greater than 1.0 inches of water when furnished with its minimum air mass flow rate of 7.0 lbs./min at an inlet temperature of 55°C and at an ambient pressure of 14.7 psia. All other operating temperatures and pressures will correspondingly scale the mass flow rate. The CV efficiency should be greater than 70% at 25 amps DC output; 80% from 100 to 300 amps DC output; and 65% at 450 amps DC output. The size of the CV is not to exceed the requirements stated in the Bell Boeing Envelope Drawing 901-375-201. The procurement cost requirement of less than $23K is for a production CV that meets all V-22 military qualification requirements including shock, vibration, temperature altitude, environmental and explosive atmosphere. Specific requirements are defined in Bell Boeing Report No. 901-375-738 Revision LTR G.

PHASE I: Conduct a feasibility study that defines the design required to meet the objectives for weight, reliability, production cost and electrical performance. This study must include potential commercial applications for this converter. Simulations and/or breadboard testing of electrical and thermal solutions may be used if required for tradeoff purposes. If the goals cannot be met, the feasibility study effort must identify research areas needed to accomplish the goal in Phase II.

PHASE II: Develop, test, and operationally demonstrate the regulated CV designed under the Phase I effort. The demonstration shall demonstrate all modes of electrical operation including the CV's ability to control, protect and monitor the DC system. This also includes charging the main aircraft battery and configuring the system's contactors. Output signal loads (i.e., contactor relays and logic status) may be simulated for demonstration purposes. Performance evaluation should also include EMI testing at an accredited laboratory. The EMI tests should be CEO3 and RE02. The unit should be fabricated for demonstration purposes and is not be required to be tested for shock and vibration. The design analysis effort should address all CV military specification requirements, be provided in the engineering analysis and documented in the final report, even though the CV will not be tested to all requirements. The unit should also be thermally tested varying temperature and mass airflow rates to evaluate potential innovative thermal solutions.

PHASE III: Produce the hardware developed under Phase II and evaluate in Boeing's system level bench test. Perform qualification development and safety-of-flight qualification testing, then install and flight-test on V-22 aircraft.

COMMERCIAL POTENTIAL: The commercial airlines would benefit from a regulated power supply that has a power density (kW/lb.) 34% higher and costs less than today's V-22 converter.

REFERENCES: MIL-STD-461B MIL-STD-462 MIL-STD-704D

N99-175 TITLE: Failure Detection System for Composite Joints

TECHNOLOGY AREAS: Aerospace, Materials, Surface

OBJECTIVE: Develop a portable, non-contact digital system for detecting failure initiation and propagation, and load intensity in structural composite joints in real time.

DESCRIPTION: The total ownership cost for air vehicles, both manned and unmanned (including weapons) can be reduced if the structural components have lower weight, improved structural integrity, and lower parts count. This can be accomplished by utilizing fiber- reinforced composite bonded joints and joints with woven inserts in the design and manufacture of the structural components. Efficient and reliable design of composite bonded joints requires thorough understanding of failure (e.g. delamination, fiber breakage) mechanisms and bond strength. Composite joints can only be used if we can predict the failure initiation and propagation and load intensity in the joints in real time. Tools are needed for validating the predicted results and developing the most efficient and reliable composite joints.

For example, in highly loaded composite structures, failure may start at several places simultaneously. X-rays can provide visualization of the whole field, and can be used to locate several failure locations simultaneously. This experimental information is of great value for developing optimized composite structures. The portable, non-contact digital X-ray system can be used to design and develop efficient structural composite joints. With proper modifications and calibration, it can also be used for damage assessment, inspection, and corrosion detection on carriers, in depots, and in the field. The technology will also have potential use for the medical field, airport security, and detecting illegal drugs.

PHASE I: Perform a feasibility study for detecting (2D and 3D) failure (e.g., delamination, fiber breakage) initiation and propagation, and load intensity at failure locations in representative test specimens in real time. The specimens should be fiber-reinforced composite lap joints and joints with woven inserts. The system should be portable, have spatial resolution of the order of 15 line pairs per millimeter, contrast sensitivity of the order of 0.2%, and make no contact with the specimens. The maximum size of the specimens could be 10 inches in diameter and 6 inches thick, and the speed of scanning should be at least 1 second per scan for two dimensional scanning and 8 second per scan for three dimensional scanning.

PHASE II: Based on the feasibility study in Phase I, develop a portable system with appropriate software, and perform extensive tests on various composite lap joints and joints with woven inserts. The testing should document digitally (2D and 3D) the failure initiation and propagation and load intensity at failure locations in the specimens. The test data will be utilized to validate the failure analyses by government/industry laboratory personnel. The system should also have the capability for damage assessment and inspection on carriers, in depots, and in the field.

PHASE III: Transition the technology to the government and commercial communities for structural damage assessments, corrosion detection, and nonmetallic, polymeric and organic material identification.

COMMERCIAL POTENTIAL: The proposed system could be used for airport security, medical applications, corrosion detection in offshore pipelines, and identifying illegal drug identification.

KEYWORDS: Composites; Bonded; Joints; Woven; Inserts; Failure; Damage; Inspection; Digital

N99-176 TITLE: Selective Depainting and Precision Cleaning

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: To develop a capability for the selective depainting of Navy aircraft and to clean precision instruments and equipment.

DESCRIPTION: Recent advances in ultrasonic technology show significant promise for depainting, and cleaning critical equipment using non-hazardous materials. All of this occurs without any damage to the underlying substrate. Navy aircraft finishing systems for aluminum consist of an inorganic surface pretreatment (chromated, conforming to MIL-C-81706) followed by a series of organic coatings: primer (conforming to MIL-P-23377 or MIL-P-85582) and topcoat (conforming to MIL-PRF-85285). The surface pretreatment enhances corrosion inhibition and adhesion to the primer. The primer contains additional corrosion inhibitors and provides an adhesion layer for the topcoat. The topcoat provides chemical and weather resistance, as well as flexibility and the required optical properties. Currently, there is a need for an environmentally friendly method for the selective depainting of aircraft to remove the 10-15% of paint remaining after the use of flash jet and other technologies. Such a method has a second potential application for the precision cleaning of gyroscopes, bearings, and other components without the need for volatile solvents or hazardous chemicals.

PHASE I: Demonstrate depainting and precision cleaning in a laboratory setting. Design a system to scale up the process for rapid depainting of various types of paints on common aircraft surfaces. Estimate the speed of depainting based on results. Explore a method for precision cleaning of aircraft and crew systems equipment.

PHASE II: Build and test a prototype system and conduct full-scale tests to demonstrate the feasibility for depainting or cleaning Navy aircraft and equipment. Conduct full-scale precision cleaning tests for applications identified in Phase I.

PHASE III: Customize and implement the Phase II work for appropriate Navy aircraft and ship programs and for commercial aircraft.

COMMERCIAL POTENTIAL: An efficient, environmentally friendly method for de-painting has applications to commercial aircraft as well as to both Navy and commercial ships, engines and manufacturing equipment. Applications in cleaning include industrial, medical and commercial applications where removal of contaminates on critical surfaces or life support equipment is needed. The transition should occur rapidly after the process is validated for Navy aircraft and ships.

REFERENCES: 1. SAE MA4872 2. MIL-C-81706 3. MIL-P-23377 4. MIL-P-85582 5. MIL-PRF-85285

KEYWORDS: Environmentally Friendly; Depainting; Selective; Precision Cleaning

N99-177 TITLE: Innovative Protective Coating Systems for Aircraft

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: Find a single-component, protective coating system for use over aircraft surfaces which does not require pretreatment, a primer, and/or a topcoat. The technology shall meet the performance requirements of TT-P-2756, MIL-P-23377, MIL-P-85582, MIL-PRF-85285, and AMS 3603.

DESCRIPTION: Currently, the Navy aircraft finishing systems for aluminum consist of an inorganic surface pretreatment (chromated, conforming to MIL-C-81706) followed by a series of organic coatings: primer (conforming to MIL-P-23377 or MIL-P-85582) and topcoat (conforming to MIL-PRF-85285). The surface pretreatment enhances corrosion inhibition and adhesion to the primer. The primer contains additional corrosion inhibitors and provides an adhesion layer for the topcoat. The topcoat provides chemical and weather resistance, as well as flexibility and the required optical properties. Although this finishing system has been the premiere finishing system on aircraft for many years, it has several deficiencies. An increased awareness and concern for environmental issues as well as worker safety have caused local, state, and federal agencies to limit volatile organic compound (VOC) and hazardous air pollutant (HAP) emissions. The majority of these corrosion inhibitors found in pretreatments and primers are hexavalent chromates and have been identified as human carcinogens. VOCs have been attributed to the production of ground-level ozone and smog. The Navy wants to develop an environmentally friendly, single-component coating system.

PHASE I: Provide an initial development effort that combines nontoxic corrosion inhibitors with a binder system to produce a single-component coating for use on Navy aircraft. The coating must meet the current military and performance specifications as well as be compatible with existing materials. Additionally, the application of the proposed coating should not interfere with the logistical and operational requirements of the naval facility tasked to use the coating.

PHASE II: Refine, test, and field demonstrate the coating developed under the Phase I effort.

PHASE III: Produce the coating demonstrated in the Phase II effort. The coating will be transitioned to the Fleet through specification modifications and revisions to aircraft weapons system technical manuals. If further development and/or field-testing are require, aircraft programs funding or W2210 funds will be pursued.

COMMERCIAL POTENTIAL: A non-hazardous, single-component coating system can be used on commercial aircraft as well as non-aerospace applications for both the government and private sector, making this technology directly transferable.

REFERENCES: 1. MIL-C-81706 2. MIL-P-23377 3. MIL-P-85582 4. MIL-PRF-85285 5. TT-P-2756 6. AMS 3606

KEYWORDS: Environmentally Friendly; Coating System; Single Component; Pretreatment; Primer; Topcoat

N99-178 TITLE: Non-Chromated Flexible Primer

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: Develop a primer for aircraft applications that contains no chromated corrosion inhibitors and exhibits exceptional flexibility.

DESCRIPTION: The Navy and the Air Force currently use a flexible primer as the primary component of the corrosion-prevention finishing system on various aircraft (e.g. E-2/C-2, H-53, large cargo aircraft). This step is necessary to prevent film cracking at low temperatures (-60°F) and subsequent corrosion primarily at high-flexing components and fastener patterns. The current flexible primer contains chromated corrosion inhibitors; these compounds have been identified as carcinogens and elimination of their use has been mandated at all levels of government, especially in southern California. This is particularly crucial because most Navy rework involving high-flexing aircraft is performed at the Naval Air Depot, North Island, which is located near San Diego.

PHASE I: Provide an initial development effort that incorporates nontoxic corrosion inhibitors into a polymeric binder system to produce a sprayable, flexible coating for use on Navy aircraft. The coating must meet the current military specification as well as be compatible with existing pretreatments and topcoats. Additionally, the application of the proposed coating should not interfere with the logistical and operational requirements of the naval facility tasked to use the coating.

PHASE II: Develop, test, and field demonstrate the coating formulated under the Phase I effort.

PHASE III: Produce the coating demonstrated in the Phase II effort. The coating will be transitioned to the Fleet through specification modifications and revisions to the aircraft weapons system technical manuals. If further development and/or field-testing are required, aircraft program funding or demonstration programs funds will be pursued.

COMMERCIAL POTENTIAL: Successful coating can be used on commercial aircraft as well as on other DOD aircraft.

REFERENCES: 1. TT-P-2760 2. MIL-C-85285 3. MIL-C-81706/5541 4. TT-P-2756

KEYWORDS: Primer; Coating; Non-Toxic; Chromates; Flexible

N99-179 TITLE: Innovative Thermal Barrier Technology for Exterior Aircraft Structures

TECHNOLOGY AREAS: Aerospace, Materials

OBJECTIVE: Develop a thermal barrier technology that can easily be applied to exterior aircraft structures. The technology should prevent premature hardware failure due to localized overheating and should meet a thermal insulation requirement for target applications. The technology insulation requirement is aircraft dependent, with potential short-term thermal excursions as high as 8000F (60 seconds), and long-term exposure at 2850F (duration of flight). Depending on substrate materials, the substrate operation time could be as high as 3250F or as low as 2000F.

DESCRIPTION: During certain flight and/or ground operations on several types of aircraft, exterior structures and components are exposed to engine exhaust. These structures and components were not designed for these errant non-flight profile cyclic temperature profiles. As a result they are in need of premature repair or replacement. A thermal barrier technology composed of environmentally responsible materials with low toxicity is sought for protection from transient temperature excursions. Furthermore, a thermal barrier technology that is easy to apply and remove at both field and depot level is needed to minimize heat conduction. The developed protection system must not inhibit the use of standard depot nondestructive inspection techniques for evaluating the integrity of the underlying substrate.

PHASE I: Develop a thermal barrier protection concept that can be applied to the exterior surfaces of aircraft and withstand the dynamics of airflow during typical flight operations. Zero volatile organic compounds (VOC) emitter, non-organic hazardous air pollutant (HAPS) and single-component should be target properties of the thermal barrier protective coating. In addition, the coating should have an ambient temperature cure and storage (not mandatory). The technology's thermal conductivity properties should be defined. In addition this technology should meet VOC content limits as established by NESHAP (National Emissions Standards for Hazardous Air Pollutants) regulations. The fluid resistance, humidity resistance, adherence properties and flexibility must meet the performance requirements of AMS 3603, MIL-PRF-85285, and/or TT-P-2756. Preliminary laboratory testing will demonstrate the feasibility of this technology as thermal protection for its target application (exterior aircraft structures and components).

PHASE II: Further develop the technology to meet the objectives of the Phase I results and conduct laboratory testing to further characterize the properties of the materials. The laboratory testing will provide adhesion characteristics, thermal conductivity, hot/wet thermal cycling, nondestructive inspection characteristics, and failure mode characteristics. If possible, conduct flight testing of the material on an aircraft.

PHASE III: Production of the technology demonstrated in Phase II of this effort should be demonstrated and studied for both the military and commercial markets. If further development and/or field-testing are required, aircraft program or demonstration program funds will be pursued.

COMMERCIAL POTENTIAL: This technology can be transitioned to commercial aircraft as well as non-aerospace applications for both the government and private sectors.

REFERENCES: 1. AMS 3603 2. MIL-PRF-85285 3. TT-P-2756.

KEYWORDS: Thermal Barrier; Thermal Insulation; Aircraft Surfaces

N99-180 TITLE: <u>Design Assistant and Software Tools for System Identification and Adaptive Fault-Tolerant Control</u>

TECHNOLOGY AREAS: Aerospace, Computing, Electronics, Modeling

OBJECTIVE: : Enhance the maneuverability and survivability of aircraft under adverse conditions such as battle damage and critical system failures using on-line system identification (SI), Health Monitoring and Failure Detection and Identification (HM-FDI), and Adaptive Fault-Tolerant Control (AFTC)

DESCRIPTION: Future combat aircraft will be expected to operate outside currently achievable flight envelopes and achieve desired flying qualities in the presence of large uncertainty, severe subsystem failures, battle damage and large unanticipated disturbances. In addition, the dynamics of the aircraft under aggressive maneuvers are highly nonlinear. While some results related to aircraft HM-FDI, disturbance estimation and rejection, AFTC and structure and parameter estimation using efficient SI techniques are available in the existing literature, many of the important related problems have not been addressed. These include:
1. How to determine the sensitivity of the overall closed-loop system to different failures and disturbances?
2. How to model and parameterize different types of failures and structural damage?
3. How to relate the available redundancy to failure accommodation and disturbance compensation?
4. How to address the problem of severe single and multiple failures that cannot be handled using existing methods?
5. How to achieve fast and accurate on-line identification of aircraft flutter and rigid body modes and uncertain aircraft parameters?
6. How to effectively combine the on-line nonlinear SI techniques with HM-FDI and robust controllers to arrive at a highly efficient AFTC system for failure accommodation and flutter suppression?

In addition, a software tool is needed to aid the flight control designers in the design of HM-FDI, AFTC systems and SI techniques.

PHASE I: Design integrated HM-FDI and AFTC algorithms for an aircraft model under battle damage, sensor/actuator failure conditions, and parametric uncertainties. Demonstrate the viability of the algorithms and stability, robustness and performance of the overall closed-loop system. Test adaptive fault-tolerant controllers on an aircraft model for different critical maneuvers under failures and parametric uncertainties. Design new and unique SI techniques for fast and accurate on-line estimation of flutter and rigid body modes and uncertain aircraft parameters. Develop a conceptual solution for the HM-FDI and AFTC design toolbox.

PHASE II: Demonstrate the features of the software tool using hardware-in-the-loop simulations. Carry out further validation, including in-flight testing, of the SI, HM-FDI and AFTC software.

PHASE III: Apply tool box to solve Navy aircraft fleet problems or aircraft performance enhancement. Demonstrate this improved design through simulation and then flight test. The flight test demonstration for a high-performance aircraft will be accomplished using the research flight control computer developed for the F-18 ABCD aircraft (fleet support flight control computer (FSFCC)). Incorporate tool box into commercial software for use by automotive industry, commercial aircraft companies, biotechnology industries, etc.

COMMERCIAL POTENTIAL: The toolbox could be incorporated into commercial software for use by automotive industry, commercial aircraft companies, biotechnology industries, etc.

REFERENCES:
1. Abel, "An Analytical Technique for Predicting the Characteristics of a Flexible Wing Equipped with an Active Flutter Suppression System and Comparison with Wind Tunnel Data", NASA, Technical Paper 1367, 1979.
2. F. Ahmed-Zaid, P. Ioannou, K. Gousman and R. Rooney, "Accommodation of Failures in the F-16 Aircraft using Adaptive Control", IEEE Control Systems Magazine, Vol. 11, No. 1, pp. 73-78, January 1991.

3. M. Anderson, "Robustness Evaluation of a Flexible Aircraft Control System", Journal of Guidance, Control & Dynamics, Vol. 16, No. 3, pp. 564-571, May-June 1993.
4. S. N. Balakrishnan and V. Biega, "Adaptive-Critical-Based Neural Networks for Aircraft Optimal Control" Journal of Guidance, Control & Dynamics, Vol. 19, No. 4, pp. 893-898, July-August 1996.
5. M. Bodson and J. Groszkiewicz, "Multivariable Adaptive Algorithms for Reconfigurable Flight Control", IEEE Transactions on Control systems Technology , Vol. 5, No. 2, pp. 217-229, Mar 1997.
6. J. D. Boskovic, "A Multiple Model-Based Controller for Nonlinearly-Parametrized Plants", in Proceedings of the American Control Conference, Vol. 3, pp. 2140-2144, Albuquerque, NM, June 1997.

KEYWORDS: Adaptive Control; Health Monitoring; Failure Detection; Failure Identification; Adaptive Fault-Tolerant Control and System Identification

N99-181 TITLE: Weight Efficient Corrosion Resistant Composite Heat Exchangers

TECHNOLOGY AREAS: Materials

OBJECTIVE: Develop a weight efficient composite heat exchanger for the V-22, capable of withstanding a high temperature, corrosive environment.

DESCRIPTION: The Navy has an immediate need for an alternative to the metallic Environmental Control System (ECS) primary and secondary heat exchangers currently being utilized on the V-22. The primary and secondary heat exchangers cool high temperature air that is the power source for the ECS. These components, which are fabricated from an aluminum alloy, are similar in construction to many other aircraft ECS heat exchangers. The operational conditions for the V- 22 require that the hot side inlet on the primary heat exchanger be capable of withstanding a maximum temperature of 525 degrees F, where the mass flow is 40 lbs/min at 51 psia. The corresponding conditions at the cold side of the primary heat exchanger include a temperature of 215 degrees F and a 72 lbs/min mass flow at 14.9 psia. The existing metallic designs are weight inefficient, and may be prone to oxidation and corrosion degradation. Metallic heat exchangers utilized on other aircraft, such as the F-18, have a long history of corrosion and oxidation related problems. The unique requirement that Navy aircraft operate in a salt prone environment compounds these issues. The environment induced damage mechanisms have led to reductions in the life expectancy of the heat exchanger components, and resulted in significant fleet maintenance burdens. The end result is an increase in life-cycle costs associated with the aircraft. Advanced high-temperature composite materials such as carbon-carbon and ceramic matrix composites (CMC's) may provide the necessary solution for the life extension of these components. Carbon-carbon has been demonstrated to withstand a high-temperature environment and can be designed to exhibit a high thermal conductivity. CMC's, although typically thought of as insulators, may provide higher resistance to oxidation and a corrosive environment.

PHASE I: Demonstrate feasibility by designing, fabricating, and testing prototype composite sub elements representative of a V-22 primary or secondary heat exchanger. Provide preliminary data, which indicates the ability of the design to withstand the harsh environment. Analytically show that the proposed concept provides the required thermal performance and meets the structural requirements as well.

PHASE II: Develop the detailed design of a complete V-22 primary or secondary heat exchanger, including attachment concepts and fabrication methods. Demonstrate produceability by fabricating a full scale V-22 primary or secondary heat exchanger. Demonstrate the ability of the design to withstand the hot corrosive and oxidation environment. Evaluate the performance of the component under realistic simulated flight conditions.

PHASE III: Utilize the developed V-22 heat exchanger design and fabrication methods to transition the technology to other aircraft and other heat exchanger configurations.

COMMERCIAL POTENTIAL: Advanced composite heat exchanger components have the potential to transition to the commercial aircraft market for weight reduction and enhanced life expectancy.

KEYWORDS: Heat Exchanger; V-22; Composite Materials; Carbon-Carbon; Ceramic Matrix Composites

N99-182 TITLE: Low Cost Turbojet Engine for Expendable Target Applications

TECHNOLOGY AREAS: Aerospace

OBJECTIVE: The US Navy is interested in exploring the potential of low cost turbojets to fulfill the propulsion requirements of future aircraft target systems. Current radio controlled (RC) hobby aircraft use inexpensive turbojet engines that generate up to 40 pounds of static thrust, which is less than our envisioned future requirements.

DESCRIPTION: We are interested in either new engines using current hobby engine technology or increasing current hobby engine performance >160 pounds of maximum static thrust, or the simultaneous use of two engines generating >80 pound of static thrust each. These engines will be expected to operate in target aircraft that operate in a salt air environment. Target flights do not typically exceed 60 minutes, operate for a maximum of five flights, and use JP-5/JP-8 fuel during these flights. They should start by use of compressed air into the engine's compressor to reach a minimum self-sustaining operating RPM, and should provide maximum thrust, without degradation, over the expected life of 200 minutes. The cost goal for each target propulsion system is <$10,000.00 (in current 1998 dollars) in production runs of not less than 200-250 engines.

PHASE I: Provide an in-depth study characterizing current RC aircraft turbojet performance (thrust, fuel consumption, operating temperatures), along with a detailed design study of potential changes and improvements that meet both the performance and cost objectives listed above.

PHASE II: Execute an engine modification, or prototype production program for selected engines, utilizing the design study of Phase I. Perform sea level performance and reliability/durability testing on these engines to demonstrate minimum performance based upon Phase I projections.

PHASE III: Provide production representative engines to airframe manufacturers for low cost target program.

COMMERCIAL POTENTIAL: Success through Phase III will provide hardware that could be modified for turboshaft and turbofan applications for both civil aviation and ground applications (gen-sets, automotive, etc)

KEYWORDS: Turbojet; Target

N99-183 TITLE: Motion Coupling in a Deployable Virtual Environment Trainer

TECHNOLOGY AREAS: Human Systems, Manpower, Modeling

OBJECTIVE: Develop strategies and methods for linking real-world motion with perception in a virtual environment

DESCRIPTION: The military's vision of deployable training systems introduces a novel problem for application of virtual environments (VE) in these settings. Cybersickness, a type of motion sickness particular to immersion in a VE, is produced by discordance between the perception of motion in the VE and lack of actual motion. A deployed VE trainer would have the additional difficulty of having actual motion discordant with VE perceived motion (rather than a lack of motion). This could substantially limit the usefulness of deployed VE trainers. One possible method of combating this perceptual discordance is to include the actual real-world motion in the VE. This would require motion information from the deployed platform (such as a ship or aircraft) to be transmitted to and incorporated in the virtual environment. This could be especially useful for tasks in which the actual motion is a true part of the task (such as for a conning officer or landing signals officer).

PHASE I: Identify and develop methods and techniques to effectively couple actual motion with perceived VE motion. Hardware and software requirements will be defined and established with consideration given to potential deployment platforms (such as ships) and human performance requirements (such as lag time).

PHASE II: Implement the design requirements identified in phase I in a test bed for an identified Navy application.

PHASE III: Based on a successful Phase II effort, refine the test bed into a product suitable for commercial and military applications.

COMMERCIAL POTENTIAL: This technology would enable effective use of virtual environments on any moving platform (such as ships, aircraft, hovercraft, land transportation, etc.).

REFERENCES:
(1) Burkicohen J. Soja NN. Longridge T. "Simulator platform motion - the need revisited." International Journal of Aviation Psychology. 8(3):293-317, 1998.

(2) DiZio, P., Lackner, J.R. "Spatial orientation, adaptation and motion sickness in real and virtual environments." Presence, 1(3):319-328, 1992.
(3) Kennedy RS. Lanham DS. Drexler JM. Massey CJ. Lilienthal MG. "A comparison of cybersickness incidences, symptom profiles, measurement techniques, and suggestions for further research." Presence- Teleoperators & Virtual Environments. 6(6):638-644, 1997 Dec.
(4)Kennedy RS. Berbaum KS. Lilienthal MG. "Disorientation and postural ataxia following flight simulation." Aviation Space & Environmental Medicine. 68(1):13-17, 1997 Jan.
(5)Lackner, J.R. "Human Orientation, Adaptation, and Movement Control. In: Motion sickness," Visual Displays, and Armored Vehicle Design, National Research Council, Washington, D.C. National Academy Press, Washington, D.C., 29-50, 1989.
(6)Martin, M., Sheldon, E., Kass, S., Mead, A., Jones, S., & Breaux, R. (in press). "Using a virtual environment to elicit shiphandling knowledge." 20th Interservice/Industry Training, Simulation and Education Conference, Orlando, FL, December 1998.
(7)Money, K., Lackner, J.R., Cheung, R. "The autonomic nervous system and motion sickness." In: Vestibular Autonomic Regulation, Yates, B.J., Miller, A.D. (Eds), CRC Press, 1996.
(8)Pouliot NA. Gosselin CM. Nahon MA. "Motion simulation capabilities of three-degree-of-freedom flight simulators." Journal of Aircraft. 35(1):9-17, 1998 Jan-Feb.
(9)Schroeder JA. "Evaluation of simulation motion fidelity criteria in the vertical and directional axes." Journal of the American Helicopter Society. 41(2):44-57, 1996 Apr.

KEYWORDS: Virtual Reality; Training; Motion Simulation; Simulation; Cybersickness; Motion Sickness

N99-184 TITLE: Alternate Time Management Schemes for Use in High Level Architecture (HLA) Federate Simulation

TECHNOLOGY AREAS: Manpower

OBJECTIVE: Enabling joint force exercises to occur through the linking of military training simulators would reduce the operation and maintenance costs of the weapons systems involved by at least an assumed 20 to 30 percent. Specifically, this topic seeks to develop software architecture capable of interfacing with federated simulations to demonstrate timing and latency compliance in a jointly scripted mission scenario. The architectural model for processing simulation data transfer messages will be in accordance with the federate and object templates and HLA compliance rules. To the maximum extent feasible, the solution should be based upon the utilization of standardized components, such as the management object model (MOM), data interchange format (DIF), and data dictionary (DD), rather than customized extension solutions.

DESCRIPTION: The Navy is vigorously increasing its use of modeling and simulation to improve war fighting skills in a peacetime environment and to develop superior capable weapon systems. To this end, the DOD initiative establishing HLA simulation has directed the Services to guarantee inter-operability of federated simulation models and allow reusability based upon both common interfacing and separation of message data handling from object model functionality. Thus the system models developed can provide federated mission oriented training capability with the required fidelity to train crews in a total tactical environment. This will involve networking of joint simulations including full man-in-the-loop aircraft simulators configured for mission scenario training such as Navy: F-14; F-18; E-2; EA-6; Air Force: USN CV; F-22; F-16; USAF conventional takeoff and landing (CTOL); Marine Corps: F/A-18; AV-8B; STOVL; in joint strike scenario tactics. Present aircraft simulators do not support mission synthetic training because no provision enables the inter-operability required for networking that does not follow a common message protocol. Although distributed interactive systems (DIS) provided such a common protocol at a message broadcast rate, large bandwidth requirements often resulted in data latency. In contrast to DIS interface standards, HLA allows for a choice of interface time management schemes for message traffic between federated simulation models that may reduce bandwidth requirements. In order to implement interpretable federates with compatible message transfer which minimize delay or latency in tactical event timing, a time management scheme must be chosen which complements the data transfer requirements. HLA has a mechanism in place that is well suited for addressing this sort of thing -- MOM. In addition to the MOM, there are other standards, or standard pending mechanisms, that can be of use in this area of research. These mechanisms include DIFs and the DD under development by the Defense Management and Simulation Office (DMSO). However, many of those who have looked at event/timing management, have implemented solutions based upon their own customized federation object model (FOM) extensions. Rather than develop another customized FOM extension solution, perhaps a more desirable approach (more conducive to generic inter-operability) is to implement a solution that is based upon utilization of standardized components, such as the MOM, DIFs, and DD, to the maximum feasible extent. A study is needed of the mission training message data requirements and their impact upon message transfer rates and upon the simulation message processing architecture and data base design. Alternate message architecture and timing management must be investigated to provide the basis for selection of schemes meeting federate requirements.

PHASE I: Investigate mission federate data transfer requirements in the context of scenario events and options and the alternate message time management schemes that might meet data transfer and latency requirements. The project must investigate use of filtering schemes (using MOM or DDM). Also, Naval Air Warfare Center, Training Systems Division in-house developed software, Simulation and Modeling Object Classes/Common Interoperability Mechanism (SMOC/CIM) should be included in the Phase I review. A conceptual, message timing and processing architecture will be postulated and mapped to a software structure. It is expected that problem areas identified in the literature would be identified and documented for inclusion in the Phase II effort.

PHASE II: Implement the message timing management scheme by prototyping the architecture software and interfacing with federated simulations for demonstration of timing and latency compliance in a jointly scripted mission scenario; i.e., implement a filtering using MOM, DIFs, DD, or even DDM. The architectural model for processing simulation data transfer messages will be described in accord with the federate and object templates and HLA compliance rules. Research into how different time management schemes could be used within a single federation or how the protocols could be designed to accommodate different simulation types but merge to a single time management scheme should also be conducted.

PHASE III: A transition filtering scheme to a naval simulation would be made to include naval surface simulation, Army and Marine Corps simulated ground forces and helicopter support, and command and control simulations. Commercial transitions are anticipated to occur as well.

COMMERCIAL POTENTIAL: FOMs can be written for a wide variety of applications far beyond the military's simulated weapons platform interactions. For example, the HLA message timing management scheme could enable logisticians to assess the impact of new support models on an existing (simulated) delivery system faster than real time. Accountants may wish to test the effects of new cost models on a simulation-based acquisition process. Manufacturers designing new plants could have their assembly-line designs tested and analyzed by adding suppliers' virtual models of sub-assembly stations and robotic concepts to their virtual assembly-line prototype model. Moreover, with a standardized architectural model for processing simulation data transfer messages, it is possible that any of the models just described could be combined as needed for any number of yet-to-be identified simulated tests.

REFERENCES:

(1) Simulation Interoperability Workshop (SIW); http://www.sisostds.org/siw/98spring/rpts-papers.htm
(2) Sell, S. Ronald. 98S-SIW-049 "Federation Management: Using MOM and FOM Data to Manage the Federation"
(3) Braudaway, Wes. 98-SIW-107 "Synchronized Player Models For Embedded Training"
(4) Hopkins, Mike. 98-SIW-251 "Order of Battle Data Interchange Format and Access Tool"
(5) Dale Mace, Russell. 98F-SIW-058 "A Composite HWIL/Event Driven Federation For Mine Warfare Analysis"

KEYWORDS: High Level Architecture; Federated Simulation Models; Federation Object Model, Simulation, Modeling, DIS.

N99-185 TITLE: Client/Server Part Task Trainer Interface

TECHNOLOGY AREAS: Manpower

OBJECTIVE: Develop a client/server interface and supporting client and server software to enable a helicopter part task trainer (PTT) emulation to function in a standalone or in an internet server interactive training mode. Develop server and distributed embedded client PTT software to enable bi-directional synchronous and asynchronous data transfer over the Internet. These Internet data transfers will enable server administrative management of single or multiple remote site PTTs concurrently. This capability sequentially leads the way for aircraft representative collaborative training for military aircrews, synthetic warfare, and commercial aircraft operations.

DESCRIPTION: The Navy has fielded multiple helicopters PTTs that emulate a variety of aircrew control display units (CDUs). These CDU emulations (CDUEs) reflect unique operational flight program (OFP) functionality for specific types of aircraft. Several Navy helicopters use common CDU hardware; however, some use unique CDU hardware with a unique faceplate design and a unique OFP (e.g., AH-1W Cobra helicopter). The mission functionality in each CDU (common or not) is unique to each aircraft platform, and is representative of the implemented hardware and the resident OFP. However, the objective of each CDUE is common - to provide aircrew training using an aircraft representative man/machine interface. Current PTTs that host CDUEs are stand-alone systems under full control of the trainee. Training objectives that cannot be met with a stand-alone PTT include instructor initiated fault insertion, and interactive training operations with remote site users in a common theater of operation (collaborative training). Expanding CDUE functionality to enable server connectivity with an embedded data transfer interface is required. This distributed CDUE environment will support incremental expansion of mission training in a multi-aircraft environment.

PHASE I: Conduct in-depth analysis and provide proof of concept that a CDUE can host and support an embedded network communication application in a client/server mode transparent to the user. This interface must provide scheduled and unscheduled CDUE-to-server and server-to-CDUE data transfers in a background mode. The aircrew interface must remain aircraft representative during all modes of training operations.

PHASE II: Continue with the concept developed in Phase I and develop a prototype system. Demonstrate the operation and feasibility of using multiple CDUEs to perform collaborative mission functions (e.g., establish single-channel ground airborne radio system (SINCGARS) link between two aircraft) and server initiated fault insertion.

PHASE III: Produce PTT and server software applications that comprise an embedded client/server interactive PTT system. This interactive system will be the basis for further development and production of PTT systems for all Navy aircraft.

COMMERCIAL POTENTIAL: Avionics similar to the CDU are utilized in a variety of commercial aircraft. As the FAA approaches implementation of "Free Flight", collaborative multi-aircraft aircrew training requirements will increase as aircraft traffic management transitions from ground based controllers to aircraft avionics control. Commercial aircrew training systems will share the same cost savings advantages as DoD with the fielding of this system. Training for collaborative processes or procedures is seen to capitalize on the technology implemented in this system.

REFERENCES:
(1) AH-1W Cobra 1A Human Interface Document
(2) AH-1W Cobra 1A Functional Requirements Document
(3) AH-1W Cobra 1A System Specification.

KEYWORDS: PTT; CDU; Server Client Interface; Interactive Collaborative Training; Internet

N99-186 TITLE: Shallow Water Directional Noise Measurement Sensors

TECHNOLOGY AREAS: Battlespace, Environmental, Sensors, Modeling

OBJECTIVE: Develop and fabricate a sensor to measure the directional noise and reverberation characteristics for active systems in shallow water ocean areas.

DESCRIPTION: Active sonar detection and classification systems require detailed knowledge of the background noise and reverberation field in order to operate effectively. Knowledge of the reverberation direction and amplitude is important in selecting sonar transmitter parameters, setting receiver beamwidths and steering angles, and establishing sonar deployment geometry. Currently, only limited background noise directionality is attainable with on-board or expendable measurement sensors. Current environmental acoustic sensors only measure parameters for passive acousitc systems such as temperature versus depth and ambient noise. New technology will develop new innovative ways to measure environmental acoustic parameters applicable to both active and passive system performance such as monostatic and bistatic reverberation. Other required performance prediction parameters can be derived from this such as bottom backscatter, bottom depth, and bottom loss. These parameters are critical to the performance of active acoustic systems operating in littoral environments. An innovative approach that incorporates new technologies to affordably measure both passive and active environmental acoustic parameters using one multi-parameter device. It will also measure the directional noise and reverberation field in-situ. Emphasis should be placed on a compact, affordable automatic measurement sensor capable of being used in expendable air deployed measurement devices. It is anticipated that the sensor will require a sound source, receiving array, and processing algorithms within the device. The sensor should be capable of operating at frequencies below 1000 Hz but as a goal be capable of operating between 50 Hz and 10 kHz. The sensor must survive the shock, vibration, and temperature environments of an air deployed device, and be capable of providing both monostatic and bistatic directional measurements in water depths to 1000 ft. This sensor is intended to support performance predictions for Air ASW Tactical Acoustic Systems such as Improved Extended Echo Ranging (IEER) and Airborne Low Frequency Sonar (ALFS). A key technology would be to incorporate some type of Active Acoustic Probe Pulse using coherent or impulsive source technology (e.g. source sparkler technology may apply).

PHASE I: Develop a conceptual design for a directional noise measurement sensor that meets Navy needs. Include transducer elements, electronic interface circuitry, and processing algorithms that will implement the proposed concept. Also conduct a study to investigate the feasibility of integrating this sensor into an A-size sonobuoy configuration.

PHASE II: Develop detailed designs for the Phase I sensor design and fabricate a limited number of prototype sensors suitable for open ocean proof of concept testing. Conduct preliminary testing in a laboratory and in ocean shallow water environments and report the results of this preliminary testing to the Government.

PHASE III: The sensor, upon meeting Navy requirements, will be transitioned into the airborne sensor production program and/or into a multi-purpose environmental measurement probe program.

COMMERCIAL POTENTIAL: The directional noise sensor developed should have applicability to a variety of commercial needs as an environmental quality technology. These application would include investigations of marine mammal behavior and habitat changes due to increasing noise levels in the ocean environment. This device could also be used to monitor the level and direction of underwater noise caused by offshore oil exploration/drilling or other underwater commercial activities to assure compliance with EPA regulations.

REFERENCES: TAMDA (Tactical Acoustic Measurement and Decision Aid) Program, funded by CNO (N096) FY-99 to FY-01 and in CNO (N88) POM FY-02 to FY-07.

KEYWORDS: Active Sonar; Ocean Environment; Noise; Reverberation; Sensor; Expendables

N99-187 TITLE: High-Bandwidth Scene Projector Drive Electronics

TECHNOLOGY AREAS: Electronics, Electronic Warfare, Manpower, Sensors, Manufacturing

OBJECTIVE: Develop high-bandwidth scene projector electronics capable of providing signals to large area infrared emitter arrays (e.g., 1024x1024 pixels at rates up to 420 megabytes/sec (2 bytes per pixel)). High-bandwidth drive electronics will be incorporated into the Navy's Air Combat Effective Test and Evaluation Facility (ACETEF) for use in simulation/stimulation of integrated/installed EO/IR sensors and associated processing avionics.

DESCRIPTION: Technologies are needed to develop drive electronics to handle a throughput of approximately 420 megabytes/sec (2 bytes per pixel) to effectively evaluate current and future systems under test (SUTs). Significant innovation is required to solve the problem of data throughput. The high-bandwidth scene projector drive electronics will accommodate data processing functions at up to 420 megabytes/sec such as: (1) accept as input 16 bit pixels, (2) playback from local memory stored sequences, (3) perform 32 point linear interpolation per pixel non-uniformity correction, and (4) output scan conversion. Under this task, innovative approaches to fabricate and demonstrate high-bandwidth scene projector driver electronics will be developed. The electronics should be capable of supporting high-resolution infrared emitter arrays that perform projection at real-time rates. Cost reductions can be expected in: -More effective stress testing of IR sensor performance capability, thereby reducing the number of rescheduled open range test flights caused by sensor system malfunctions or performance deficiencies. - Providing pilot and operator training using wide field-of-view IR sensor simulations/stimulations that require high-bandwidth drive electronics. - Supporting sensor developers with the ability to test engineering and managing development (EMD) sensors under dynamic and accurate simulations/stimulations. - Providing aircrew with the ability to test the effectiveness of evasive tactics, thereby increasing safety of flight.

PHASE I: Produce a design for prototype high-bandwidth scene projector drive electronics capable of controlling government identified infrared emitter arrays (either existing or emerging technology) with emphasis on throughput, weight/volume, low noise, uniformity, and adaptability to a variety of emitter array types and formats. Design trades for optimizing throughput must also be shown.

PHASE II: Construct prototype high-bandwidth scene projector drive electronics and demonstrate control of several government furnished emitter arrays. Develop a graphical user interface (GUI) through which the user will have control of all functions of the drive electronics. The GUI must be hosted on either an NT or UNIX platform. Electrically interface the prototype electronics with existing Navy image simulation/stimulation equipment. Also conduct trade studies to validate the choice of drive electronics.

PHASE III: Transition the high-scene projector drive electronics technology to a production capable item. Expand the applicability of the drive electronics to other sensor test programs, as well as to commercial applications.

COMMERCIAL POTENTIAL: Commercial applications include associated information systems and communications areas requiring high data throughput driver electronics.

REFERENCES:

1. R.G. Lane, "Innovations in Infrared Scene Simulator Design", SPIE Proceedings, 3368, pp. 78-88, 1998.

2. R.A. Ericson, et. Al., "Unique Digital Imagery Interface Between a Silicon Graphics Computer and the Kinetic Kill Vehicle Hardware In the Loop Simulator (KHILS) Wideband Infrared Scene Projector (WISP)", SPIE Proceedings, 3368, pp. 376-381, 1998.

KEYWORDS: Infrared Projection; Stimulation; Emitters; Missile Detection and Warning; Real-Time Data; Signal Analysis; Test and Evaluation

N99-188 TITLE: Novel Signal Processing Algorithms to Exploit and Classify Active Sonobuoy Returns

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Use unique non-conventional signal processing concepts to enhance performance of future airborne Active ASW systems operating in high clutter environments.

DESCRIPTION: New ways are sought to separate "signals of interest" from "clutter". This may include making environmental measurements, developing techniques that involve the signal structure and /or clutter characteristics, or other information to make the classification. These techniques could be applied to the buoys in or proposed for the fleet's use. Our primary interest is Air Deployable Sensors. We are also looking for techniques that could aid, but not necessarily replace, the current classification techniques.

PHASE I: Define unique and innovative active signal processing concepts and classification algorithms that will exploit the signal structure and signal returns in an active (coherent and incoherent) airborne mission. The concepts must demonstrate significant if not total elimination of clutter and false alarms while enhancing the capability to detect the true signal. The concept must be low cost, simple and transportable for ease of implementation into existing and future active processing systems. The Phase I effort will identify the algorithms to be exploited, the system architecture, the techniques employed and signal exploitation. A working demonstration of the algorithm will be required.

PHASE II: Develop a redefined and fully working prototype of the algorithms and techniques defined and demonstrated under the Phase I. The prototype system will demonstrate the value added and performance attributes using real data furnished by the Government.

PHASE III: Implementation of the processing concepts and techniques in fleet ASW platform avionics (P-3, S-3, SH-60).

COMMERCIAL POTENTIAL: The system concepts and signal processing techniques developed under this task can be applied to commercial oceanography topography, bottom sediment characterization, environmental analysis and commercial sonar systems. These techniques could also be beneficial for commercial security and surveillance systems.

KEYWORDS: Anti-Submarine Warfare; Active Signal Processing; Novel Classification Algorithm Techniques

N99-189 TITLE: Small GPS Controlled Reception Pattern Antenna for Aircraft

TECHNOLOGY AREAS: Electronics, Electronic Warefare, Sensors, Modeling

OBJECTIVE: Develop and demonstrate a small controlled reception pattern antenna (CRPA) for naval aircraft applications that provides cost-effective anti-jam capabilities.

DESCRIPTION: The U.S. Navy and Marine Corps employ GPS navigation and targeting subsystems in a major fraction of current airborne weapon systems. Dependence on GPS continues to increase, making reliable and accurate GPS operation a critical requirement for successful mission accomplishment by current and future weapon systems. Battle situations are expected to present harsh environments for GPS operation, with high levels of radio frequency (RF) interference from spoofers, jammers, and other electronic warfare equipment, resulting in degraded GPS accuracy or complete loss of GPS operation. Spatial nulling by CRPA systems is very effective at countering these RF threats, and is the only reliable method for overcoming some types of threats. Conventional CRPA systems are large and expensive, and include antennas which are large, non-conformal, have high radar cross-sections (RCS), and otherwise unsuitable for current and future airborne platforms. Therefore, a need exists for a new GPS antenna system. The system should provide anti-jam capability against expected threats at an affordable price. It should be small enough for conformal installation aboard small airborne vehicles. Key technical challenges for this new antenna system include a) radiation pattern control with a small aperture area, b) electrically small broadband antenna elements, c) small and efficient nulling electronics and algorithm, and d) RCS control.

PHASE I: Trough a study of electrically small arrays for aperture size versus pattern agility versus implementation approach, design a preliminary system architecture, array configuration, and radiating element design(s). Generate measured and/or computational data of key system elements.

PHASE II: Design, fabricate, and demonstrate a proof-of-concept antenna system, including radiating elements, radome, and nulling electronics.

PHASE III: Transition this antenna technology for airborne integration, operation evaluation, and production, provided sponsorship is secured from F-18, JSF, F-14, EA-6, P-3, V-22 or other aircraft programs

COMMERCIAL POTENTIAL: This program is focused on providing the military with protection against intentional threats. Commercial users are faced with unintentional RF interference from television and radio broadcasts, PCS systems, Satcom systems, and other communication systems. Commercial GPS users also suffer performance degradation due to GPS signal multi path. The proposed new antenna will solve both of these civilian problems.

KEYWORDS: Antenna; GPS; Controlled Reception Pattern Antenna; Anti-Jam; Airborne

N99-190 TITLE: Expendable Broadband Projectors for Undersea Warfare

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop innovative hardware for producing a broadband acoustic projector that will enable anti-submarine warfare (ASW) and mine warfare (MIW) sonar systems to adapt to harsh shallow water environments.

DESCRIPTION: Active sonar systems are very much affected by the environment within which they operate. This is particularly true in shallow water, where boundary interactions tend to defocus and lessen the strength of the source and echoes. Additionally, local bathymetric features along the path of the signals can obscure the signal or cause false returns, emulating real targets. Furthermore, surface, bottom, and volume reverberations add to the background noise level and reduce signal-to-noise level dramatically. Sonar systems that have the ability to change their operating parameters to adapt to the environmental characteristics will give better performance than less capable fixed parameter systems. These parameters include source level, beam pattern, frequency and waveform shape. A design concept should be developed based on innovative projector implementations, resulting in a transducer with high power, wide band frequency coverage and complex signal waveform capability. The overall objective is to develop an innovative transducer that is adaptable over a number of parameters, has high reliability, and is low in cost. Various transducer designs should be evaluated using appropriate mathematical models. A single design will be selected for in-depth evaluation.

PHASE I: Develop a detailed design for an innovative acoustic projector, including assembly drawings, modeling of predicted performance, and cost estimates. Analyze the performance based on simulated data such as that produced by state-of-the-art models.

PHASE II: Build a prototype acoustic projector of the design developed in Phase I, demonstrate its performance compared with the model predictions. Based on the results of testing, incorporate appropriate modifications to the performance models to better predict performance. Modify the transducer design if needed to improve performance.

PHASE III: Identify potential candidate Navy systems to transition the projector developed under Phase I and II. Build an improved prototype acoustic projector aimed at a specific Navy tactical application, showing advantages in cost or performance over the existing technology used or being considered for that application. Conduct sea tests and transition technology to an ongoing Navy acquisition program.

COMMERCIAL POTENTIAL: The technology developed should have applicability to a variety of commercial needs. Commercial potential is dependent on specific problems addressed but include off-shore petroleum and mineral exploration; ocean bottom mapping; underwater obstacle avoidance; underwater inspection services including environmental assessment; non-destructive evaluation of structures, and medical imaging technology; and enhanced underwater acoustic communications, for example among divers.

KEYWORDS: Active Sonar; Transduction; Sensor; Expendables

N99-191 TITLE: Compact Mid-Infrared Laser for IRCM

TECHNOLOGY AREAS: Electronic Warfare

OBJECTIVE: Develop a low-cost, small, lightweight mid-IR laser as a source for directed IR countermeasures (DIRCM) on board tactical aircraft.

DESCRIPTION: The most advanced threat to tactical aircraft is the IR missile threat. These IR missiles have accounted for more than 80% of all of the aircraft combat losses. The advanced IR threat may only be countered in the end game with a limited number of expendable IR decoys. Off-board countermeasures require multiple IR decoys deployed in the proper combinations, for a specific threat, at precisely the correct time. Improvements to existing threats and emerging advanced threats may render existing countermeasure techniques ineffective. An airborne DIRCM solution is needed to augment existing IR expendable decoys. The Navy seeks innovative advanced technology developments in the generation and propagation of directed laser energy. Tactical aircraft DIRCM systems require a compact, high-power laser source in the mid-IR band. Current IRCM lasers are costly and exceed weight, space and power constraints of Navy tactical aircraft. Promising laser technologies that may provide a low-cost, compact solution for tactical aircraft DIRCM systems will be assessed for feasibility, prototyped, integrated into an existing system and demonstrated for suitability. The selected laser technology must efficiently generate sufficient power to effectively jam IR missile seekers at distances large enough to prevent damage to the aircraft.

PHASE I: Research appropriate technologies; conduct atmospheric propagation analyses to define optimum lasing wavelengths; establish innovative concepts/approaches; perform tradeoff analyses; and define hardware, software, safety, and integration requirements. Prepare validation test plan and document results.

PHASE II: Prototype a DIRCM laser transmitter and perform the requisite analyses to integrate it with an existing CM system. The integrated laser will be tested in the laboratory and ground tested (long-range) to demonstrate acceptable performance. Deliverables will include the prototype laser, system interface control document (ICD), test plan, test report and a technical report documenting the performance parameters of the delivered laser.

PHASE III: Upon successful completion of the Phase II effort, the DIRCM system will transition to PMA-272 for use in defensive systems being developed for tactical fixed- and rotary-wing aircraft.

COMMERCIAL POTENTIAL: The successful mid-IR countermeasure solution can be commercialized for a multiple use to provide a laser that could be used by OSHA, EPA, and the Coast Guard in monitoring effluents from waste treatment plants, power plants, and ships. The FAA has and is still performing studies to assess installations of IRCM on commercial aircraft flying into certain areas of the world. These systems may be adapted to commercial aircraft to counter the growing terrorist threat to commercial aviation. It is not likely to equip a commercial aircraft with flare decoys. A compact laser provides for flexibility as it applies to available space, weight, and power.

KEYWORDS: Infrared; Infrared Countermeasures; Laser; Integration; Tactical Aircraft; Jammer; Directed IR Countermeasures

N99-192 TITLE: EO/IR Sensor Applications on Supersonic Vehicles

TECHNOLOGY AREAS: Materials, Sensors

OBJECTIVE: Develop techniques, which permit EO/IR sensors to operate in the high temperature environment of supersonic weapons and aircraft.

DESCRIPTION: Time-on-target requirements for land-attack weapons and aircraft have established the need for faster en-route and terminal velocities, often supersonic. EO/IR sensors, which perform target acquisition and track functions for the vehicles, are required to operate in very high temperature environments. The sensor dome or window, which isolates the sensor's internal optical system from the outside environment, must withstand the high temperatures while, at the same time, transmitting the optical radiation required by the sensor to perform acquisition and track. The purpose of this SBIR is to examine techniques, which might permit EO/IR sensors to effectively operate in high temperature environments of supersonic flight. Possible approaches include conductive or convective heat sinking, heat absorption by bi-state materials, coolant air on the window, closed or open cycle cooling, heat shields, etc. Geometrically position the sensor to a lower temperature location on the flight vehicle is permitted as long as it retains a field of view in the forward direction. In order to bound the technological requirements, respondees may consider supersonic flight up to Mach 4 at altitudes up to 60,000 feet. Sensor operating time at lower altitudes can be limited to two minutes at Mach 2 following a six-minute flight at Mach 4 at 60,000 feet. Cost will be an important consideration in any proposed solution. Currently available EO/IR sensors are limited in their application to supersonic flight conditions due to unacceptable deterioration of sensitivity or resolution or both. Infrared window and lens materials lose transmission capability or generate a high background flux, which greatly reduces system sensitivity. Respondees should not address the problem of EO/IR wavefront distortion due to the supersonic shock wave since that problem is being addressed elsewhere. Increased temperatures due to the shock waves, however, should be addressed. Proposed solutions should discuss the selection of window and lens materials, electronic components, gimbals, and detector arrays. Proposed sensors may operate in the visible or infrared regions and may include active or passive sensors.

PHASE I: Investigate various approaches that will allow EO/IR sensors to effectively operate in high temperature environments of supersonic flight. Demonstrate, through modeling analysis, the most promising approaches. The results of the Phase I effort should clearly demonstrate not only the feasibility, but establish a defined approach for a phase II effort.

PHASE II: Develop, test, and demonstrate under realistic conditions the most promising sensor approaches. Tests will demonstrate the capability of critical items such as windows and lenses to operate effectively in the high temperature environments. During Phase II, commercial and military sponsors for Phase III will be sought.

PHASE III: Build prototype sensors using the techniques and components demonstrated in Phase II. Apply to military and commercial sensors used in supersonic flight.

COMMERCIAL POTENTIAL: The technology developed in the SBIR will have a wide variety of commercial applications. Examples are supersonic aircraft which will employ passive or ladar sensors to perform safety area searches; re-entry vehicles which will use infrared or visible sensors for navigation or guidance after entering the earth's atmosphere; space vehicles which operate in planetary atmospheres such as Venus or Jupiter. Cooling techniques such as heat sinks have multiple private sector applications.

REFERENCES: References will be provided to DTIC for distribution to requesting bidders.

KEYWORDS: Sensors, Supersonic, High Temperature, Bi-State, Infrared Materials

N99-193 TITLE: GPS Ground Plane Nulling Antenna

TECHNOLOGY AREAS: Electronics, Electronic Warefare, Sensors

OBJECTIVE: Develop a low-cost GPS antenna that is effective against ground-based jammers.

DESCRIPTION: The development of the GPS navigation system has generated a myriad of users including weapons, aircraft, and ships. The effectiveness of this navigation system has prompted adversaries to exploit the vulnerabilities of the GPS navigation system by the use of ground and airborne GPS jammers. Tactical weapons are expected to be subjected to low power and moderate power jammers that are located on the ground. This SBIR will address how to counter ground-based jammers without resorting to the cost, weight, or power penalties typically associated with Controlled Reception Pattern Antennas (CRPA). The low-cost antenna is expected to provide nulling of GPS jammers on the ground and reception of GPS satellite signals.

PHASE I: Define innovative antenna design concept(s) that provide a minimum of 20 dB attenuation of signals (objective 30 dB) that are less than 5 degrees above the antenna horizon. The antenna should also provide a 0 dB or greater gain more than 20 degrees above the antenna horizon. The antenna should have a design to cost goal less than $1,000, require no electronic processing or electrical power, possess stealth characteristics, and have a twenty-year shelf life. The antenna is mounted on the top of the weapon conformal to a flat surface. The new antenna design will replace an existing antenna with a three-inch aperture. More specific form factor requirements will be provided by the Government during this phase. Phase I should demonstrate the feasibility of the design through analysis or breadboard hardware. Initiate the design of a prototype antenna that can be fabricated and tested during phase II.

PHASE II: Finalize the design, fabricate, and test the selected antenna concept evolving from the phase I program. The testing should include both RF gain pattern characterization and survivability characterization. Initiate producibility studies of the design along with production planning and design to cost analysis. Fixtures to support the testing may be provided by the Government.

PHASE III: Build 10 ship sets that will be used by the government for flight test, environmental qualification, and reliability development/growth testing. Provide engineering support via corrective action redesign resulting from the above testing.

COMMERCIAL POTENTIAL: This antenna concept is applicable for any commercial application of GPS which is subjected to electromagnetic interference such as business aircraft or helicopters flying in and out of populated areas. It would be particularly useful for commercial aircraft, which might be subjected to potential terrorist threats employing low power GPS jammers around airports. The commercial market could drive the cost of the antenna below the desired $1,000 cost objective.

KEYWORDS: GPS; Antenna; Countermeasures; Weapon; Precision Attack

N99-194 TITLE: Low Cost GPS Oscillator

TECHNOLOGY AREAS: Electronics, Electronic Warfare, Sensors

OBJECTIVE: Develop a low-cost GPS oscillator that meets military GPS accuracy requirements.

DESCRIPTION: The development of the GPS navigation system has generated a myriad of users including weapons, aircraft, and ships. The GPS receivers, referred to as the user equipment, use a high quality crystal oscillator to receive and properly interpret the GPS signals from the GPS satellites. This SBIR will address the development of a temperature compensated or other low power oscillator that provides the same quality performance as today's oven controlled crystal oscillators without the size, weight, power, and cost penalties of the oven controlled oscillator.

PHASE I: Develop a crystal oscillator design concept and perform analyses to verify that the design will meet the following characteristics. The oscillator will cost less than $200 (goal less than $100), use less than two watts of power, support fast response over the standard military temperature range (rated stability within 30 seconds - goal of 3 seconds), and provide good long term stability (1 ppm over 20 yrs) and good short term stability (< 5 x 10 e -10 rt Allan variance, t = 0.1 sec - goal of < 3 x 10E-11 rt Allan variance, t = 1.0 sec). Initiate the design of an engineering prototype oscillator than can be fabricated and tested during Phase II.

PHASE II: Finalize the design. Fabricate, and test the selected crystal oscillator concept evolving from the Phase I program. The testing of the engineering prototype should include testing over the entire environment range. Initiate producibility studies of the design along with production planning and design-to-cost analysis. Provide three test articles to the Government for early engineering assessment.

PHASE III: Build 10 production representative units that will be used by the Government for flight test, environmental qualification, and reliability development/growth testing. Provide engineering support via corrective action redesign resulting from the above testing.

COMMERCIAL POTENTIAL: This oscillator design is applicable for any commercial application of GPS which desires low power utilization combined with rapid response. This oscillator would improve GPS performance where the receiver is subjected to electromagnetic interference such as business aircraft or helicopters flying in and out of populated areas.

KEYWORDS: GPS; GPS Receiver; Crystal Oscillator

N99-195 TITLE: Real-Time Pattern Recognition Algorithms for High Density Commercial and Military Applications

TECHNOLOGY AREAS: Computing, Sensors

OBJECTIVE: Develop algorithms which can perform real time pattern recognition for applications involving real-time inspection of hundreds of images or other digitized files with minimum expenditure of processor memory and throughput.

DESCRIPTION: Increasing numbers of military and commercial systems are faced with the task of automatically performing pattern recognition examinations of a large number of very large digital files. The digitized data can contain fingerprint records, digitized photographs, DNA records, eye prints or any number of other records which must be examined in order to find a match to a reference file. An example is a face recognition system located in an airport or other busy location. The system would have to compare real time video imagery with stored photographs in order to recognize a person (s) being sought. Another example is that of finding a commercial or military object of interest, such as a potential military target, immersed in a cluttered background. Current autonomous recognition capabilities are limited by the immense memory and processing throughput requirements associated with real time correlations of large files of digitized data. Several techniques have evolved to lessen the memory and throughput limitations. They include data compression; use of mathematical techniques such as Fourier transforms in order to process in complex space; Hough transforms for edge correlations; use of templates such as edge templates, corner templates, or other geometric templates; polarization techniques; and fuzzy algorithms such as neural networks. The purpose of this SBIR is to identify those innovative algorithms which show most promise of being able to perform pattern matching of hundreds of digitized records in real time.

PHASE I: Identify and analyze algorithms that show the most promise of being able to perform pattern matching of hundreds of digitized records in real time. Select the most promising algorithms.

PHASE II: Develop, test, and demonstrate under realistic conditions the most promising real time autonomous pattern recognition algorithms. Where it can be done economically, with non-SBIR funding, comparisons of the SBIR-tested algorithms with other available pattern recognition algorithms will be performed. During Phase II, commercial and military sponsors for Phase

III will be sought. Commercial and Governmental agencies which are potential users of the algorithms include: law enforcement agencies, health agencies, and environmental protection agencies.

PHASE III: Build prototype real-time autonomous pattern recognition systems using the techniques demonstrated in Phase II. Apply to military seeker and FLIR systems as well as to commercial imaging and pattern recognition systems. Examples of military systems which may employ the algorithms are Stand-off Land Attack Missile with Expanded Response (SLAM-ER) and the Joint Service Stand-off Weapon (JSOW).

COMMERCIAL POTENTIAL: Increasing numbers of commercial systems are faced with the task of performing pattern recognition examinations. The new algorithms will have a wide variety of possible applications such as identifying individuals at airport security checks, DNA pattern correlations, finger and eye pattern correlations, and airborne searches of cluttered ground scenes for items of interest. Currently available Autonomous Object Recognition (AOR) algorithms are computationally intensive. It is expected that the algorithms which are identified and tested as part of this SBIR will be more efficient and not require special equipment such as specialized correlators. The resulting AOR algorithms will have the potential to provide expanded capabilities to law enforcement and health research agencies as well as to military systems. If the SBIR is successful, video imagery and/or computer files will be examined much more quickly, either in real time or during playback, in the search for a particular object of interest. In addition to the business-oriented applications, home-oriented security applications are possible as, for example, the identification of visitors or intruders.

N99-196 TITLE: Geometric Patterning of Radar Absorptive and Reflective Materials (RARM) and Selective Combining of RARM materials to Achieve Improved Electromagnetic Interference (EMI) Protection and Significantly Reduced Radar Cross Sections (RCS)

TECHNOLOGY AREAS: Materials

OBJECTIVE: Investigate various shapes and patterns of RARM materials to ascertain which geometric patterns result in improved EMI protection and reduced RCS. Investigate which combinations of RARM coatings give improved EMI protection and reduced RCS. The end result of this demonstration will be an EMI-reduction/radar cross section technology that provides equal or better protection to military and commercial aircraft, land craft, and sea craft.

DESCRIPTION: Commercial and military vehicles are faced with the need to operate properly in high EMI fields. They are also often at risk if their RCS permits easy detection by opposing radar systems. Military systems include missiles, aircraft, ships, and ground vehicles. Commercial vehicles include coastal security craft, space vehicles, and aircraft that operate near high-power radar. Current RARM coatings are costly and heavy. They often do not give significant protection over large angles and are limited in frequency range. Their performance is often limited by the shape and size of the vehicle that they cover. It has been shown that properly shaped RARM coatings can provide more protection than uniform coatings. Shaped coatings can reduce the EMI/RCS in areas where it is the hardest to achieve results such as broad side. Shaping the RARM can provide equal or better protection while using significantly less material. The result is less cost and weight. The use of properly applied RARM results in larger production buys and increased vehicle mileage due to reduced weight and volume. Current investigations of EMI/RARM materials are concentrated in the area of investigating the materials themselves. Few demonstrations of the improvements achievable from geometric shaping have been conducted. Fewer still are documented. Although much progress has been reported in the development of materials, little progress has been reported in the area of combining those materials to provide protection to various areas of the base vehicle.

PHASE I: Identify the most promising methods of geometric patterning and RARM materials to improve EMI protection and reduce RCS.

PHASE II: Develop, test, and demonstrate under realistic conditions, the most promising shapes and combinations of RARM to provide additional protection over current methods of applying RARM.

PHASE III: Build and test prototype RARM-protected bodies using the techniques demonstrated in Phase II. Apply to military systems as well as to the most promising commercial systems.

COMMERCIAL POTENTIAL: The new algorithms will have a wide variety of commercial applications. Many commercial systems have to operate in the vicinity of high-power radar. EMI protection will be provided by the technologies developed under this SBIR. Some commercial vehicles seek lowered RCS for security reasons. The technology provided in this SBIR will help provide the required protection at a lower cost and weight.

KEYWORDS: Radar; Radar Cross Section; Electromagnetic Interference; Radar Absorbing Materials

N99-197 TITLE: Handheld Remote Fuel Quality Sensor

TECHNOLOGY AREAS: Sensors

OBJECTIVE: This topic seeks to develop an advanced portable fuel quality monitor capable of wireless transmission of data using the latest TCP/IP protocol. The resulting hardware will enable real-time, on-site determination of fuel type and quality, when "clear and bright" isn't enough. DESCRIPTION: The military needs to the capability to assess the quality of host nation or captured fuel supplies in near real time. Additionally, they need the capability to retest and certify stored or cached fuel across a distributed battlefield. A number of vehicle maintenance problems can be attributed to poor quality or contaminated fuel. These maintenance problems impact life cycle cost and readiness.

Generally, fuel is tested on receipt from the refinery, or when vehicles are diagnosed with fuel-related problems. Fuel testing is a time consuming procedure of collecting samples, sending them to a laboratory (rear area), and waiting for results. The time lag is double edged; corrective action can't be initiated until results are returned, and the stock of "suspect" fuel can't be distributed until it is certified "clean" thereby creating an additional burden on the logistics supply line to provide certified fuel until the stock on hand is deemed acceptable.

The United States Marine Corps (USMC), in conjunction with the US Army, is seeking development of the capability to determine fuel type and quality on site, in real-time. The basic concept is to determine fuel type and quality wherever fuel is stored, transferred, or dispensed. As a concept of operation, this can include assessing captured fuel supplies, caches of pre-positioned packaged fuel, or in-line fuel. The concept of operations dictates that the test unit be man-portable, and preferably hand-held. This topic seeks approaches utilizing sensor technologies that may involve, but are not limited to, near-infrared/infrared spectrometers integrated with wireless transmission of data using TCP/IP. The prototype system may be designed to function solely with all diesel fuels, but further development should yield equipment suitable for use with Kerosene based fuels, and various grades of gasoline as well. Fuel quality shall be determined in view of several properties, which may include moisture, density, viscosity, total aromatics, cetane index (diesel), octane rating (gasoline) cloud point, and net heat of combustion. Calibration models for over 30 fuel properties currently exist in industry and provide varying degrees of accuracy. The properties or approach selected for the determination of fuel quality shall be chosen on the bases of providing the most accurate estimates concerning the quality of the fuel.

PHASE I: Determine, define and establish acceptable fuel quality parameters for Marine Corps and Army vehicles providing information in a prioritized format. Define the high priority fuel quality parameters on a vehicle by vehicle or engine type (piston, turbine) basis, and relate this to the maturity or feasibility of sensor technologies to measure those parameters. Present findings in such as manor as to facilitate down-selection and project focus. Develop designs and demonstrate the technologies to determine and assess the previously prioritized priorities fuel quality parameters using sub-component sensors. The sub-component sensors shall be used to rapidly assess fuel parameters by direct contact with fuel through vents, caps, valves, or other orifices.

PHASE II: Develop and integrate those sensing components into a single hand held fuel quality monitor. Integrate data outputs from the sub components into a usable TCP/IP format suitable for wireless transmission. Demonstrate the hand held fuel sensor in view of phase I definitions of acceptable fuel qualities.

PHASE III: Develop a "smart" fuel quality data base which will provide information integrating the fuel sensor real-time data with "smart" decisions to provide remedial action necessary to bring the unacceptable fuel quality to acceptable levels or suggest alternate uses for the product.

COMMERCIAL POTENTIAL: The development of a compact, handheld, remote fuel quality sensor has broad application in the trucking, mining, timber and agricultural industry where large quantities of fuel are stored and used in remote locations. The fuel is generally transferred directly from temporary storage to the fuel tanks of the end user equipment where single deterrent to engine and environmental problems arising from contaminated fuel is the fuel filter. Department of Transportation enforcement officers could use the device to verify that appropriate highway taxes have been paid on fuel used for highway transport of commercial goods.

REFERENCES: Remote near-Infrared Fuel Monitoring System, Dec 97 by Southwest Research Institute; available through DTIC-OCC, 8725 John J. Kingman Rd, Suite 0944, Fort Belvoir, VA 22060-6218

KEYWORDS: Fuel; Quality; Sensing; Logistics

N99-198 TITLE: Ray-tracing Tool for directly interrogating Pro-Engineer Geometry

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Develop a standalone UNIX based program that can directly interrogate a Pro-Engineer geometry and produce Line-of-Sight (LOS) raytrace information to support vulnerability, lethality, and signature analyses.

DESCRIPTION: Current state-of-the-art survivability assessments use a Computer Aided Design (CAD) generated 3D target description to model threat penetration and damage. A shotlining or raytracing program is used to simulate the target/threat interaction by taking a ray and passing it through a target to produce LOS information. The AAAV Program currently has requirements to assess the vulnerability of their vehicle using the Modular Unix-Based Vulnerability Estimating Suite (MUVES) suite of assessment models. The AAAV was designed using Pro-Engineer. Because the MUVES model can only be used to generate LOS information for Ballistic Research Laboratory Computer Aided Design (BRLCAD) geometry's, the AAAV Pro-Engineer CAD geometry must be converted to BRLCAD format. The conversion of the geometry from a Pro-Engineer format into a BRLCAD format is an extensive effort and sometimes produces component representations that are not optimal for the subsequent vulnerability assessment. A raytracing tool is needed that uses an open and standard interface to directly interrogate the Pro-Engineer geometry. This would eliminate the need to perform geometry conversions to the BRLCAD format and would directly support not only the AAAV's vulnerability assessment needs but could support signature and reparability assessments as well. This tool would be designed as a standalone raytracing capability to respond to survivability programs such as the Advanced Joint Effectiveness Model (AJEM), MUVES, Stochastic Analysis of Fragmentation Effects (SAFE), Computation Of Vulnerable Area and Repair Time (COVART) model, etc. The capability to directly interrogate Pro-Engineering geometry's will ultimately produce significant savings in the time and effort required to perform survivability assessments (including signature, vulnerability and reparability analyses) for systems designed using Pro-Engineer.

PHASE I: A standalone prototype Pro-Engineer geometry raytracing tool will be developed and demonstrated. The prototype should demonstrate that simple component level geometry's (i.e.; cylinders, boxes, etc.) can be accurately raytraced and that accurate evaluation of components and materials (i.e.; material encountered, material thickness, incident angles correctly identified, etc.) along the shotline is accomplished.

PHASE II: The raytracing tool will be expanded to address all Pro-Engineer geometry combinations (i.e.; complex geometry combinations). A fully functional Pro-Engineer raytracing tool that accurately identifies materials, material thickness and incident angles for every item intercepted along the shotline will be delivered. The raytracer will produce accurate data for any impact point on the target and all possible impact and yaw angles for each impact point. The raytracing tool will be optimized for speed and will be integrated into a Sponsor-selected analysis code.

PHASE III: Market the tool to other vehicle, aircraft and systems designers (including military and commercial radar, infrared and thermal imager designers) who are currently using Pro-Engineer to design vehicles/systems that require vulnerability analysis. Modify the tool as necessary to meet aircraft, ship or other system unique requirements or to address designs accomplished using other CAD programs.

COMMERCIAL POTENTIAL: This tool will aid aircraft, surface ship, submarine, combat vehicle, space vehicle, and armored car/limousine designers who are currently using Pro-E in evaluating the survivability of their designs. This tool has immediate applicability to the Army's Crusader, M1A2 Tank 2000, HIMARS, Grizzley and Kiowa Warrior programs. Additionally this product can support survivability assessment of Pro-E designed facilities that may be subjected to terrorist attack (i.e.; nuclear power facilities, embassies, Government buildings, key factories, etc.). This tool has applicability to both signature and vulnerability assessments. Both military and commercial radar, infrared and thermal imaging system designers routinely analyze the effectiveness of their designs using raytracing tools such as the one proposed in this SBIR. Providing them the ability to directly interrogate systems they are interested in has the potential to significantly reduce costs shorten the assessment process.

REFERENCES: The following references provide a description and source documentation for MUVES and BRLCAD applications used in assessing vulnerability, system signature and repairabilty. The references describe model architecture, raytracing requirements, model input requirements and formats (including BRLCAD). Additionally they describe special requirements and usage of MUVES modules such as SAFE, SPRAE and COMPART.

1. Hanes, P.J., et.al., "Modular UNIX-based Vulnerability Estimation Suite (MUVES) Analysts Guide", US Army Ballistic Research Laboratory Memorandum Report No. 3954, December 1991.

2. Murray, K.R., et.al., "Modular UNIX-based Vulnerability Estimation Suite (MUVES) Analysts Guide, Release 2.0 - Draft", US Army Research Laboratory, Aberdeen Proving Ground, Maryland, May 1994.

3. Bain Jr, L.W.., et.al., The Gift User Code Manual; Volume 1, Input Requirements", US Army Ballistic Research Laboratory Report No. 1802, July 1975.

KEYWORDS: Vulnerability assessments, BRLCAD, Pro-E, raytracing, MUVES

N99-199 TITLE: Real Time Motion Capture for Virtual Reality

TECHNOLOGY AREAS: Human Systems, Manpower, Modeling

OBJECTIVE: Provide a high fidelity depiction of humans immersed in a shared virtual environment by capturing the persons full body movements, facial expressions, and eye gaze direction to allow realistic verbal and non-verbal communications between two or more immersed individuals.

DESCRIPTION: Depicting humans in a shared virtual environment realistically enough to allow recognition of particular individuals from body postures and motions and to allow non verbal communications requires accurate capturing of the individuals body parts and motions. The Marine Corps Small Unit Tactical Trainer (SUTT) advanced technology demonstration and the Army Dismounted Warrior Network (DWN) experiments have shown that simple animated humans are not adequate for realistic interactions in a shared virtual environment. Current tracking systems are not capable of tracking an entire human fast enough and/or accurately enough in harsh environments such as on board ship. Current magnetic and acoustic tracking systems are inadequate even in ideal laboratory conditions and are not capable of operating in a deployed ship setting. Inertial systems have drift and accuracy problems that require augmentation with other trackers to even work at all. This leaves an optical tracker as the only potential solution. Current optical trackers based on cameras and image processing are not accurate enough or cost effective. The tracking system must have much better than one millimeter accuracy to track a weapon well enough to perform realistic marksmanship and the target price for a complete real time motion tracking system which meets all the Phase II requirements should cost less than $25K. Current optical tracking systems cost ten times that amount and don't perform adequately. Software must be provided which takes the raw tracker data and processes it in order to distribute the necessary information required by the distributed system's renderer. The human should be untethered by the tracking system. The system should calibrate quickly and easily and require minimal setup or preparation time for each individual. The system should allow the human to operate within a 10 foot square room with an 8 foot ceiling and provide reliable data for the human and weapon anywhere within that room at all times.

PHASE I: Develop a non-tethered prototype tracking system that can track an entire human body and a weapon to better than one millimeter accuracy. This should be accomplished within a 10 foot square room with an 8 foot ceiling and provide the necessary information to visually render the human in a distributed shared virtual environment.

PHASE II: Extend the system to track individual fingers, mouth and lips for talking, facial expressions and eye position for realistic face to face verbal and non verbal communications. Add the ability to depict walking, running, crawling, dying, etc. in the virtual world without actually performing those tasks in the real world. Demonstrate the system in an actual HLA dismounted infantry distributed simulation.

PHASE III: Apply technology to enhance Indoor Simulated Marksmanship Trainer.

COMMERCIAL POTENTIAL: This system is applicable to any virtual reality application (training, games, etc.) where high fidelity humans are required. This system is also applicable to the entertainment industry for motion pictures, cartoons, etc.

REFERENCES: Dismounted Warrior Network, Front End Analysis Experiments Final Report, Do#0020, Sept 15, 1997 ADST-II-CDRL-DWN-9700392, CDRL AB06

KEYWORDS: optical tracker; animated humans; virtual environment; verbal and non-verbal; SUTT; and marksmanship

N99-200 TITLE: Non-Lethal Clearing Facilities of Personnel

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Enable operator to clear all personnel from a facility without having to enter the building and conduct traditional room to room inspection and clearing operations.

DESCRIPTION: The ability to non-lethally clear facilities of all personnel is desired for conducting military operations in urban terrain (MOUT) and other areas where inhabited facilities are within the battlespace. Such settings are challenging from a military perspective since there are many places where combatants can hide and set up ambushes. This ability is also useful for removing noncombatants from a military target such as a weapons manufacturing facility prior to a lethal strike. The proposed technology solutions should be effective, non-lethal to personnel, and produce little to no structural damage to the facility. The proposed technology solution should also not be easily countered. Delivery of the proposed solution must be possible from at least 50 meters from the facility with ranges beyond small arms range (>500m) being preferred. Traditional methods such as tear gas and pepper spray are effective for small one-room structures, but the effectiveness diminishes with larger facilities and multiple rooms. The proposed solution needs to be effective for large, multi-room structures. It also needs to be easy to transport and easy to deliver/deploy.

PHASE I: Determine candidate technology solution(s) and conduct initial testing to demonstrate potential for technology to non-lethally clear facilities of all personnel. Health effects must be addressed at this phase to show that the technology solution(s) is non-lethal to personnel.

PHASE II: Demonstrate technology solution(s) for a two or more story structure with multiple rooms and at least 5000 square feet of total space. This demonstration should involve human test subjects, and as such the correct protocols need to be approved. Develop conceptual delivery mechanism capable of delivering the technology solution(s) from at least 50 meters from the facility.

PHASE III: Build prototype delivery system for technology solution(s) and demonstrate effectiveness of complete system against large (15,000 square feet) multi-story, multi room facility from a range of at least 50 meters with >500 meters preferred. This demonstration should involve human test subjects, and as such the correct protocols need to be approved.

COMMERCIAL POTENTIAL: This system could be used by law enforcement agencies for breaking barricades and for hostage rescue situations.

REFERENCES: Joint Non-Lethal Weapons Concept, Signed by LtGen M.R. Steele, Deputy Chief of Staff for Plans, Policy, and Operations, U.S. Marine Corps on 1/05/98, Available on World Wide Web at www.hqmc.usmc.mil/nlw/nlw.nsf

KEYWORDS: Clear Facilities; Non-Lethal; MOUT

N99-201 TITLE: Armored Vehicle Internal Noise Reduction System

TECHNOLOGY AREAS: Environmental, Human Systems, Surface

OBJECTIVE: Develop a system to reduce/cancel noise in the interior of an armored vehicle to a level that hearing protection is inherent to the vehicle and would not require the crew and/or other personnel inside the vehicle to wear hearing protection.

DESCRIPTION: The need is to provide an area active noise cancellation/reduction system that would monitor the noise levels and frequencies and remove/reduce them to level that would permit a conversation at normal/near normal voice levels. Current noise reduction means all require the personnel to wear either passive or active noise suppression devices to reduce the noise level in the vehicle. Noise levels in the Advanced Amphibious Assault Vehicle (AAAV) will exceed acceptable levels and will require some form of hearing protection. To effectively operate in a combat situation close coordination is necessary between individuals. When working in armored vehicle noise levels preclude virtually all voice communications and generate harmful levels of noise. An effective vehicle wide, noise cancellation/reduction system would permit effective voice communication to occur inside the vehicle. The system must be lightweight, low power and small enough so as to be easily installed into an armored vehicle without impacting on the personnel. Noise levels will need to be reduced from a nominal 120+ dba to 75dba. Noise is primarily from engine noise and track induced vibration.

PHASE I: The program is expected to result in the identification of potential technologies and the design of a prototype unit that would be produced in Phase II. The Phase I design would include a modeling effort to validate the design and its implementation/integration into to the AAAV. The Phase I effort is expected to incorporate a consideration of manufacturability, and reliability.

PHASE II: Build and test a prototype unit and perform lab testing in an environment similar to that of the AAAV to mature and validate the design.

PHASE III: Market the system for use in any human occupied area with excessive noise levels.

COMMERCIAL POTENTIAL: Both military and commercial systems would benefit from the availability of an area wide noise cancellation system. This technology would be useful in a wide range of applications in ground and aviation vehicles as well as commercial application where manufacturing systems and activities produce excessive noise levels.

REFERENCES:
1. Active Noise Control Systems: Algorithms and DSP Implementations, Sen M. Kuo, With Dennis R. Morgan / Hardcover / Date Published: January 1995

2. Active Noise Control: Fundamentals for Acoustic Design G. Rosenhouse / Hardcover / Date Published: March 1998
3. Active Control of Noise and Vibration C. H. HANSEN,SCOTT SNYDER / Hardcover / Date Published: November 1996

KEYWORDS: Noise cancelling, hearing protection

N99-202 TITLE: Remote Meteorological Sensor Package

TECHNOLOGY AREAS: Sensors

OBJECTIVE: This topic seeks to develop an advanced, low probability of detection, means to sense atmospheric conditions from a single location for radial distances of 1 to 184 Km and altitudes of 0 to 30 Km inclusive. Conditions of interest are wind speed, wind direction, air temperature, barometric pressure, air density, and humidity at multiple altitudes and distances. This capability would replace the current capability. The system must be transportable by a single HMMMV or a HMMWV and trailer combination is also acceptable.

DESCRIPTION: The Marine Corps needs the ability to collect information on atmospheric condition in any operational area. Today, the information is collected by sensor packages carried by hydrogen filled balloons. A radio accompanies the sensors to transmit data to a ground center for analysis and processing. Dispersion of the sensors is at the mercy of the winds at the time of release.

PHASE I: Analyze methods of sensing atmospheric conditions without using a balloon borne sensor and radio package. Perform a feasibility study of the alternatives, report the results of the study, and recommend two best value alternatives for providing the capability based on cost, schedule, and technical performance. The system must be a portable, self-contained unit that can be set up and operated by no more than two individuals in less than 15 minutes.

PHASE II: Build a prototype of the alternative from Phase I that is selected by the government. The prototype shall be made to best commercial practices. Develop a commercial marketing plan for the system.

PHASE III: Further develop the system for both commercial and military applications. The resultant shall be made commercially available by the close of Phase III.

COMMERCIAL POTENTIAL: Private and public organizations have a need to collect atmospheric information to report weather conditions and to produce weather forecasts. The system could be use to generate information for agricultural, aviation, news, and weather organizations.

REFERENCES:
(1) Mission Need Statement for the Meteorological Measuring System dated 1993
(2) Operational Requirements Document for Meteorological Mobile Facility dated 1996
(3) Operational Requirements Document for Meteorological Mobile Facility Replacement dated 05 May 1996.

KEYWORDS: Meteorology; Remote Sensors; Weather; and Winds Aloft

N99-203 TITLE: Fiber Optic Multi-pin Connector for Towed Arrays

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop a low-loss, low-reflection, multi-pin, fiber optic connector capability for optical towed array sonar applications.

DESCRIPTION: The Navy is developing low cost passive optical acoustic sensor technology for use in future Navy towed arrays. To deploy these arrays from tactical platforms, multi-pin fiber optic connectors are required with the following capabilities/characteristics: a minimum capacity of 8 single mode optical fibers, an optical wavelength of 1530-1565 nm, 0.5 dB max optical loss per pin, transient peak power of +40 dBm, and a goal of less than - 60 dB optical back reflection per pin. The multi-pin connector inserts must be designed to operate within existing towed array connector shells. Drawings of the connector shell are available on request. The backside of the insert is exposed to ISOPAR L at pressure. The connection side of the insert is in air but materials should be compatible with ISOPAR L. The multi-pin fiber optic connector shall operate in a towed array environment with the following characteristics: 1200 psia operating pressure, 2500 psia survival pressure for 1 hour, -2oC to +40oC operating temperature, -28oC to +65oC storage temperature. The connector insert body dimensions may not exceed 0.625 inches diameter by 2.64 inches length. The connector's optical performance should not degrade more than 1.0 dB over 1000 mate-demate cycles, or more than 1.5 dB over the life of the connector. Capability of handling polarization-preserving fiber is a goal.

PHASE I: Develop a prototype multi-pin fiber optic connector which will meet the above performance and mechanical requirements. This multi-pin fiber optic connector may be a laboratory breadboard; however, the design must clearly be capable of meeting the dimensional and environmental requirements.

PHASE II: Develop and test a fully functional multi-pin fiber optic connector. Deliver several multi-pin fiber optic connectors to the Navy for preliminary testing.

PHASE III: Produce multi-pin fiber optic connectors for incorporation into military and civilian towed arrays.

COMMERCIAL POTENTIAL: These multi-pin fiber optic connectors could be applied in any environment that required passing multiple optical signals through a small bulkhead.

KEYWORDS: Fiber-optic, towed arrays, connectors, acoustic arrays, mateable, multi-pin

N99-204 TITLE: <u>WATER BASED HYDRAULIC SYSTEM</u>

TECHNOLOGY AREAS: Materials

OBJECTIVE: To develop an environmentally benign hydraulic fluid, such as a water based system, to eliminate releases from current petroleum based systems that have the potential to create an adverse impact to the environment.

DESCRIPTION: The Clean Water Act, Section 311, 40 CFR 110, various State water quality standards, and OPNAVINST 5090.1B prohibit the discharge of petroleum products in such quantities as may cause a film or sheen upon or discoloration of the surface of the water, or violate water quality standards. In addition, since the effects of acute toxicity associated with the additives used in hydraulic fluid is currently unknown, it would be prudent to identify/develop an environmentally benign substitute.

PHASE I: Determine the scientific, technical, and commercial merit and feasibility of developing a water based hydraulic system for use on Navy submarines. The contractor shall submit a report describing the proposed technology, how it will be developed and tested, operation, maintenance, efficiency, effectiveness, estimated cost, training requirements, and identification of other commercial benefits. The report shall contain all data generated during the investigation of the recommended technology.

PHASE II: Develop a prototype for testing. Prepare an implementation plan to demonstrate the technology on an operating submarine that will include installation, monitoring, and performance evaluation requirements. The contractor shall prepare a final report assessing the demonstrated technology.

PHASE III: A small business Phase III award is predicated upon a successful technology demonstration that will allow consideration for implementation into the fleet.

COMMERCIAL POTENTIAL: Although the Navy's submarine fleet will be the principal beneficiary of a successful demonstration, the potential exists for the technology to be implemented on Navy surface ships, other DoD weapon systems, non-military vessels, and at facility installations where the use of a water based hydraulic system is a viable alternative to petroleum based systems.

REFERENCES: Initiation Decision Report (IDR) on Water Hydraulics for Submarine External Hydraulic Systems. Dr. Mike Klinkhammer, Report No. CDNSWC-TR-63-98/32, Dec 98.

KEYWORDS: Submarine; hydraulic; water-based; petroleum; environmental; Clean Water Act

N99-205 TITLE: <u>Search and Rescue (SAR) Using Active Light Detections and Ranging (lidar) Technology</u>

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Develop specific SAR algorithms to be used in the Navy's Magic Lantern Deployment Contingency (ML(DC)) and Advanced Technology Development project number 111 (ATD-111) lidar systems to supplement the Navy's SAR capabilities and decrease search time.

DESCRIPTION: Two active lidar systems currently being flown by the Navy are the ML(DC) and ATD-111 systems. The ML(DC) system was developed for the Mine-Countermeasures mission and is flown by personnel at Helicopter Squadron Light Airborne Multi-purpose Nine Four (HSL-94). The ATD-111 system was developed for the ASW mission and is flown by personnel at Naval

Air Warfare Center Aircraft Division Patuxent River (NAWCAD PAX). Both systems have the capability for detecting small (man-sized) object on the surface of the water. Because the systems can search and process data much faster than an operator, the SAR mission could greatly be enhanced, especially at night, by use of these systems. However, the search algorithms for a survivor have not been developed. While there are only a few ML(DC) and ATD-111 systems, the Airborne Laser Mine Detection System (ALMDS) will be put into production within the next three years to replace the ML(DC) systems and be provided to the active duty Fleet. Reference (1) contains information regarding both ML(DC) and ATD-111 design and operation. Information regarding ALMDS that is available for public access is located at http://www.ncsc.navy.mil/CSS/Projects/ALMDS/almds.htm.

PHASE I: Determine the statistically best modes of operation to search for the following - 1) Single survivor no raft, 2)Single survivor w/raft, and 3)Four man raft. Also, analysis should be conducted on the effects of sea dye marker (e.g., increased contrast that would allow better detections). Suggested implementation, that is changes to the existing software code, should also be submitted.

PHASE II: Implement the suggested changes and perform in-field testing using the ML(DC) and ATD-111 systems on the SH-2G and SH-60B helicopters. Targets and ground truthing will be also need to be used to determine SAR capabilities. Development of lidar SAR search patterns and methods of increasing probabilities of detection will need to be accomplished. Modification of the existing ML(DC) ground station to include SAR briefing cards, areas cleared, and residual threat (i.e., chance that the survivor was missed) will need also need to be accomplished. A briefing and training course will need to be developed so that currency in performing the lidar SAR mission can be maintained. Lessons learned not only from training but also from the data collection will need to be compiled in preparation for final product delivery to the Fleet.

PHASE III: Develop a lidar SAR update package for the ALMDS (with Phase II software remaining in the ML(DC) and ATD-111 systems). This package should contain software code for the ALMDS sensor, code/algorithms for the ALMDS ground station that is expected to be MEDAL compliant, lessons learned, course of instruction, and pocket checklist/briefing cards.

COMMERCIAL POTENTIAL: The U.S. Coast Guard and analogous overseas organizations would be the primary customer but local law enforcement and civil air patrol could also benefit from use of this SAR development.

REFERENCES:
(1) (U) Coastal Systems Station Document, Test Report, Airborne Mine Countermeasures, Competitative Evaluation Field Test, March 1998 (C) *Title unclassified, document confidential.*
ALMDS information is currently procurement sensitive. Information approved for public release can be found on the Internet at the following address: http://www.ncsc.navy.mil/CSS/Projects/ALMDS/almds.htm

KEYWORDS: Lidar; SAR; search patterns; tactical decision aid; training; Airborne Laser Mine Detection System (ALMDS)

N99-206 TITLE: Fault Diagnostics For Waterfront Construction

TECHNOLOGY AREAS: Materials

OBJECTIVE: Develop cost competitive, long-lived fault diagnostic systems for Navy waterfront construction having a zero maintenance requirement for 75 years in a severe marine environment.

DESCRIPTION: The Navy is demonstrating the feasibility of constructing waterfront pier and wharf structures using high performance concrete and FRP composite materials to meet changes in ship characteristics, force realignments, and rapid buildup of infrastructure. The structural designs will maximize maintenance free service life while providing a competitive initial cost with conventional construction. The Navy has a need to develop fault diagnostic systems to monitor its high performance waterfront infrastructure. The system must provide an analog of load performance including lateral load response, vertical load response (static, creep), as well as perform as a structural health monitoring system. The instrumentation design must employ real time sensing of stress, strain, displacement, and natural frequency to diagnose distress in structural elements. The fault diagnostics system must be robust to have a service life at least as long as the service life of the structure in which it is installed.

PHASE I: Develop concepts and characteristics. Demonstrate performance by computer or other mathematical modeling.

PHASE II: Conduct laboratory tests to demonstrate diagnostic system integration into waterfront structure. PHASE III. Construct and install diagnostic system into pier components at NFESC's Advanced Waterfront Test Site at Port Hueneme and validate performance tests. Validate the technology through an accepted industry standard accreditation office such as the Innovation Technology Evaluation Center.

COMMERCIAL POTENTIAL: This research encompasses sensor systems. In addition to commercial ports this technology base is applicable to the nation's highway bridges in need of health monitoring. This technology base will present a fertile mix of innovative materials, techniques and systems that will reduce the time and cost of developing a low maintenance pier concept and will present opportunities for technical exchanges and coordinated efforts.

REFERENCES:

1. MILHDBK 1025/1

2. New Materials for Prestressing and Monitoring Heavy Structures, CONCRETE INTERNATIONAL, Sept 1989.

3. Fiber-Optic Sensors for Concrete Strain/Stress Measurement, ACI MATERIALS JOURNAL, May/June, 1991.

4. An Integrated Fiber Optic Strain Sensor, ADVANCED CONSTRUCTION TECHNOLOGY CENTER Document No. 92-20-01, Mar 1992.

5. Smart Structures, CIVIL ENGINEERING, Nov 1992.

6. Non-Intrusive Quality Health Monitoring of Composite Reinforcement Applied to Norfolk Pier 11, CENTER FOR INTELLIGENT MATERIAL SYSTEMS AND STRUCTURES, Jan 1997.

7. Fiber-Optic Bragg Grating Sensors for Bridge Monitoring, CEMENT & CONCRETE COMPOSITES Special Issue on Fiber Optic Sensors, Feb 1997.

8. Waterfront Repair and Upgrade Advanced Technology Demonstration Site No.2: Pier 12 Naval Station San Diego, NAVAL FACILITIES ENGINEERING SERVICE CENTER SSR-2419-SHR, Nov 1998.

KEYWORDS: Composites; Structural Fault Diagnostics; Waterfront Infrastructure

N99-207 TITLE: Scriptable Human Animation Figures in an Open Environmental Framework

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Provide the designers of complex human systems a tool to script human motor task behavior in perceptual, cognitive, ecological and physically correct environments for ergonomic simulations.

DESCRIPTION: Available animation-based ergonomic tools are quasi-manual in programming human motor activities in weak simulated environments. The design iteration speed and quality is limited due to the human figure programming effort and lack of suitable embedding environments.

PHASE I: Research a pathway from human neuromotor behavior to kinematically, dynamically correct behavior in simulated potential ergonomic and physical environments. Develop an open framework for integrating perceptual, cognitive and visualization tools for ergonomic design.

PHASE II: Develop human motor simulator model software, situation knowledge database and interfaces to other design tools using the open framework. Research and develop a scripting interface to the simulated figures that utilizes elements-part or whole-of design descriptions used by the system architects for the product.

PHASE III: Offer scripting and knowledge database to human engineers, training and job designers, industrial and ergonomic analysts in the area of complex systems where human behavior is an essential element. Disseminate to design community for use in all areas where human motor behavior is of consequence and scripting is necessary to achieve human integration verification within the time constraints of other parallel system design disciplines that currently have better developed tool sets.

COMMERCIAL POTENTIAL: Can be applied in any area where human motor behavior in complex environments can be predicted the extent necessary to reduce analysis time, mock-up and prototype costs.

REFERENCES:

1. DD 21 Request For Proposal, Solicitation N00024-98-R-2300

2. Broad Agency Announcement N00024-98-R-6332

KEYWORDS: Ergonomic design in complex systems, virtual figure scripting, and human motor task analysis

N99-208 TITLE: Lightweight and Inexpensive Rigid Construction Paneling Material

TECHNOLOGY AREAS: Materials

OBJECTIVE: To further develop strong, lightweight and inexpensive rigid construction paneling materials rendering them suitable for exterior expeditionary uses.

DESCRIPTION: Expeditionary operations require materials that are lightweight, versatile, environmentally sound, and durable for construction of temporary rigid structures (i.e. shelters, quansit huts). Most rigid construction paneling materials such as wood, metal, and plastics tend to be heavy thus increasing transportation costs. The lightweight rigid construction materials such as wood or metal composites tend to be expensive increasing capital costs. A variety of strong, lightweight, and inexpensive ($0.63/ft2) rigid fiberboards made from recycled and/or bio-based materials are currently on the market. However, these materials currently lack weather-resisting properties rendering them unsuitable for exterior expeditionary use. Some of these fiberboards are 18 lb/ft3 yet still meet ANSI A208.1 requirements for LD-2 particle board. In addition, these fiberboards can be molded into curved shapes without spring- back eliminating the need for framing. Other suitable fiberboard materials may also exist which meet or exceed above specifications. This project seeks to reduce expeditionary costs for temporary shelters without compromising performance by further developing lightweight materials.

Table 1: Characteristics of Various Rigid Construction Materials

Construction Material	Material Tensile(psi)	Material Thickness(inch)	Material Density (lb.ft3)
6061-T6 Aluminum	45,000	0.05	168.5
Oak (white)	11,300	0.20	43.4
SAE 1010 Steel	53,000	0.04	490.0
HDPE	4,000	0.57	59
Molded Fiberboard	5,000	0.75	18

PHASE I: Identify promising candidate materials, coatings and fiberboards, that can potentially meet expeditionary needs while reducing costs and maintaining environmental soundness. Test material combinations to ensure suitability for expeditionary use without adding significant weight (<3lb/ft3).

PHASE II: Develop rigid collapsible and stackable modular shelters that are capable of being erected in the field without specialized tools or equipment.

PHASE III: Develop appropriate specifications/documentation to make the system standard in the fleet. Complete strategy for incorporating the specifications of the products with the various national accrediting agencies.

COMMERCIAL POTENTIAL: This technology development could provide inexpensive temporary shelter for humanitarian services. The developed product may also be used for temporary exterior construction projects such as bracing and sheeting for concrete foundations, shoring trenches in pipeline operations, excavation operations, and temporary construction of barrier walls for indoor and outdoor asbestos removal projects.

REFERENCES:
1. Naval Facilities Engineering Service Center(NFESC). Technical Memorandum TM-2217-AMP. "A Survey of Commercial Packaging and Handling" by Brian Cable, Sept 1996
2. Naval Facilities Engineering Service Center(NFESC). Technical Memorandum TM-2265-AMP. "A Cargo Supply Methodology for USMC Expeditionary Deployments" by Brian Cable, October 1997

KEYWORDS: Temporary Shelter; Rigid Construction Material; Collapsible Structures; Expeditionary; Lightweight Fiberboards; Economical; Environmentally Friendly

N99-209 TITLE: Constructed Wetland System for Treatment of Washrack Effluent

TECHNOLOGY AREAS: Environmental

OBJECTIVE: Develop and commercialize a compact constructed wetland system for treating industrial washrack effluents.

DESCRIPTION: Commercial and DOD industrial facilities need a treatment system that can easily and inexpensively treat washrack effluent. Constructed wetland technology has the capability to fulfill this need. However, the extensive land requirements can make treatment of wetlands an unacceptable option. Development is needed to create a compact system that will work in an industrial environment.

A compact wetland system should be applicable or adaptable to washrack effluent streams that vary in flowrate, volume, composition, and contaminant concentration. For example, the product should be capable of treating heavy metals from an aircraft washrack effluent and solids from vehicle washrack effluent. It should be very low maintenance, have capital costs comparable to existing systems for similar purposes, not generate appreciable secondary waste-streams, and meet the requirements of an industrial setting (i.e. minimal area requirements).

Additional requirements include (1) easily meeting or exceeding existing and proposed standards applicable to industrial washracks (2) protection of human health and the environment, (3) operation without material replacement or chemical addition, and (4) simplicity of design and operation to minimize possibility of breakdown.

PHASE I: Develop a design and bench-scale or full-scale system that meets the above criteria. The system should be tested with appropriate washrack effluent streams to generate preliminary performance data.

PHASE II: From the Phase I effort, develop a fully functional prototype system. The prototype will be performance tested and demonstrated on washrack effluent at a military installation. This phase will proceed according to demonstration plan and quality assurance project plan approved by the government. An evaluation report shall be delivered within three (3) months of the test(s) completion.

PHASE III: Validate the technology to a certification organization or regulatory agency approved according to a validation plan approved by the government. Create user-friendly manuals, effective marketing tools, and presentation materials. Develop strategies to facilitate system implementation in "real world" scenarios. Identify and develop tools and techniques for overcoming implementation barriers.

COMMERCIAL POTENTIAL: A system that meets the objectives of this effort has tremendous potential for sale and use in the United States and abroad. The treatment concepts, those dealing with specific contaminants would have wide application in the field of environmental pollution control - not limited to wetland applications. The flexibility offered by the proposed technology will benefit environmental consultants, planners, regulators, and facility managers as they respond to changes in technology and regulations. By increasing treatment options, manufacturers of pollution control technology would benefit.

KEYWORDS: Washrack; Constructed Wetland; Industrial; Effluent; Vehicle; Aircraft

N99-210 TITLE: Carbon Composite Reinforcement For Concrete Waterfront Construction

TECHNOLOGY AREAS: Materials

OBJECTIVE: Develop innovative, cost competitive, carbon fiber composite reinforcement for Navy waterfront construction.

DESCRIPTION: The Navy is demonstrating the feasibility of constructing waterfront pier and wharf structures using high performance concrete and FRP composite materials to meet changes in ship characteristics, force realignments, and rapid buildup of infrastructure. The structural designs will maximize maintenance free service life while providing a competitive initial cost with conventional construction. The Navy has a need to develop innovative, high strength, high modulus reinforcement for its high performance lightweight concrete waterfront infrastructure. The reinforcement will be used for both conventional and pre-stressed concrete construction and can be configured in any geometry that exploits the strengths of FRP composite materials and bonds well with concrete. The Navy is particularly interested in reinforcement that does not mimic traditional bars, tendons and mesh. Epoxy and other polymer rich surfaces of FRP do not chemically bond well when cast in concrete. Therefore, it is prone to bond failure under impact loads normal to the FRP surface. The reinforcement must be robust to perform without degradation for a service life of at least 100 years. In order to compete with conventional steel reinforcement and prestress steel, the FRP should possess comparable stiffness properties to that of steel and have tensiles strengths in the order of 400 - 500 KSI (2800 - 3400 MPa).

PHASE I: Develop reinforcement concepts and characteristics. Demonstrate performance by computer models or otherwise.

PHASE II: Conduct laboratory tests to demonstrate reinforcement system integration into waterfront structures.

PHASE III: Construct half scale structural systems at NFESC's Advanced Waterfront Test Site at Port Hueneme and initiate performance tests. Validate the technology through an established Navy demonstration program or through an accepted industry standard accreditation office such as the Innovation Technology Evaluation Center.

COMMERCIAL POTENTIAL : This research encompasses alternatives to steel reinforcement that is inherently corrosive in a chloride environment on the waterfront. In addition to commercial ports this technology base is applicable to the nation's highway bridges in need of non-corrosive reinforcing systems for concrete. This technology base will present a fertile mix of innovative materials, techniques and systems that will reduce the time and cost of developing a low maintenance pier concept and will present opportunities for technical exchanges and coordinated efforts.

REFERENCES:
1. MILHDBK 1025/1
2. Tensile and Bond Properties of FRP Rebars, ACI MATERIALS JOURNAL, May/June 1995.
3. Bond Stress-Slip Characteristics of FRP Rebars, NAVAL FACILITIES ENGINEERING SERVICE CENTER R-2013-SHR, Feb 1994.
4. Waterfront Repair And Upgrade Advanced Technology Demonstration Site No. 2: Pier 12 Naval Station San Diego, NAVAL FACILITIES ENGINEERING SERVICE CENTER SSR-2419-SHR, Nov 1998.
5. A Look at the World's FRP Composites Bridges, MARKET DEVELOPMENT ALLIANCE of the SPI COMPOSITES INSTITUTE, 1998.
6. FRP Concrete Composite Pier N47408-98-C-7529, BERGER ABAM for the NAVAL FACILITIES ENGINEERING SERVICE CENTER, Apr 1999.

KEYWORDS: Composites; FRP composite reinforcement, waterfront infrastructure

N99-211 TITLE: Automated Electromagnetic Optimization for Advanced Antenna Design

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Create an antenna design modeling suite, utilizing existing validated electromagnetic codes, for the purpose of automated optimization, requiring a minimum of operator interaction.

DESCRIPTION: Embed state-of-the-art optimization routines in a feedback loop between existing electromagnetic codes and geometry meshers, permitting automated design of complex antenna structures. This package must compute an error function based upon the output of the code, and iteratively modify the structure geometry in order to minimize a user defined error function over a constrained multi-dimensional space.

PHASE I: Compare and identify one or more suitable optimization algorithms. Using the Numerical Electromagnetic Code as a testbed, develop a prototype optimizer that can use several different algorithms such as WIPL & EIGER. Each algorithm should be performance tested on a variety of antenna problems (such as the UHF Electronically scanned array) for convergence time, ability to find optimal solutions, etc.

PHASE II: Continue development, performance characterization, and prepare a graphical user interface. Develop coarse grain parallelization.

PHASE III: Graduate the developed product to one of several moment method codes having more generalized structures. This will likely involve interfacing the optimizer to meshing programs such as IDEAS, PATRAN, etc. COMMERCIAL POTENTIAL: Numerous electronics firms involved with the design of antennas, filters, etc. use the same electromagnetic codes and face the same problems. This product would be completely applicable to the commercial sector ? cellular phone industry, automotive industry, etc.

KEYWORDS: Automation, Electromagnetic Modeling, optimization

N99-212 TITLE: SMART Damage Control Boundary Opening System

TECHNOLOGY AREAS: Materials, Sensors

OBJECTIVE: Provide a damage control boundary opening system that prevents water, air, and fire from passing through the boundary when a damage control condition (flooding, chemical/biological agents present, or fire) exists. The boundary opening system must also allow the passage of people and cargo during non damage control conditions.

DESCRIPTION: Navy damage control boundaries provide structural integrity, prevent flood progression, prevent fire progression, prevent the passage of chemical/biological agents, and prevent weather intrusion. These boundaries typically consist of structural steel panels with steel stiffeners. To allow for the passage of personnel and cargo, openings are cut in the steel panels and doors installed to prevent the passage of the above mentioned elements. In an effort to maintain watertight/airtight integrity, the Navy is spending $38M per year in maintaining and fixing watertight/airtight doors; however, INSURV inspections indicate only 50 to 75% of the fleet's 52,000 doors meet watertight/airtight integrity requirements. It is extremely rare that a door is ever called upon to perform its watertight function yet many of these doors and their associated dog system are being cycled more than 1000 times a day. The Navy needs a reliable, maintenance free, smart, damage control boundary opening system that allows people and cargo to pass through (99% of the time) but prevents water, air, and fire from passing though when a damage control condition exists. Through the use of advanced technologies (sensors, materials, processes, etc.), the opportunity exists for the Navy to significantly reduce the cost of maintaining damage control boundary opening systems.

PHASE I: Conduct a cost and feasibility analysis and design a damage control boundary opening system that will sense a watertight/airtight condition and respond by preventing passage of water, air and flame.

PHASE II: Develop a prototype system and demonstrate the watertight/airtight boundary response time to a watertight/airtight condition and demonstrate the reliability of the system.

PHASE III: Transition system design to commercial and military ship applications.

COMMERCIAL POTENTIAL: U.S., Foreign Commercial, and military ships of the future will be operated with very small crews. The specialized resources required to maintain, fix, inspect, and provide specialized training to ensure watertight integrity with the current technology will be unaffordable in the future. Development of a new and proven technology that can be uniformly applied to commercial as well as military ships will be readily adopted as a cost effective measure.

KEYWORDS: Damage Control; Watertight; Airtight; Flametight; Door; Boundary

N99-213 TITLE: <u>Non-Cooperative Moving Target Recognition Using ISAR</u>

TECHNOLOGY AREAS: Computing

Objective: Develop algorithms capable of real-time ISAR radar imaging of maneuvering aircraft, small ships at sea, and moving ground vehicles. Demonstrate the capability of extracting reliable target features useful for non-cooperative target classification. Develop and demonstrate target classification processes and algorithms that can accommodate approximately 30 different target classes.

PHASE I. Demonstrate ability to form ISAR images of moving targets such as ground vehicles, small ships, and aircraft and the ability to robustly extract target features that can be used for automated target classification. These capabilities must be demonstrated at all target aspect angles and for a variety of target motion. The government COTR will provide a controlled data set (UNCLASSIFIED) of aircraft and/or ship targets to be imaged (raw I/Q data will be provided) to all phase 1 participants.

PHASE II. The government COTR will provide a more extensive data set of moving targets. The phase II contractor(s) will optimize their feature extraction methods and develop robust classification processes based on this data set. This data set will also be unclassified, however restricted data can also be provided if the contractor possesses the necessary clearances. Phase II efforts will culminate by having the government conduct an independent evaluation of algorithm performance (image formation algorithms, feature extraction, classifier performance, etc.). A sequestered data set reserved for this purpose will be provided. This evaluation can either be done at contractor facilities with COTR participation, or by delivering all algorithms to the COTR.

PHASE III. The COTR will facilitate the incorporation of compelling phase II results into appropriate Navy funded programs; e.g. Small Craft Automatic Target Recognition (SCATR) & All-Aspect Complex Target ID Variable Engagements (ACTIVE). The contractor is also encouraged to develop relationships with suitable aerospace companies capable of integrating phase II products into weapons systems. The Navy will consider suitable proposals on a yearly basis and envisions the SBIR contractor would be listed as a sub-contractor in the proposal. Alternatively, the SBIR contractor can propose on its own if it has the necessary resources.

COMMERCIAL POTENTIAL: The ability to include an effective non-cooperative moving target recognition capability is required for Navy airborne and shipborne radar. Existing methods must be improved to provide reliable all sensor/target aspect angles, and to accommodate large numbers of targets with similar appearance. All industries involved with DoD surveillance, reconnaissance and strike technology will benefit from this SBIR program. In addition, algorithms capable of providing well focussed real-time radar imagery of moving targets can readily be adapted for real-time medical imagery, such as magnetic resonance imaging, so the medical community will also benefit from this program.

REFERENCES:
1. NATO RTO Meeting Proceedings 6, Non-Cooperative Air Target Identification Using Radar, RTO-MP-6, AC/323(SCI)TP/2, Proceedings of Symposium held in Mannheim GE between 22-24 April 1998, published Nov. 1988
2. Chen, C.C. and Andrews, H.C., A Target-Motion-Induced Radar Imaging,@ IEEE Trans. On AES, vol. 16, no.1. pp 2-14, 1980
3. Chen, V.C. and Miceli, W.J., A Time-Frequency Transforms for Radar Imaging of Maneuvering Targets,@ IEE Proceedings-Radar, Sonar, and Navigation, vol 145, no.5 pp 262-268, 1998

KEYWORDS: ISAR, radar imaging, moving target radar imaging, non-cooperative target recognition

N99-214 TITLE: Maritime Intelligence, Surveillance, Reconnaissance (ISR) and Space Exploitation

TECHNOLOGY AREAS: Command & Control(C3)

OBJECTIVE: Further the development of technology to automatically develop complete awareness of the littoral maritime situation long before, leading up to, during, and after military engagement.

DESCRIPTION: The focus of this SBIR topic is to stimulate bold new concepts for significantly increasing the performance of automated maritime ISR including use of space assets. The Century 21 Navy will need complete awareness of the subsurface and surface situation within a wide area of interest. This SBIR focuses on the littoral situation, which is complicated by the presence of many neutral surface ships of all sizes and purposes, as well as that of friendly and enemy combatants, including mines. Awareness must extend seamlessly across time, beginning well before and extending through hostilities. Situation awareness must be consistent among all involved. Situation awareness will be expressed in the form of a complete picture of who is where as a function of time. This picture will be available to all Naval personnel at an appropriate level of resolution (this SBIR focuses on aspects of maritime ISR other then conventional ASW and MCM since these are covered by other SBIR topics). Novel means of exploiting or improving existing sensors, including space sensors are of interest. Methods of detecting and classifying (or, in some cases, identifying) neutrals (commercial shipping, fishing and pleasure craft) and unusual threats such as small surface craft (i.e. 'Boghammers'2) and small submarines (mini-submarines) are of interest. Examples include but are not limited to: 1) surface ship surveillance exploiting ship acoustic, electromagnetic, or hydrodynamic signatures or, of particular interest, use of GPS signals or low resolution space based radar to illuminate the ocean surface; and 2) undersea surveillance via fusing of multistatic active acoustic sensing or novel matched field methods for autonomous deployed sensors. Methods of tracking entities of interest in the complex littoral environment are sought. The littoral scene may contain many objects with crossing paths and unknown motion models. Methods of maintaining a consistent awareness of the situation among Navy personnel who are dispersed and intermittently in contact with each other are sought.

PHASE I: Develop a complete algorithm or detailed description of the proposed ISR concept. If the concept involves hardware produce a design. This algorithm, description, or design and supporting documentation should be sufficient to convince qualified engineers that the proposed concept is technically feasible.

PHASE II: Produce and demonstrate performance of a computer program based on the algorithm or description of the concept. If the concept involves hardware, produce and demonstrate performance of an exploratory Development Model (XDM). Demonstrate performance in such a way as to convince qualified engineers that the proposed concept is capable of meeting requirements in an operational environment.

PHASE III: Team with the manufacturer of one of the Navy's ASW or MIW ISR systems to integrate the concept into future generations. Team with manufacturers of commercial fusion systems, such as air traffic or harbor control, to integrate the concept into these products.

COMMERCIAL POTENTIAL: There is a commercial market for ISR concepts applied to air traffic and harbor control. There is a growing commercial market in tracking littoral traffic for law enforcement (smuggling and illegal fishing).

REFERENCES:
Waltz, Edward and James Llinas, AMultisensor Data Fusion,@ Artech House, 1990,
Bar-Shalom, Y., ATracking Methods in a Multitarget Environment,@ IEEE Transactions on Automated Control, Vol. AC-R3, August 1978, pp. 618-626

KEYWORDS: Electromagnetic, Acoustic and Hydrodynamic signatures, multitarget tracking, state estimation, common tactical picture

N99-215 TITLE: Pressure-Tolerant Batteries for Undersea Applications

TECHNOLOGY AREAS: Electronics

DESCRIPTION: Small, rechargeable, pressure-tolerant batteries for use in autonomous underwater vehicles and in situ instruments are needed. Pressure-tolerant batteries operate effectively at depth in seawater without the use of a pressure case. Elimination of the pressure case effectively doubles the energy that can be carried for a given amount of buoyancy. These batteries will operate at pressures up to an equivalent of 4,000 m of sea water and in all orientations. Efficient recharging while at elevated pressure is required. Management of evolved gases during pressure cycling must be addressed. Objectives will likely be achieved through innovative packaging of state-of-the-art battery chemistries, for example, lithium polymer solid state systems. Specific energy of the battery system should be no less than 100Wh/kg with a minimum cycle life of 200 cycles. The cost goal is less than $1000/KWh.

PHASE I: The contractor will convincingly demonstrate the feasibility of the proposed technology to meet the desired requirements and cost.

PHASE II: The contractor will design, construct, test, demonstrate and document a prototype of the new technology, including performance specifications and estimated production cost.

PHASE III: The technology is expected to transition to a wide variety of in-situ ocean sensors and platforms used by the Navy, government laboratories, academia and industry. The successful developer will likely have a number of opportunities to participate in initial commercialization.

COMMERCIAL POTENTIAL: Beneficiaries of this technology include manufacturers of remote marine instrumentation. The autonomous underwater vehicle industry will benefit from lighter weight, rechargeable power supplies.

KEYWORDS: pressure; tolerant; batteries; undersea

N99-216 TITLE: Improve the Performance and Reduce the Cost of Central Components of Ocean Sampling Systems

TECHNOLOGY AREAS: Sensors

DESCRIPTION: An improved magnetic compass with an absolute accuracy of better than 0.5 degree in the horizontal components of the earth's magnetic field is needed. Calibration should be independent of location and time over a one year period. The unit should also provide two axes of tilt information each to an accuracy of 0.5 degree. Sampling frequency up to several times per second and power consumption under 10 milliwatts is required. The compass unit will operate in undersea and sea-surface environments with transient orientations and must withstand forces typical of shipboard deployments in moderate sea states, suggesting a solid state device. The cost goal is under $1000/unit.

PHASE I: The contractor will convincingly demonstrate the feasibility of the proposed technology to meet the desired requirements and cost.

PHASE II: The contractor will design, construct, test, demonstrate and document a prototype of the new technology, including performance specifications and estimated production cost.

PHASE III: The technology is expected to transition to a wide variety of in-situ ocean sensors and platforms used by the Navy, government laboratories, academia and industry. The successful developer will likely have a number of opportunities to participate in initial commercialization.

COMMERCIAL POTENTIAL: Beneficiaries of this technology include manufacturers of remote marine instrumentation that requires an accurate, long term geo-reference such as wind, wave and current sensors. The autonomous underwater vehicle industry will benefit from more accurate subsurface navigation.

KEYWORDS: magnetic; compass; geo-location; subsea navigation

N99-217 TITLE: Identification of Shallow Water Acoustic Environmental Parameters

TECHNOLOGY AREAS: Computing

OBJECTIVE: Improve shallow water applications of active sonar by estimating the acoustic environment in situ using properties of ownship's transmissions and bistatic/multistatic receptions.

DESCRIPTION: Shallow water applications for sonar are defined to be those applications where surface and bottom boundary interactions are present and dominate the propagation of typical acoustic paths from the transmitter to the target and the target to the receiver. In bistatic operations the receiver and the transmitter can be in separate locations. The bottom interaction depends on the seafloor composition, roughness, and structure of the sub-seafloor. Surface interactions depend on sea-state, the wind velocity vector, and the bubble fields generated. Active transmissions and local targets of opportunity or local bathymetric features, along with direct transmissions from the transmitter to receiver, can provide information which will aid in the estimation of reverberation levels, clutter maps, multipath effects, normal-mode excitations and ray paths. Estimation of these parameters can aid in best operational resource selections. In addition, signal processing procedures such as multipath recombining can use this knowledge to improve detection and tracking performance. Innovative techniques are required to provide useful estimates of environmental parameters for improved shallow water processing.

PHASE I: Initial feasibility studies will be conducted to begin development of a set of algorithms to estimate the acoustic environment in situ and to determine the relevant shallow water sonar parameters. The Generic Sonar Model (GSM) will analyze the performance of the proposed algorithms using simulated data such as that produced.

PHASE II: Further development of selected algorithms will be performed, using real sea data for regions of known propagation conditions. Algorithms will be evaluated based on their ability to mitigate the problems associated with shallow water sonar.

PHASE III: Successful algorithms will be integrated into envi-ronmental models used for performance prediction purposes.

COMMERCIAL POTENTIAL: The techniques developed under this topic would be applicable to many situations involving complex propaga-tion of waves. Examples include cellular telephony, weather radar, medical imaging and seismology.

REFERENCES:
1. Isabel, M.G., Lourtie and G. Clifford Carter, ASignal Detec-tion in the Presence of Inaccurate Multipath Time Delay Modeling@ J. Acoust. Soc. Am., 88(6):2692-2694, December 1990.
2. Ainslie, M.A., et al., ASignal and Reverberation Prediction for Active Sonar by Adding Acoustic Components@, IEE Proceedings for Radar, Sonar, and Navigation, 143(3), June 1996.

KEYWORDS: Acoustic Propagation; Shallow Water Acoustics; Multipath; Recombining; Sonar; Signal Processing

N99-218 TITLE: Simulation Based Acquisition Development Environment

TECHNOLOGY AREAS: Modeling

OBJECTIVE: Design an architecture to support the Simulation Based Acquisition (SBA)

DESCRIPTION: The Department of Defense (DoD), faced with decreasing budgets, has developed several initiatives which focus on obtaining the maximum effectiveness from its total resources. One such initiative is Simulation Based Acquisition or SBA and its major components: the Smart Product Model (SPM) and the Simulation Test and Evaluation Process (STEP). The objective is to: 1. Design an architecture to support the Simulation Based Acquisition (SBA) of future surface combatants, consistent with DoD requirements 2. Demonstrate the life cycle applicability of virtual prototype, i.e. Smart Product Model, to support SBA to ship acquisition. While research into SBA and SPM have been sponsored for the past few years by the Defense Advanced Research Projects Agency (DARPA), there are many applications, each with their own set of challenges, that must be developed and applied in order to gain their full benefits.

PHASE I: Define a virtual product model of at least one major ship system and infrastructure addressing interoperability and standards. Define an information flow model for driving the virtual product model. Identify any incompatibilities or other problems that interoperability and standards that might impose on SBA limiting its use for ship acquisition. Demonstrate the design supporting the application of SBA to ship acquisition.

PHASE II: Develop and test the SBA tool for at least one major ship system virtual prototype that can be used to perform life cycle analyses that demonstrate the use of SBA to affect design, manufacturing, testing, training, and operational procedures in the ship acquisition process.

PHASE III: Demonstrate, extend and deploy the SBA tool in support of a broad variety of Naval and Defense acquisition programs and commercial industry systems/products.

COMMERCIAL POTENTIAL: This SBA tool can be applied to any complex product development such as the Boeing 777 or the Chrysler automotive Cybersynthesis™ process.

REFERENCE: "The SBD Smart Product Model Architecture - Overview", SBD-SYS-13, Lockheed Martin, DARPA Contract MDA 972-95-D-0003, 13 February 1997.

KEYWORDS: Simulation Based Acquisition; Modeling; Simulation; Smart Product Model; Distributed Architecture; High Level Architecture

N99-219 TITLE: In-Situ Device for the Measurement of Gas in Shallow Sea Floor Sediments

TECHNOLOGY AREAS: Battlespace

OBJECTIVE: Rapid and accurate in-situ determination of the gas content of shallow water marine sediments to ascertain it's affect on shock waves and other explosive phenomena, thereby enhancing Naval capabilities at the beach head during amphibious operations.

DESCRIPTION: Gas bubbles are known to exist in various shallow-water deposits and to modify important sediment properties including the acoustic response, the permeability, the electrical conductivity and static and dynamic geo-technical properties. Gas bubbles have a major impact on the transport and the accumulation of materials (water and dissolved and suspended matter) and energy through the sediment pore network. Free gas imposes a significant acoustic impedance mismatch between the gas phase and the surrounding interstitial water and solids. This affects not only the attenuation or energy absorption but also the reflection of acoustic energy. Understanding the degree of saturation in marine sediments is crucial in the modeling and prediction of pressure attenuation, energy transmission, and fluid flow through shallow water deposits. At present, however, no satisfactory in situ method of quantitatively measuring the degree of saturation exists.

PHASE I: Design and test a system to measure the insitu gas content of the upper meter of a variety of marine sediment types in water depths ranging from the surf zone (<1 meter) to 100 meters. Vertical resolution of the system should be selectable over the centimeter to decimeter range. This design and supporting documentation should be of sufficient detail to convince qualified engineers that the proposed concept is technically feasible.

PHASE II: Produce and demonstrate performance of a prototype device in a number of well characterized sedimentary environments that contain different classes of sediment, and varying gas contents. Demonstrated performance should be in such a way to convince qualified engineers that the device is capable of meeting requirements in an operational environment.

PHASE III: Team with the developers of the naval MCM systems to integrate the concept into future generations.

COMMERCIAL POTENTIAL: Team with manufacturers of commercial environmental measuring devices, such as for offshore engineering requirements, pollution related harbor reclamation or ecosystem monitoring, to integrate the concept into commercial products. This system has strong dual use ranging from civil engineering to pollution related harbor reclamation and ecosystem habitat studies. Offshore engineering companies servicing the oil industry have a long standing need for this type of system.

REFERENCES:
1. M.H. Hubert and R.H. Bennett, 1982: Anomalous Pore Pressures in Mississippi Delta sediments: gas and electrochemical effects; Marine Geology, 5, p 51-62

2. R.H. Bennett, 1992: Geo-acoustic and Geological Characterization of Surficial Marine Sediments by In Situ Probe and Remote Sensing Techniques, in CRC Handbook of Geophysical Exploration at Sea, CRC Press, Boca Raton, p 295-350.

KEYWORDS: Gas; in-situ; sediment; Sea floor; measurement; shallow water.

N99-220 TITLE: Bright Ultra-cold Positron Beam Source for Chemical and Materials Analysis

TECHNOLOGY AREAS: Electronics, Materials

OBJECTIVE: Novel techniques are sought for the production of bright, ultra-cold positron beams with small diameter and high efficiencies.

DESCRIPTION: Low energy positrons have unique capabilities to characterize surfaces and solids for material interactions(1), mass spectrometry (2) and in atomic, molecular and plasma physics (3). This is due, in part, to the annihilation radiation they produce when combined with electrons. Conventional technique (1) are limited in efficiency and the lowest temperature that can be achieved. Novel techniques are sought for the production of bright cold positron beams. This effort will take advantage of the latest scientific developments in positron sources and storage devices to develop an apparatus that will produce ultra-cold, low energy positron beam apparatus.

PHASE I: Develop the designs of a bright ultra-cold positron beam sources and demonstrates the feasibility of the key components.

PHASE II: Build and test a bright ultra-cold positron beam source.

PHASE III: Build a "turn key" bright ultra-cold positron beam source.

COMMERCIAL POTENTIAL: This system could be used as a diagnostic tool in a wide variety of applications. For example it may be used on microelectronics production line. It has the potential of providing a unique approach to environmental testing.

REFERENCES:
1. P.J. Schultz and K. G. Lynn, "Interactions of positron beams with surfaces, thin films, and interfaces," Reviews of Modern Physics, 60, 701 (1988)
2. L. D. Hulett et al., "Mass spectrometry studies of the ionization of organic molecules by low-energy positrons," Chemical Physics Letters, 216 236 (1993)
3. W. E. Kauppila and T. S. Stein, Comparisons of Positron and Electron Scattering by Gases," Advances in Atomic, Molecular, and Optical Physics 26, (1990)

KEY WORDS: Positron, Beam, Diagnostics, Ionization, Annihilation, Radiation

N99-221 TITLE: Extended Torso Garment for Tactile Transduction

TECHNOLOGY AREAS: Clothing & Textiles

OBJECTIVE: Enable garmentry that provides a consistent human torso skin interface for tactile transduction applications for operators in harsh enviromments.

DESCRIPTION: Tactile displays have proven useful to provide situation awareness information in field tests in aviation and undersea environments. These tested displays utilize small, light weight tactile transducers ("tactors") that are placed in arrays surrounding the torso to provide a three dimensional representation of the world space surrounding the operator. A wide variety of three dimensional information may be presented such as course deviations, spatial orientation, target locations, etc. In order to accurately represent three dimensional space on the torso, tactors must be placed in a body garment extending from the mid thigh to the neck, including the upper arms. For operators to trust a tactile display system, it must provide reliable, consistent contact force with the body of the wearer. To enhance user acceptance, the garment should provide a comfortable constant temperature to the skin and operators must be able to easily don and doff the tactile display garment.

PHASE I: Develop a torso garment design for the Tactile Situation Awareness System. Such a garment will reach from the neck to the mid thigh with a simple closure. It will provide mounting for and consistent contact force at the skin for a variety of tactile transducers. This garment design will allow for servicing of tactors, and connection of tactor control lines via umbilical or other means. The garment must be scaleable for small, medium and large sizes and should be easily adjustable to accommodate a variety of body habitus.

PHASE II: Develop and test torso garments with Tactile Situation Awareness System operations in simulated and/or actual aviation, undersea and space environments.

PHASE III: Develop robust tactor garments of appropriate certified materials for use in military and general aviation and military and commercial diving operations.

COMMERCIAL POTENTIAL: This development could be used in any environment that would benefit from a non-visual non-competing information display in harsh or mild environments. In addition displays resulting from this development could be used to augment human machine interfaces in many applications and could also be used a framework for biosensing applications.

REFERENCES: Numerically list any readily available references that would be helpful in solving the problem

KEYWORDS: Tactile Interface; Tactor; Garment; Situation Awareness; Biosensing; Human Machine Interface

N99-222 TITLE: Self Regenerating Controller for High Power Magnetostrictive Devices

TECHNOLOGY AREAS: Surface

OBJECTIVE: Investigate new electronic topologies to provide force and motion control of multi-phase, inductively coupled actuators in the 4,000 to 15,000 pound-force linear thrust range.

DESCRIPTION: In the ongoing effort to engineer an all-electric ship and eliminate hydraulic systems from surface combatants, a new generation of high force/torque actuators/motors will be necessary. One such system utilizes inductively coupled, direct acting intermetallic elements that convert magnetic energy directly into motive energy. The major drawback in designing compact heavy duty, magneto-mechanical systems has been clearly identified by the Navy as the drive electronics. The fundamental operation of magneto-mechanical system mandates high energization at fast slew rates. The present use of linear power electronics is not capable of meeting specifications and incur prohibitively large weight and power penalties for almost all heavy duty applications such as hatch /door closures, machinery isolation or valve control that require the unique ability of magneto-mechanical systems to achieve actuation authority not available in conventional mechanisms and devices. The goal of this SBIR is to provide a full solution to this dominant issue. Efficient use and control of these devices will require a system capable of re-utilizing the back EMF induced in each segment, frequency of operation up to 10 kHz, current levels per phase up to 100 Amps, total phasing control, and self-sensing diagnostic abilities.

PHASE I: Develop a preliminary design. Fabricate and test a multi-phase segment prototype for a typical system application. Prototype to be capable of a minimum of 100 amps per phase at 4 kiloHertz.

PHASE II: Develop a full up system of the optimal design. Test system in conjunction with an actuator set to address a current Navy usage problem. Demonstrate private sector applications. Demonstrate the ability of the system to control multiple actuators. Make maximum use of standardized components.

PHASE III: Transition equipment and technology to new ship construction such as DD21. Transition equipment and technology to commercial shipbuilding companies.

COMMERCIAL POTENTIAL: The results of this research will have immediate impact on the efforts to commercialize magneto-mechanical systems both for military applications and non-military products. The introduction of a lighter weight compact, practical design for energization of inductively couple actuators at high frequency would overcome the single principle obstacle to the ready availability of this technology both to commercial markets and Navy adoption. Transitions that are anticipated for new ship construction includes: ADCX, DD21, and LHX. Equipment to be affected include: aircraft elevators, anchor windlasses, bow thrusters, cargo weapons elevators, cranes, conveyors, davits, fin stabilizers, steering, and underway replenishment. Commercial transitions are anticipated to ventures that will replace medium to heavy equipment machinery such as hydraulic actuators, palletization automation, machine tool positioners, and high torque - low speed motors.

REFERENCES:

1. "Design of Power Actuator Systems", G.G. Zipfel, Jr and G.W. Terpay, internal document, AT&T Bell Laboratories, Wippany, NJ, Jan. 25, 1994.
2. "Energy-Based Comparison of Solid State Actuators", V. Giurgiutiu, Z. Chaudhry, and C.A. Rogers, Report # CIMSS 95-101, Virginia Polytechnic Inst., Blacksburg, VA, September 1995.

KEYWORDS: Actuators; Regeneration; Inductors; All electric ship; Motors; control surfaces; elevators

N99-223 TITLE: Mine Blast Seat Attenuation System

TECHNOLOGY AREAS: Surface/Ground Vehicles

OBJECTIVE: Develop a lightweight, bracket-mounted troop seat capable of attenuating the ballistic shock effect of a mine to below the level of personnel injury.

DESCRIPTION: The Advanced Amphibious Assault Vehicle (AAAV) is designed to transport 17-18 embarked infantry under light armor from ships at sea to inland objectives over a variety of terrain. Ballistic shock transmitted to embarked troops following the detonation of a mine via the hull and troop seating is a concern. DRPM AAA seeks a lightweight, bracket-mounted troop seat capable of attenuating ballistic shock delivered by a reasonable sized land mine detonated under the vehicle to below levels that will produce personnel incapacitation. The seat must also insure acceptable ride quality in a AAAV in land and sea operational modes. A vehicle set contains 17 troop seats. Seats must be designed so that they flip up or otherwise automatically stow out of the way of troops rapidly exiting the vehicle. The seats must weigh no more than 17.7 lbs apiece and cost less than $885.00 apiece.

PHASE I: Develop and demonstrate a prototype troop seat capable of attenuating the ballistic shock effect of a mine to below levels that will produce personnel incapacitation. The vendor must demonstrate that the prototype produces the desired level of attenuation while being as lightweight and compact as possible. Provision for automatic return to a stowed position that does not inhibit rapid troop egress from the vehicle under emergency or combat deployment conditions is also required.

PHASE II: Develop, deliver, and demonstrate a prototype seat that will attenuate the ballistic shock effect of a mine to below the level of personnel injury.

PHASE III: Develop a fully capable seat and demonstrate the effectiveness of those seats in attenuating blast effects through live fire tests. Market the seat to combat vehicle, aircraft and ship designers. Modify the seat as necessary to address threat, material and shock conditions of interest to other combat and tactical vehicles as well as aircraft, ship designers.

COMMERCIAL POTENTIAL: Potential exists for application of this seat in the construction of armored cars, limousines, embassy buildings, law enforcement vehicles, ship, boats, helicopters, aircraft, and other systems that require protection of personnel from mechanical shock loads.

KEYWORDS: Ballistic shock, mine blast, protection, seats.

N99-224 TITLE: Advanced Concepts for Hull Array Beamforming Technology

TECHNOLOGY AREAS: Computing

OBJECTIVE: Improve the active sonar performance of hull mounted volumetric arrays in the presence of reverberation.

DESCRIPTION: Develop, implement, and demonstrate the utility of rapidly convergent adaptive beamforming (ABF) techniques for volumetric arrays (three dimensional array geometry) that can improve signal to noise ratio at the beam output by rejecting reverberation without suppressing returns from targets of interest. Techniques should be able to form beams in vertical and horizontal directions.

PHASE I: Characterize hull-mounted array reverberation noise statistics using existing sea test data and leveraging from on-going Navy sea tests. Develop techniques to exploit hull array noise characteristics in an adaptive algorithm to minimize reverberation contamination at the beamformer output. Develop and analyze models of candidate adaptive beamformer algorithms. Quantify potential benefits of alternate approaches based on noise gain improvement, minimum loss of signal gain, adaptation convergence rate, and estimated computational efficiency. Deliver a summary report with recommendations for phase II.

PHASE II: Develop prototype hull array adaptive beamformer algorithms and integrate into an analysis processing architecture. Using at-sea data recordings, perform a comparative analysis of algorithm performance from quantitative and qualitative measurements, including active acoustic detection displays. Refine algorithm adaptation parameters to achieve robust performance across a variety of active reverberation environments. Deliver a summary report with recommendations for Phase III.

PHASE III: Phase III tasking will include implementation and integration of an adaptive beamforming capability in an operational hull array sonar system. A final system specification, system design, and interface design shall be developed for initial production of this beamformer. System testing will include an operational demonstration of beamformer performance and robustness in diverse acoustic environments.

COMMERCIAL POTENTIAL: Other applications of the techniques developed in this SBIR are merchant ship sonar and fathometers, geophysical exploration, ocean salvage and mapping, seismic array processing for detection of under ground testing of nuclear weapons, ultrasonic medical imaging, and phased array radar.

REFERENCES: H. Cox, "Improved DMR," Adaptive Signal Array Processing Workshop, MIT Lincoln Laboratory, 1998.

KEYWORDS: active sonar; volumetric arrays; adaptive beamforming

DEFENSE ADVANCED RESEARCH PROJECTS AGENCY
Submission of Proposals

DARPA's charter is to help maintain U.S. technological superiority over, and to prevent technological surprise by, its potential adversaries. Thus, the DARPA goal is to pursue as many highly imaginative and innovative research ideas and concepts with potential military and dual-use applicability as the budget and other factors will allow.

DARPA has identified technical topics to which small businesses may respond in the second fiscal year (FY) 99 solicitation (99.2). Please note that these topics are UNCLASSIFIED and only UNCLASSIFIED proposals will be entertained. These are the only topics for which proposals will be accepted at this time. A list of the topics currently eligible for proposal submission is included, followed by full topic descriptions. The topics originated from DARPA technical program managers.

Please note that **5 copies** of each proposal must be mailed or hand-carried; DARPA will **not** accept proposal submissions by electronic facsimile (fax). A checklist has been prepared to assist small business activities in responding to DARPA topics. Please use this checklist prior to mailing or hand-carrying your proposal(s) to DARPA. Do not include the checklist with your proposal.

It is expected that the majority of DARPA Phase I awards will be Firm Fixed Price contracts. Phase I proposals **shall not exceed $99,000**. DARPA Phase II proposals must be invited by the respective Phase I technical monitor (with the exception of Fast Track Phase II proposals – see Section 4.5 of this solicitation). DARPA Phase II proposals must be structured as follows: the first 10-12 months (base effort) should be approximately $375,000; the second 10-12 months of incremental funding should also be approximately $375,000. The entire Phase II effort should not exceed $750,000. It is expected that a majority of the Phase II contracts will be Firm Fixed Price-Level of Effort or Cost Plus Fixed Fee.

Prior to receiving a contract award, the small business **MUST** be registered in the Centralized Contractor Registration (CCR) Program. You may obtain registration information by calling 1-800-334-3414 or internet: http://ccr.edi.disa.mil. The small business **MUST** also have a Commercial & Government Entity (CAGE) Code. This code is part of the CCR registration package. For information call 1-888-352-9333 (Press 3) or 1-888-227-2423 or internet: www.ccr.dlsc.dla.mil.

The responsibility for implementing DARPA's SBIR Program rests with the Administration and Small Business Directorate (ASBD). The DARPA SBIR Program Manager is Ms. Connie Jacobs. DARPA invites the small business community to send proposals directly to DARPA at the following address:

DARPA/ASBD/SBIR
Attention: Ms. Connie Jacobs
3701 North Fairfax Drive
Arlington, VA 22203-1714

(703) 526-4170
Home Page http://www.darpa.mil

SBIR proposals will be processed by DARPA ASBD and distributed to the appropriate technical office for evaluation and action.

DARPA selects proposals for funding based on technical merit and the evaluation criteria contained in this solicitation document. DARPA gives evaluation criterion a., "The soundness and technical merit of the proposed approach and its incremental progress toward topic or subtopic solution" (refer to section 4.2 Evaluation Criteria - Phase I), twice the weight of the other two evaluation criteria. As funding is limited, DARPA reserves the right to select and fund only those proposals considered to be superior in overall technical quality and highly relevant to the

DARPA mission. As a result, DARPA may fund more than one proposal in a specific topic area if the technical quality of the proposal(s) is deemed superior, or it may fund no proposals in a topic area. Each proposal submitted to DARPA must have a topic number and must be responsive to only one topic.

In order to ensure an expeditious award, cost proposals will be considered to be binding for a period of 180 days from the closing date of this solicitation. For contractual purposes, proposals submitted to DARPA should include a statement of work which does not contain proprietary information. Successful offerors will be expected to begin work no later than 28 days after contract award. For planning purposes, the contract award process is normally completed within 45 to 60 days from issuance of the selection notification letter to Phase I offerors.

To encourage the transition of SBIR research into DoD Systems, DARPA has implemented a Phase II Enhancement policy. Under this policy DARPA will provide a phase II company with additional phase II SBIR funding if the company can match the additional SBIR funds with non-SBIR funds from DoD core-mission funds or the private sector; or at the discretion of the DARPA Program Manager. DARPA will generally provide the additional Phase II funds by modifying the Phase II contract.

On a pilot basis, the DoD SBIR Program has implemented a streamlined Fast Track process for SBIR projects that attract matching cash from an outside investor for the Phase II SBIR effort, as well as for the interim effort between Phases I and II. Refer to Section 4.5 for Fast Track instructions. DARPA encourages Fast Track Applications between the 5th and 6th month of the Phase I effort. Technical dialogue with DARPA Program Managers is encouraged to ensure research continuity during the interim period and Phase II. If a Phase II contract is awarded under the Fast Track program, the amount of the interim funding will be deducted from the Phase II award amount. It is expected that interim funding will not exceed $40,000.

DARPA 1999 Phase I SBIR
Checklist

1) Proposal Format

   a. Cover Sheet - Appendix A (identify topic number) ______

   b. Project Summary - Appendix B ______

   c. Identification and Significance of Problem or Opportunity ______

   d. Phase I Technical Objectives ______

   e. Phase I Work Plan ______

   f. Related Work ______

   g. Relationship with Future Research and/or Development ______

   h. Commercialization Strategy ______

   i. Key Personnel, Resumes ______

   j. Facilities/Equipment ______

   k. Consultants ______

   l. Prior, Current, or Pending Support ______

   m. Cost Proposal (see Appendix C of this Solicitation) ______

   n. Company Commercialization Report - Appendix E ______

2) Bindings

   a. Staple proposals in upper left-hand corner. ______

   b. **Do not** use a cover. ______

   c. **Do not** use special bindings. ______

3) Page Limitation

   a. Total for each proposal is 25 pages inclusive of cost proposal and resumes. ______

   b. Beyond the 25 page limit do not send appendices, attachments and/or additional references. ______

   c. Company Commercialization Report (Appendix E) is not included in the page count. ______

4) Submission Requirement for Each Proposal

   a. Original proposal, including signed Appendices A and B ______

   b. Four photocopies of original proposal, including signed Appendices A, B and E. ______

INDEX OF DARPA FY99.2 TOPICS

SUBJECT/WORD INDEX TO THE DARPA FY99.2 TOPICS

DARPA 99.2 TOPIC DESCRIPTIONS

DARPA SB992-032 TITLE: Low Cost, Miniature Energy Storage and Management Devices

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: To develop an innovative, miniature, robust energy storage and management system for supplying multiple voltage levels to miniature sensor suites.

DESCRIPTION: Modular suites of micro-sensors for health monitoring of missiles/weapon systems (emphasizing small size, low power consumption, and low cost for environmental conditions sensing) are under development. It is envisioned that the microelectromechanical systems (MEMS) devices will be capable of detecting and/or measuring real time extremes in temperature, humidity, shock, strain, and adverse chemical presence for early-warning health monitoring of missiles in their storage containers, as well as other applications. A major technology barrier to implementing new and innovative sensor technology, however, is energy storage and management. New and innovative techniques are needed to provide micro-batteries and smart energy sources for supplying various power levels to the sensing devices, and conserving and managing the energy supply for a 10 year shelf-life. Not only do power sources need to be miniaturized, made 'smart', and made to last ten years (at a low cost), they also need to be able to withstand and function under the harshest of military environments. Small, smart, robust energy sources are a must for the future of miniature systems and a great technological challenge.

PHASE I: Develop a detailed approach to the development of an energy source for accomplishing the stringent objectives of this project. Analytically and/or with prototype devices demonstrate the capability of the proposed technology(ies) that will provide miniaturized, low-cost, 'smart' power to MEMS sensing devices over harsh environments for 10 years. Define all theoretical limitations of, and any technological barriers to implementation of, your design (including such parameters as minimal size, maximum peak capacity, output capabilities at hot and cold temperatures, etc.) Provide example energy demand profiles that the devices will be able to meet. Describe the concept for interfacing or integrating the energy devices with miniature sensors.

PHASE II: Fabricate and demonstrate prototype miniature power sources. Develop 'smart' processing for the power sources (discharging, recharging, scavenging, etc.) Assuming a cyclic energy usage profile, test and develop specifications for the micro-battery devices.

PHASE III DUAL USE APPLICATIONS: The dual use potential of the product from this effort is phenomenal. A DOD study of the MEMS technology market released in 1995 anticipates markets within the next decade to approach $3 billion per year. MEMS sensor production is currently over $200 million per year. Micro-battery technology directly feeds that industry. It is believed that micro-battery usage by MEMS sensor users would be near 100 percent. Furthermore, miniaturization technologies among multiple engineering disciplines (spanning military, bio-medical, and industry) could benefit from and apply 'smart', miniature power technology.

KEYWORDS: Batteries, Micro-Batteries, MEMS, Power Supplies, Energy Scavengers, Smart Technologies

REFERENCES: Department of Defense, "Microelectromechanical Systems: A DoD Dual Use Technology Industrial Assessment," December 1995.

DARPA SB992-033 TITLE: Low-Cost, High-Speed, Efficient Generation of Communication Signals Using Chaotic Devices

KEY TECHNOLOGY AREA: Command, Control, and Communications

OBJECTIVE: Creation of a prototype device that uses a chaotic signal generator along with a controller that can be used to produce communication signal.

DESCRIPTION: Research and development leading to a prototype signal generation device that exploits the natural complexity of chaotic systems. Efforts need not focus on synchronization of chaotic transmitter/receiver pairs, rather on the generation of a controllable sequence of pulses intended for communication purposes. Prototype devices can be either electronic or optical and should have a natural frequency of at least one megahertz and be scalable, in principle, to gigahertz frequencies using existing technology. An evaluation of possible benefits of this technology in terms of practicality, cost, size, reliability, and energy efficiency will be required.

PHASE I: Construction of a megahertz frequency chaotic device and a controller capable of fast switching between unstable periodic orbits for the purpose of producing useful symbol sequences. Define the limits of scalability and quantify the expected benefits.

PHASE II: Produce a prototype capable of being used as a drop-in replacement for a new or existing application. Prototype along with complete documentation of test cases and results must be delivered.

PHASE III DUAL USE APPLICATIONS: Harnessing chaotic dynamics from simple systems could result in reduced device complexity for wireless communication systems. Device simplification would lead to possible improvements in cost, size, reliability, and energy efficiency. Such improvements would be especially important for portable communication devices such as pagers and cellular phones as well as devices used by soldiers and unmanned ground and aerial vehicles. Deep underwater optical repeaters, satellites, and other difficult to access devices would also highly benefit from a reduction in complexity and power requirements.

KEYWORDS: Chaos, Chaos Control, Chaos Communications, Symbolic Dynamics

DARPA SB992-034 TITLE: Acoustic Bandgap Materials and Devices

KEY TECHNOLOGY AREAS: Air Vehicles, Materials, Surface, Manufacturing

OBJECTIVE: Develop the modeling and processing capability to manufacture components with regions of acoustic mismatched impedance such that the vibrations within a specific frequency range are selectively and substantially reduced in amplitude.

DESCRIPTION: Acoustic scattering from impedance mismatched regions within a component can be used to reduce or enhance sound propagation at a given frequency depending on the characteristics of the material(s), the positional relationships of the scattering regions, and the resulting phase shifts. This topic is designed to exploit this phenomenon for the fabrication of acoustic bandgap materials and devices. Potential applications include quieting or vibration reduction in heavy equipment mounts for rotating machinery, races for angular contact bearings, or other areas of significant impact on Department of Defense needs. Experiments to quantify the benefits of components made from these novel materials as a function of frequency should be conducted along with suitable controls. It is important to compare the performance of devices manufactured with acoustic bandgap materials with that of conventionally fabricated components. Thus, bandgap materials for use above 5,000 Hz (where passive damping materials are of limited effectiveness) are of particular interest. In order to effectively reduce sound and/or vibrations, acoustic bandgap materials typically contain two- and three-dimensional internal structures of mixed materials. Thus, one approach to the fabrication of these components is through the use of solid freeform (SFF) manufacturing methods. Because SFF technologies are toolless (machines fabricate parts directly from digital representations), optimized components containing specific mixtures and locations of materials may be developed rapidly and affordably. For example, it is anticipated that the use of SFF equipment may play an important role in the fabrication of inserts for metal or polymer cast structures.

PHASE I: Design, fabricate and characterize an acoustic bandgap material with a relatively simple geometry (plate, bar or rod). Characterization to include damping behavior as a function of frequency.

PHASE II: Design, fabricate and characterize equipment mounts or bearing races using acoustic bandgap materials. Develop analytical and/or experience based models for the design of acoustic bandgap materials. Develop optimization methodologies for acoustic performance and validate with experiments. Cost models and a plan for commercial exploitation of the technology should be developed.

PHASE III DUAL USE APPLICATIONS: Acoustic bandgap materials are of interest in all areas where the control of excess sound or vibration is important. Military and civilian applications include equipment/motor mounts, bearing races, acoustic imaging array back planes, aircraft engine mounts, and avionics chassis. The potential improvement in performance (at relatively low cost) and the enhancements in the reliability of the resulting system (through fewer deleterious vibrations) make these devices attractive for further development in the private sector.

KEYWORDS: Acoustic Bandgap, Vibration Reduction Noise Reduction, Solid Freeform Manufacturing, Bearings.

REFERENCES:

1. "Theory of Acoustic Band Structure of Periodic Elastic Composites", M.S. Kushwaha, P. Halevi, and G. Martinez, L. Dobrzynski and B. Djafari-Rouhani; Physical Review B, Vol. 49, No. 4, Jan. 15, 1994, pgs. 2312-2323.

2. "Band-gap Engineering in Periodic Elastic Composites", M.S. Kushwaha and P. Halevi, Applied Physics Letters, Vol. 64, No. 9, Feb. 28, 1994, pgs. 1085-1087.

3. "Ultrasonic Band Gap in a Periodic Two-Dimensional Composite", F.R. Montero de Espinosa, E, Jimenez and M. Torres, Physical Review Letters, Vol. 80, No. 6, Feb. 9, 1994, pgs. 1208-1211.

4. "Sonic bands, bandgaps and defect states in layered structures-theory and experiment", R. James, S. Woodley, C. Dyer and V. Humphrey, Journal of Acoustical Society, Vol. 97, No. 4, April 1995, pgs. 2041-2047.

5. "Large Two Dimensional Sonic Band Gaps", F. Meseguer, Acoustical Society of America meeting in Norfolk, VA 1998. Web site for the article is: http://www.acoustics.org/136th/meseg2.htm.

DARPA SB992-035 TITLE: Biomolecular Electronic Materials and Devices

KEY TECHNOLOGY AREAS: Electronics, Materials, Sensors

OBJECTIVE: Develop and test biomolecular materials and processes for the creation of novel electronic, photonic and/or energy-conversion devices of interest to the military.

DESCRIPTION: The field of biomolecular electronics is focused on using biomolecules or their complexes (e.g., photosensitive proteins) for application as independent functional devices capable of interfacing with modern electronics. Typical examples include biosensors (proteins used for molecular recognition and catalysis), photoconverters, optical correlators, and optical data storage devices. Many of these devices are based on natural constructions and schemes; especially devices using light sensitive retinal protein complexes (a critical component in the human vision process). For example, retinal proteins, such as bacteriorhodopsin, promise to make possible high performance volumetric memory storage systems and artificial retina (image) sensors. Recent work demonstrated the possibility of building high-speed optical random access memory based on retinal proteins. These memory devices could offer storage densities in excess of 100 gigabytes/cc. Through this research we seek to develop biomolecular materials, processing, and fabrication methodologies that will allow for the construction of novel photonic, electronic and/or energy-conversion devices. Research should focus on those materials that can offer a significant improvement (revolutionary) in the area of optical (and/or electronic) image and data processing and storage, multi-spectral sensing, analog sensor fusion and energy conversion such as artificial photosynthesis. Interesting biomolecular material and device properties include: fault tolerance, defect-tolerance, energy efficiency, the ability to power from sunlight, self-healing, and system-level approaches to connection to other devices.

PHASE I: Synthesize biomolecular materials having the proper functionality needed for optical and/or electronic processing applications (stability, processing, diffraction efficiency, etc.). Sufficient characterization of these materials to indicate that their properties may exceed those of the materials currently used in purely abiotic devices, or offer functionalities not capable in abiotic materials.

PHASE II: Design, fabricate, and test optical and/or electronic components (sub-devices) based on biomolecular materials (developed under Phase I) that will demonstrate the utility and enhanced capability of these materials in an application of interest to the military or intelligence communities (e.g., high-density data or image storage, multi-spectral imaging or sensing, analog sensor fusion, etc.).

PHASE III DUAL USE APPLICATIONS: These materials may impact an array of systems (both military and commercial) requiring high speed optical processing, biosensors, vision capabilities and ultra-high density data and image storage. In addition, these biomolecular materials can be tailored, through protein engineering, to meet applications that are only barely envisioned at this time.

KEYWORDS: Biomolecular Electronics, Retinal Proteins, Artificial Retina, Biosensors, Optical Data Storage.

REFERENCES:

1. Vsevolodov, N.N., Biomolecular Electronics: An Introduction Via Photosensitive Proteins, Birkhauser, Boston, 1998
2. Joshua, J. and Ratner, M., Molecular Electronics: A 'Chemistry for the 21st Century' Monograph, Blackwell Science Inc., Boston, 1997.
3. Benys, J.M. "Biomimicry", William Morrow and Company, New York. 1997.

DARPA SB992-036 TITLE: Direct Chemo-Mechanical Actuation

KEY TECHNOLOGY AREA: Surface/Undersurface Vehicles; Ground Vehicles

OBJECTIVE: Develop actuators capable of converting chemical energy directly into mechanical energy for applications involving autonomous robotic vehicles and/or lightweight devices to help humans augment their existing physical capabilities, e.g., human "exoskeletons."

DESCRIPTION: Autonomous machines like robots are often powered by electrical energy provided via batteries and/or solar arrays. While a variety of designs, architectures, and capabilities have been developed for these machines, most have very limited endurance and are, thus, of little military utility. Although needs for systems like combat-ready walking machines exist, significant electrical (battery) requirements often make them impractical from a logistics perspective. This results primarily from the low energy density of most batteries (<<500 Wh/kg). In contrast, hydrocarbon-based fuels have energy densities in excess of 10,000 Wh/kg, but their conversion to electricity via standard rotating machinery is relatively inefficient (typically much less than 20% in small sizes). Thus, this solicitation focuses on the design and proof-of-concept demonstration of a high-efficiency direct chemo-mechanical actuation system. This actuation system should be capable of producing large forces (1-40 N) over strokes ranging from 2-20 cm ideally with common hydrocarbon-based fuels. These actuators would allow, for example, for the development of long-range (5-20 km) walking machines or of an active "exoskeleton" to assist and enhance a soldier's locomotion and load bearing capabilities. Other applications for these devices that support DoD system needs are of interest as well. These chemo-mechanical actuators need to be controllable so that varying degrees of force may be obtained, possibly akin to conventional pneumatic actuators but without the need for a traditional compressor. One approach to obtain this controllability may be to regulate the amount of fuel consumed via mesoscale devices, smart material actuators, or even micro-electromechanical systems (MEMS) based components. Such devices should be able to properly control combustion/reaction processes, fuel/oxidizer mixing, and/or other elements of the system in order to achieve the desired level of force fidelity. A small amount of electrical energy for command and control may be necessary, but all mechanical work should be the result of direct chemo-mechanical transduction.

PHASE I: A preliminary/conceptual design for the actuator architecture will be developed and its feasibility will be demonstrated via analyses/modeling. A test of at least one critical component of the actuator system will be performed to prove the efficacy of the core ideas behind the device.

PHASE II: The actuator concept developed in Phase I will be applied to a complex machine such as a lightweight "exoskeleton" capable of augmenting the existing performance level of a human limb or an autonomous, multi-legged vehicle capable of "walking" at least 3.0 km. Integrated sensor feedback and control for the actuation system (s) should be included.

PHASE III DUAL USE APPLICATIONS: Actuators are crucial components throughout our industrial infrastructure. Numerous applications that utilize direct chemical-to-mechanical conversion concepts may be possible in areas ranging from construction equipment to pumps to field-portable equipment. A lightweight "exoskeleton" system capable of enhancing a soldier's mobility (endurance) and load bearing capability would be of interest to the military. Another area of interest would be machines capable of autonomous locomotion for long duration operations; these machines would be useful for intelligence gathering missions in a variety of battle scenarios and terrains.

KEYWORDS: Direct Chemo-Mechanical Actuation, Robotics, Exoskeletons, Actuators, Smart Materials, Controls

DARPA SB992-037 TITLE: Miniature Piezomotors

KEY TECHNOLOGY AREAS: Air Vehicles, Materials, Surface, Manufacturing

OBJECTIVE: Develop small-scale, piezoelectric motors that efficiently convert electrical energy directly to mechanical energy.

DESCRIPTION: There is a need for small (mesoscale), high efficiency electromechanical motors on the order of 0.1-10 cubic centimeters in size. At this scale, the energy density of piezoceramics and emerging single crystals piezoelectrics make these transducer materials attractive when compared to traditional electromagnetic devices. In order to develop efficient actuation systems, transduction elements need to be concurrently designed with driving power electronics, however. For example, the capacitive nature of the actuator's piezoelements should be tuned both electrically and mechanically to the same frequency in order to maximize the system efficiency (greater than 80%). A piezomotor must then find a way to drive the actuator in resonance while still achieving a controllable output. Other approaches to increase efficiency include schemes such as charge recovery in the driving amplifier. The power electronics design should constitute a significant part of the proposed effort. While numerous Coulombic drive piezomotors have been developed, novel designs that utilize genuine mechanical interference instead of friction are of particular interest. The precision typically generated in a Coulombic motor may be sacrificed to produce a high-speed device (10-50 msec time constants). Overall motor work output should be on the order of 1-10 watts and its efficiency and power density must exceed that of even the best electromechanical motors of comparable size.

PHASE I: A design for the mechanical and electrical portions of the actuator will be developed, including modeling adequate enough to infer that the performance of the device exceeds state-of-the art electromechanical motors. Preliminary electromechanical tests will be performed to examine and prove the fundamental concept of the device.

PHASE II: Working devices will be fully integrated with the power electronic system and electronic miniaturization will be pursued. The devices will be tested for efficiency, power, etc. in both terrestrial and space environment operations. The device will be specified for an application of interest to the military and/or intelligence communities and tested in situ.

PHASE III DUAL USE APPLICATIONS: The high cost of future space missions is driving our satellites and spacecraft to become ever smaller, yet actuators for the deployment of satellite subsystems, such as radiators, solar arrays or antennas, still rely on large, inefficient electromagnetic release mechanisms and motors. Small, efficient piezomotors are expected to enable more complex, reliable appendage articulation and deployments in a compact package. Aeroelastic and shape control of aircraft structures and small robotic actuation are other potential military and civilian applications of these motors. In addition, a distributed system of these active devices may permit accurate control of wings and engine inlets for enhanced flight capability (thus replacing heavy, costly, and inherently unreliable pneumatic controls).

KEYWORDS: Piezoelectrics, Smart Materials, Actuators, Motors, Electromechanics

REFERENCES:

1. Wallaschek, J., "Piezoelectric Ultrasonic Motors," Journal of Intelligent Material Systems and Structures, Vol. 6, Jan. 1995, pg. 71-83
2. Ueha, S., "Present State of the Art of Ultrasonic Motors," Journal Name Japanese Journal of Applied Physics, Vol. 28, 1989, Supplement 28-1, pg 3-6

DARPA SB992-038 TITLE: Terahertz (Thz) Device Technology

KEY TECHNOLOGY AREAS: Command & Control(C3), Electronics, Materials, Manufacturing, Modeling

OBJECTIVE: Development of solid state terahertz devices for operation in the range between 0.3 Thz to 10 Thz suitable for coherent sources and detectors for use in space-based and short range terrestrial communications, atmospheric sensing, and near object analysis.

DESCRIPTION: The electromagnetic spectrum from 300 Ghz to 10 Thz is scientifically rich but relatively technologically poor. The region represents a gap separating electronics, oriented towards transport, from photonics, oriented toward quantum transistors. Devices that mix quantum and transport physics will fill this void. The region offers the potential for a number of applications including space-based and short-range terrestrial or near earth communications, atmospheric sensing, collision avoidance for aircraft and ground vehicles, and near object observation and spectroscopy. To realize this potential the appropriate sources, detectors, and systems need to be developed. Innovative approaches are needed leading to the development, fabrication, and operation of coherent solid state terahertz sources. Efforts may include electrically excited devices as well as those driven by solid state optical lasers. Three terminal devices, and classical approaches, such as Gunn diode oscillators may be considered as long as proper power and efficiency advances are addressed. Highly desired are approaches in quantum wells and tunneling devices, as well as other novel quantum structure approaches. Desired are devices and device concepts that will deliver coherent radiation at potentially milliwatt power level, ultimately coupled efficiently in Thz circuits, guided wave structures and antennas. Work is needed in detectors to greatly improve the sensitivity, speed, and bandwidth. Specifically desired are efforts in semiconductor-based quantum well structures and the subsequent development of a useable detector that is narrow band, widely tunable, and yet highly sensitive. Other solid-state approaches may be considered. Approaches toward compact system modules addressing both generation and detection are also of interest.

PHASE I: Clearly demonstrate the feasibility of the proposed approach. Define the device that will deliver up to milliwatts of coherent radiation at specified frequencies in the Thz regime. And/or define the detector or detector structure detailing optimal geometry, bandwidth limitations, tunability, and current-carrying capacity. The definition of the device/ system-module needs to include principal of operation, material, processing, associated circuit or guided wave structure, and regime of operation.

PHASE II: Build upon Phase 1 work with a demonstration of system components and implementation of a prototype. Perform appropriate analysis and modeling, grow the material or structure, fabricate the device and test its performance.

PHASE III DUAL USE APPLICATIONS: Terahertz electronics and photonics have many potential applications. Covert communication on the battle field or in space, chemical agent detection, atmospheric environment sensing, near object detection, material imaging will benefit from new technology in this part of the electromagnetic spectrum. New terahertz electronics will also make possible ultra high speed signal processing.

KEYWORDS: Microelectronics, Photonics, Terahertz, Terahertz Electronics, Communications, Sensing, Heterojunctions, Quantum Wells, Semiconductors, Solid State, Sources, Detectors

DARPA SB992-039 TITLE: Very High Speed Atomic Force Microscope Imaging

KEY TECHNOLOGY AREA: Electronics

OBJECTIVE: Develop an atomic force microscope based instrument for high-speed, large-field, imaging in the contact and intermittent-contact modes of operation.

DESCRIPTION: The atomic force microscope (AFM) is a compact non-invasive tool for the characterization of surfaces with significant amounts of relief. While the advantages of the AFM are well documented, it has one overriding drawback which has limited its use in DoD and commercial applications. This disadvantage is that only extremely slow scanning rates are possible. For example, state of the art performance is such that data acquisition rates are limited to ~300 Hz, i.e. a 256 by 256 image, over 50 m square with several microns of topography, takes over four minutes. This SBIR seeks to sponsor the development of AFM type instrumentation to scan a 50 m (or greater) field containing microns of relief at scan rates 1 to 2 orders of magnitude faster than this level of performance, i.e. about a second. The instrument should incorporate both contact and intermittent-contact mode operation with lateral and vertical position measurement accuracy in the nanometer range.

PHASE I: Define and analyze the approach to high-speed, large-field AFM imaging. Quantify the expected benefits and describe the limits of performance. Provide proof of concept demonstration of critical components.

PHASE II: Develop a high-speed, large-field AFM prototype with a sample translation capability. Demonstrate high speed AFM imaging in the contact and intermittent-contact modes on a variety of semiconductor and data storage samples.

PHASE III DUAL USE APPLICATIONS: Microelectronics is key to numerous DoD systems. Inspection and monitoring of critical levels is essential to maintain process control and yield. The AFM offers significant advantages over existing tooling as it provides true 3D surface characterization and metrology with nanometer scale accuracy without invasive and damaging incident radiation. DoD will benefit by having such tooling on its dedicated fabrication lines. In the commercial sector, improving the speed of the AFM without sacrificing its sensitivity would allow the use of the AFM where high-throughput is required such as microelectronics manufacturing, biotechnology and data storage manufacture.

KEYWORDS: Atomic Force Microscope, AFM, Imaging, Metrology, Inspection, Imaging, Proximal Probe, Contact, Intermittent Contact, 3D Imaging, Surfaces

DARPA SB992-040 TITLE: Computer-Assisted Modeling of Urban Environments

KEY TECHNOLOGY AREAS: Computing

OBJECTIVE: The objective is to design and develop an integrated geospatial data extraction workstation with capabilities to insert image understanding (IU) components for the automated extraction and three-dimensional (3D) representation of urban terrain (e.g., buildings, roads, vegetation, complex terrain) from digital space, airborne and/or terrestrial imagery.

DESCRIPTION: There is growing need for more cost-effective capabilities to generate 3D models of urban environments. Current operational capabilities are largely based on interactive photogrammetric, radargrammetric or computer-aided design (CAD) workstations. Algorithms to partially automate the extraction of urban features such as buildings, roads, vegetation and complex terrain are being developed and demonstrated in the image understanding (IU) research community. There is an opportunity to design and develop an advanced geospatial data extraction workstation that integrates the functionality of disparate photogrammetric, radargrammetric and CAD systems. The system would be capable of generating integrated geospatial models of urban environments (e.g., buildings that lie on the terrain, water runs downhill, cut-and-fill roadbeds, overpasses and undercrossings modeled with 3D topology). Interfaces to facilitate insertion of automated feature extraction components would enable incremental evolution of the system to support increasingly higher levels of automation. Specific goals towards these objectives include implementation of Application Program Interfaces (APIs) for the geometric modeling of disparate sensors, APIs for insertion of urban feature extraction components, and a mechanism for transmittal of derived complex 3D spatial data such as the Synthetic Environment Data Representation and Interchange Specification (SEDRIS).

PHASE I: Identify critical design issues for desired workstation and associated APIs. Refine concepts for integration of sensor model and image understanding components to meet system objectives. Conduct experiments to establish essential functionality. Specify targeted commercial and military applications. Deliver a specification, development plan, testing plan and cost estimate for the prototype system.

PHASE II: Implement the system and produce a functional prototype. Integrate at least one urban feature extraction algorithm. Demonstrate system performance in accordance with testing plan. Evaluate operating characteristics of the implemented system. Prepare marketing plan for targeted commercial and military applications.

PHASE III DUAL USE APPLICATIONS: Potential Phase III dual use applications lie in both defense and civilian applications for planning and execution of operations in urban environments. Military applications of increasing importance include force protection and military operations in urban terrain. Projected commercial growth areas for urban mapping include planning for the wireless communications industry and the security surveillance industry.

KEYWORDS: Photogrammetric Workstation, Radargrammetric Workstation, Interferometic Synthetic Aperture Radar, IFSAR, Image Understanding, Computer Vision, Digital Mapping, Urban Environments

REFERENCES:
1. DARPA Image Understanding Program Home Page (http://www.darpa.mil/iso/iu/)
2. SEDRIS Home Page (http://www.sedris.org/)

DARPA SB992-041 TITLE: Modeling The Terrorist Threat

KEY TECHNOLOGY AREAS: Modeling

OBJECTIVE: Develop a family of adaptive cognitive and behavioral models representing a terrorist organization's capabilities and vulnerabilities to support enhanced detection, assessment, and interdiction.

DESCRIPTION: To date there are at least twenty countries and over 400 organizations considered hostile to the United States and its allies. Increasing these countries and organizations to directly have or have access to weapons of mass destruction. As a result of this heightened threat, the United States strategy must increasingly focus on developing detection, assessment, and interdiction capability of the potential threat at the earliest possible time within the terrorist decision cycle. Research advances in area of cognitive and behavioral modeling offer potential enhancement to the predictive capability of these terrorist threats. However, there still remain some significant challenges to modeling the robust characteristics necessary to adequately represent and provide a predictive capability of an evolving organization in a dynamic environment such as terrorism and counter terrorism. Technology shortcomings include modeling of behavior moderators (ideology, cultural values, personality, etc), organizational dynamics and adaptive learning. In an effort to meet the objective of this SBIR, research may draw upon existing models, architectures, and techniques or create new ones. However, the approach should yield a significantly enhanced predictive capability in the following areas: early detection of potential threats; automated mapping of threat attributes and capability to potential targets; assessment of the potential target's vulnerability; assessment of the potential threat's vulnerability; and automated development of a range of recommended courses of action to support both force protection and interdiction.

PHASE I: In detail, conceptualize approaches for developing and validating a family of adaptive cognitive and behavioral models representing a terrorist organization's capabilities and vulnerabilities throughout its respective life-cycle, to include formation/emergence, fragmentation, reconstitution, and dissolution.

PHASE II: Create an implementation of the models to embody complete functionality of the components being demonstrated and validated. Provide complete documentation of test cases and results.

PHASE III DUAL USE APPLICATIONS: The development of organizational modeling algorithms and technologies will have a very strong commercial potential, to include a wide range of organizations and other social systems in both the private- (e.g., municipal planning) and public-sector (e.g., EPA response to hazardous materials incidents).

KEYWORDS: Cognitive Modeling, Behavior Modeling, Psychosocial Modeling, Decision-Making Modeling, Information Warfare, Information Dominance, Adaptive Learning, Adaptive Behavior.

DARPA SB992-042 TITLE: Human Interaction with Software Agents

KEY TECHNOLOGY AREAS: Computing

OBJECTIVE: Improve military information management systems for C4I applications through the development of tools that allow users to create, dispatch, steer, and control the performance of information agents, mobile code, and/or multi-agent software systems.

DESCRIPTION: This effort will conduct research and development leading to tools that enhance the abilities of users to interact with large information spaces and/or heterogeneous systems via the use of software agent technology. Efforts may address any aspect of agent-based computing for which significant leverage can be demonstrated; however, the area of human-computer interaction with agent-based code is of particular interest. Efforts should emphasize the creation of tools that enable users to create agent-based software, to dispatch the agent to do a search, query or other task, to determine the status of the agent, and/or to set preferences that "steer" the agent towards specific information sources or other resources.

PHASE I: Define the approach, and precisely explain the expected benefits of the system. Implement a feasibility demonstration of system functionality.

PHASE II: Design and build a prototype tool that embodies the approach, and show its performance on one or more demonstration of information management for military C4I systems. Complete documentation of test cases and results will be delivered.

PHASE III DUAL USE APPLICATIONS: Perform specific system demonstrations on end-to-end performance of the system on information management problems for military C4I. The development of agent-based software is a critical need in both military and industrial applications. This work will stress those current uses of agent-based codes that include information-seeking applications, user guidance and querying aid for large knowledge sources, and for other distributed information management and search applications. Better human-interaction tools for the programming and control of agents will enhance the military's ability to efficiently and rapidly find information on open-source and classified resources in support of both conventional and asymmetrical warfare. It will similarly allow non-government users to more efficiently find information in their large databases or on the Internet. In addition, the scaling of agent-based software appears to be a key enabler for e-commerce technologies that will allow significant cost savings in both the military and civilian sectors.

KEYWORDS: Agent-Based Computing, Human-Computer Interface, Distributed Information Sources, Information Agents, Integration of Information, Mobile Code.

REFERENCES:

1. US Air Force Science Advisory Board, "Information Management to Support the Warrior," 1999 - see http://web.fie.com/fedix/sab.html
2. J. Hendler, Intelligent Agents --- Where AI meets Information Technology, IEEE Expert , December, 1996

DARPA SB992-043 TITLE: Cyber Defense Situation Modeling

KEY TECHNOLOGY AREAS: Computing

OBJECTIVE: Development of techniques and tools for representing and assessing system status, readiness, potential attack circumstances, and defensive options to enable effective response.

DESCRIPTION: Research and development leading to techniques and tools that provide effective representation of the situation faced by a large system or application in relation to potential or ongoing information warfare attacks and its own ability to withstand such attacks to preserve its mission. Such techniques may either focus on performing computerized analysis or simply present relevant information in such a way as to significantly improve human ability to understand and assess the cyber defense situation. While efforts may address any technique for which significant leverage can be demonstrated, areas of particular interest include: abstraction of single host characteristics and detailed sensor data (e.g., from intrusion detection systems) to a higher conceptual level, representing application or mission impact; postulation and testing of hypotheses concerning attacker objectives; effective visual representations of cyber defense situation; modeling of system information flow and effects of disruptions; identification and selection of key system and application characteristics and information elements that best represent the current situation or serve as bellwethers for conditions of particular concern; modeling of defensive options and their impact on both attack progress and the system mission, including temporal elements; and adaptation of techniques from previous work in military situation awareness. Efforts may draw from existing methods, algorithms, or tools or create new ones, but in all cases proposals must clearly state what improvements are expected, for what ranges of system and application types, to what scale, for what types of attacks and under what conditions.

PHASE I: In detail, define the technique or approach to cyber defense situation representation and demonstrate its benefit through limited prototyping.

PHASE II: Create the full implementation of a tool that embodies the technique and validate its benefits for an actual large, mission-relevant system, using substantial data sets, by experiment, simulation, or case studies.

PHASE III DUAL USE APPLICATIONS: The development of effective models and representation of system defensive state against potential and actual attacks is important for Internet service providers, large distributed commercial enterprises, and critical infrastructure organizations. This type of capability will help lead to the ability to weigh overall effectiveness of options for reacting to developing attack situations, which should have significant dual-use applicability to the kinds of organizations noted.

KEYWORDS: Information Warfare, Situation Awareness, Security, Attack Modeling, Intrusion Detection and Response, Visualization, Indications and Warning

DARPA SB992-044 TITLE: Technologies to Support Real-Time Human Immersive Environments

KEY TECHNOLOGY AREAS: Human Systems

OBJECTIVE: Develop algorithms and other computational techniques that reduce processing and telecommunication loads for technologies that can achieve "virtual" teleportation of humans for Remote Human-Human Interfaces (RHHI) and Remote Human Computer Interfaces (RHCI).

DESCRIPTION: Recent advances in 3D video pixelization of remote environments and 3D immersive air-acoustic sound fields make concepts for "virtual" teleportation feasible for prescribed scenarios at a cost of highly intensive preprocessed computations of the "virtual" field. Such capability make it possible to envision fully dynamic "virtual worlds" where humans can join together in collaborative environments with other humans and/or machine data representations for sharing data and conveying decisions. In such environments, the distinction between real and projected representations of human forms and graphical displays and decision aids is lost, thereby enabling true collaboration and data transfer without hardware. The removal of a prescribed and restrictive hardware environment provides flexibility for providing the most appropriate media channels and forms for transfer of information. Additionally, other biometrics measurements may be transmitted to enhance the quality of sensation required for conveying more realistic personal experiences of "physical" presence in a "virtual" world. However, achieving this level of real-time remote immersive environments probably requires several orders of magnitude speed-up in both the computations associated with the generation of the 3D visual-acoustic field and the transmission of data for remotely projecting the environment. Therefore, algorithmic methods are being sought to reduce these processing demands and communication loads.

PHASE I: In detail, conceptualize approaches for developing real-time RHHI and RHCI capabilities and method for sampling and conveying digitized biometrics measurements that convey sensory evidence of human presence. Phase I initiatives should demonstrate feasibility of achieving significant speed-up in computational and/or communication bandwidth reduction.

PHASE II: Create an implementation of algorithms that embodies complete functionality of the components being demonstrated, and validates performance and multi-scalability. Complete documentation of test cases and results must be delivered.

PHASE III DUAL USE APPLICATIONS: The development of such algorithms enables a new level of realism in collaborative environments for business, travel and leisure. These investments will further enhance the capabilities of interface systems to meet the process needs such as countering future military for providing direct interface between operational commanders and subordinate staff assigned with the execution of mission. Such applications will add to maintaining military and commercial superiority throughout the world.

KEYWORDS: Virtual Reality, Virtual Immersion, Teleportation, High Performance Computing, Data Compression, Biometrics Measurements, 3D Virtual Environments, Acoustic Signal Processing, Virtual Acoustic Environments, 3D Pixelization, Virtual Human Environments, Remote Human-Human Interfaces, Remote Human-Computer Interfaces.

DARPA SB992-045 TITLE: Handheld One-way Voice Communications System

KEY TECHNOLOGY AREAS: Computing

OBJECTIVE: To develop a handheld voice-to-voice one-way communications device capable of translating spoken English into another language.

DESCRIPTION: There is a need by the military and civilians to be able to communicate by voice in another language without the use of a human interpreter. While the concept of one-way voice-to-voice communications has been demonstrated, a robust and affordable system solution is needed. Moreover, until now a relatively powerful notebook computer with external microphone and speaker has been used; this configuration needs to follow industry trends and be implemented in a small, light weight configuration. The heart of the problem is system components that work for a wide range of minimally trained users. Work in text based machine translation indicates that a true two way speech translator is not feasible as an affordable product at present. The envisioned handheld one-way translation system will be simplified by focussing on domains like travel and crisis management, and will enable the user to easily conduct one-way voice communications in another language. System features should include: accurate translation of up to 2000 phrases for each task area; reliability and robustness; small size and weight; ease of use and training; ease of adding additional language translations and mission specific modules; and affordability in production quantities.

PHASE I: Develop a concept of operations and preliminary design. System components should include: hand held hardware (processor, storage, display, microphone, and speaker), application software, and phrase module database management.

PHASE II: Design, build and demonstrate engineering prototype system. Employ prototype system in operational scenarios and evaluate. Extensively stress test the system for two selected tasks such as crisis information interviewing, and common travel and navigation tasks in several languages including but not limited to Arabic, Mandarin, and Korean.

PHASE III DUAL USE APPLICATIONS: Identified military applications for this technology include special operations, medical interview, military training, check points, and ship boardings and inspections. Government applications include: use by police and firefighters directing or interviewing non English speakers in multicultural cities; U.S. Customs inspections; and humanitarian assistance. Commercial users include tourists and business travelers, and commercial aviation flight crews.

KEYWORDS: Voice Communications, Machine Translation, Translator.

DARPA SB992-046 TITLE: Stand-off Biosensors and Air-Motion Sensors

KEY TECHNOLOGY AREAS: Chemical/Bio Defense, Sensors

OBJECTIVE: Development of unattended sensors which rapidly provide a sensitive and accurate warning of the presence and identity of biological threat agents at a distance of 1 km or greater, and which also measure air velocity.

DESCRIPTION: Biological agents, which may occur in many forms, e.g. bacteria, spores, viruses are extremely difficult to detect and classify, especially at longer ranges from the sensor (1-10 km). This solicitation requests novel sensor technologies (or improvements of existing sensor technology) which detect, locate, classify, and measure the level of all biological threats at stand-off ranges. Also desirable is the ability to measure air motion in 3-D, perhaps using the same sensor, and taking advantage of doppler effect and the sensor ability to measure range. Use of particulate measurement may provide a capability to measure airflow. The detection technology desired can be modified to have sensitivity against any new biological threat, and react without modifications to pathological variants of known agents. Ideally, the sensitivity should be an order of magnitude or more above that of a lethal/infectious dose for 10% of the population, but due to the stand-off nature of the sensor, considerably less sensitivity may be adequate. Use of multiple sensors to detect and track a cloud of agent, and predict its future path is desirable. The detector technology should be able to classify the agent and measure the threat density. The technology should support minimally attended operation, operation in the presence of interferants such as would be found in urban or battlefield situations, and provide a response in a few minutes or less, with low false alarm rate. A quantitative measurement of agent density is required. Small size is desirable. No known sensors currently available meet the above criteria. Understanding of the physical and biological processes that form the basis of detector operation is required, along with propagation prediction, and must be expressed through modeling of sensor behavior.

PHASE I: Design and demonstrate a laboratory prototype with sensitivity to a harmless agent or agents (simulants) which approximate a biological weapon(s), and validate modeling of performance.

PHASE II: Design and fabricate a laboratory prototype sensor which verifies performance quantitative models of sensitivity and false alarm characteristics against a variety of simulants.

PHASE III DUAL USE APPLICATIONS: The biological threat includes such agents as anthrax, plague, smallpox, and e-boli. These agents may be released inside or outside military/government facilities, and the response to protect life depends on rapid, reliable detection and classification of threat agents with very low false alarms. The civilian sector has a very similar threat environment due to terrorists who could take advantage of the very small quantities of agent required, and the difficulty of defense. The sensors developed may also have a much wider range of applications, including verification of Computational Fluid Dynamics code to predict air flow for building heating and cooling systems, and modeling of the intrusion of external irritants into a building.

KEYWORDS: Biological Defense, Biological Sensors, Stand-Off Biological Sensors, Sensors, Air Particle Counters, Meteorological Instruments.

DARPA SB992-047 TITLE: Wide-Area Terrain Mapping Using Ground Moving Target Indicator (GMTI) Radar

KEY TECHNOLOGY AREAS: Sensors

OBJECTIVE: Development of GMTI radar signal processing and image exploitation techniques to provide on-demand, near-real-time measurement of terrain elevation maps over very large areas.

DESCRIPTION: In standard GMTI radar operation ground clutter is purposefully filtered out using Doppler processing. However, many applications of GMTI, such as the military applications of tracking and targeting and civilian applications such as traffic monitoring and support to disaster relief, require accurate knowledge of terrain elevation and terrain feature positions (e.g. roads). While terrain elevation databases currently exist, the coverage is currently far from global. Other sensors which could potentially provide terrain survey information may not be available in a timely manner. Furthermore, even in regions for which these data exist, resolution varies, there are often bias errors in overall accuracy, and elevation and features may change over time due to natural (e.g. landslides) and human (e.g. construction) events. When GMTI Doppler filters are turned off, the result is a map of ground clutter return, showing all regions masked by terrain as shadowed areas. While GMTI resolution cells are coarse (e.g. Global Hawk GMTI resolution is approximately 10-m in range and 100-m in azimuth), GMTI radar provide repetitive coverage of potentially very large areas at very high revisit rates. It may be possible to take advantage of the rapidly changing geometry provided by these revisits to make estimates of terrain elevation very accurately registered to the sensor coordinate space by calculating the change in shadows with sensor geometry. This effect could be enhanced further by using any available terrain databases as a priori information in the calculation.

PHASE I: Develop and define in detail the mathematical and processing approach for real-time GMTI-based terrain elevation measurement for cases with and without a priori terrain elevation data. Demonstrate the capability non-real-time using simplified simulated data to be provided by the government.

PHASE II: Develop a real-time version of the algorithm developed under Phase I. Evaluate performance of the algorithm under a variety of conditions, including different terrain types, sensor parameters and geometry, and accuracy of a priori data.

PHASE III DUAL USE APPLICATIONS: There is a rapidly growing number of available GMTI radar, both military and civilian. On the military side, the Joint Surveillance Target Attack Radar System (JSTARS) is already operational and the Global Hawk Unmanned Aerial Vehicle (UAV) is in final development phases. On the civilian side, Raytheon sells the HISAR multi-mode radar with a GMTI mode, and the Canadian RadarSat II may include a GMTI mode. The growing availability of GMTI data make possible such dual-use applications as vehicle flow analysis for traffic monitoring and assessment of terrain conditions and trafficability during natural disasters. None of these techniques is possible without terrain data accurately registered in the radar's reference frame. The successful completion of this effort would facilitate these dual-use GMTI applications by providing these sensors to collect this type of registered terrain data in real-time without relying upon the availability of current, accurate databases or supplemental terrain mapping sensors.

KEYWORDS: Radar, GMTI, Terrain Registration, Doppler Processing, Image Processing, Terrain Feature Extraction.

DARPA SB992-048 TITLE: Active Spectral Sensors

KEY TECHNOLOGY AREA: Sensors

OBJECTIVE: Development of scattering theory and material classification technology specific to active illumination to support the development of active spectral sensors.

DESCRIPTION: There is a proliferation of sensors and applications for passive multi- and hyper-spectral processing. These include military applications, such as the detection of camouflaged targets, and civilian applications, such as the characterization of terrain material properties. Any type of material classification application prefers to function in the visible to near-infrared (IR) region of the optical spectrum. However, for passive sensors this region is completely undetectable at night or in poor visibility conditions. For certain military applications, this problem has been somewhat alleviated by operating in the mid- and far-IR regions, but these give worse spatial resolution and much worse material classification capability. Furthermore, all passive techniques suffer from variations in illumination, target emissivity, and additional diurnal effects. One way to operate in the more beneficial visible to near-IR region while avoiding the above problems with variants is to illuminate the scene of interest actively with a tunable laser transmitter. Unfortunately such broadly tunable lasers are very difficult to build at practical energy levels for remote sensing, so it is desirable to identify first the optimal radiation bands. While much of this can be determined from existing spectral reflectivity databases, material phenomenology will be somewhat different because of the glint returns present in active sensing and the variation of glint properties with wavelength.

PHASE I: Develop a theoretical model to predict unique active illumination spectral phenomenology. Model should highlight the variation of optical scattering physics as a function of wavelength. Develop an initial design of spectral material classification based upon this model, with special emphasis on feature invariants resulting from active illumination. Determine optimal illumination bands based upon these initial studies as well as understanding of existing and near-term developmental laser sources.

PHASE II: Develop a laboratory test apparatus, including a broadly tunable laser illumination source, to evaluate theory developed in Phase I. Experimentally confirm phenomenology predictions. Fully develop active spectral material classification algorithms, and evaluate their performance using the laboratory test apparatus. Use this evaluation to produce the design for a fieldable active spectral sensor, including transmitter, receiver, and processing algorithms.

PHASE III DUAL USE APPLICATIONS: There is a current proliferation of applications for spectral technology. On the military side, such a sensor facilitates the detection and classification of camouflaged and otherwise hidden targets. Civilian applications focus on classification of terrain types and properties for mineral detection, environmental planning, and agriculture. Active capability permits the flexibility to execute these applications day or night, even in moderately poor weather conditions. Furthermore, the use of active illumination eliminates many of the variants common to passive illumination that degrade passive spectral robustness. The availability of potentially higher spatial resolutions as well as the added degrees of freedom of range and polarization provide the potential for great enhancements of baseline spectral capability.

KEYWORDS: Multi-Spectral, Hyper-Spectral, Active Spectral, Laser Radar, Ladar, Lidar, Tunable Lasers, Material Scattering Phenomenology, Material Classification.

DARPA SB992-049 TITLE: Autonomous Satellite Docking System

KEY TECHNOLOGY AREAS: Air Vehicles, Sensors

OBJECTIVE: Development of a precision autonomous satellite docking sensor and guidance system.

DESCRIPTION: Future unmanned satellites may evolve to require periodic servicing by low cost unmanned micro shuttles. What is envisioned in this topic is an end game sensor and navigation subsystem to allow precise and autonomous docking of the micro shuttle and the satellite to be serviced. An ideal solution would provide a supervisory, "man in the loop", yet fundamentally autonomous control system to provide regular low risk docking with suitably designed satellites. Simple docking mechanisms allowing less precise two body docking control are envisioned. Final docking sensors and guidance systems proposed efforts under this topic may address specific partial technology barriers and opportunities germane to ultimate vision, but must include system engineering efforts aimed at identifying remaining critical technology factors. Proposed efforts should encompass technology maturation through development and exercise of appropriate test items. Research areas of interest include but are not limited to precise automatic determination of the position and orientation of a complex three dimensiional body in space, automated control of a final approach trajectory in six dimensions, and effective use of a ground based human controller.

PHASE I: In detail, define the technology development to be undertaken and model expected operation. Conduct initial survey to scope system-level concept, define expected performance, and identify remaining technology issues.

PHASE II: Develop and exercise test items demonstrating critical technology issues. Complete system engineering definition and validate expected system-level performance. Develop approaches for addressing remaining technology issues.

PHASE III DUAL USE APPLICATIONS: Development of autonomous satellite servicing systems would have a wide range of uses in both the military and commercial arenas. Obvious applications in commercial markets include communications satellites, navigation satellites and potential for space station micro resupply. Military application would include surveillance and reconnaissance satellites as well as military communications satellites.

KEYWORDS: Reconnaissance Satellites, Electronic System Design, Sensors, Navigation, Autonomous Systems, Satellite Communications.

DARPA SB992-050 TITLE: Shape Shifting Portable Robots

KEY TECHNOLOGY AREAS: Surface

OBJECTIVE: This topic seeks to enable the development of portable robotic platforms that can change shape to gain access to denied areas and support Military Operations in Urban Terrain (MOUT) by functioning efficiently within confined spaces in urban environments.

DESCRIPTION: This effort will promote innovative research and development leading to adaptive re-configuration technologies that can be realized in portable reconnaissance systems. Efforts may address any innovative design that can provide mobile robots with an ability to vary their geometric alignment on any particular axis or combination of axes to adapt to confined space entry points (such as in collapsed buildings) and perform reconnaissance and rudimentary manipulation (push, pull, prod, etc.) tasks once inside.

PHASE I: Define the innovative approach in detail and describe enabling technologies that will address design and integration challenges associated with variable geometry such as adaptive materials, actuators, sensor arrangement, communications, power, etc. Present a basic design approach to the development of a portable (man-packable) shape shifting robot for use in confined spaces.

PHASE II: Design and build a functional shape-shifting robotic platform that is capable of penetrating a collapsed structure (to a distance of approximately 300 meters) and searching for trapped victims and hazardous materials inside. The system should provide 2 way audio and visual sensing modalities as a minimum. Additional payload capacity for chem/bio sensors is highly desired but not essential to the effort. System should strive for, but not be limited to a 4-hour mission duration and wireless communications where possible. Partial autonomy is desired in terms of fault tolerant navigation and severed communication recovery.

PHASE III DUAL USE APPLICATIONS: Portable robotic platforms have been envisioned as USAR (Urban Search and Rescue) assets since the SOFROB (Special Operations Robotics) and KNOBSAR (Knowledge Base for Search and Rescue) projects were initiated in 1994. Operational experience in the aftermath of the Oklahoma City Bombing and the Oakland Freeway Collapse (Northridge Earthquake) indicates that small shape shifting robots could be of enormous value in negotiating confined spaces in search of victims. Once found, victims could be further supported via transport of material (oxygen, medicine, water, food, etc.) via towed tubes, and human interface via 2 way speakers. Additional potential exists for applications in law enforcement, industrial inspection, confines space welding, shipbuilding, etc.

KEYWORDS: Robotics, Re-Configurable Mechanics, Artificial Intelligence, Computer Science, Electronic System Design, Reconnaissance, Surveillance, Target Acquisition, RSTA, Search and Rescue, SAR.

REFERENCES:
1. Blitch, J.G. and Maurer, R., 1996, "KNOBSAR: An Expert System for Robot Assisted Urban Search and Rescue", in Simulations Journal, June 1996.
2. Blitch, J.G. 1997, "Guise vs. Gadgets: The Case for SOF Overwatch in Robot Assisted Reconnaissance", in Proceedings of the 8th Annual Symposium for Special Operations and Low Intensity Conflict, Washington D.C., Feb 1997.

OSD DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING SMALL BUSINESS INNOVATION RESEARCH PROGRAM

PROGRAM DESCRIPTION

Introduction

The Army Research Laboratory, the Army Research Institute, the Naval Sea Systems Command and the Air Force Research Laboratory, hereafter referred to as a DoD Component acting on behalf of the Office of the Director, Defense Research and Engineering, invites small business firms to submit proposals under this Small Business Innovation Research (SBIR) program solicitation. Firms with strong research and development capabilities in science or engineering in any of the topic areas described in this section and with the ability to commercialize the results are encouraged to participate. Subject to availability of funds, DoD Components will support high quality research and development proposals of innovative concepts to solve the listed defense-related scientific or engineering problems, especially those concepts that also have high potential for commercialization in the private sector.

Objectives of the DoD SBIR Program include stimulating technological innovation, strengthening the role of small business in meeting DoD research and development needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DoD-supported research and development results.

The DoD Program presented in this solicitation strives to encourage technology transfer with a focus on advanced development projects with a high probability of commercialization success, both in the government and private sector. The guidelines presented in the solicitation incorporate and exploit the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DoD and the private sector.

Three Phase Program

Phase I is to determine, insofar as possible, the scientific or technical merit and feasibility of ideas submitted under the SBIR Program and will typically be one half-person year effort over a period not to exceed six months. Proposals should concentrate on that research and development which will significantly contribute to proving the scientific and technical feasibility of the proposed effort, the successful completion of which is a prerequisite for further DoD support in Phase II. The measure of Phase I success includes evaluations of the extent to which Phase II results would have the potential to yield a product or process of continuing importance to DoD and the private sector. Proposers are encouraged to consider whether the research and development they are proposing to DoD Components also has private sector potential, either for the proposed application or as a base for other.

Subsequent Phase II awards will be made to firms on the basis of results from the Phase I effort and the scientific and technical merit of the Phase II proposal. Phase II awards will typically cover 2 to 5 person-years of effort over a period generally not to exceed 24 months (subject to negotiation). Phase II is the principal research and development effort and is expected to produce a well defined deliverable prototype or process. A more comprehensive proposal will be required for Phase II.

Under Phase III, the DoD may award non-SBIR funded follow-on contracts for products or processes, which meet the component mission needs. This solicitation is designed, in part, to encourage the conversion of federally sponsored research and development innovation into private sector applications. The small business is expected to use non-federal capital to pursue private sector applications of the research and development.

This solicitation is for Phase I proposals only. Any proposal submitted under prior SBIR solicitations will not be considered under this solicitation; however, offerors who were not awarded a contract in response to a particular topic under prior SBIR solicitations are free to update or modify and submit the same or modified proposal if it is responsive to any of the topics listed in this section.

For Phase II, no separate solicitation will be issued and no unsolicited proposals will be accepted. Only those firms that were awarded Phase I contracts, and have successfully completed their Phase I efforts, will be considered. DoD is not obligated to make any awards under Phase I, II, or III. DoD is not responsible for any money expended by the proposer before award of any contract. For specifics regarding the evaluation and award of Phase I or II contracts, please read the front section of this solicitation very carefully, as well as the Component's specific requirements contained in their respective sections. Each of the services and Defense Agencies have developed their own Phase II enhancement policy, which can also be found in their respective sections. The DDR&E topics will follow the Phase II enhancement policy corresponding to the topic author's service. That is, the Army Research Laboratory and the Army Research Institute will follow the Army Phase II enhancement policy, the Naval Sea Systems Command topics will follow the Navy policy, and the Air Force Research Laboratory topics will follow the Air Force policy. (Refer to their respective sections in this solicitation for details.)

The Fast Track provisions in section 4.0 of this solicitation apply as follows. Under the Fast Track policy, SBIR projects that attract matching cash from an outside investor for their Phase II effort have an opportunity to receive interim funding between Phases I and II, to be evaluated for Phase II under an expedited process, and to be selected for Phase II award provided they meet or exceed the technical thresholds and have met their Phase I technical goals, as discussed Section 4.5. Under the Fast Track Program, a company submits a Fast Track application, including statement of work and cost estimate, within 120 to 180 days of the award of a Phase I contract. Also submitted at this time is a commitment of third party funding for Phase II. Subsequently, the company must submit its Phase I Final Report and its Phase II proposal no later than 210 days after the effective date of Phase I, and must certify, within 45 days of being selected for Phase II award, that all matching funds have been transferred to the company.

Follow-On Funding

In addition to supporting scientific and engineering research and development, another important goal of the program is conversion of DoD-supported research and development into commercial products. Proposers are encouraged to obtain a contingent commitment for private follow-on funding prior to Phase II where it is felt that the research and development has commercial potential in the private sector. Proposers who feel that their research and development have the potential to meet private sector market needs, in addition to meeting DoD objectives, are encouraged to obtain non-federal follow-on funding for Phase III to pursue private sector development. The commitment should be obtained during the course of Phase I performance. This commitment may be contingent upon the DoD supported development meeting some specific technical objectives in Phase II which if met, would justify non-federal funding to pursue further development for commercial purposes in Phase III. The recipient will be permitted to obtain commercial rights to any invention made in either Phase I or Phase II, subject to the patent policies stated elsewhere in this solicitation.

Contact with DoD

General informational questions pertaining to proposal instructions contained in this solicitation should be directed to the point of contact identified in the topic description section. Proposals should be mailed to the address identified for this purpose in the topic description section. Oral communications with DoD personnel regarding the technical content of this solicitation during the pre-solicitation phase are allowed, however, proposal evaluation is conducted only on the written submittal. Oral communications during the pre-solicitation period should be considered informal, and will not be factored into the selection for award of contracts. Oral communications subsequent to the pre-solicitation period, during the Phase I proposal preparation periods are prohibited for reasons of competitive fairness. Refer to the front section of the solicitation for the exact dates.

Proposal Submission

Proposals shall be submitted in response to a specific topic identified in the following topic description sections. Each topic has a point of contact to which the proposals shall be submitted. The topics listed are the only topics for which proposals will be accepted. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

OSD DEPUTY DIRECTOR OF DEFENSE RESEARCH & ENGINEERING

FY 1999 Topic Descriptions

ARMY RESEARCH LABORATORY TOPICS

Technology Focus Area: Sensors

The Army Research Laboratory (ARL) consists of technical Directorates and Centers focusing on specific "fields of endeavor" of critical importance to the Army and DOD. ARL is a leader of basic research for the Army and the ARL primary locations are Adelphi and Aberdeen Proving Ground, Maryland.

Technology Focus Area: Sensors/ Electronic Devices

The DDR&E/Army Research Laboratory topics are:

OSD99-001 Microsensor Information Assurance

OSD99-002 Novel X-ray Detection for Large Field of View Very High Resolution Computed Tomography Inspection and Evaluation

OSD99-003 Improved Breakdown Properties in Large Area SiC Devices

Submission of Proposals for the above topics:

All proposals written in response to the above topics must be received by the date and time indicated in section 6.2 of the introduction of this DOD solicitation. **All proposals (one original, with original signatures, and four copies) must be submitted to the ARL SBIR Program Manager at the following address:**

U.S. Army Research Laboratory
Technology Transfer Office
AMSRL-CS-TT (D.HUDSON)
2800 Powder Mill Road
Adelphi, Maryland 20783-1197

For more information or clarification about the above topics you may contact Mr. Dean Hudson on (301) 394-4808 or email: dhudson@arl.mil

OSD99-01 TITLE: Intersensor Information Assurance

DOD CRITICAL TECHNOLOGY: Sensors

OBJECTIVE: Develop methods of information assurance for battlefield intersensor networks.

DESCRIPTION: We anticipate that future battle commanders will deploy distributed arrays of networked sensors or sensor elements for remote sensing, surveillance, and/or area denial missions. Individual microsensors may consist of small arrays of individual sensing elements (acoustic, seismic, magnetic, etc.), or groups of different kinds of sensor elements, or both. Data from these sensor elements must be collected at a local central processing unit (CPU), which will attempt to detect, classify, and/or identify various battlefield targets of interest. Microsensors may also communicate with neighboring microsensors in order to improve their estimates of the target/s, and with gateways to more conventional information networks.

PHASE I: Intersensor communications, i.e., between microsensor elements and their associated CPU as well as between neighboring microsensors, will likely employ different transmission mechanisms and communication protocols than conventional computer networks, yet will be subject to similar constraints on information reliability. Specifically, individual microsensor performance should degrade gracefully as sensor elements are lost from intersensor network, or as neighboring sensors are compromised. A mechanism to quantify and evaluate this needs to be developed.

PHASE II: Hardware and/or software should be developed to demonstrate improved network performance in the kind of adverse environment/s discussed above.

PHASE III DUAL-USE COMMERCIALIZATION: It is anticipated that microsensors will be the "eyes and ears" of future battlefields. They must be able to communicate with individual soldiers, small units, and higher-eschelon C4I assets through self-forming, wireless networks. These networks will have specialized internal and external communication protocols and algorithms that are conceptually similar to, but functionally unlike, those for conventional computer networks. Tactical sensors and sensor networks must be secure and robust in the face of information warfare attacks; this is the essence of sensor information assurance. It is anticipated that the research described above could also be applied to commercial and industrial networks of microsensors used to monitor traffic, automated warehouses, and secure installation, perimeters and borders.

REFERENCES:

Paul Walczak (ed.), "Land Warfare Information Survivability Worshop: Volume 1", ARL-SR-79, 28 Jan 99. Note: This report includes Peter Neumann's "Practical Architectures for Survivable Systems and Networks", Final report, SRI project 1688, Contract DAKF-11-97-C-0020, SRI International, 1999, which contains almost 300 additional references. It should be available via DTIC in May or June 1999, or via the web at http://www.csl.sri.com/~neumann/arl-one.html

KEYWORDS: Information Assurance, Unattended Ground Stations, and Microsensors

OSD99-02 TITLE: Novel X-Ray Detection for Large Field of View (FOV) Very High Resolution Computed Tomography (CT) Inspection and Evaluation

OBJECTIVE: Develop x-ray detectors for very high spatial resolution computed tomography imaging and evaluation of large areas.

DESCRIPTION: X-ray computed tomography (CT) is used for the nondestructive evaluation (NDE) of complex and advanced materials and components of civilian and military structures. X-ray CT imaging is applied in the automobile, aerospace, and nuclear waste industries, and is also applied to inspecting missile and rocket components (i.e., propellant, motors/motor casings, and nozzles). Medium energy x-ray CT using 300KeV-450KeV x-ray sources can attain spatial resolution of about 250 microns. Low energy x-ray CT using 160KeV microfocus x-ray sources can attain spatial resolution of about 25 microns or better. However, large factors of geometric magnification are necessary to attain this resolution, so only small areas on the order of a few or several millimeters, not inches, can be inspected. Secondly, 160KeV tubes can only penetrate relatively low atomic number (low Z), low density materials. Conventional and microfocus x-ray tubes are typically manufactured with certain focal spot sizes, which cannot be changed. However, there is much more flexibility in designing and developing x-ray detector systems. There is a need to develop x-ray detector systems for use with medium energy conventional tubes to provide better spatial resolution than currently attainable. This will allow inspection of significantly larger materials or components with better spatial resolution. Detectors with this capability could immediately be applied in the previously mentioned areas as well as three dimensional mapping and evaluation of mechanical/ballistic damage in armor material systems. Current CT imaging techniques have been successfully used to fully map ballistic damage in armor assemblies, including ceramics and composites. CT imaging has also been used for pre-impact characterization of armor target assemblies, including metal matrix composites with embedded ceramic plates. However, it is integration of pre and post impact characterization that will result in the best understanding of evolution of damage in a ballistic impact. X-ray detector systems capable of increased resolution over large areas will provide important, possibly critical, information on the ballistic behavior of armor material systems.

PHASE I: Develop a prototype x-ray detector system of very high (i.e., better than 200 micron) spatial resolution for medium energy x-ray CT imaging. The detector should provide this resolution over a field-of-view of at least 2-3 inches without using large geometric magnification factors.

PHASE II: Develop and demonstrate a x-ray detector system with improved spatial resolution for advanced CT imaging to detect defects in and assess structural integrity of armor material systems and components, including pre-and post mechanical/ballistic testing characterization of armor target assemblies.

PHASE III DUAL-USE COMMERCIALIZATION: The x-ray detector system will significantly enhance the inspection and evaluation of Army and commercial armor material systems by providing capability of very high resolution and relatively large area advanced x-ray CT imaging. This will be applicable to a variety of armor systems, including those using metals, ceramics, metallic/nonmetallic composites, and metal foams. Metal foams with high fraction of porosity are becoming a new class of engineering materials. Application for metal foams include commercial armored vehicles, blast protection in wall structures, and blast protection underneath vehicles for landmines. Certainly, metal foams could be used in military armor systems as well.

REFERENCES:
1. ST Neel; RN Yancey; DS Eliasen; DH Phillips; "NDE X-ray Computed Tomography Applications Research", Report Number WL-TR-95-4010, Materials Directorate, Wright Laboratory, Air Force Materials Command, Wright-Patterson AFB, OH, 1994.
2. MJ Dennis; "Industrial Computed Tomography", Methods of Nondestructive Evaluation, pp.358-386
3. C Bueno; MD Barker; RC Barry; RA Betz; SM Jaffey; B Staff; "High Resolution Digital Radiography and 3D Computed Tomography of Composite Materials", Proceedings of the Moving Forward With 50 Years of Leadership in Advanced Materials Conference, Vol. 39. I, pp. 766-778, Anaheim, CA. 1994.
4. RH Ossi; GE Georgeson; RD Rempt; "X-Ray Computed Tomography for Emerging Aerospace Materials and Processes Development", Interim Progress Report, Sept. 1991-May 1993, Boeing Defense and Space Group, WA, 1993.
5. JH Stanley; "Physical and Mathematical Basis of CT Imaging", American Society for Testing and Materials (ASTM), ASTM CT Standardization Committee, ASTM Tutorial: Section 3, 1986.

KEYWORDS: armor, x-ray computed tomography, nondestructive evaluation, ballistic damage, mechanical damage, and x-ray detector

OSD99-03 TITLE: Improved Breakdown Properties in Large Area SiC Devices

DoD CRITICAL TECHNOLOGY: Electronics

OBJECTIVE: Develop a method to increase the power handling capability of SiC devices by eliminating, or at least reducing, the decrease in the breakdown voltage as the size of the SiC devices increase. This will, for example, enable people to make single thyristors that can handle the current in inverter circuits used to operate electric motors in the more electric combat vehicle rather than using a larger number of devices connected in parallel as is currently done.

DESCRIPTION: There is a strong interest in the Army to replace many mechanical controls with electronic controls in their future combat systems; the interest is sufficient for it to be incorporated into a Science and Technology Objective (STO). One example is the drive system where replacing the mechanical with an electric drive would increase the flexibility in the design, enhance the performance, reduce the weight and volume, provide more stealth, improve reliability, and reduce the production costs. A key element in the electric drive is the SiC gate turn-off (GTO) thyristor that not only can handle large amounts of power, but also can operate efficiently at higher temperatures so it can be cooled by engine oil. Great strides have been made in making devices, but being able to use it effectively has been stymied by the problem of the breakdown voltage decreasing as the size of the device increases. This means that, in order to retain the required large breakdown voltage and at the same time handle the large amounts of current that are required, a number of smaller thyristors have to be combined in parallel. This is both cumbersome and demanding as all the thyristors have to have very similar characteristics. People have suggested that this problem can be solved through improved material quality through the reduction of crystalline defects such as dislocations and micropipes and/or improved processing by replacing etched mesa structures with junction edge termination geometry. Any other creative approach would also be considered.

PHASE I: Demonstrate that the approach selected shows a quantitative improvement in increasing the breakdown voltage in larger area devices.

PHASE II: Quantify the approach selected and identify its strengths and weaknesses. Incorporate the process into manufacturing of a SiC power device.

PHASE II DUAL-USE APPLICATION: SiC thyristor based circuits could be used in power electronic applications such as those in turbine engines, propulsion systems, systems and automotive and aerospace electronics.

KEYWORDS: Silicon Carbide, Breakdown Voltage, Thyristor, Dislocations, Micropipes, and Junction edge termination

REFERENCES:
1. J.W. Palmour, R. Singh, L.A. Lipkin, and D.G. Waltz, "4H SiC High temperature Power Devices," Trans. 3rd HiTEC Conf., Albuquerque, NM, June, 1996, Vol.2,p XVI-9-14
2. A.K. Agarwal, JB Casady, LB Rowland, S Seshadri, RR Siergiej, WF Valek, and CD Brandt, "700-V Asymmetrical 4h-SiC Gate Turn-off Thyristors," IEEE Electron Device Lett. 18, 518 (1997)
3. PG Neudeck and JA Powell, "Effects of Micropipes on the Breakdown Voltage of SiC Devices,"IEEE Electron Dev. Lett. 15, 63 (1994)
4. SV Rendakova, IP Nikitina, AS Tregubova, and VA Dmitriev, "Micropipe and Dislocation Density Refunction in 6H-SiC and 4H-SiC Structures Grown by Liquid Phase Epitaxy," J Electron. Mat. 27, 292 (1998)

ARMY RESEARCH INSTITUTE TOPIC

The U.S. Army Research Institute (ARI) is a directorate of the Total Army Personnel Command and is the Army's principal agency for soldier-oriented research and development in personnel and training. ARI is made up of a number of Research Units and is headquartered in Alexandria, VA. **Any questions and all proposals regarding the following topic, OSD99-04, should be addressed to:**

ARI RWARU
ATTN:TAPC-ARI-IR
William R. Howse
Building 5100
FORT RUCKER, AL 36362-5354
PHONE: 334-255-3686

OSD99-04 TITLE: Adaptive Instructional Systems

DOD CRITICAL TECHNOLOGY: Human Systems (Personnel Performance and Training)

OBJECTIVE: Develop an approach to design and implementation of computer-based training systems that dynamically adapt instructional methodology to individual differences in learning style and rate, capitalize on student strengths and match content and structure of training events to the student's conceptual structure.

DESCRIPTION: As military systems have become more complex so have their training requirements. Force reductions further necessitate increased training to maintain readiness and proficiency, which in turn increases pressure on, limited training resources. Military training programs tend toward temporally driven schedules which are incompatible with proficiency based progression. This produces a tendency toward outcome proficiency criteria derived from the mean or minimum obtainable level in a fixed time window. This results in unnecessarily high elimination rates and remedial instruction loops. The remediation loops increase manpower requirements and complicate training planning. Training eliminations entail wasted investment in recruiting and training those personnel.

Adaptive training methodologies have the potential to accommodate individual differences within required time limits to avoid instructional failures, ensure minimal proficiency outcome and the opportunity for maximizing the outcome proficiency for each individual. Current advances in conceptual modeling and in artificial intelligence technologies may provide the basic components of machine based instruction that adapts to and evolves with the individual student through the skill acquisition process.

PHASE I: Develop a technical approach to conceptual modeling of student and instructor behaviors and inferred cognitive processes as they evolve through the process of learning a complex skill, specifically, hovering a helicopter. Develop a technical approach for implementing these models within a computer based instruction module that teaches this task in a low-cost flight simulator.

PHASE II: Implement the approach developed in Phase I in a demonstration conducted on the ARI Intelligent Flight Trainer. Generalize the principles of the approach for application to other aspects of initial flight training and to other skill acquisition instruction modules.

PHASE III DUAL USE APPLICATIONS: The specific implementation of the demonstrated adaptive instruction system may be refined and used in initial entry training of rotary wing pilots. It is likewise adaptable to other occupational skill training programs such as advanced aircraft transitions, air traffic control and aviation maintenance. In addition, the technical approach will be applicable to instructional systems that are more heavily loaded on cognitive skills such as command and control and staff officer training. They are equally applicable in industrial and academic settings.

KEYWORDS: Training Technology, Artificial Intelligence, Intelligent Tutoring, Automated Instruction, Adaptive Training

REFERENCES:

1. Dohme, Jack. (1995) "The Military Quest for Flight Training Effectiveness". In: W.E. Larsen, R.J. Randle, Jr., and L.N. Popish (Eds.), *Vertical Flight Training*, (pp. 103-123). NASA Reference Publication 1373.
2. Gutstein, E. (1992) "Using Expert Computer Knowledge to Design a Self-Improving Intelligent Tutoring System". In: C. Frasson (Ed.) *Intelligent Tutoring Systems*, New York: Springer-Verlag.
3. Wolf, Randall P. and Delugach, Harry S. (1996), ``Knowledge Acquisition via the Integration of Repertory Grids and Conceptual Graphs,'' *Auxiliary Proceedings, 4th Intl. Conf. on Conceptual Structures*, P.W. Eklund, G. Ellis and G. Mann, eds., University of New South Wales, Sydney, Australia

NAVAL SEA SYSTEMS COMMAND TOPICS

Technology Area: Condition Based Maintenance Technology

The Naval Sea Systems Command has identified the following five topics:

OSD99-05 **Development of Metrics and a Process for Mechanical Diagnostic Technique Qualification and Validation**

OSD99-06 **Prognostic Enhancements To Diagnostic Systems**

OSD99-07 **In-Situ Corrosion Detection and Mitigation for Inaccessible Areas**

OSD99-08 **Integrated Mechanical Load and Condition Assessment for Mechanical Components**

The Program Executive Office for Aircraft Carriers (PEO Carriers) develops, acquires and supports operationally superior and affordable aircraft carriers for the Navy. The Navy goal is to significantly reduce the cost of ownership of aircraft carriers. Currently, maintenance costs represent approximately one-third of the total life cycle cost of the carrier itself, not including the embarked air wing. PEO Carriers is looking for innovative solutions to achieve large reductions in maintenance costs. One potential area of interest is condition based maintenance (CBM). DDR&E has identified four technical topics in the CBM technology area for the FY 99.2 solicitation. CBM capabilities are critical to meeting DoD platform, infrastructure, and logistical needs. Continued progress in CBM is essential to ensure increased affordability, performance, and longevity in DoD systems.

The topics were initiated by the Naval Sea Systems Command's technical offices that manage the research and development in these areas. The topics listed are the only topics for which proposals will be accepted.

PEO Carriers is seeking small businesses with a strong research and development capability and an understanding of the CBM capabilities. PEO Carriers invites the small business community to **send proposals (original plus 3 copies) directly to the following address**:

Mailing Address for Proposals and Technical Point of Contact:

Program Executive Office for Aircraft Carriers
Attn: PMS 378R, Ms. Gemma M. Meloni
Airport Plaza I
2711 Jefferson Davis Why
Arlington, VA 22202
Tel (703) 872-3249
Fax (703) 416-0327
E Mail melonigm@navsea.navy.mil

In addition, please electronically submit your appendices A, B and E through the Navy SBIR website at http:\\www.onr.navy.mil\SBIR.

Inquires of a general nature or questions concerning the administration of the SBIR program should be addressed to:

Office of Naval Research
Attn: NAVY SBIR PROGRAM, CODE 362, Mr. John Williams
800 No. Quincy Street, RM 633
Arlington, VA 22217
Tel (703) 696-0342
Fax (703) 696-4884
E Mail williajr@onr.navy.mil

OSD99-05 TITLE: Development of Metrics and a Process for Mechanical Diagnostic Technique Qualification and Validation

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: Develop an approach, process and metrics to impartially evaluate performance and effectiveness of mechanical diagnostic techniques based on a particular Condition Based Maintenance (CBM) application.

DESCRIPTION: In an effort to reduce the total cost of ownership, while increasing readiness and reliability, the U.S. Navy has implemented condition based maintenance and monitoring systems on shipboard equipment/systems. In this age of open/modular systems, more and more third party software vendors are attempting to integrate their equipment/system specific diagnostic/prognostic systems into an existing core capability. Verification of these diagnostic and prognostic solutions is a key element of robust, reliable systems especially as these systems are developed in an open architecture comprised of solutions offered by a variety of technology vendors. Real-world validation is expensive and time consuming. An effective process and measures of effectiveness and performance need to be developed based on an evolving database of in-service data, simulations, and test bed data, all adequately quality assured and configuration managed to assure reliability. The primary goals of this task are to design processes, techniques and metrics for determining if a technology or near-COTS product should be considered for integration into currently deployed and future Naval equipment automated diagnostic systems that support the basic concepts of Reliability Centered Maintenance (RCM) and Condition Based Monitoring and Maintenance philosophies. The processes and metrics developed must be amenable to cost-effective assessment of a given technique against a variety of applications and for a given application against a variety of techniques. The process must account for different approaches to address the same diagnostic problem (e.g., oil analysis vs. vibration vs. thermography for bearing fault detection) without penalty other than that associated with the cost of implementation of one technique in a given application. The process must account for the specific application for which a particular technique is being considered. It must recognize that some techniques will perform better in some applications than others, but that failure to perform in one application is not reason to reject from all applications. The process must also outline an approach to gather and maintain data sets useful for development and test. These data sets must be adequately controlled, useful, and available to a broad range of developers and end-users.

PHASE I: Outline and specify the requirements for mechanical diagnostic technologies in a variety of applications aboard a future aircraft carrier. Identify the critical performance measures that differentiate acceptable from non-acceptable performance (e.g., false alarm rate, miss rate, hardware reliability) applicable to those equipment types. Define an approach to implement techniques to measure any diagnostic technique against those performance measures and to develop and maintain a library of data sets and simulations to support development and testing of candidate techniques.

PHASE II: Implement the approach defined in Phase I for a variety of machinery applications of interest to future aircraft carriers. Establish an initial data repository and library of applicable data sets for those machinery applications. Exercise the process and data library in controlled application.

PHASE III: Develop a software tool for use by military or commercial program managers to exercise a proposed diagnostic technique against a particular application requirement. The tool should user-friendly and easily updateable, potentially linked directly with the data repository via the Internet.

COMMERCIAL POTENTIAL: CBM is an important opportunity in both the military and commercial sectors. As open architecture systems evolve enabled by standards like MIMOSA, the need to reliably and fairly compare alternative techniques for a given application will become a critical issue for owners and operators of any system considering implementation of CBM.

REFERENCES:

1. Nickerson, G. William; Michael Van Dyke; and Carl S. Byington; "Qualification and Validation of Diagnostic Techniques Using Fleet Data", ASNE Condition Based Maintenance Symposium, June 1998.
2. Hadden, Ph.D., George D, George Vachtsevanos, Bonnie Holte Bennett, Ph.D., Joe Van Dyke P.E., "Machinery Diagnostics and Prognostics/Condition Based Maintenance: A Progress Report", Failure Analysis: A Foundation for Diagnostics and Prognostics Development, Proceedings of the 53rd Meeting of the Society for Machinery Failure Prevention Technology, April 1999.
3. Essawy, Magdi A. and Saleh Zein-sabatto, "Measures of Effectiveness and Measures of Performance for Machine Monitoring and Diagnosis Systems", Maintenance and Reliability Conference, May 1999.

KEY WORDS: Condition-Based Maintenance, CBM, Qualification and Validation, Data Repository

OSD99-06 TITLE: Prognostic Enhancements To Diagnostic Systems

SCIENCE/TECHNOLOGY AREA: Modeling and Simulation

OBJECTIVE: To develop prognostic algorithms and computer software applications that will readily support backfit into existing Naval platforms employing both SMART and conventional Command, Control, and Communications (C3); Human-System Interfaces (HIS), and sensor technologies as well as extensibility into new acquisition Naval platforms.

DESCRIPTION: This project will provide strategies for developing "add-on", "plug 'n play" type software modules that can be integrated and/or interfaced to existing system and equipment diagnostic software deployed on Navy ships and aircraft to estimate the time to failure and/or time to maintenance action for specific high value pieces of machinery. A number of options for enhancing existing diagnostic software will be addressed and evaluated. Options will include (1) data fusion drawing performance and intrinsic health data from shipboard and aircraft Condition Based Maintenance (CBM) databases; (2) executing external, independent artificial intelligence (ie: neural nets, fuzzy logic, genetic algorithms) algorithms on real-time and CBM database data through open software interface standards,; (3) incorporating mechanical components reliability design equations and algorithms in performance curve analyses and existing Boolean rule based diagnostics; and, (4) adapting data mining algorithms to sort and capture prognostic indicators from existing shipboard and aircraft CBM databases.

PHASE I: Select promising prognostic and HSI concepts that can be integrated or interface with existing shipboard CBM systems architectures. Perform preliminary investigations to determine the most likely supporting open systems interface specifications that can be adapted to support demonstration of the selected prognostic and HSI concept in conjunction with existing shipboard CBM databases. Develop a software design document and interface control document for demonstrating the selected prognostic and HSI concept.

PHASE II: Program and optimize the prognostic and HSI software modules in accordance the Phase I documentation utilizing machinery CBM database data for three types of equipment found aboard Navy ships and/or aircraft. Install and demonstrate the effectiveness of the software modules in both a land-based and shipboard environment in prognosticating potential failures and corrective maintenance actions.

PHASE III: Prepare plug-in software modules for individual shipboard, aircraft, and power generation, and chemical processing equipment with installation documentation for use with commercial and military Condition Assessment and Health Monitoring systems.

COMMERCIAL POTENTIAL: These software modules will be directly transferable to any machinery health monitoring application in the electrical power industries, commercial ship industry, commercial air travel industry, and chemical processing industry.

REFERENCES:

1. Carl S. Byington, Susan E. George, G. William Nickerson, Prognostic Issues for Rotorcraft Health and Usage and Monitoring Systems, Proceedings of a Joint Conference, A Critical Link: Diagnosis To Prognosis, 51st Meeting of the MFPT Society 12th Diennial RSAFP Conference, MFPT Society, April 1997, p, 93-102;
2. T. G Edwards and G. D Hadden, An Autonomous Diagnostic/Prognostic System for Shipboard Chilled Water Plants, Proceedings of a Joint Conference, A Critical Link: Diagnosis To Prognosis, 51st Meeting of the MFPT Society 12th Diennial RSAFP Conference, MFPT Society, April 1997, p, 139-150.
3. Lynn Yarosh et al, A Management Approach to Condition Based Maintenance for CVX, NSWC Crane Technology Management Symposium, November 1997.

KEY WORDS: Prognosis, Diagnostics, Machinery, Condition, Maintenance

OSD99-07 TITLE: In-Situ Corrosion Detection and Mitigation for Inaccessible Areas

SCIENCE/TECHNOLOGY AREA: Materials and Processes

OBJECTIVE: To develop the technology, manufacturing method, and associated hardware and software, to non-intrusively apply an in-situ Impressed Current Cathodic Protection (ICCP) system to detect and subsequently mitigate corrosion at hidden or hard-to-access sites in shipboard seawater systems.

DESCRIPTION: One of the most deleterious problems for shipboard seawater systems is corrosion in hidden or hard-to-access areas. Examples of corrosion which occurs in these systems include corrosion at crevices such as those created by flange joints and valve seats, erosion-corrosion in valves, pumps, or other areas of turbulent flow (elbows, tees) in piping, and galvanic corrosion caused by the use of dissimilar metals. These types of corrosion negatively impact both the total cost of ownership (TOC) and operational readiness. For non-critical systems, TOC is affected by the need to repeatedly perform repairs or replace components or piping sections. For critical systems where access is not possible or practical, costly non-destructive evaluations (NDE) are performed in an attempt to detect corrosion prior to the occurrence of a failure. NDE is often ineffective since the corrosion is typically localized and/or associated with complex geometries. Operational readiness is affected since corrosion in hard-to-access areas often progresses to the point of system failure prior to detection.

This topic seeks to provide a method with the ability to detect and then remotely stop corrosion while maintaining the structural integrity of the hidden area, without the need for disassembly. ICCP has been used extensively and successfully to suppress corrosion of external hulls, piers, and other submerged structures. However, it has not been applied to the mitigation of corrosion in hidden or inaccessible areas of complex seawater handling systems such as those on Navy ships. This topic seeks a technology capable of delivering ICCP to hidden areas, which are susceptible to corrosion, for detection and mitigation of that corrosion. Such a technology will allow the Navy to meet its requirements of reduced manning, increased operational readiness, and reduction in the total cost of ownership.

PHASE I: Demonstrate the technical and economic feasibility of a technology that will enable mitigation/prevention of localized corrosion, through in-situ application of ICCP to hidden areas. The proposed technology should be adaptable to a wide variety of hidden corrosion sites such as those found in Navy piping systems.

PHASE II: Optimize manufacturing methods, measurement devices, methods, and computer responses for the proposed technology. Build a prototype system, with dedicated hardware/ software that could be monitored through a variety of methods, including manual, automated, and/or wireless transmission. On multiple test sites, measure the corrosion currents and provide impressed current cathodic protection as applicable.

PHASE III: Statistically demonstrate the effectiveness of the technology for mitigation of localized corrosion in hidden areas. Manufacture the technology and optimized equipment. Assemble and transport equipment to a U.S. Navy shipyard to be designated and make a test installation on a Navy ship in overhaul or major availability. Train ship's force personnel to use the technology. Monitor and provide logistics support for a period of up to three years.

COMMERCIAL POTENTIAL: Strong potential for use throughout the world shipping industry, chemical industries, commercial power industry, off-shore oil industry, and anywhere crevice corrosion is a problem in hidden areas.

REFERENCES:
1. Clayton, N., Steiner, W., Aylor, D., Dersch, F., and Hays, R. (1998), Condition-Based Maintenance for Surface Ship Seawater Valves: Analysis of Surface Ship Seawater Valve Degradation, CARDIVNSWC-TR-61-95-02.
2. Inman, M., Taylor, E.J., Myers, D.L., Moran, P.J., and Kain, R.M. (1997), Detection and Monitoring of Crevice Corrosion Inside Pipe Flanges, Tri-Service Conference on Corrosion, Wrightsville Beach, NC.
3. Inman, M., Taylor, E.J., Rawat, A.K., and Moran, P.J. (1997b), Detection of Crevice Corrosion Under an O-Ring by Polarization Resistance Measurements Using Electrodes Embedded in the O-Ring, Corrosion '97, Paper No. 312, NACE International, New Orleans, LA.
4. Sunkara, M.K., Rawat, A.K., Taylor, E.J., Moran, P.J. and Hays, R.A. (1996), Detection Methods for Sites of Localized Corrosion Applicable to Pipelines", Proceedings of the Electrochemical Society Symposium "Critical Factors in Localized Corrosion II".
5. Kain, R.M, 1996, Proc. Corrosion '96 Research Symposium, NACE International, Corrosion/96, Orlando, FL.
6. Klein, P.A. and Ferrara, R.J., 1987, DTRC Report SME-87-05.
7. Klein, P. A., Ferrara, R.J., and Kain, R.M. (1989), Crevice Corrosion of Nickel-Chromium-Molybdenum Alloys in Natural and Chlorinated Seawater, Corrosion/89, Paper No. 118, New Orleans, LA, April 17-21.
8. Reid, J.P. (1995), Time for Titanium Piping on Navy Ships?, 32nd Annual Technical Symposium of the Association of Scientists and Engineers, Arlington, VA.
9. Shaw, B.A., Moran, P.J., and Gartland, P.O., 1991, Corrosion Science, 32, 7, p. 707.

OSD99-08 TITLE: Integrated Mechanical Load and Condition Assessment for Mechanical Components

OBJECTIVE: Develop technology to reduce the cost of integrating smart sensors with machinery and processes.

SCIENCE/TECHNOLOGY AREA: Sensors

DESCRIPTION: The cost to implement condition-based maintenance (CBM) technology widely on Navy weapons platforms will be dramatically impacted by the level of integration and penetration of the same technology into industrial and commercial markets. It is anticipated that integration of smart sensors with distributed processing capability needs to extend to the machine and machine component level. It is envisioned that the ultimate affordability will be achieved when smart machine components are widely available to build smart machines that are used to build smart weapons platforms. Today, sensors and machine components such as bearings, gearboxes and motors are designed and manufactured separately. This topic solicits innovative proposals to develop smart machine components that can show cost/performance advantages over current technology.

PHASE I: Research the Navy's critical machinery and document need. Classify critical machinery components into common and machine specific categories. Develop a smart machine component concept for those components with the greatest potential for payoff. Determine the critical technology development needs to demonstrate an economic advantage over current technology.

PHASE II: Develop the technology needs identified in Phase I. Produce a prototype smart machine component. Demonstrate how it integrates with a smart machine and ship wide CBM system. Conduct detailed cost/benefits analysis.

PHASE III: Implement the developed technology in commercial machine component manufacturing. Market these components widely to smart machinery opportunities such as turbines, generators, pumps, compressors, motors, etc. Produce large quantities to enable the reduction of cost of implementation of CBM aboard Naval ships and industrial manufacturing facilities.

COMMERCIAL POTENTIAL: CBM is an emerging market with tremendous potential in the US Navy, petro-chemical, pulp and paper, construction equipment, aerospace and consumer appliance markets. Smart machine components would be cost effective building blocks of the systems of the future.

REFERENCES:
1. Nickerson, G. W. and Lally, R., "An Intelligent Bearing Health Monitoring System", 1997 International Mechanical Engineering Congress, ASME International, Nov. 1997

2. S.C. Jacobson, M. Olivier, B.J. Mclean, M.G. Mladejovsky, and M. R. Whitaker, "Multi-regime Integrated Transducer Networks", 1998 Solid-State Sensor and Actuator Workshop.

KEY WORDS:
Condition-Based Maintenance, CBM, Smart Sensors, Smart Machine Components

AIR FORCE RESEARCH LABORATORY TOPICS

Technology Area: Electronics

The mission of the Air Force Research Laboratory (AFRL) is to lead the discovery, development, and transition of affordable, integrated technologies for our air and space forces -- to keep our Air Force "the best in the world." Our mission is executed by our nine technology directorates, located throughout the United States. The following topics are focused on the technology area of electronics. Two of the topics are in the Munitions Directorate and the third is in the Sensors Directorate.

The AFRL Munitions Directorate, located at Eglin AFB FL, develops conventional munitions technologies to provide the Air Force with a strong technology base upon which future air-delivered munitions can be developed to neutralize potential threats to the United States. Their mission is to develop, integrate, and transition science and technology for air-launched munitions for defeating ground fixed, mobile/relocatable, air, and space targets to assure the pre-eminence of U.S. air and space forces. The following topics are managed by the Munitions Directorate:

OSD-009 "Electrophoretic Processing of Electronic Polymer Materials"
OSD-010 "Phase Tunable Spatial Light Modulator"

Mailed or hand carried proposals in response to the above topics, #OSD-009 and OSD-010, must be delivered to the SBIR focal point at the following address:

AFRL/MNOB
Attn: Dick Bixby
101 W Eglin Boulevard Suite 140
Eglin AFB FL 32542-6810
E-MAIL: bixby@eglin.af.mil
(850) 882-8591, ext. 1281

The AFRL Sensors Directorate specializes in the research and technology development needed for superior US air and space reconnaissance, surveillance, precision engagement, and electronic warfare systems. Their primary areas of technology investment include radio frequency sensors and countermeasures; electro-optical sensors and countermeasures; and automatic target recognition and sensor fusion. The following topic is managed by the Sensors Directorate: OSD99-11 "Silicon Carbide Power Transistors for High Power Transmitter"

Mailed or hand carried proposals in response to the above topic, #OSD-011, must be delivered to the SBIR focal point at the following address:

AFRL/SNOX
Atten: Marleen Fannin
Building 620, 2241 Avionics Circle
Wright-Patterson AFB, OH 45433-7318
E-MAIL:fanninbm@sensors.wpafb.af.mil
(937)255-5285, ext.4117

The following are the Air Force Research Laboratory topics.

OSD99-09 TITLE: Electrophoretic Processing of Electronic Polymer Materials

DoD CRITICAL TECHNOLOGY: Electronics

OBJECTIVE: To develop electrophoretic processing techniques for fabrication of bulk conductive, superconductive, and ferromagnetic polymers.

DESCRIPTION: Electrophoretic deposition (or electrophoresis) has inherent versatility unlike that of more commonly used techniques for advanced polymer fabrication. Electrophoresis is a process that involves movement or buildup of suspended particles (electrophores) through a fluid under the action of an applied electromotive force. In this way, tiny clusters of active polymer molecules can be combined as fundamental building blocks in order to form a desired bulk polymer material. Electrophoresis has potential application in fabrication of a variety of electronic polymers. There is a considerable amount of published information pertaining to the use of electrophoresis to form dielectric coatings on capacitor plates and printed circuit board cores. It may be feasible to extend the technology to conductive or superconductive polymer fabrication and for ferromagnetic polymer processing.

PHASE I: Phase I of this effort would involve demonstration of electrophoretic processing approaches for fabrication of bulk ferromagnetic polymers exhibiting magnetic permeability greater than 6 and bulk conductive polymers having conductivity well in excess of 1000 siemens. Detailed electronic and electromagnetic characterization of the new polymers would be required to verify achievement of unique material properties.

PHASE II: Phase II would address development of new electronic components useful for advanced future Air Force weapon fuzes, including low loss transmission lines for detonators and inductive couples for wireless connection of separately sealed, testable fuze modules.

PHASE III DUAL USE APPLICATIONS: This technology will find military usage in inductively coupled modular fuzes, connectors, and transmission lines. Additional applications include lightweight motors, electrical appliances, portable magnetic resonance imaging/medical examination devices, electronic test equipment, wireless communications devices, power transmission and distribution systems, and electric vehicles.

REFERENCES:

1. L.C. Scala, W.M. Alvino, and T.J. Fuller, IPC Technical Review, July 1982, pg. 12-16.
2. W.M. Alvino and L.C. Scala, J of Appl Polym Sci 27(1982)341.
3. DTIC REFERENCES: ADD411321 - Electrophoresis: Selected References (for Polymers)
   ADD401667 - Polymer Coating by Electrophoretic Deposition

KEYWORDS: Electrophoresis, ferromagnetic polymer, electrophoretic deposition, superconductive polymer, conductive polymer, modular fuze

OSD99-10 TITLE: Phase Tunable Spatial Light Modulator

CATEGORY: Exploratory Development

OBJECTIVE: The objective is to identify an innovative concept for a pure phase Spatial light modulator.

DESCRIPTION: The research is to result in a fast (1K frames per second), high-resolution (256x256 or greater), gray scale (8 bits of controllable dynamic range), and affordable spatial light modulator (SLM) for application in phase-only optical correlators. The ideal SML should provide 360 degrees of pure phase modulation and can be compatible with a fast framing CCD array, i.e. it should operate at greater than 1kHz and have resolutions of 256 x 256 or greater. Most important is the need for full 360 degrees ($-\pi$ to π) gray-scale modulation across the visible spectrum with low noise levels, as well as pixel size of 20 microns or less and fill factor of 80 percent or greater. Proposals may involve the development of new materials and/or novel integrated device structures. Possible approaches might include liquid-crystal phase modulators or pixel-level addressable MEMS arrays. Appropriate drive electronics should be included in the design and integration of the system. Particular attention should be paid to keeping the overall package small and low cost.

PHASE I: The structure of the modulator is to be designed, materials are to be specified, the array fabrication process is to be established, and any subcomponent or materials testing necessary should be accomplished. Electronic drive circuits are to be designed. A proof-of-principle demonstration is to be carried out to show viability of the concept.

PHASE II: The complete prototype working devices are to be fabricated and demonstrated in Phase II. In particular, the number of bits of phase control, the linearity, the range of phase control, and the optical flatness should be established through rigorous testing. One complete prototype copy of the external drive electronics and three working modulator arrays should be delivered.

PHASE III DUAL USE APPLICATIONS: Optical modulators are critical elements in a multitude of commercial and military systems including: cameras, CCD video cameras, computer and video displays, simulators, photolithography, optical interconnects, telecommunications, security devices, and noninvasive medical procedures. There are almost no limits to the applications for modulators described here. This research is intended to introduce breakthrough technologies (new capabilities, enhanced performance, and reduced system size and weight) that significantly reduce future system cost. Spatial light modulators are used in optical processing, telecommunications, computing, and in display applications. In optical processing, they are used in such applications as optical correlators and real-time processors for synthetic aperture radars. In telecommunications they are used to route communications signals, optically connect electronic boards, and provide massively parallel transmission of data. Spatial light modulators are also often used as display devices in everything from consumer electronics to miniature head-up projectors to flight simulators.

REFERENCES:
1. Wang, F., Li, K., V. Fuflyigin, H. Jiang, J. Zhao, P. Norris, and D.H. Goldstein, "Thin Ferroelectric Interferometer for Spatial Light Modulations", Appl. Opt. 37 pp. 7490-7495 (1998).
2. Bauchert, K.A., S.A. Serati, G.D. Sharp, and D.J. McKnight, "Complex Phase/Amplitude Spatial Light Modulator Advances and Use in a Multipspectral Optical Correlator," Proc. SPIE Vol. 3073, Optical Pattern Recognition VIII, April 1997.

KEYWORDS: Spatial light modulators, phase modulators, liquid crystal modulators, MEMS, optical processing, optical correlation

OSD99-11 TITLE: Silicon Carbide Power Transistors for High Power Transmitter

DOD KEY TECHNOLOGY AREA: Electronics Technology

OBJECTIVE: Develop Silicon Carbide power transistors that will enable high power pulsed transmitters to achieve a stable output signal.

DESCRIPTION: Silicon Carbide power transistors are being used in the design of high power, high temperature applications. Current Silicon power transistors have a maximum operating temperature of below 150 degrees C and a maximum power of 300 Watts. Silicon Carbide power transistors on the other hand, can operate at temperatures on the order of 400 degrees C and a maximum power of 650 Watts. Therefore, Silicon Carbide power transistors can develop about twice the power of Silicon power transistors. Additionally, Silicon Carbide transistors are more efficient, which means that more power can be generated for the same cooling and power requirements as Silicon power transistors. When these power transistors are used in pulsed transmitter operations, output signal stability becomes an issue. In order to obtain a stable output signal, particular attention must be paid to design of both the power supply and the pulsed transmitter. The process development of SiC devices and circuits is evolving. Although the SiC materials have excellent high temperature operation, additional work remains to be completed on developing compatible metal contact systems and packaging/interconnect technologies that efficiently operate at high temperatures. These process and packaging issues should be addressed as part of the subject effort.

PHASE I: This topic focuses on the design of Silicon Carbide power transistors. The design should lead to improved device fabrication processes and packaging techniques. To optimize high temperature operation, compatible metal contact systems and packaging/interconnect techniques should be considered.

PHASE II: Construct and demonstrate the operation of a prototype pulsed transmitter with Silicon Carbide power transistors.

PHASE III DUAL USE APPLICATIONS: In both airborne and space applications where space is limited, pulsed transmitters using Silicon Carbide transistors will allow for smaller transmitter designs with high output power.

KEY WORDS: Silicon carbide, Power transistors, Pulsed transmitter, High temperatures, Output signal stability, Airborne and space applications

REFERENCES:
1. J. Henning, L. Yuan, A. Przadka, V. Kolagunta, Prof. J. A. Cooper, Jr., Prof. M. R. Melloch, and Prof. K. J. Webb, Supported by the Office of Naval Research under a 1996 MURI grant, administered by UCSB, "Microwave Power Devices in Silicon Carbide", Annual Research Summary, Purdue University, School of Electrical & Computer Engineering, 1 July 1996 – 30 June 1997
2. R. C. Clarke, A. K. Agarwal, R. R. Siergiej, C. D. Brandt, and A. W. Morse, "The Mixed Mode 4H-SiC SIT as an S-band Microwave Power Transistor," IEEE Device Research Conference, Santa Barbara, CA, 24-26 June 1996.

UNITED STATES SPECIAL OPERATIONS COMMAND

Proposal Submission

The United States Operations Command's (USSOCOM) mission includes developing and acquiring unique special operations forces (SOF) equipment, material, supplies and services. Desired SOF operational characteristics for systems, equipment and supplies include: lightweight and micro-sized; reduced signature/low observable; built-in survivability; modular, rugged, reliable, maintainable and simplistic; operable in extreme temperature environments; water depth and atmosphere pressure proof; transportable by aircraft, ship and submarine, and deployable by airdrop; LLPI/LPD jam resistant C3I, electronic warfare capable of disruption and deception; near real-time surveillance, intelligence and mission planning; highly lethal and destructive; low energy/power requirements; and compatible with conventional force systems.

USSOCOM is seeking small businesses with a strong research and development capability and an understanding of the SOF operational characteristics. The topics represent a portion of the problems encountered by SOF in fulfilling its mission.

Inquires of a general nature or questions concerning the administration of the SBIR program should be addressed to:

United States Special Operations Command
Attn: SOAL-KS/Ms. Karen L. Pera
7701 Tampa Point Blvd.
MacDill Air Force Base, Florida 33621-5316
Tel: (813) 840-5514
Fax: (813) 840-5481
Email: perak@socom.mil

USSOCOM has identified 3 technical topics for the FY 99.2 solicitation. Proposals will only be accepted for these 3 topics. The USSOCOM technical offices responsible for the research and development in these specific areas initiated topics. The same office is responsible for the technical evaluation of the proposals. Proposal evaluation factors are listed below. Each proposal must address each factor in order to be considered for an award. Scientific and technical information assistance may be requested by using the DTIC SBIR Interactive Technical Information System (SITIS).

Firms are encouraged to submit a proposal with an optional task, which would be performed during the period between Phase I, completion and Phase II contract award. The optional task provides the opportunity to reduce the gap between Phase I and II funding. The maximum amount of SBIR funding used for an USSOCOM Phase I award is $100,000. Proposals that include the option task shall not exceed $70,000 for Phase I and $30,000 for Phase I Option. Options must be submitted with the basic Phase I proposal and will be included in the Phase I proposal 25-page limitation. The basic Phase I proposal shall be evaluated exclusive of the option tasks and must be proposed and priced separately. The option portion of the proposal shall not exceed $30,000, not exceed three months in duration, and will be evaluated using the same evaluation criteria as Phase I proposals. The transition option work shall be included as an option in the Phase I contract and evaluated for USSOCOM unilateral exercise at any time after Phase I award through the conclusion of the basic Phase I contract. The maximum time frame for a Phase I with or without option is 6 months. Exercise of any option shall be at the sole discretion of USSOCOM and shall not obligate USSOCOM to make a Phase II award.

Evaluation Criteria – Phase I & II

1) The soundness, technical merit, and innovation of the proposed approach and its incremental progress toward topic or subtopic solution.

2) The qualifications of the proposed principal/key investigators supporting staff, and consultants. Qualifications include not only the ability to perform the research and development but also the ability to commercialize the results.

3) The potential for commercial (government or private sector) application and the benefits expected to accrue from this commercialization.

Selection of proposals for funding is based upon technical merit and the evaluation criteria included in the solicitation. As funding is limited, USSOCOM will select and fund only those proposals considered to be superior in overall technical quality and most critical. USSOCOM may fund more than one proposal in a specific topic area if the technical quality of the proposals are deemed superior, or it may fund no proposals in a topic area.

USSOCOM also encourages contractors to participate in the SBIR Fast Track program as described in the DOD 99.2 Solicitation. Proposing Options in the Initial proposal will not prevent a contractor from participating in the Fast Track Program, however, the total USSOCOM funds for a Phase I, Options, and the Fast Track funding will not exceed $140,000. It is anticipated the vast majority of Fast Track proposals will receive interim funding between Phases I and II, and that the percentage of Phase I Fast Track projects that are selected for Phase II awards should be significantly higher that the overall percentage of Phase I projects that are selected for Phase II.

The Phase II enhancement plan for the Special Operation Command is intended to encourage the acquisition programs to leverage the technology being developed under the SBIR program. The SBIR program will provide a one to four match of SBIR dollars to non-SBIR program dollars (from acquisition programs, the private sector, etc.) for Phase II work, not to exceed $100,000 in additional SBIR funding. The additional SBIR dollars will only be available for testing and/or further development that will result in a prototype as a deliverable. Offerors are strongly encouraged to develop a Phase II proposal that will include a tangible product to be used for marketing purposes.

Electronic Submission Requirements

USSOCOM is implementing an electronic proposal submission process. The entire proposal, comprising of the technical proposal, Appendix A & B, and Company Commercialization Report (Appendix E) will be submitted electronically. Internet web site for submission of proposals is http://www.tda.ecrc.ctc.com/socom/default.htm. This site will guide you through the proposal submission process. Firms not able to obtain Internet access must request an exemption by calling (813) 840-5514 by Monday, August 9, 1999 by 4:30 PM EDT. Postal submission includes one original signed proposal with all forms plus three copies sent directly to the following address:

United States Special Operations Command
Attn: SOAL-KB/SBIR Program, Topic 99-00
7701 Tampa Point Blvd.
MacDill Air Force Base, Florida 33621-5316

USSOCOM currently requires all Phase I monthly reports to be submitted via e-mail. Offerors must understand e-mail is the communication medium of choice for the SBIR program. Should an offeror be awarded a Phase I, the offeror will be expected to be able to communicate reports via e-mail.

Electronic technical Proposal Preparation

The term "Technical Proposal" refers to the part of the submission as described in Section 3 of the Solicitation. WordPerfect, Text, MS Word and MSWorks are the preferred formats for submission of proposals for all systems. Please use standard fonts in order to prevent conversion difficulties. The offeror is encouraged, but not required, to embed graphics within the work processed document. Separate files may be submitted as Bit-Mapped (.bmp), Graphics Interchange Format(.gif), JPEG (.jpg), PC Paintbrush (.pcx), WordPerfectGraphic (.wpg) and Tagged Image Format (.tif). The various files comprising the electronic version are required to reflect the paper version and will not exceed the page limitation. The offeror is responsible for performing a virus check on each proposal submitted via the internet address. The detection of a virus on any submitted electronic technical proposal may be cause for the rejection of the proposal. Offerors will receive an electronic confirmation receipt of the proposal. The proposal will not be opened prior to the closing date and time. Withdrawal of proposals must include the topic number and the title of the proposal and may only be made by an officer of the company.

USSOCOM offers information on the Internet about its SBIR program at http://www.socom.mil.

USSOCOM
FY 99.2 SBIR TOPIC INDEX

Sensors

USSOCOM
FY 99.2 TOPIC DESCRIPTIONS

SOCOM 99-004 TITLE: Individual SOF Operator

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop a head-worn sensor package to enable the SOF Operator to utilize either a LWIR sensor, a NIR sensor, or a combination of the two. The system would aid the individual SOF operator with navigation and target detection during times of limited vision.

DESCRIPTION: SOF operators are required to operate during darkness and environments where vision is limited due to smoke and other obscurants. Current capabilities exist that permit the individual to operate in such environments with limited capabilities. The desired system would utilize the benefits of two night vision capabilities--LWIR and NIR. The system would allow the operator to select from either source and would allow the operator to combine the inputs from both sources in varying amounts. The SOF operator would view the sensor outputs via a head-worn display. Due to the utilization of this system as a navigational tool, the system should be head-worn. Due to the need for ballistic protection, the desired weight of the head-worn portion of the system is 1.25 pounds with a maximum of 2.25 pounds. The entire system is not required to be head worn; for example, the power source and/or a portion of the electronics and system controls may be separate from the actual head-worn components. The total system weight shall not exceed 6.0 pounds. The system shall provide detection of man targets at a minimum of 100 meters. The system shall operate in harsh environments, to include: both hot and cold temperature extremes, high humidity, conditions of salt-water spray, and submersion in salt water to a depth of 1.0 meter. Due to the use of two separate sensors, a single aperture is desired for the elimination of parallax. In the event that two separate apertures are employed, the system must provide sensor adjustments to limit the parallax for the specified applications. The LWIR sensor shall provide a 40° horizontal by 30° vertical field-of-view (FOV). The NIR sensor must match the 40° FOV along the center axis as a minimum. Both sensors shall provide unity power magnification.

PHASE I: Design and fabricate a field demonstration system as part of Phase I. The system shall be evaluated to determine its performance during various environments and mission profiles. Support for the evaluations shall be provided to insure the operation of the system and to perform modifications when possible.

PHASE II: Based on the results of Phase I, design and fabricate a second system for further evaluation. The Phase II system should include design changes to meet the desired goals of the system to include weight and a single aperture. The contractor shall support the evaluations, upon request, and incorporate required modifications.

PHASE III COMMERCIAL POTENTIAL: This system has great potential to law enforcement applications, such as search and rescue or locating criminal suspects.

SOCOM 99-005 TITLE: Retro Reflector Detector

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Take advantage of emerging illuminator/sensor technologies to develop a family of devices to detect the use of optical equipment, e.g., ambient light magnifiers, thermal detectors, spotting scopes, rifle scopes.

DESCRIPTION: Take advantage of emerging illuminator/sensor technologies to develop a family of devices to detect the use of optical equipment, e.g., ambient light magnifiers, thermal detectors, spotting scopes, rifle scopes. It would be best if this device would detect the use of this equipment before the threat platform is within hazardous range (nominally at distances greater than 1500 meters). A family of these detection devices could include short-range man-portable and longer-range platform-based versions.

PHASE I: The purpose of this phase is to demonstrate a viable approach. Design and fabricate a laboratory prototype, and demonstrate using common battlefield sensors. Any illuminators used for this project must be eye safe.

PHASE II: Based upon the results of Phase I, fabricate a prototype suitable for limited field testing, which minimizes weight and volume, as well as power consumption; and support Government testing.

PHASE III DUAL USE COMMERCIAL APPLICATIONS: These devices would have application across DOD and law enforcement operations, anywhere more capable battlefield sensors are found. Also, there are opportunities to apply this technology to vehicle, aircraft, and maritime platforms as avoidance sensors.

SOCOM 99-006 TITLE: Ruggedized Digital Camera

TECHNOLOGY AREAS: Sensors

OBJECTIVE: Develop a Ruggedized Digital Camera capable of operating underwater to depths up to 100 ft without the need of a separate environmental housing and on land to 15,000 ft. (MSL).

DESCRIPTION: Operational requirements to successfully carry out surveillance and reconnaissance missions specifies the need for a ruggedized digital camera that is capable of operation both underwater at depths to 100ft and on land to elevations of 15,000 (MSL). The preference is for a camera that does not require a separate environmental housing since these housings tend to be both fragile and bulky. Emerging mission requirements continue to specify the need for a ruggedized digital camera capable of operating while subjected to severe environmental conditions often encountered during the conduct of surveillance and reconnaissance missions. The Nikonos RS-Based Kodak DCS-425/435 met this requirement. Unfortunately, the Nikonos RS is now out of production resulting in the cancellation of the Kodak DCS-425/435. To meet this requirement a replacement for the Kodak DCS-425/435 is needed. In addition to the capabilities of the Kodak DCS-425/435 there are additional specified capabilities required of this new ruggedized digital camera. The camera would be capable of both underwater and above ground use capable of taking high-resolution stills and low to high-resolution progressively scanned video (user selectable). The minimum still resolution would be 1K by 1K pixels and the minimum video resolution would be 640 by 480 pixels. The video (or motion imagery) would be a minimum of ten frames per second (fps), with 30 fps desired. The video frame rate must be user selectable from 1 to 30 frames per second. The camera must be capable of having interchangeable waterproof (100ft.) lenses for focal lengths of 28mm to 1200mm and a waterproof low light/night vision device. The camera must be autofocus and have SLR-type "through the lens" viewing. The camera shall make no sound perceptible outside a 2 foot range when used above water.

PHASE I: Effort should focus on technological approach for addressing requirement. This should result in the delivering of a Systems Requirements Document and a Preliminary Systems Design Document. Accompanying the Systems Design Document would an in-depth cost estimate for developing three prototype cameras for use in developmental test & evaluation.

PHASE II: Build, test and report on design from Phase I effort.

PHASE III COMMERCIAL APPLICATION: A ruggedized digital camera as described above would have many commercial uses. Photojournalist would have a camera capable of withstanding hard use. Underwater photographers would have a camera not requiring bulky environmental housings. Some of the technology developed might be migrated to the consumer digital camera market that could result in the development of a lower cost less robust (but still more rugged than current digital cameras) version for the consumer camera market. This camera would be have a market with SCUBA hobbyist, backpackers, mountain bikers or anyone requiring a more rugged "sports" camera to meet their needs.

9.0 SUBMISSION FORMS AND CERTIFICATIONS

Section 9.0 contains:

Appendix A: **Proposal Cover Sheet**
Appendix A (or photocopy) must be signed and included with each proposal submitted.

Appendix B: **Project Summary Form**
Appendix B (or photocopy) must be included with each proposal submitted. Don't include proprietary or classified information in the project summary form.

Appendix C: **Cost Proposal Outline**
A cost proposal following the format in Appendix C must be included with each proposal submitted.

Appendix D: **Fast Track Application Form**
A DoD pilot program under which projects that attract outside investors receive interim funding and selection for Phase II award provided they are "technically sufficient" and have substantially met Phase I goals.

Reference A: **Proposal Receipt Notification Form**

Reference B: **Directory of Small Business Specialists**

Reference C: **SF 298 Report Documentation Page**

Reference D: **DoD Fast Track Guidance**

Reference E: **DoD's Critical Technologies**

Reference F: **DoD SBIR/STTR Mailing List Form**

APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM

PROPOSAL COVER SHEET

Failure to fill in all appropriate spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____________________

____

FIRM NAME: ____________________

MAIL ADDRESS: ____________________

____

CITY: ____________________ STATE: ________ ZIP: ________

PROPOSED COST: ____________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

BUSINESS CERTIFICATION:

	YES	NO
▸ Are you a small business as described in paragraph 2.2?	▯	▯
▸ Number of employees including all affiliates (average for preceding 12 months): ____________		
▸ Are you a socially and economically disadvantaged business as defined in paragraph 2.3? (Collected for statistical purposes only)	▯	▯
▸ Are you a woman-owned small business as described in paragraph 2.4? (Collected for statistical purposes only)	▯	▯
▸ Have you submitted proposals or received awards containing a significant amount of essentially equivalent work under other DoD or federal program solicitations? If yes, list the name(s) of the agency or DoD component, submission date, and Topic Number in the spaces below.	▯	▯

____________________ ____________________

____________________ ____________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR	CORPORATE OFFICIAL (BUSINESS)
NAME: ____________________	NAME: ____________________
TITLE: ____________________	TITLE: ____________________
PH: __________ FAX: __________	PH: __________ FAX: __________

For any purpose other than to evaluate the proposal, this data except Appendix A and B shall not be disclosed outside the Government and shall not be duplicated, used or disclosed in whole or in part, provided that if a contract is awarded to this proposer as a result of or in connection with the submission of this data, the Government shall have the right to duplicate, use or disclose the data to the extent provided in the funding agreement. This restriction does not limit the Government's right to use information contained in the data if it is obtained from another source without restriction. The data subject to this restriction is contained on the pages of the proposal listed on the line below.

PROPRIETARY INFORMATION: ____________________

Before signing below, please read the cautionary note at Section 3.7

____________________	________	____________________	________
SIGNATURE OF PRINCIPAL INVESTIGATOR	DATE	SIGNATURE OF CORPORATE BUSINESS OFFICIAL	DATE

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

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Courier 71 10 pitch
Elite 71
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Pica 72 10 pitch
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Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

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DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROPOSAL COVER SHEET

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TOPIC NUMBER: ______________________

PROPOSAL TITLE: ____

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FIRM NAME: ____

MAIL ADDRESS: ____

____

CITY: ______________________ STATE: ________ ZIP: ________

PROPOSED COST: ______________________ PHASE I OR II: _____ PROPOSAL PROPOSED DURATION: _____ IN MONTHS

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______________________ ______________________

______________________ ______________________

PROJECT MANAGER/PRINCIPAL INVESTIGATOR

NAME: ______________________

TITLE: ______________________

PH: ____________ FAX: ____________

CORPORATE OFFICIAL (BUSINESS)

NAME: ______________________

TITLE: ______________________

PH: ____________ FAX: ____________

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APPENDIX A

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
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FIRM NAME: ____

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CITY: ______________________ STATE: ________ ZIP: ________

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U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

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TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____________________

____

FIRM NAME: ____________________

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words or short (2-3 word) phrases that describe the Project.

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

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FIRM NAME: ____

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List a maximum of 8 Key Words or short (2-3 word) phrases that describe the Project.

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Complete and submit the Appendix A and B forms as pages 1 and 2 of each proposal. In addition, (4) complete copies of the proposal must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

Additional forms may be downloaded from our Home Page (http://www.acq.osd.mil/sadbu/sbir). They may also be obtained from your State SBIR Organization (Reference D) or:

DoD SBIR Support Services
2850 Metro Drive, Suite 600
Minneapolis, MN 55425-1566
(800) 382-4634

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

Failure to fill in all appropriate
spaces may cause your proposal to be disqualified

TOPIC NUMBER: ____________________

PROPOSAL TITLE: ____

____

FIRM NAME: ____

PHASE I or II PROPOSAL: __________

Technical Abstract (Limit your abstract to 200 words with no classified or proprietary information/data.)

Anticipated Benefits/Potential Commercial Applications of the Research or Development.

List a maximum of 8 Key Words or short (2-3 word) phrases that describe the Project.

____________________ ____________________

____________________ ____________________

____________________ ____________________

____________________ ____________________

Nothing on this page is classified or proprietary information/data

INSTRUCTIONS FOR COMPLETING APPENDIX A

AND APPENDIX B

General:

DOD Components employ automated optical devices to record SBIR proposal information. Therefore the proposal cover sheet (Appendix A) and the project summary (Appendix B) should be typed without proportional spacing using one of the following type styles:

Courier 12,10 or 12 pitch
Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
OCR-B 10 or 12 pitch
Pica 72 10 pitch
Prestige Elite 10 or 12 pitch
Prestige Pica 10 Pitch

Whenever a numerical value is requested type the numerical character (i.e. in "Proposed Duration" type 6 NOT six).

When typing address information use the two alphabet characters used by the Post Office for the state, DO NOT SPELL OUT THE FULL STATE NAME (i.e. type NY not New York or N.Y.).

Complete and submit the Appendix A and B forms as pages 1 and 2 of each proposal. In addition, (4) complete copies of the proposal must be submitted (see Section 6).

Carefully align the forms in the typewriter using the underlines as a guide. The forms are printed to accommodate standard typewriter spacing.

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U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
PROJECT SUMMARY

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AND APPENDIX B

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Courier 71 10 pitch
Elite 71
Letter Gothic 10 or 12 pitch
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U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
COST PROPOSAL

Background:

Offerors should indicate the following items, as appropriate, in their proposal, following the instructions in Section 3.4(m) of this solicitation.

Cost Breakdown Items (in this order, as appropriate):

1. Name of offeror
2. Home office address
3. Location where work will be performed
4. Title of proposed effort
5. Company's taxpayer identification number and CAGE code. *(Note: Offerors that do not yet have these items -- e.g., because the company does not yet exist at the time of proposal submission -- should so indicate in the cost proposal. Such offerors, if selected for award, should talk with their DoD contracting officer about obtaining these items, both of which are required before a contract can be awarded.)*
6. Topic number and topic title from DoD Solicitation Brochure
7. Total dollar amount of the proposal
8. Direct material costs
   a. Purchased parts (dollars)
   b. Subcontracted items (dollars)
   c. Other
      (1) Raw material (dollars)
      (2) Your standard commercial items (dollars)
      (3) Interdivisional transfers (at other than cost dollars)
   d. Total direct material (dollars)
9. Material overhead (rate_____%) x total direct material = dollars
10. Direct labor (specify)
    a. Type of labor, estimated hours, rate per hour and dollar cost for each type (e.g., "computer programmer, 40 hours, $26 per hour, $1040 cost"). Include the name as well as the hours, etc. of all key personnel.
    b. Total estimated direct labor (dollars)
11. Labor overhead
    a. Identify overhead rate, the hour base and dollar cost
    b. Total estimated labor overhead (dollars)
12. Special testing (include field work at government installations)
    a. Provide dollar cost for each item of special testing
    b. Estimated total special testing (dollars)
13. Special equipment
    a. If direct charge, specify each item and cost of each
    b. Estimated total special equipment (dollars)
14. Travel (if direct charge)
    a. Transportation (detailed breakdown and dollars)
    b. Per diem or subsistence (details and dollars)
    c. Estimated total travel (dollars)
15. Subcontracts (e.g., consultants)
    a. Identify each, with purpose, and dollar rates
    b. Total estimated subcontracts costs (dollars)
16. Other direct costs (specify)
    a. Total estimated direct cost and overhead (dollars)
17. General and administrative expense
    a. Percentage rate applied
    b. Total estimated cost of G&A expense (dollars)
18. Royalties (specify)
    a. Estimated cost (dollars)
19. Fee or profit (dollars
20. Total estimate cost and fee or profit (dollars)
21. The cost breakdown portion of a proposal must be signed by a responsible official, and the person signing must have typed name and title and date of signature must be indicated.
22. On the following items offeror must provide a yes or no answer to each question.
    a. Has any executive agency of the United State Government performed any review of your accounts or records in connection with any other government prime contract or subcontract within the past twelve months? If yes, provide the name and address of the reviewing office, name of the individual and telephone extension.
    b. Will you require the use of any government property in the performance of this proposal? If yes, identify.
    c. Do you require government contract financing to perform this proposed contract? If yes, then specify type as advanced payments or progress payments.
23. Type of contract proposed, either cost-plus-fixed-fee or firm-fixed price.

APPENDIX D

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION COVER SHEET

Failure to fill in all appropriate spaces may cause your application to be disqualified

To qualify for the SBIR Fast Track, a company must submit a Fast Track application and meet the other requirements detailed in Section 4.5 of the solicitation. This form, when completed and signed by both the company and its investor, should be included as the cover sheet of the Fast Track application. Instructions on where to submit the application are on the back of this form.

TOPIC #: ______________ CONTRACT #: ______________________ PHASE I EFFECTIVE START DATE: ______________

SPONSORING DOD COMPONENT: ______________________________ PHASE I COMPLETION DATE: ______________

PHASE I TITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

CITY: ______________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ______________________

NAME OF OUTSIDE INVESTOR: ____

MAIL ADDRESS: ____

CITY: ______________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ______________________

BUSINESS CERTIFICATION:

	YES	NO
▸ Has your company ever received a Phase II SBIR or STTR award from the federal government (including DoD)? If yes, the minimum matching rate is $1 for every SBIR dollar. If no, the minimum matching rate is 25 cents for every SBIR dollar. (Matching rates differ slightly for BMDO applicants-- see the BMDO section of this solicitation)	☐	☐
▸ Does the outside funding proposed in this application qualify as a "Fast Track investment", and does the investor qualify as an "outside investor", as defined in DoD Fast Track Guidance (Reference D)? If you have any questions about this, call the DoD SBIR Help Desk (800-382-4634). The Help Desk will refer any policy and/or substantive questions to appropriate DoD personnel for an official response.	☐	☐

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PROPOSED SBIR AND MATCHING FUNDS:

- Proposed DoD SBIR funds for the interim effort: $______________
- Proposed DoD SBIR funds for Phase II: $______________
- Total proposed DoD SBIR funds (interim + Phase II): $______________
- Amount of matching funds (cash) the investor will provide: $______________

By signing below, the parties are stating that the outside investor will provide matching funds, in the amount listed above, contingent on the company's selection for Phase II SBIR award. If the matching funds are not transferred from the investor to the company within 45 days after DoD has notified the company that it has been selected for Phase II award, the company will be ineligible to compete for a Phase II award not only under the Fast track but also under the regular Phase II competition, unless a specific written exception is granted by the Component SBIR program manager.

COMPANY OFFICIAL	OUTSIDE INVESTOR OFFICIAL
NAME: ______________	NAME: ______________
TITLE: ______________	TITLE: ______________
TELEPHONE: ______________	TELEPHONE: ______________
SIGNATURE ______ DATE ______	SIGNATURE ______ DATE ______

INSTRUCTIONS FOR COMPLETING APPENDIX D

SUBMISSION:

Submit the Fast Track application, including the three items discussed in Section 4.5(b), to the technical monitor for your Phase I project. In addition, submit a copy of the entire application to the Program Manager of the DoD Component funding the SBIR project (addresses below). Finally, send a copy of this application cover sheet, when completed, to the DoD SBIR Program Manager, 1777 N. Kent Street, Suite 9100, Arlington, VA 22209. Do not submit other items in the Fast Track application to the DoD SBIR Program Manager.

Department of the Army
Dr. Kenneth A. Bannister
Army SBIR Program Manager
Army Research Office - Washington
5001 Eisenhower Avenue, Room 8N23
Alexandria, VA 22333-0001

Department of the Navy
ONR 362 SBIR
800 N. Quincy Street
Arlington, VA 22217-5660

Department of the Air Force
AFPL/XPXP, Suite 6
ATTN: R.J. Dickman
Wright Patterson AFB, OH 45433-5006

Defense Advanced Research Projects Agency
ATTN: SBIR Program Manager Ms. C. Jacobs
3701 N. Fairfax Drive
Arlington, VA 22203-1714

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Army Research Office - Washington
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Ballistic Missile Defense Organization
ATTN: TOI/SBIR (Bond)
1725 Jefferson Davis Highway
Suite 809
Arlington, VA 22202

Office of the Director, Defense Research and Engineering
Lab Management & Tech Transition
ATTN: SBIR Program Manager
3040 Defense Pentagon
Washington, DC 20301-3040

Defense Threat Reduction Agency
ATTN: AM/SADBU, Mr. Bill Burks
45045 Aviation Drive
Dulles, VA 20166-7517

US Special Operations Command
ATTN: SOSB/Ms Karen L. Pera
7701 Tampa Point Blvd.
MacDill AFB, FL 33621-5323

National Imagery and Mapping Agency
Dr. Young Suk Sull
Mail-Stop: P-53
12301 Sunrise Valley Drive
Reston, VA 20191-3449

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APPENDIX D

U.S. DEPARTMENT OF DEFENSE

SMALL BUSINESS INNOVATION RESEARCH (SBIR) PROGRAM
FAST TRACK APPLICATION COVER SHEET

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TOPIC #: ______________ CONTRACT #: ____________________________ PHASE I EFFECTIVE START DATE: ________________

SPONSORING DOD COMPONENT: ______________________________ PHASE I COMPLETION DATE: ________________

PHASE I TITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

CITY: ______________________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ____________________

NAME OF OUTSIDE INVESTOR: ____

MAIL ADDRESS: ____

CITY: ______________________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ____________________

BUSINESS CERTIFICATION:

	YES	NO
▸ Has your company ever received a Phase II SBIR or STTR award from the federal government (including DoD)? If yes, the minimum matching rate is $1 for every SBIR dollar. If no, the minimum matching rate is 25 cents for every SBIR dollar. (Matching rates differ slightly for BMDO applicants-- see the BMDO section of this solicitation)	☐	☐
▸ Does the outside funding proposed in this application qualify as a "Fast Track investment", and does the investor qualify as an "outside investor", as defined in DoD Fast Track Guidance (Reference D)? If you have any questions about this, call the DoD SBIR Help Desk (800-382-4634). The Help Desk will refer any policy and/or substantive questions to appropriate DoD personnel for an official response.	☐	☐

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PROPOSED SBIR AND MATCHING FUNDS:

- Proposed DoD SBIR funds for the interim effort: $____________________
- Proposed DoD SBIR funds for Phase II: $____________________
- Total proposed DoD SBIR funds (interim + Phase II): $____________________
- Amount of matching funds (cash) the investor will provide: $____________________

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COMPANY OFFICIAL	OUTSIDE INVESTOR OFFICIAL
NAME: ____________________	NAME: ____________________
TITLE: ____________________	TITLE: ____________________
TELEPHONE: ____________________	TELEPHONE: ____________________
____________________ SIGNATURE ________ DATE	____________________ SIGNATURE ________ DATE

INSTRUCTIONS FOR COMPLETING APPENDIX D

SUBMISSION:

Submit the Fast Track application, including the three items discussed in Section 4.5(b), to the technical monitor for your Phase I project. In addition, submit a copy of the entire application to the Program Manager of the DoD Component funding the SBIR project (addresses below). Finally, send a copy of this application cover sheet, when completed, to the DoD SBIR Program Manager, 1777 N. Kent Street, Suite 9100, Arlington, VA 22209. Do not submit other items in the Fast Track application to the DoD SBIR Program Manager.

Department of the Army
Dr. Kenneth A. Bannister
Army SBIR Program Manager
Army Research Office - Washington
5001 Eisenhower Avenue, Room 8N23
Alexandria, VA 22333-0001

Department of the Navy
ONR 362 SBIR
800 N. Quincy Street
Arlington, VA 22217-5660

Department of the Air Force
AFPL/XPXP, Suite 6
ATTN: R.J. Dickman
Wright Patterson AFB, OH 45433-5006

Defense Advanced Research Projects Agency
ATTN: SBIR Program Manager Ms. C. Jacobs
3701 N. Fairfax Drive
Arlington, VA 22203-1714

Chemical and Biological Defense Program
Dr. Kenneth A. Bannister
Army Research Office - Washington
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Ballistic Missile Defense Organization
ATTN: TOI/SBIR (Bond)
1725 Jefferson Davis Highway
Suite 809
Arlington, VA 22202

Office of the Director, Defense Research and Engineering
Lab Management & Tech Transition
ATTN: SBIR Program Manager
3040 Defense Pentagon
Washington, DC 20301-3040

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SPONSORING DOD COMPONENT: ______________________________________ PHASE I COMPLETION DATE: ____________________

PHASE I TITLE: ____

____

FIRM NAME: ____

MAIL ADDRESS: ____

CITY: ______________________________________ STATE: __________ ZIP: ____________

TAXPAYER IDENTIFICATION NUMBER: ______________________

NAME OF OUTSIDE INVESTOR: ____

MAIL ADDRESS: ____

CITY: ______________________________________ STATE: __________ ZIP: ____________

TAXPAYER IDENTIFICATION NUMBER: ______________________

BUSINESS CERTIFICATION:

	YES	NO
▸ Has your company ever received a Phase II SBIR or STTR award from the federal government (including DoD)? If yes, the minimum matching rate is $1 for every SBIR dollar. If no, the minimum matching rate is 25 cents for every SBIR dollar. (Matching rates differ slightly for BMDO applicants-- see the BMDO section of this solicitation)	▯	▯
▸ Does the outside funding proposed in this application qualify as a "Fast Track investment", and does the investor qualify as an "outside investor", as defined in DoD Fast Track Guidance (Reference D)? If you have any questions about this, call the DoD SBIR Help Desk (800-382-4634). The Help Desk will refer any policy and/or substantive questions to appropriate DoD personnel for an official response.	▯	▯

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NAME: ____________________	NAME: ____________________
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U.S. DEPARTMENT OF DEFENSE

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PHASE I TITLE: ____

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FIRM NAME: ____

MAIL ADDRESS: ____

CITY: ______________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ______________________

NAME OF OUTSIDE INVESTOR: ____

MAIL ADDRESS: ____

CITY: ______________________ STATE: __________ ZIP: __________

TAXPAYER IDENTIFICATION NUMBER: ______________________

BUSINESS CERTIFICATION:

	YES	NO
▸ Has your company ever received a Phase II SBIR or STTR award from the federal government (including DoD)? If yes, the minimum matching rate is $1 for every SBIR dollar. If no, the minimum matching rate is 25 cents for every SBIR dollar. (Matching rates differ slightly for BMDO applicants-- see the BMDO section of this solicitation)	▯	▯
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NAME: ______________	NAME: ______________
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TELEPHONE: ______________	TELEPHONE: ______________
SIGNATURE ______________ DATE ______	SIGNATURE ______________ DATE ______

INSTRUCTIONS FOR COMPLETING APPENDIX D

SUBMISSION:

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1725 Jefferson Davis Highway
Suite 809
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Reference A
DoD SBIR Solicitation 99.2

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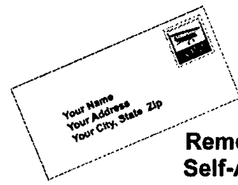

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Standard form 298 (Rev. 2-89)
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Standard Form 298 (Rev. 2-89)

DoD Fast Track Guidance

This paper contains DoD's official guidance on what types of relationships between a small company and outside investors in the company qualify as an investment under the SBIR and STTR Fast Track ("Fast Track investment"). It includes specific examples of company-investor relationships that we have been asked about and our official responses on whether these relationships qualify as a Fast Track investment. If you have questions about whether a particular company-investor relationship qualifies, please contact the DoD SBIR/STTR Help Desk (tel. 800/382-4634, fax 800/462-4128, e-mail SBIRHELP@us.teltech.com). The Help Desk will refer any policy or substantive questions to appropriate DoD personnel for an official response.

I. General Guidance on What Qualifies As A "Fast Track Investment"

- The investor must be an "outside investor," which may include such entities as another company, a venture capital firm, an individual "angel" investor, a non-SBIR/non-STTR government program, or any combination of the above. It does not include the owners of the small business, their family members, and/or "affiliates" of the small business, as defined in Title 13 of the Code of Federal Regulations (C.F.R.), Section 121.103. As discussed in that Section:
    - Concerns are affiliates of each other when one concern controls or has the power to control the other, or a third party or parties controls or has the power to control both.
    - [We] consider factors such as ownership, management, previous relationships with or ties to another concern, and contractual relationships, in determining whether affiliation exists.
    - Individuals or firms that have identical or substantially identical business or economic interests, such as family members, persons with common investments, or firms that are economically dependent through contractual or other relationships, may be treated as one party with such interests aggregated.

  Although DoD is guided by this definition of affiliation in the Code of Federal Regulations, we also exercise our own discretion in determining whether a particular entity qualifies as an "outside investor."

- The investment must be an arrangement in which the outside party provides cash to the small company in return for such items as: equity; a share of royalties; rights in the technology; a percentage of profit; an advance purchase order for products resulting from the technology; or any combination of the above. The investor's funds must pay for activities that further the development and/or commercialization of the company's SBIR technology (e.g., further R&D, manufacturing, marketing, etc.).

II. Specific examples of What Does and Does Not Qualify As a "Fast Track Investment"

A. Examples of What Qualifies as an "Outside Investor"

(1) Can a small company contribute its own internal funds to qualify for the Fast Track?

No. DoD is seeking outside validation of the commercial potential of the company's technology, and therefore requires that the funds come from an outside investor. Also, cash from an outside investor shows up plainly on the company's books and therefore can be more readily verified than a company's own matching contribution.

(2) Company A spins off company B, which wins a phase I SBIR award. Company A then wants to contribute matching funds to qualify company B for the Fast Track. Can A be considered an outside investor for purposes of the Fast Track?

In making our determination of whether company A is an outside investor, we would be guided by the definition of "affiliates" in 13 C.F.R. Sec. 121.103, discussed above. Our presumption is that in this example A and B would be considered "affiliates," and that A would therefore not be an outside investor for purposes of the Fast Track. However, that presumption could be rebutted by showing, for example, that the spin-off occurred several years ago and that A and B do not exercise control over one another, do not have common ownership or management, have different business interests, etc.

(3) Small company S wins a phase I SBIR award. The president of S is a major shareholder in another company Y, which wants to contribute matching funds to qualify S for the Fast Track. Can Y be considered an outside investor?

Our presumption is that Y would not be considered an outside investor. Our determination would be guided by whether the president's stake in Y is large enough that S and Y would be considered "affiliates" under 13 C.F.R. Sec.121.103. Subsection (c.) of Section 121.103 specifically discusses affiliation based on stock ownership:

c. Affiliation based on stock ownership.
   1. A person is an affiliate of a concern if the person owns or controls, or has the power to control 50 percent or more of its voting stock, or a block of stock which affords control because it is large compared to other outstanding blocks of stock.
   2. If two or more persons each owns, controls or has the power to control less than 50 percent of the voting stock of a concern, with minority holdings that are equal or approximately equal in size, but the aggregate of these minority holdings is large as compared with any other stock holding, each such person is presumed to be an affiliate of the concern. If S and Y are found to be affiliates, we would determine that Y is not an outside investor.

(4) Does the outside investor have to be a single entity (e.g., a single venture capital firm) or can it be more than the entity (e.g., two angel investors and a venture capital firm)?

It can be more than one entity.

(5) Small company A contributes matching funds to small company B in order to qualify B for the Fast Track, and, at the same time, B contributes matching funds to A in order to qualify A for the Fast Track. Do A and B qualify as outside investors under the Fast Track?

No. A and B's relationship is such that their investment in each other would not provide outside validation of the commercial potential of their respective SBIR projects. We would therefore not consider them to be outside investors for purposes of the Fast Track.

(6) Can the brother of an employee of small company S contribute funds to qualify S for the Fast Track?

Probably not. Again, we would be guided by the definition of "affiliates" in 13 C.F.R. Sec. 121.103. The brother presumptively would be an affiliate of company S and not an outside investor.

(7) Venture capital firm V currently is a 22 percent shareholder in small company S. Can V invest additional funds in S to qualify S for the Fast Track?

Our presumption is yes. In making our determination, we would be guided by whether V and S are "affiliates," as defined in 13 C.F.R. Sec. 121.103. Section 121.103 provides (in subsection (b)(5)) that a venture capital firm is not affiliated with a company if the venture capital firm does not control the company -- e.g., by owning more than 50 percent of the stock of a small company (prior to its investment under the Fast Track), as described in 13 C.F.R. 107.865.

(8) Large company L makes a cash investment in small company S, and then serves as a subcontractor to S on an SBIR project. Can L's investment in S count as a matching contribution for purposes of the Fast Track?

Only L's cash investment net of its subcontracting effort can count as matching funds for purposes of the Fast Track. For example, if L invests $750,000 in S and subcontracts with S for $250,000, only L's net contribution ($500,000) can count as matching funds for purposes of the Fast Track.

(9) Company Y makes a cash investment in small company S for purposes of the Fast Track, and also enters into a separate contract with S under which Y provides certain goods/services to S in return for $500,000. Can Y's cash investment in S count as a matching contribution for purposes of the Fast Track?

As in the previous example, only Y's cash investment net of the $500,000 it receives from S can count as matching funds for purposes of the Fast Track. However, if the separate contract between Y and S pre-dates S's submission of its phase I SBIR proposal, Y's entire cash investment can count as matching funds for purposes of the Fast Track.

(10) A group of investors wishes to invest funds in small company S to qualify S for the Fast Track. One of the investors is the mother of S's president, who wants to contribute $50,000 toward the effort. Can the group's investment in S count as a matching contribution to qualify S for the Fast Track?

The mother's investment of $50,000 does not count, because she is not an outside investor (see item (6) above). Contributions of the other investors can count provided that they meet the other conditions for the Fast Track (e.g., each must be an outside investor).

B. Examples of What Qualifies as an "Investment"

(1) Can a loan from an outside party qualify as an "investment" for purposes of the Fast Track?

No. The rationale behind the Fast Track is that an outside party is betting on the company's success in bringing the technology to market -- not just its ability to repay a loan.

(2) How about a loan that is convertible to equity?

A loan that is convertible to equity at the company's discretion would count as an investment under the following circumstances: (1) the loan is provided by a public entity (e.g., a state agency), or (2) the loan is provided by a private entity, and the SBIR company actually converts the loan to equity before the end of phase I.

(3) Can in-kind contributions from an outside investor count as matching funds under the Fast Track?

No. The matching contribution must be in cash. A cash contribution is a stronger signal of the outside investor's interest in the technology, and can be readily verified.

(4) Can a purchase order from an outside investor count as a matching contribution under the Fast Track?

An advance purchase order for new products resulting from the SBIR project can count as a matching contribution under the Fast Track. The purchase order must be for one or more products directly resulting from the SBIR project (including, for example, a duplicate of the prototype that will be delivered to DoD at the end of phase II). The investor must provide its cash payment to the small business during phase II, within the time frame set out in the solicitation (section 4.5). To ensure that the investor's funds are "at risk," the payment cannot be refundable to the investor if the product is not delivered or does not work.

(5) Can the funds raised from an initial public offering (IPO) count as matching funds for purposes of the Fast Track?

Yes, as long as the offering memo indicates that a portion of the funds from the IPO will pay for work (e.g., R&D, marketing, etc.) that is related to the SBIR project.

(6) If large company L pays small company S for work related to S's SBIR project and expects a deliverable (goods or services) from S in return, would that qualify as an "investment"?

With the exception of an advance purchase order (discussed in (4) above), this arrangement would not qualify as an investment, for the same reason a loan does not qualify. Specifically, in this situation the large company is not betting on the small company's success in bringing the technology to market, but merely on its ability to provide the deliverable.

C. Examples Re: Timing/Logistics of the Fast Track Investment

(1) Can entity E's investment in small company S during the first month of S's phase I SBIR project count as a matching contribution to qualify S for the Fast Track?

Yes, provided that E is an outside and that the other Fast Track conditions are met. The investment can occur any time after the start of the phase I project.

(2) Small company A, which has won a phase I award, spins off small company B to commercialize the SBIR technology. A then convinces angel investor I to invest funds in B. Can I's investment in B count as a matching contribution to qualify A for the Fast Track?

For I's investment in B to qualify A for the Fast Track, DoD must determine that A and B are substantially the same entity, as evidenced, for example, by their meeting the definition of "affiliates" in 13 C.F.R. Sec.121.103. If DoD determines that A and B are substantially the same entity, I's investment in B could qualify A for the Fast Track. Of course, the parties must also meet the other conditions for the Fast Track (e.g., I must be an outside investor).

(3) Small company S is collaborating with a university on an STTR project. Investor I wishes to provide funds to the university in order to qualify S for the STTR Fast Track. Can I's investment in the university count as a matching contribution to qualify S for the Fast Track?

In order to qualify S for the STTR Fast Track, I's investment of funds must be in small company S, not in the university. S can then subcontract some of the funds to the university. The rationale is that a cash investment in the small company is a very strong indication of commercial potential, whereas an investment in the university is less so.

(4) Must the activities funded by the investor be included in the statement of work for the small company's phase II contract?

No. The investor's funds must pay for activities that further the development and/or commercialization of the company's SBIR technology (e.g., further R&D, manufacturing, marketing, etc.), but these activities need not be included in the phase II contract's statement of work. In practice, funds from private sector Fast Track investors generally are not included in the phase II contract's statement of work, whereas funds from government Fast Track investors (such as DoD acquisition programs) sometimes are.

DoD's Critical Technologies
(Defense Technology Area)

1.	**Aerospace Propulsion and Power** -- technology directed toward propulsion and power systems for aircraft, missiles, and space vehicles in four major sub-areas: 1) gas-turbine propulsion systems for aircraft and cruise missiles; 2) propulsion systems for space and missile systems; 3) ramjet, scramjet, combined cycle propulsion systems for missile and space-launch systems and fuels; 4) non-propulsive power generation systems for aircraft, missiles, and space vehicles.
2.	**Air Vehicles/Space Vehicles** -- Air vehicles: technology of aeromechanics, flight controls, subsystem, air vehicle structures in fixed wing vehicles, rotary wing vehicles, unmanned air vehicles, and system integration technology. Space Vehicles: technology oriented toward the spacecraft bus, technologies unique to space and the military and their implementation through flight experiments in the following sub-areas: 1) thrust producing engines and devices for space launch, orbit transfer, and maneuver; 2) generation and distribution of electrical power on-board spacecraft; 3) thermal management for all satellite applications; 4) structures focused on adapting advanced materials and structures produced in basic research for space applications; 5) survivability focused on "environments" (both natural and hostile) and "techniques" (including active and passive approaches); 6) guidance, navigation, and control for the launch from earth, earth orbit and free space; 7) technology integration focused on adapting products of other technology areas to space systems; 8) flight experiments which focus on space qualification and transfer of technology to the military and civilian space communities.
3.	**Battlespace Environments** -- study, characterization, prediction, modeling, and simulation of the terrestrial, ocean, lower atmosphere, and space/upper atmosphere environments to understand their impact on personnel, platforms, sensors, and systems; enable the development of tactics and doctrine to exploit that understanding; and optimize the design of new systems.
4.	**Biomedical** -- yield superior technology in support of the DoD mission to provide health support to U.S. military forces by preserving the combatant's optimal mission capabilities and health despite battle and non-battle threats from military operations. Medical research programs must be conducted for the benefit of mankind and many are regulated by the U.S. Food and Drug Administration.
5.	**Chemical and Biological Defense** -- U.S. forces must be prepared for conflict in a chemical and biological environment in a Global Reach concept. The CB defense technology area includes four major subareas: 1) detection; 2) protection; 3) decontamination, and 4) information processing and dissemination.
6.	**Clothing, Textiles and Food** -- focuses on protecting and sustaining soldiers, sailors, airmen, and marines, individually and collectively. This technology includes two sub-areas: 1) Clothing and textiles - includes all textile-related polymer, fiber, yarn, fabric, film, dye, pigment, coating, and clothing systems and their packaging which enhance survivability, performance, and mobility. These efforts provide ballistic protection, percutaneous chemical/biological protection, countermeasures to sensors, integrated protection (flame/incendiary and anthropometric/biomechanical concepts), and bioengineered materials for protection. This subarea includes textile based technologies for items such as tentage and parachutes. 2) Food -- includes science and technological efforts to sustain warriors and enhance their mental and physical acuity and performance by nutritional performance enhancement, food preservation, food packaging, consumer acceptance, and equipment and energy technologies. This technology area supports the unique feeding requirements of the military services ranging from general purpose individual rations to group ration systems for special operations.

7.	**Command, Control and Communications (C3)** -- area encompasses C3 systems of all types: data processing hardware and software dedicated to operational planning, monitoring or assessment (including information fusion), distributed processing, distributed data storage, and distributed data management. **NOT INCLUDED:** general purpose computer hardware and high performance computers, general purpose software, languages, software engineering, environments, and communications and processing elements considered subsystems in vehicles.
8.	**Computing and Software** -- push the frontiers of advanced information technology beyond that normally achieved by the commercial sector alone, to enable creation of broad range advanced information processing systems of critical value in support of the missions of the DoD. This area is separated into six broad subareas: 1) system software; 2) software and systems development; 3) intelligent systems; 4) user interface; 5) computing systems and architecture; and 6) networking.
9.	**Conventional Weapons** -- develop conventional armament technologies for all new and upgraded non-nuclear weapons which includes efforts directed specifically toward non-nuclear munitions, their components, and launching systems, guns, bombs, guided missiles, projectiles, special warfare munitions, EOD devices, mortars, mines, countermine systems, torpedoes, and underwater weapons and their associated combat control. There are six major sub-areas: 1) fuzing/safe & arm; 2) guidance and control; 3) guns; 4) countermine/mines; 5) warheads and explosives; and 6) weapon lethality/vulnerability.
10.	**Electronics** -- extends from basic research to applications at the subsystem level. The electronics technology area includes research, development, design, fabrication, and testing of electronic materials; electronic devices, including digital, analog, microwave, optoelectronic, vacuum and integrated circuits; and electronic modules, assemblies, and subsystems organized into five sub-areas: 1) RF components; 2) electro-optics; 3) microelectronics; 4) electronic materials; and 5) electronic models and subsystems.
11.	**Electronic Warfare/Directed Energy Weapons** -- <u>Electronic Warfare:</u> Develop technology for the offensive and defensive application of EW which includes efforts in intercept, counter, and exploit the complex threat weapons spanning the entire electromagnetic spectrum, including radio frequency (RF), infrared (IR), electro-optic (EO), ultraviolet (UV), and multispectral/multimode sensors. Electronic Warfare is divided in three subareas: 1) force protection; 2) Offensive EW; and 3) EW support functions. <u>Directed Energy Weapons:</u> Technologies relate to the production and projection of a beam of concentrated electromagnetic energy or atomic/subatomic particles. The DEW technology is divided into three sub-areas: 1) laser weapons; 2) RF weapons; and 3) particle beam weapons.
12.	**Environmental Quality/Civil Engineering** -- <u>Environmental Quality:</u> technologies which reduce the costs of DoD operations while ensuring mission accomplishment is not jeopardized by adverse environmental impacts. There are four sub-areas: 1) cleanup of contaminated sites resulting from DoD operations; 2) compliance with laws concerning the treatment and disposal of hazardous waste products; 3) pollution prevention; 4) conservation of natural and cultural resources. <u>Civil Engineering:</u> technology efforts to solve critical DoD civil engineering problems related to training, mobilizing, deploying, and employing a force at any location at any time. This technology area includes survivability and protective structures, airfields and pavements, conventional facilities, critical airbase facilities and recovery, ocean and waterfront facilities and operations, sustainment engineering, and fire fighting.
13.	**Human Systems Interface** -- technology fully leverages and extends the capabilities of warfighters and maintainers to ensure that fielded systems will exploit the fullest potential of the warfighting team, irrespective of gender, mission or environment. This technology is organized into four areas: 1) crew systems integration and protection; 2) performance aiding; 3) information management and display; and 4) performance assessment and design methodologies.

14. Manpower, Personnel and Training -- Manpower and personnel technology addresses the recruitment, selection, classification, and assignment of people to military jobs. It seeks to reduce the attrition of high-quality personnel and helps the senior department leadership to predict and measure the consequences of policy decisions. Training systems technology improves the effectiveness of DoD's investment in training instruction, improves the efficiency of student flow through the training pipeline, enhances military training systems, provides opportunities for skill practice and mission rehearsal, and lowers life-cycle costs of training systems and combat systems.
15. Materials, Processes and Structures -- technologies produce an enabling array of capabilities for every DoD system that flies in air or space, navigates on land or over/under the sea, and fires or is fired upon. MP&S spans all material categories -- metal and intermetallic alloys; ceramics; polymers; composites of all types; semiconductors; superconductors, optical, ferroelectric, and magnetic materials; and materials for power sources.
16. Sensors -- technologies are divided into five major sub-areas: 1) radar sensors; 2) electro-Optic sensors; 3) acoustic sensors; 4) automatic target recognition; and 5) integrated platform electronics and sensors. Applications include strategic and tactical surveillance, identification and targeting of threats from all military platforms including satellites, aircraft, helicopters, ships, submarines, ground vehicles and sites, unmanned air vehicles, unattended ground sensors and the individual soldier.
17. Surface/Under Surface Vehicles/Ground Vehicles -- Surface/Under surface vehicles: technology for improved combat efficiency, survivability, and stealth of surface ships, submarines and unmanned undersea vehicles. Ground vehicles: technologies to support the basic Army and Marine Corps land combat functions: shoot, move, communicate, survive and sustain. Covered here are propulsion and power, track and suspension, vehicle subsystems, hydrodynamics, signature reduction, fuels and lubricants and integration technologies related to land combat vehicles, including amphibious vehicles with a ground combat role.
18. Manufacturing Sciences and Technology (MS&T) -- area is focused on cross-cutting engineering and manufacturing process technologies beyond those developed in conjunction with new product technologies in the other technology areas. Includes ARPA 6.2 and 6.3 programs in information technology for manufacturing applications, Service/DLA manufacturing technology (ManTech) programs, advanced technology demonstrations for affordability, and advanced industrial practices to demonstrate the combination of improved process technology and improved business practices. These programs encompass process technologies at all manufacturing levels (enterprise/factory/cell/machine/unit process).
19. Modeling and Simulation (M&S) -- includes development, integration, and implementation of tools and applications to apply M&S more broadly and with greater validity across DoD. Directly dependent on enabling technologies such as high speed computing, communications and networking, human systems interfaces, and software. Major sub-areas are: 1) architectures (software, data/database methodologies, and interfaces with communications and networks); 2) environmental representations (terrain, weather, atmosphere, space, oceans, and others); and 3) computer generated forces (systems representations, human behaviors, and their interactions).

Note: The above information is a summary of the information contained in documents "Defense Technology Plan" (DTIC # A285415) and "Defense Science and Technology Strategy" (DTIC # A285414).

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