NAVSWC MP 91-142

TECHNOLOGY TRANSFER SUMMARY REPORT (FY90) NAVAL SURFACE WARFARE CENTER

BY RAMSEY D. JOHNSON
TECHNOLOGY BASE PROGRAM OFFICE

MARCH 1991

NAVAL SURFACE WARFARE CENTER
Dahlgren, Virginia 22448-5000 • Silver Spring, Maryland 20903-5000

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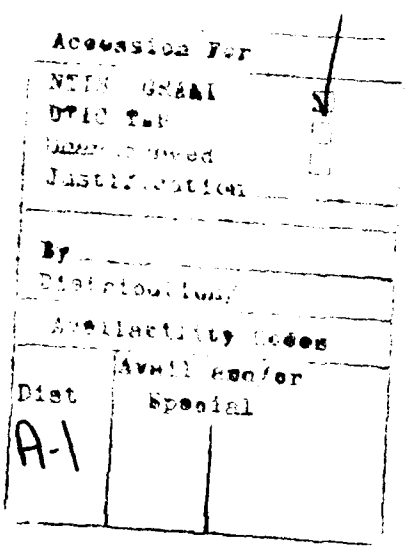

NAVAL SURFACE WARFARE CENTER
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FOREWORD

This report summarizes the Naval Surface Warfare Center's (NAVSWC) participation in the following five principal areas involving technology interactions with the public and private sectors:

1. Domestic Technology Transfer (DTT)
2. Navy Potential Contractor Program (NPCP)
3. Industry Independent Research & Development (IR&D)
4. Small Business Innovation Research (SBIR)
5. Technology Base Contracting

Center technical staff members supporting technology base and domestic technology transfer tasks contributed to the information presented in this report. Questions or requests for additional information should be referred to NAVSWC, Code D4T, Mr. Ramsey D. Johnson, (301) 394-1505 or Autovon 290-1505.

Approved by:

THOMAS A. CLARE
Technical Director

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INTRODUCTION

The Naval Surface Warfare Center (NAVSWC) is an active participant in the following Navy and Department of Defense (DOD) programs that promote technical interactions with the private sector:

- Navy Domestic Technology Transfer (DTT)
- Navy Potential Contractor Program (NPCP)
- Industry Independent Research and Development (IR&D) Program
- Small Business Innovation Research (SBIR) Program
- Category 6.1, 6.2, and 6.3A (Technology Base) Contracting

This report summarizes FY90 NAVSWC participation in these programs.

DOMESTIC TECHNOLOGY TRANSFER

BACKGROUND

For many years, the U.S. civilian sector has derived significant spinoff benefits from the Navy's efforts in the development and application of technology. In most cases, these transfer actions occurred on an ad hoc basis. Recognizing that the Nation would derive considerably greater benefits if DTT activity were encouraged and systematically pursued as a matter of policy, Congress passed legislation[1] to stimulate improved use of federally funded technology developments, including authority for federal laboratories to participate in cooperative research and development agreements (CRDAs) with U.S. industry and academia. To underscore this legislative interest, the President issued an Executive Order[2] calling for prompt action in implementing these initiatives for facilitating U.S. private sector access to federal science and technology. The DOD DTT Program was authorized[3] in response to the requirements of References 1 and 2.

NAVY DTT

The Navy policy of actively promoting military-civilian DTT and associated CRDAs is promulgated by a directive from the Secretary of the Navy.[4] In this context, DTT involves the transfer of technology developed by the Navy, including inventions, software, and training technology, to the U.S. civilian sector for use in nonmilitary applications. Of course, in carrying out this policy, due care must be taken to avoid actions that might create the appearance of undue influence over, or competition with, private enterprise and the free operation of the economy. In

addition, the policy must be carried out within the constraints of proper control of classified information, military sensitive unclassified information, and militarily critical technologies.

NAVSWC PARTICIPATION

NAVSWC was participating in technology transfer activities prior to the federally enacted legislation[1] and was a charter member of the DOD Technology Transfer Consortium in 1971. This organization has subsequently evolved into the Federal Laboratory Consortium, of which NAVSWC continues to be a contributing member.

Although NAVSWC endorses and actively pursues technology transfer activities involving Center R&D efforts, significant and necessary limitations exist on the amount of NAVSWC-developed technology appropriate for transfer. With the work heavily oriented toward naval warfare applications, frequently no civilian application is apparent without extensive adaptive engineering effort. Security classification and export control of critical technologies are also significant constraints.

Public Law 99-502[1] requires that each federal laboratory either establish an Office of Research and Technology Applications (ORTA) to manage DTT activities or perform the ORTA functions within an existing organizational structure. Since NAVSWC has long maintained a DTT office, this organizational structure was unchanged following passage and implementation of Public Law 99-502. The principal elements of NAVSWC participation in DTT are described below.

PROGRAM IMPLEMENTATION

Management

The Center's domestic technology transfer policy is administered by the Technology Base Program Office (Code D4). This office provides policy planning and guidance on technology matters impacting the role, mission, and long-term commitments of the Center. Policy implementation vehicles for technology transfer include the Center's ORTA, the Navy Potential Contractor Program, and the Federal Laboratory Consortium for Technology Transfer. The IR&D Program is also a contributor to technology transfer activities since the transfer process can involve a two-way exchange between government and non-government organizations. The IR&D Program serves to inform government technologists about industry-initiated research and it also serves as a mechanism for government researchers to appraise the progress and relevance of industry-initiated efforts. Guidance regarding technology transfer constraints is provided by the Militarily Critical Technologies List (MCTL), and the Center contributes to the technical review of export license applications received by the Navy International Programs Office. Technology transfer management functions include:

- managing the program within the Center;

- maintaining external liaison (with the Office of the Chief of Naval Research, the Federal Laboratory Consortium for Technology Transfer, the Department of Commerce, other federal agencies, state and local governments, universities, and private industry);
- preparing Technology Application Assessments;
- assisting potential user organizations in formulating their problems;
- providing and disseminating information on federally owned or originated products, processes, and services having potential application to state and local governments and private industry;
- providing technical assistance in response to requests from state and local governments;
- functioning as Center manager for MCTL matters; and
- serving as Center manager for review of Navy-related export license applications.

The Center manager for ORTA/Technology Transfer is Mr. Ramsey D. Johnson, Code D4T, (301) 394-1505 or Autovon 290-1505.

Technical Effort

Project Work. Directly attributable and quantifiable technology transfer work performed by Center technical departments is generally represented by those projects funded by other government (non-DOD) sponsors and private parties (excluding that effort funded under DOD contracts). This type of effort, identified as project work, has manpower and funding allocations that are directed towards a specific objective or requirement per sponsor request.

Technological Disclosures. In its role as a major government R&D center, NAVSWC also serves as a significant contributor to federal technology transfer in a more generic nature via technological disclosures in the open literature such as patents, reports, journals, and participation in symposia. The benefits from this type of activity accrete as spin-offs from DOD mission-related projects that are supported by federal R&D appropriations. Although it is less tangibly measurable than technology transfer contributions of direct project work involving end-products, the long-term benefits are more highly promising since they provide the innovative community with a broad spectrum of new stimuli to promote economic, technical, and quality-of-life growth in the private and public sectors.

Navy-wide Services

The Center manages, edits, and publishes the "Navy Domestic Technology Transfer Fact Sheet." This monthly publication highlights Navy-wide technology and developments that have the appropriate approval for public release and are of potential benefit to public and private organizations, individuals, and other federal laboratories. The program is sponsored by the Office of Naval Technology (ONT-26)

to provide a highly visible source and focus for the dissemination of domestic technology transfer contributions from the Navy laboratory community.

In FY90, NAVSWC detailed a senior staff member to support the Navy Domestic Technology Transfer Program Office (ONT-26) for six months. The purpose of this Navy Scientific and Technical Exchange Program (NSTEP) assignment was to develop Navy policy, guidance, and procedures for implementing technology transfer legislation.

PROGRAM FUNDING

A summary of FY90 funding support for management activities and project work performed by the Center is presented below:

	FY90 ($K)
1. Administrative Functions	
ORTA and NSTEP position	125
Other Technology Transfer	25
Technical Publications Division	200
2. Technical Projects	
Engineering Department	273
Electronics Systems Department	50
Protection Systems Department	145
Research and Technology Department	505
Underwater Systems Department	49
Total	1372

ACCOMPLISHMENTS AND CURRENT EFFORTS SUMMARY

Project Work and Reports

Narrative summaries of NAVSWC technology transfer related projects involving FY90 effort are presented in Appendix A. The following reports, which describe recent Center accomplishments, efforts, and technology transfer related resources and participation, were published for public release:

NAVSWC MP 90-72, *Naval Surface Warfare Center Technology Transfer Report (FY89).*

NAVSWC MP 90-445, *FY89 Technology Transfer Summary, Naval Surface Warfare Center.*

Cooperative Research and Development Agreements

As authorized by Public Law 99-502, a CRDA is any agreement between one or more federal laboratories and one or more nonfederal parties under which the participants may provide personnel, services, facilities, equipment, or other resources

toward the conduct of specified research or development efforts that are consistent with the missions of the participating federal laboratories. Also, the federal laboratories may receive funds from, but not provide funds to, nonfederal parties under a CRDA. Further, by statute, a CRDA is not a procurement contract or cooperative agreement as those terms are used in 31 U.S.C. 6303-6305, and the Federal Acquisition Regulation (FAR) and the DOD FAR Supplement are not applicable to these agreements.

NAVSWC has the following three active CRDAs:

- Loral Defense Systems: testing of a privately developed "Acoustic Test Vehicle."
- Ford Aerospace Corporation: battle force management software.
- NEAR, Inc.: software development related to supersonic airflow.

Government-Industry Conferences

These conferences provide a forum for government laboratories to inform industry participants about significant materials, processes, innovations, or developments that have promising potential for commercial application. The general format includes technical presentation sessions after which government presenters are available for individual follow-up discussions with interested industrial representatives.

Patents

As an incentive to stimulate DTT, Public Law 99-502 permits government inventors to share royalties or other income resulting from the licensing of Navy inventions. In FY90, there were 71 inventions and patent disclosures by NAVSWC with potential technology transfer applications. These are listed in Appendix B. Figure 1 shows the number of NAVSWC patents and inventions during FY86-90 that have commercial potential. Three patents have been licensed, and the NAVSWC inventors are receiving a share of the royalty income.

Navy DTT Fact Sheet

NAVSWC manages, edits, and publishes the *Navy Domestic Technology Transfer Fact Sheet*. This monthly publication highlights Navy-wide technology developments (that have been approved for public release) that are of potential benefit to public and private organizations, individuals, and other federal laboratories. The program, sponsored by the Office of Naval Technology (Code ONT-26), provides a focus and a highly visible source of information for the dissemination of DTT contributions from the Navy laboratory community. All Navy laboratories are invited to contribute articles for publication in the *Fact Sheet*, which

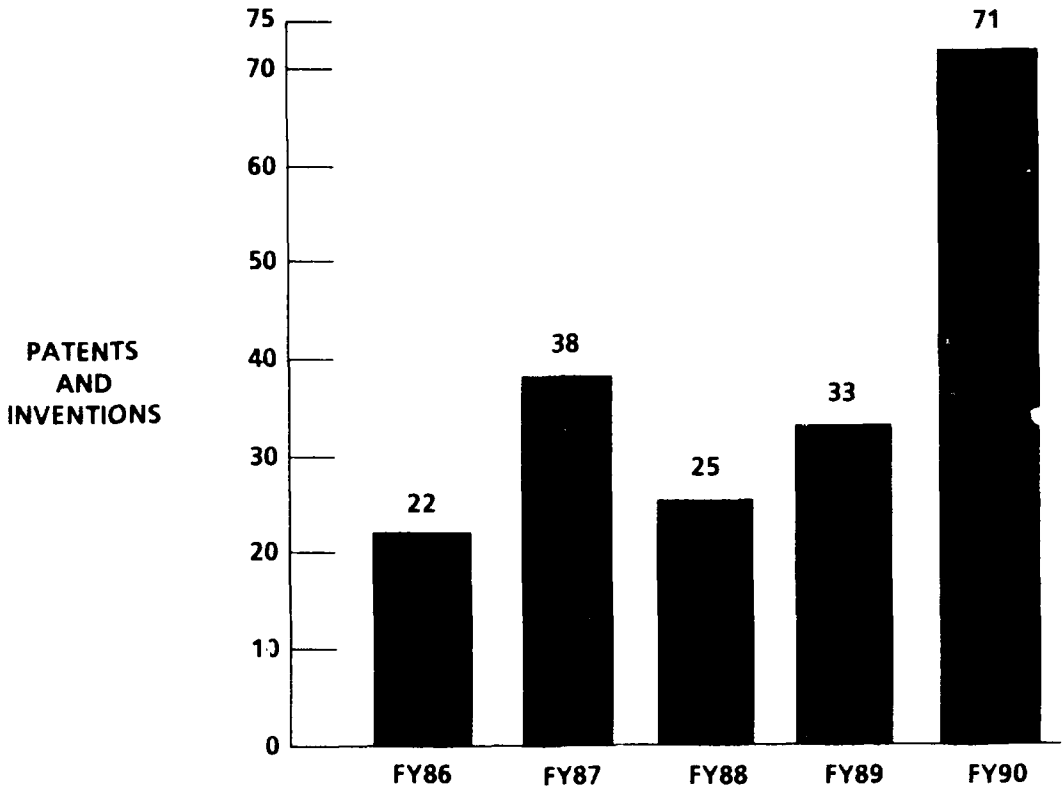


FIGURE 1. INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

is distributed to over 11,000 subscribers across the country. NAVSWC contributed the following articles during FY86-90:

FY86
- Gauge Measures High Transient Pressures
- Tool Opens Large Containers

FY87
- New Method Improves Pollution Control Devices
- Computer Software More Reliable
- Digital Dosimeter Measures Radiation Doses
- Photographic Indicator Flashes Print Status

FY88
- NSWC Develops New Electro-Mechanical Transducer
- Scientists Receive Cash Awards for Invention

FY89
- Lightweight Nickel Composite Electrode
- Data Acquisition and Reduction Processor
- New Software Tool for Navy Development
- Electronic Security Indicating Attachment Developed
- High-energy Lithium Battery

FY90
- Method for Determining the Magnitude of Earth's Gravity Developed
- Reconfigurable M-Dimensional Computer Memory Developed
- Software Package to Industry
- New Silver Oxide (AgO) Cathode Material Developed
- Freezer Alarm Developed

Technology Application Assessments

Public Law 99-502 requires that DTT offices prepare application assessments for selected R&D projects performed by their laboratories that may have commercial applications.

A technology application assessment (TAA) is a description of a government laboratory R&D project, process, or innovative development that is cleared for public release and has potential for alternative use in the private sector. This technical disclosure is provided to the National Technical Information Service (NTIS) and other appropriate release sources for broad dissemination in the public and private sectors. Preparation of TAAs by laboratory ORTAs is also directed by DOD 3200.12-R-4.[3] Figure 2 provides data on NAVSWC TAAs for FY83-90. FY90 items are presented in Appendix C and listed below:

- Magnetoresistance Magnetometer
- Crosstie Random Access Memory
- Ferroelectric Random Access Memory

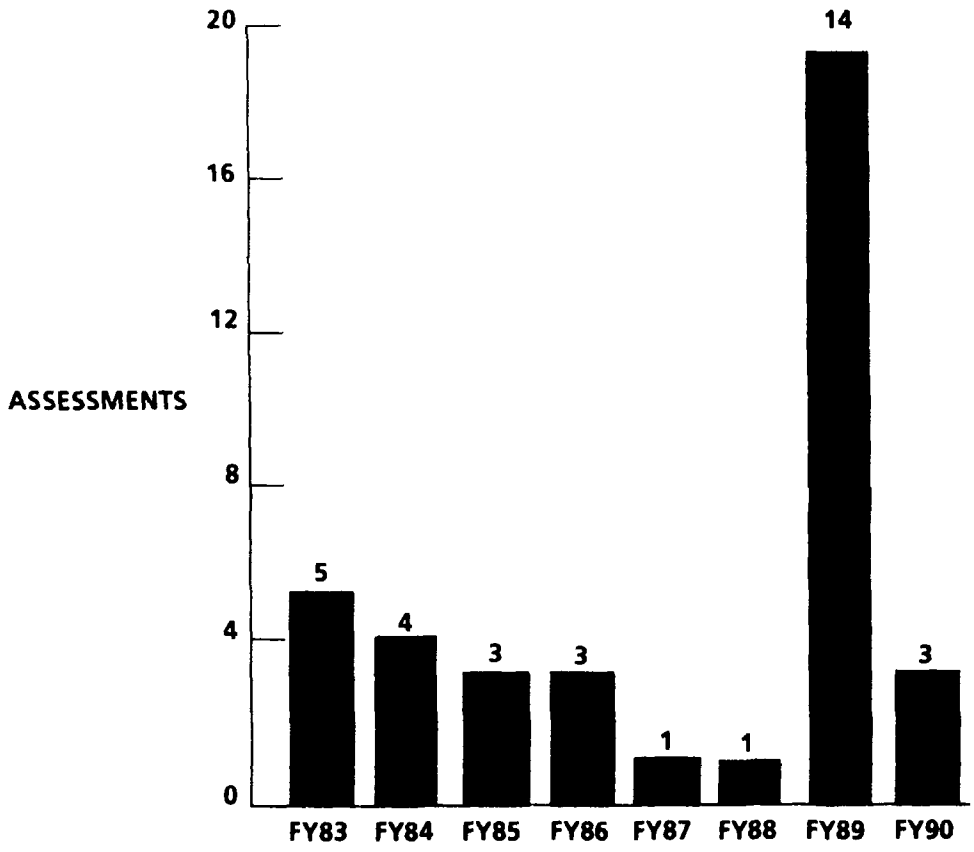


FIGURE 2. TECHNOLOGY APPLICATION ASSESSMENTS

Other DTT Disclosures/Releases

Figure 3 shows, for FY85-90, the number of NAVSWC technical publications entered in the National Technical Information Service; the number of unrestricted (public release) technical information disclosures to symposia, workshops, journals, and other publications; and the categories of responses to information requests from individuals and private industry. In FY90 the categories of responses were in the following 12 technology areas:

- Eddy current nondestructive inspection
- Batteries (lithium and alkaline)
- Composite materials–manufacturing technology
- Software reliability analysis
- Computer memory
- Radiography
- Data acquisition and processing
- Acoustic testing
- Global positioning system
- Shape-memory alloys (alarm, connector, security device)
- Explosive applications
- Nuclear hardening protection

Numerous inquiries are also made directly to NAVSWC engineers and scientists in private communications; no formal records are kept of these.

NAVY POTENTIAL CONTRACTOR PROGRAM

If technological developments are to be applied promptly to meeting Navy requirements, it is essential that the scientific and technical community have appropriate access to technical information about those requirements.

Some requirement information is conveyed to scientists and engineers by briefings, symposia, and site visits. However, there are problems inherent to the process that may preclude information from reaching those who may be able to solve Navy technical problems. They include:

- Lack of access to information required to prepare timely and technically relevant contract proposals by qualified civilian groups that do not hold a contract.

- Lack of access by holders of current contracts to classified or military critical unclassified information in areas not concerning their contracts. Those data could assist them in developing alternate solutions and in planning and executing their IR&D programs.

- Lack of orientation concerning the operational environment and probable conditions in which Navy equipment must function.

- Prevention of the compromise of sensitive information while ensuring that it reaches those who have a valid "need to know."

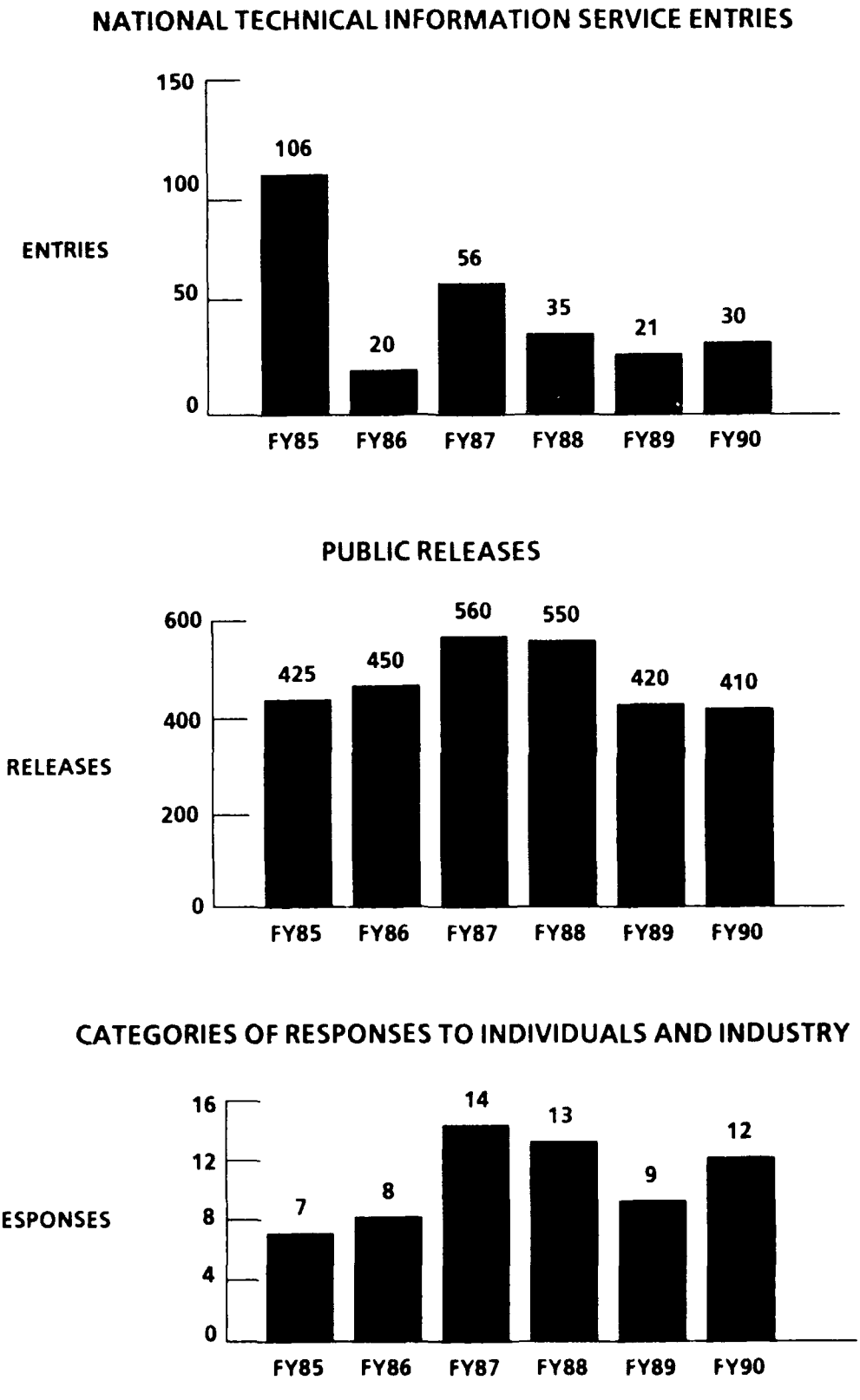


FIGURE 3. OTHER DISCLOSURES AND RELEASES

NAVY POLICY

The Navy recognizes the need to facilitate the increased use of civilian sector technological investments in meeting military requirements. That will best be accomplished by providing civilian scientists with increased, appropriate access to defense technological data. Accordingly, the NPCP is being established to provide controlled access to relevant military data by the civilian scientific and technical sector. The NPCP will also allow use of civilian discretionary funds to address Navy needs. Navy activities are to encourage U.S. qualified firms, academia, other organizations, and individuals to participate in the NPCP. That includes U.S. firms under foreign ownership, control, or influence if the foreign interest risk is managed in accordance with the Industrial Security Regulation.[5]

The NPCP will permit no-cost negotiated agreements that authorize access to information for specified purposes. Such agreements are not government procurement contracts, grant agreements, or cooperative agreements as defined in sections 6303, 630, and 6305 of U.S.C., Title 31.[6] Agreements allow access to information only, and neither party is permitted to require delivery of technical goods or services as condition for NPCP participation.

NAVSWC PARTICIPATION

Figure 4 shows the number of NPCP agreements that NAVSWC has entered into during the FY86-90 period. The agreement titles and names of the nongovernment participants for FY90 are listed below:

Company	Agreement Title
Westinghouse Electric Corp.	Stratplan 2010 Submarine Launched Strategic Systems
UNISYS Corp.	Naval Warfighting Simulation and Modeling Technology
Westinghouse Defense & Electronic Center	Correlator Tracker
FMC Corp./Naval Systems Div.	Short Range Anti-Air Warfare NATO AAW Systems Analysis and Design
SCISCO, Inc.	Cooperative Engagement (CE) Systems Concepts
Shenandoah Systems Co., Inc.	Mine Warfare Requirements
Martin Marietta Aeronautics and Naval Systems	Advanced ASW Weapons/Launchers
Loral, Defense Systems Div.	Directed Energy Warhead Concepts
Physical Sciences, Inc.	Multi-Stage Antisubmarine Torpedo

Company	Agreement Title
Magnavox Signaal Systems Co.	Radar and Electro-Optic Systems Technology
FMC Corporation	Advanced Gun Weapon Systems Analysis
UNISYS Corp.	AAW Data Fusion/Decision Aids
Omnitek Inc.	C3I/AEROSTAT Data Fusion Analysis
Hughes Aircraft Company	Improved Performance Underwater Warheads

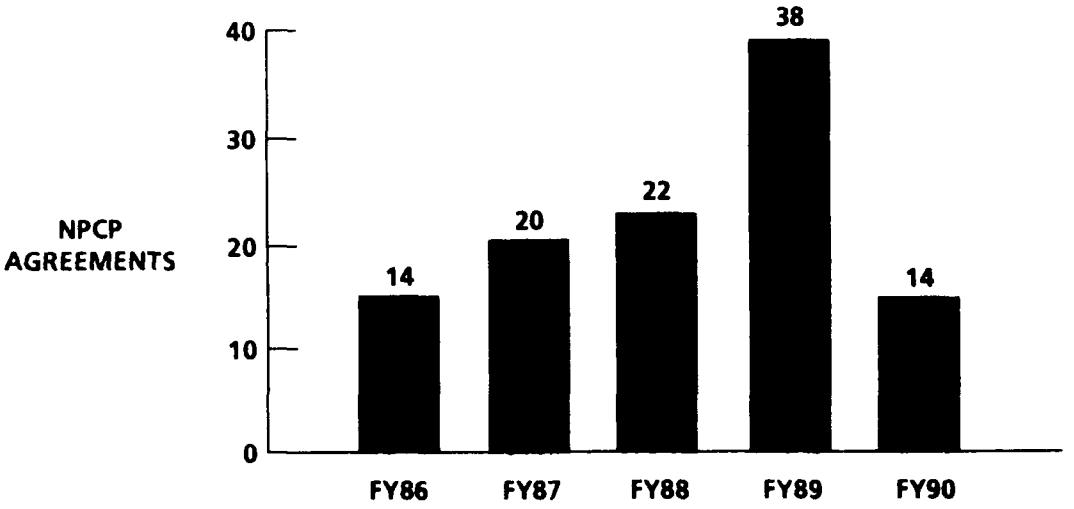


FIGURE 4. NAVY POTENTIAL CONTRACTOR PROGRAM AGREEMENTS

INDUSTRY INDEPENDENT RESEARCH AND DEVELOPMENT

IR&D is the technical effort conducted by private companies for their own business purposes; it is not sponsored by, or required in performance of, a contract or grant. IR&D represents a significant portion (about $5B annually) of the Nation's technology base; thus, the government has an interest in encouraging its coordination with other technology efforts. To encourage industry to maintain a strong IR&D effort, the government allows an average of 40 percent of the cost to be applied to overhead rates.

The potential benefits to the Navy and Marine Corps from close coordination of industry IR&D efforts with Navy research, development, test, and evaluation (RDT&E) programs are significant and range from exchanges of technology to development of cooperative R&D efforts with industry. To ensure that these benefits are fully realized, Navy and Marine Corps managers must be cognizant of relevant IR&D projects to exploit the associated results. Accordingly, the Navy has established a program to ensure the timely acquisition, dissemination, and application of IR&D information and to provide information to industry on Navy, Marine Corps, and DOD technology requirements and programs. Figure 5 summarizes NAVSWC support of industry IR&D for FY86-90.

To maintain its technological advantage and to ensure effective future defense capabilities, the DOD must aggressively employ all resources, including the IR&D programs of American industry, that can contribute to the development of future weapons systems. Specifically, the IR&D programs of DOD contractors will be thoroughly reviewed and evaluated for applicability to current and future Navy and Marine Corps needs as well as for technical quality. Because of the importance of IR&D to the Navy, the Navy will:

- Make maximum use of industry programs by integrating them with Navy program plans.
- Make industry aware of the military threat, requirements, and problems facing the Navy and Marine Corps so that industry can plan and carry out IR&D that fills Navy and Marine Corps needs.
- Encourage basic research and innovative work in the programs of DOD contractors. This includes encouragement of industry contracts to academic institutions for basic research that supports the contractor's IR&D program.
- Recognize that the review and evaluation of DOD contractor IR&D programs is a valuable part of Navy RDT&E. The review process keeps the Navy abreast of technological advances, and the resulting feedback to the contractors ensures that the IR&D program is kept aligned with significant military needs.
- Give management attention and support to the IR&D review and evaluation process by providing qualified, credible, high-level evaluators; ensure that evaluations are timely and thorough; and give official recognition and credit to the evaluators.

SMALL BUSINESS INNOVATION RESEARCH

BACKGROUND

The SBIR program is mandated by Public Law.[7,8] The basic design of the DOD SBI program is in accordance with the Small Business Administration (SBA) SBIR Policy Directive of June 1988. DOD components invite small business firms to submit proposals under an annual solicitation entitled SBIR. Firms with strong R&D capabilities in science or engineering in any of the topic areas presented are encouraged to participate. Subject to availability of funds, DOD components will

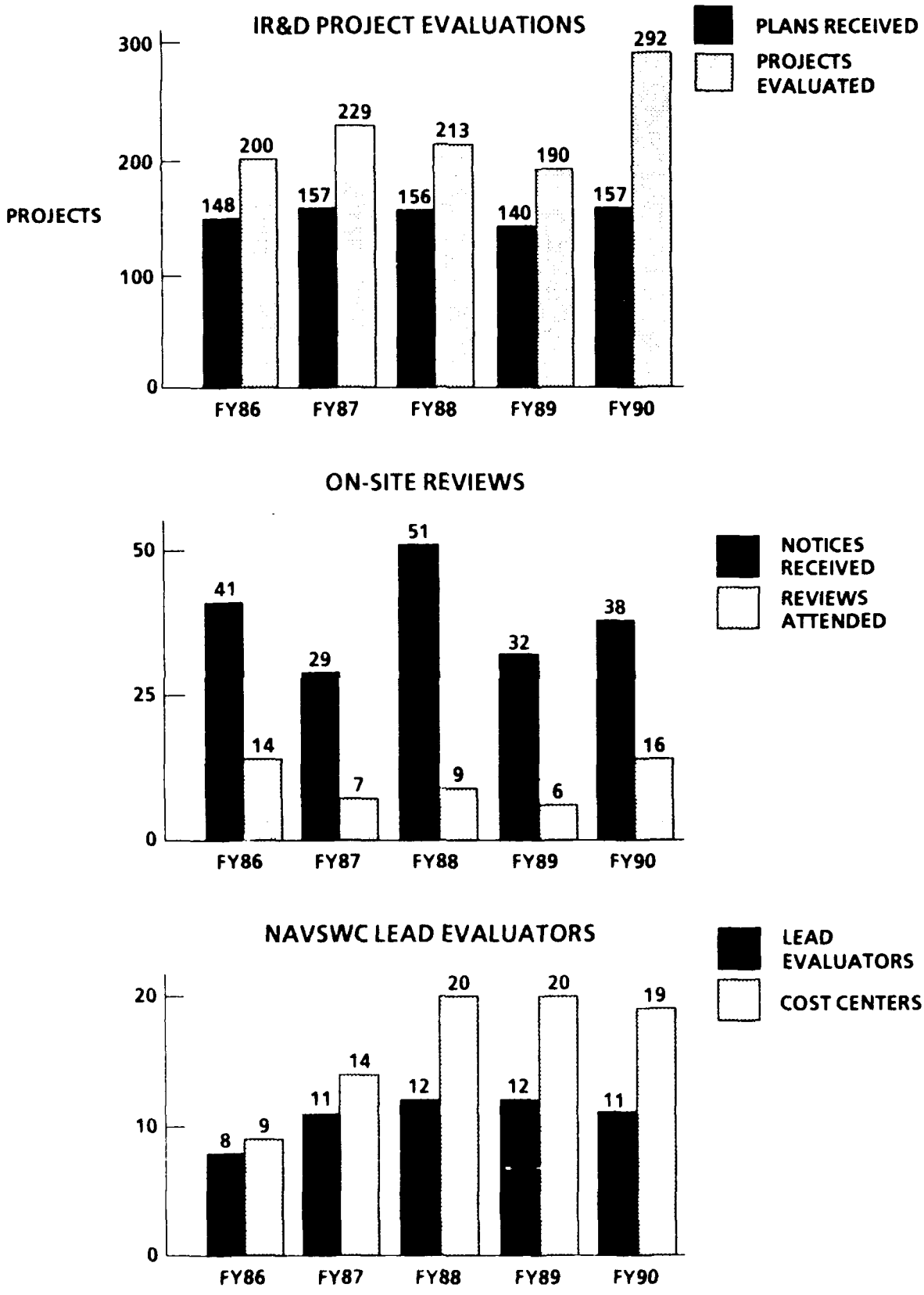


FIGURE 5. INDUSTRY INDEPENDENT RESEARCH AND DEVELOPMENT

support high-quality research or R&D proposals of innovative concepts to solve the listed defense-related scientific or engineering problems.

Objectives of the DOD SBIR program include stimulating technological innovation in the private sector, strengthening the role of small business in meeting DOD R&D needs, fostering and encouraging participation by minority and disadvantaged persons in technological innovation, and increasing the commercial application of DOD-supported research or R&D results. Recent NAVSWC SBIR participation is summarized in Figure 6.

The annual DOD program solicitation strives to encourage scientific and technical innovation in areas specifically identified by DOD components. Guidance incorporates and exploits the flexibility of the SBA Policy Directive to encourage proposals based on scientific and technical approaches most likely to yield results important to DOD.

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. Typically, it involves about half a man-year of effort over a period of 6 months or less. Proposals should concentrate on efforts that will significantly contribute to establishing the feasibility of the proposed effort. Successful completion of those efforts is a prerequisite for further DOD support in Phase II.

Phase II awards will be made to firms only 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 man-years of effort over a period generally not to exceed 24 months, subject to negotiation. Phase II is the principal research or R&D effort and is expected to produce a well-defined deliverable product or process. A more comprehensive proposal is required for Phase II.

Under Phase III, nonfederal capital is expected to be used by the small business to pursue commercial applications of the research or development. Under Phase III, federal agencies may also award non-SBIR-funded follow-on contracts for products or processes that meet the mission needs of those agencies. The solicitation is designed in part to provide incentives for the conversion of federally-sponsored R&D innovation in the private sector. The federal R&D can serve as both a technical and preventure capital base for ideas that may have commercial potential.

TECHBASE CONTRACTING

In addition to the cooperative efforts with industry described above, NAVSWC participates even more directly, in a major way, with industry by contracting out roughly half of its total Technology Base funding. Through these mutually beneficial contracts, the Navy is able to apply the talents and facilities of industry to the achievement of its technology objectives.

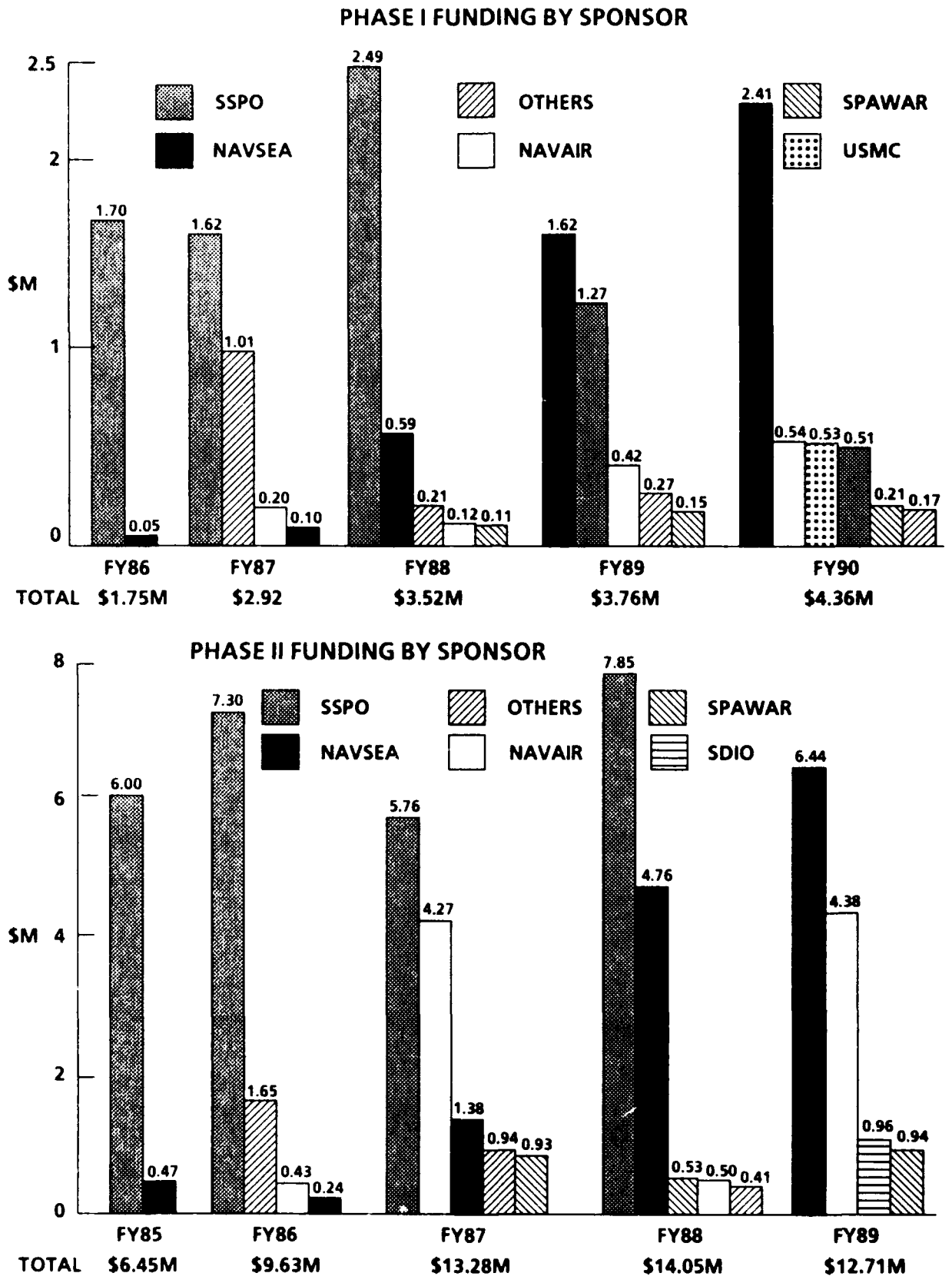


FIGURE 6. SMALL BUSINESS INNOVATION RESEARCH

Technology base funding consists of the following Category 6 funding appropriations:

- 6.1: Research
- 6.2: Exploratory Development
- 6.3A: Advanced Development

Figure 7 shows a breakout of NAVSWC in-house and contracted TechBase funding for FY89 and 90 expenditures.

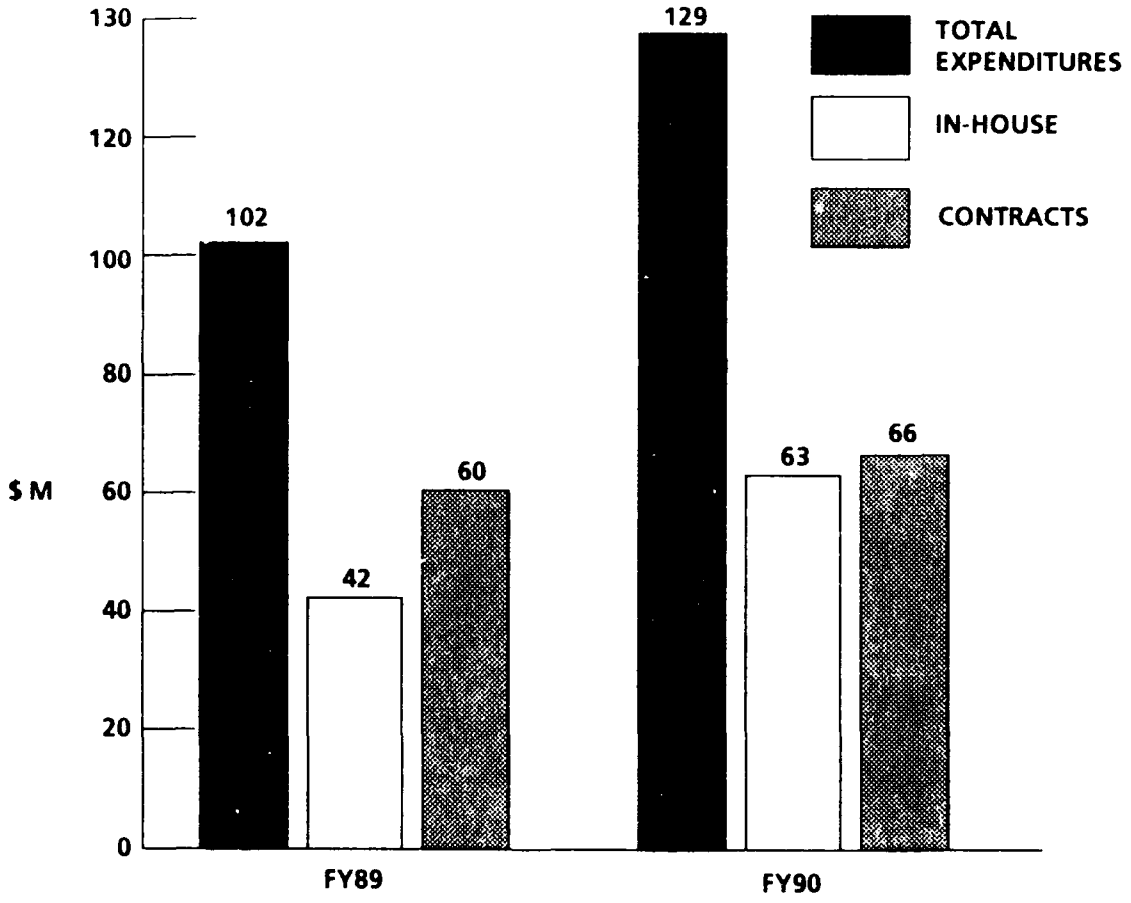


FIGURE 7. TECHNOLOGY BASE EXPENDITURES

REFERENCES

1. Public Law 96-480, "Stevenson-Wydler Technology Innovation Act of 1980," 21 October 1980, as amended by Public Law 99-502, "Federal Technology Transfer Act of 1986," 20 Oct 1986.

2. Executive Order 12591, "Facilitating Access to Science and Technology," 10 Apr 1987.

3. DOD 3200.12-R-4, "Domestic Technology Transfer Program Regulation," 27 Dec 1988.

4. SECNAVINST 5700.16, "Domestic Technology Transfer."

5. DOD 5220.22-R of Dec 1985, "Industrial Security Regulation."

6. U.S.C., Title 31, "Money & Finance: Treasury."

7. Public Law 97-219, "Small Business Innovation Development Act of 1982."

8. Public Law 99-443, "Small Business Innovation Research Program Extension."

APPENDIX A

NARRATIVE SUMMARIES FOR NAVSWC FY90 TECHNOLOGY TRANSFER RELATED PROJECTS

MANUFACTURING TECHNOLOGY

The Navy Manufacturing Technology Program requires that technology transfer to the private sector and government agencies be a major activity of each funded project. Accordingly, upon completion each project is required to have an end-of-project demonstration for potential users or vendors and to issue a final report. In both instances, efforts are made to disseminate the information to the widest possible audience. However, while some of the information is classified and some is unclassified, all is associated with critical, sensitive technologies. This information is not releasable for public information and such requests ar individually assessed based on distribution restrictions. Each project manager is encouraged to actively communicate with interested parties during the project to transfer the developing technology.

In addition to technical project work, NAVSWC also provides technical and administrative program support to the Office of Naval Acquisition Support; the Naval Sea Systems Command; and the Office of the Assistant Secretary of the Navy, Shipbuilding and Logistics (OASN, S&L) for manufacturing technology programs.

The following Manufacturing Technology programs are ongoing at NAVSWC:

- Cast Projectile Program
- Spin Form Discontinuous Metal Matrix Composites (MMCs)
- Composites for Passive Thermal Management

SPACE SHUTTLE STUDY

In FY89, NAVSWC completed a study for NASA (Marshall Space Flight Center) to determine the complete break-up process of the Space Shuttle's solid rocket boosters (SRBs) in a "command destruct," and further, to determine whether the process would also destroy the external tank (ET). This information was necessary to support a decision regarding the necessity of retaining the ET Range Safety System (RSS).

As an outgrowth of this research, NAVSWC proposed a modification to the current design of an axially running linear shaped charge. The potential advantages of the proposed redesign include dramatic decrease in SRB fragmentation, decreased risk of breaching the containment vessel for nuclear powered payloads, and the capability to destroy the liquid oxygen (LOX) and liquid hydrogen (LH_2) tanks from the destruct of one SRB with the ET RSS inactive. The redesign effort was funded beginning in FY89 and was completed in FY90. However, the costs associated with a

full-scale demonstration test program required by the Air Force Eastern Space and Missile Center led NASA to an eventual decision to retain the current RSS.

OTHER NASA/MARSHALL SPACE FLIGHT CENTER SUPPORT

1. Ultrasonic assessment of Large Solid Rocket Motor Bondline Integrity Using Time Delay Spectrometry (TDS). The investigation addresses two variations of this technique: through-transmission mode and reflection mode resonance. Included in the effort are tasks to:

- Assist the manufacturer in interpretation of TDS transmission mode inspection data on Titan Solid Rocket Motors (SRMs).
- Complete a study on the effect of variations in SRM case and insulator design options on the ultrasonic inspectability of bondlines.
- On SRMs for which the TDS reflection mode resonance technique is applicable, quantify the parameters on the equipment and technique. Also develop the inspection protocol for the specific hardware.
- On SRMs to which the TDS reflection mode is not directly applicable, evaluate alternative ultrasonic inspection techniques.

2. Carbon-carbon process investigation for the applicability of eddy current testing towards assuring proper manufacturing processes for carbon-carbon composite materials. The objective is to specify instrumentation and procedures providing:

- Bulk conductivity measurements to assure proper manufacturing processes, including the isolation of matrix and fiber contributions to the conductivity.
- Detection and measurement of localized anomalies.

3. Solid Propellant Initiative Program (SPIP) support. Conduct an Advanced Nozzle Cements and Adhesives study to assist NASA in determining those commercially available rocket nozzle cements and adhesives best suited for bonding various parts of rocket nozzles such that they will survive the intended mission. Major tasks of the study are to determine the bond strength and characteristic yield of the cement after its major decomposition together with its gas evolution.

4. Characterization of Bondline Mechanical Performance. Support NASA in developing a methodology for accurate and reliable characterization of bondline performance via chemical and mechanical testing and analysis of bondline specimens.

NASA, GODDARD SPACE FLIGHT CENTER SUPPORT

1. Stepping motors that are small, have a high energy density, can microstep, and are self-locking upon removal of power are desirable for a wide variety of NASA's space based applications. Stepping motors with these characteristics can be designed

around the magnetostrictive material "Terfenol" (invented at NAVSWC). The Goddard Space Flight Center (GSFC) requested NAVSWC technical assistance for design support and magnetic circuit analyses during the preliminary design phase of a stepping motor project.

2. NAVSWC inspected and performed nondestructive evaluation on specified spacecraft structural parts.

DRAG REDUCTION INVESTIGATION

Interest in controlling the onset of the laminar/turbulent transition using compliant materials is supported by observations of anomalously high swimming speeds attained by dolphins. To complement the theoretical work on this phenomenon, NAVSWC provided materials support (characterization and coating) and water tunnel assistance to the National Institute of Standards and Technology for obtaining experimental data on the transition delays associated with compliant materials.

NIGHT VISION EQUIPMENT

In support of the U.S. Border Patrol (USBP) of the Immigration and Naturalization Service, NAVSWC provided technical assistance and expertise for the repair and upgrade of night vision equipment owned by the USBP. This equipment is used by the USBP in the protection of U.S. land and water boundaries against illegal entry of aliens, drugs, and other contraband.

SHOCK AND VIBRATION INFORMATION ANALYSIS CENTER

The Shock and Vibration Information Analysis Center (SAVIAC) is an inter-agency effort chartered to provide a clearinghouse to analyze and exchange technical information in the technical specialty area of shock and vibration. Oversight of SAVIAC is provided by an interagency Technical Advisory Group (TAG) chaired by NAVSWC. Members from the Army, the Air Force, the Navy, the Defense Nuclear Agency, the Department of Energy, and NASA comprise the TAG. This cooperative effort at information collection, distribution, analysis, and exchange is an important tool in addressing survivability and protection issues and problems encountered in operational environments. SAVIAC can be used by any of the sponsoring agencies and their contractors. It is on-line to provide special analysis and technical evaluation studies for specific problems raised in R&D programs and other efforts.

DEPARTMENT OF TRANSPORTATION (COAST GUARD) SUPPORT

1. The following weapons system safety support was provided for the Hamilton class and Bear class Coast Guard cutters:

- design of firing cut-out cams for the MK 75 and CIWS weapons;
- fabrication of cut-out cams;
- training of Coast Guard personnel to install cams; and
- verification and certification of safety zones.

2. In collaboration with the Coast Guard, NAVSWC provided power cables to Reach Lights in the entrance channel to Norfolk, Virginia, and the shipping channel in the Baltimore, Maryland, harbor. These lights provide navigational assistance to shipping traffic. Ten thousand feet of cable were installed in the Baltimore harbor area.

DEPARTMENT OF TRANSPORTATION/FHWA

1. Under previous Federal Highway Administration (FHWA) sponsorship, NAVSWC has developed a prototype battery-operated motor vehicle detection system. This Self-Powered Vehicle Detector (SPVD) may be buried in any type of road surface and uses radio frequency (RF) transmission rather than hardwiring for communication with its control unit. The detector reads a vehicle's magnetic signature, processes it, and transmits the vehicle's presence to the remotely located control unit. Details of this device are provided in NAVSWC Technology Application Assessment NSWC-TAA-85-002.

2. In FY90, NAVSWC provided design consultation for pre-production SPVD units being manufactured by private industry under FHWA contract.

TEST INSTRUMENTATION

NAVSWC has developed unique capabilities and facilities for producing electromagnetic vulnerability test instrumentation. This specialized instrumentation was provided to the Boeing Company for certification of avionics systems having commercial and military applications.

PARACHUTE TECHNOLOGY

NAVSWC provided wind tunnel testing and analysis support to the NASA/Langley Research Center for the following cross parachute technology objectives:

- determine the tensile load distribution on the various lines in each arm as a function of the number (2, 4, and 6) suspension lines; and
- determine variations of internal canopy pressures along the centerline for each configuration.

LASER WELDING FOR ROCKET MOTORS

NAVSWC and a private company participated in a study to investigate a laser welding manufacturing procedure for steel rocket motor cases (RMCs). The principal test parameter was to hold the back wall temperature to less than 250°F (for potential live RMC applications). Laser parameters were developed and the technique was applied to steel RMC cylinders (mock-ups) and an all-up RMC simulator that was ablatively lined. Initial tests met the temperature requirement, but the organic ablative/adhesive appeared to contaminate the weld of the ablatively lined case. Additional analysis and testing is necessary to complete the investigation.

COMPUTER SCIENCE RESOURCES CONSORTIUM

The Computer Science Department at Virginia Polytechnic Institute and State University (VPI&SU) has established a Computer Science Resources Consortium (CSRC) program with the goal to strengthen existing interactions and to create new interactions between VPI&SU professors, the government, and the industry technical community. NAVSWC has been an associate member of this Consortium since 1984 and has provided a representative for the CSRC Steering Committee during that time. NAVSWC became a full member in 1990.

Mutual benefits of the program include:

- providing a resource of quality graduates to academia, industry, and government;
- promoting government/academia personnel exchanges;
- providing feedback for orienting teaching requirements toward real-life applications; and
- providing an increased awareness of outside requirements to focus academic research efforts.

During 1990, the Consortium sponsored the following events that promoted technology transfers:

- a semiannual newsletter featuring articles on current research activities,
- a catalog of technical reports from the VPI&SU Computer Science Department, and
- the Annual Virginia Computer Users Conference combined with the Annual CSRC Steering Committee meeting.

SYSTEMS RESEARCH CENTER AT VPI&SU

1. In 1983, NAVSWC; the Naval Sea Systems Command (NAVSEA), Combat Systems Directorate (SEA-06); and VPI&SU established the Systems Research Center (SRC) at the university. The SRC is intended to augment the technology base of NAVSWC in serving the R&D needs of surface combat systems, recognizing that the benefits derived can extend to subsurface and air platforms as well. The SRC has also expanded the technology base for other U.S. Navy R&D activities serving the R&D needs of surface combat systems. The SRC, NAVSWC, and NAVSEA's (SEA-06) joint effort emphasizes computer science and computing technology, key elements in modern naval applications. The SRC was established to perform only research and development.

2. By the close of FY89, the SRC had received nearly $4.52 million to perform 41 separate tasks. In FY89, there were ten active tasks with the SRC. Of these, five began in FY88 and five in FY89. Of the ten projects, NAVSWC sponsored nine at a cost of over $764K.

3. In late September 1989, an Indefinite Delivery Indefinite Quantity (IDIQ) contract was signed with VPI. The contract calls for performance from 30 September 1989 through 30 September 1994. The IDIQ contract has a potential value of nearly $7.78 million if fully funded. As of January 1991, nine delivery orders valued at $974,499 have been initiated under the IDIQ.

APPENDIX B

NAVSWC FY90 INVENTIONS AND PATENTS WITH COMMERCIAL POTENTIAL

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Semiconductors	4,870,027	Sensitization Pretreatment of Pb-Salt Epitaxial Films for Schottky Diodes by Sulfur Vapor Exposure	Infrared detectors
Electrochemistry	4,892,629	Electrochemical Preparation of Silver Oxide Electrodes having High Thermal Stability	Silver oxide batteries with long storage life
Metallurgy	4,958,763	Method of Soldering Aluminum	Soldering aluminum to aluminum or other metals
Ceramics	4,948,766	Rigid Mullite-Whisker Felt and Method of Preparation	Thermal insulation or ceramic felt structures for ceramic reinforce ceramic or metal matrix composite structures
Ceramics	4,910,172	Preparation of Mullite Whiskers from AlF_3, SiO_2, and Al_2O_3 Powders	Mullite whiskers for reinforcing ceramic or metal matrices
Ceramics	4,911,902	Mullite Whiskers Preparation	Mullite whiskers for reinforcing ceramic or metal matrices
Semiconductors	4,900,373	Sensitization Pretreatment of Pb-Salt Epitaxial Films for Schottky Diodes by Sulfur Vapor Exposure	Infrared detectors
Composites	72,769	Protective Coating for Carbon/Carbon Composites	Limited by cost
Semiconductors	4,853,339	Method of Sensitizing Pb-Salt Epitaxial Films for Schottky Diodes	Infrared detectors
Energy Conversion	4,938,026	Heat Engine Based on Shape Memory Alloys	Uncertain because of relative economic and technologically competitive factors

Technological Area	Navy Case or Patent No	Title and Purpose	Potential Commercial Applications
Image Data Processing	70,754	Centroid Target Tracking System Utilizing Parallel Processing of Digital Data Patterns	Uncertain because of adaptation to non-military purposes may require considerable additional developn ent
Data Processing	4,975,602	Logic Level Data Conversion System	Promising potential because of wide applicability to rapidly developing computer industry
Energy Radiation and Detection	71,808	Underwater Object Detection System	Possible potential with further development of underwater safety measures
Heat Transfer	4,949,920	Ablative Cooling of Aerodynamically Heated Radomes	Limited Potential
Fiber Optical Signal Processing	72,146	Optical Encoding of Imaging Data	Possible potential
Signal Data Processing	72,214	Phase Cancellation Enhancement of Ultrasonic Evaluation of Metal-to-Elastomer Bonding	Possible potential for quality control manufacturing
Wire Testing	4,979,396	Fatigue Testing Apparatus	Possible potential for quality control
Aerodynamic Cooling	72,303	Window Cooling for High Speed Flight	Limited potential
Electronic Data	72,304	Microprocessor Chip Incorporating Optical Signal Coupling	Promising potential in computer hardware industry
Fiber Optics	4,937,833	Analog Frequency Modulated Laser Using Magnetostriction	Promising potential in the optic fiber communication field
Radiation Dosimeters	72,362	Method of Recycling Dosimeters	Possible potential as economy enhancing measure

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Vibration Dampening	72,433	Vibration Damping Structural Laminate	Possible potential in wide variety of applications
Infrared Detection	72,460	Multi-Color Coincident Infrared Detector	Possible potential for space exploration equipment
Magnetic Field Detection	4,954,216	Process of Making Thin Film Vector Magnetometer	Possible potential
Shape Memory Alloys	72,728	Geothermal Energy Conversion System	Potential uncertain
Solid-State Memories	72,751	Sense Amplifier Control System for Ferroelectric Memories	Promising potential in computer hardware field
Shape Memory Alloys	72,787	Heat Engine with Corrugated Shape Memory Drive Belt	Potential uncertain
Optical Instruments	4,880,296	Opto-Optical Beam Deflector, Modular, and Shaper	Optical beam deflector, modular, and shaper
Navigation	4,881,080	An Apparatus for and a Method of Determining Compass Headings	Apparatus and method of determining compass headings in magnetic anomalies
Crystal Displays	4,915,478	Low Power Liquid Crystal Display Backlight	Low power liquid crystal display backlight; low power requirement
Solid-State Electronics	72,432	Solid State Circuitry with Optical Data Interfacing	Possible widespread commercial potential
Radiation Detectors	72,471	Semiconductor Heterojunction Device with Graded Bandgap	Commercial potential limited to infrared detectors
Communications	4,921,335	Optical Phase Conjugate Beam Modulator and Method Therefor	Limited commercial potential

APPENDIX B (Cont.)

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Sensors	4,939,407	Block Patterning of the Metallization of Polyvinylidene Fluoride Transducers	Limited commercial potential
Lasers	4,937,833	Analog Frequency Modulated Laser Using Magnetostriction	Commercial potential limited to laser technology
Sensors	4,954,216	Process of Making Thin Film Vector Magnetometer	Potential limited to scientific instrument field
Space; Ordnance	72,488	Launching Projectiles with Hydrogen Gas Generated from Aluminum Fuel Powder/Water Reactions	To provide initial acceleration to projectiles in electromagnetic guns and launchers; rapid generation of hydrogen gas
Space; Ordnance	72,461	Launching Projectiles with Hydrogen Gas Generated from Titanium-Water Reactions	To provide initial acceleration to projectiles in electromagnetic guns and launchers; rapid generation of hydrogen gas
Electronics	71,820	Low Temperature Synthesis of High Purity Monoclinic Celsian	Ceramics, electronic substrates
Electric Gun	71,395	Electromagnetic Launcher for Projectiles	Basic technology for launching satellites by year 2050
Explosive Cutting	72,145	Linear Propelling Separator	Cutting structures in space
Metallurgy	4,965,139	Corrosion Resistant Metallic Glass Coatings	Protecting steel components against corrosive gases and liquids (sea water, etc.)
Metallurgy	4,978,054	Diffusion Bonding Process for Aluminum and Aluminum Alloys	Superplastic and diffusion bonding of complex, aluminum alloy structures (aerospace)

APPENDIX B (Cont.)

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Ceramics	72,941	Low Temperature Synthesis of High Purity Monoclinic Celsian Using Topaz	Pure celsian for use in electronic substrates and structures
Computers	70,366	Input/Output Bus Interface	Computer data systems
Communication Equip	71,546	Multi-Ply Paper Separator	Multi-copy computer printers
Manufacturing	4,870,244	Method and Device for Stand-Off Laser Drilling and Cutting	Robotic assembly
Computers	69,090	Serial Data Word Processing Arrangement	A serial data word processing arrangement which can be used as a held-held security access control
Ordnance	4,893,563	Monolithic RF/EMI Desensitized Electro-explosive Device	Safety device for blasting equipment
Testing	72,337	Selectable Radius, Compound Eddy Current Probe	Potential use in materials science whenever eddy current testing of materials is accomplished
Testing	71,879	Infrared Fiber-Optical Temperature Sensor	Use in thermal testing of materials, thermal monitoring of avionics and power plants, perhaps used in nuclear generating plants
Safety	4,909,609	Nonlinear Optical Protection Against Frequency Agile Lasers	Anywhere where people and/or imaging systems must work in proximity to lasers of sufficient energy to damage the eye or the imaging device
Electronics	4,912,369	High PRF High Current Switch	Microwave applications
Computers	71,152	High Speed Parallel Backplane	In high tech computer applications where increased speed is a premium

Technological Area	Navy Case or Patent No	Title and Purpose	Potential Commercial Applications
Computers	72,019	Optical High-Speed Parallel Backplane	In new optical computer systems where speed is of increasing importance
Optics	72,419	Radio Frequency Cable to Optical Fiber Cable Converter/Interface	May find use in optical systems and new computer optics systems
Testing	4,922,201	Eddy Current Method for Measuring Electrical Resistivity and Device for Providing Accurate Phase Detection	Inspecting materials
Testing	4,924,182	Eddy Current Method to Measure Distance Between Scanned Surface and a Subsurface Defect	Inspecting materials
Electronics	71,490	Emittance Measuring Device for Charged Particle Beams	Use in high power technology, perhaps future electrical power production
Aircraft Maintenance	71,689	Portable Air Eductor	Use in aircraft maintenance facility and space
Computers	72,302	Toroidal Computer Memory for Serial and Parallel Processors	In any application that requires rapid access of large memory volume
Computers	71,002	Emittance Measuring Device for Charged Particle Beams	To all accelerator based charged particle beam technologies
Testing	69,883	Airborne Infrared Transmissometer	Laboratories and Universities involved in radiation and absorption analysis
Testing	72,762	Liquid Level and Volume Measurement Device	Medical and quality control laboratories where measurement of liquid must be accurate and quality control is important

APPENDIX B (Cont.)

Technological Area	Navy Case or Patent No.	Title and Purpose	Potential Commercial Applications
Computers	4,907,229	Selective Multimode/Multiconfigurable Data Acquisition and Reduction Processor System	This diagnostic device can be used in computer centers and mainframe installations throughout the commercial and industrial communities wherever non-intrusive real time on line troubleshooting or diagnostics are required
Testing	4,947,465	Method of Laser Discrimination Using Stimulated Luminescence	Use in multilaser processing or manufacturing environments. Possibly medical application where different laser frequencies are used; i.e., bone, fluid, tissue discrimination in surgery
Surveying	4,954,933	Method for Determining Astronomic Azimuth	Tectonic plate science, general surveying
Chemical	4,954,328	Synthesis of Hydroxylamine Salts	Use in the production of chemicals and in producing liquid rocket fuels
Explosives	4,957,027	Versatile Nonelectric Dearmer	Commercial bomb squads and police forces
Electronics	72,837	Heat Sink Device	Aircraft maintenance and other applications where the environment must be spark free
Chemical	4,956,168	Synthesis of Hydroxylamine Salts	Chemical production; manufacture of oxydizers

APPENDIX C

NAVSWC FY90 TECHNOLOGY APPLICATION ASSESSMENTS

Title	Lab No.
Magnetoresistance Magnetometer	NSWC-TAA-90-001
Crosstie Random Access Memory	NSWC-TAA-90-002
Ferroelectric Random Access Memory	NSWC-TAA-90-003

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D JOHNSON (Code D4T)
   Phone (301) 394-1505 Autovon 290 1505

3. Address SILVER SPRING, MD 20903 5000

4. Technology Name MAGNETORESISTANCE MAGNETOMETER

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: _____

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____

A. Date: 5 JULY 1990
B. CUFT #: _____
C. LAB #: NSWC TAA 90 001
D. Descriptors:
Magnetometer
Compass
Thin Film Magnetometer

E. Applications:
Compass
Sensing of tools, guns, automobiles, ships, etc.

7. Potential Support: exclusive license, consulting, joint venture, drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? The magnetoresistance magnetometer is inexpensive, small, and amenable to economical mass production techniques. It is useful for measuring magnetic fields between 1 and 10^{-5} oersted. It is useful for a compass, for traffic signals, and for detecting vehicles, guns, ships, etc.

9. Other Uses: It has been used to detect stolen tools.

10. Main Advantages: It is inexpensive, costing about 7 cents per chip.

11. Production Information: The magnetoresistance magnetometer is amenable to economical mass production

12. Descriptive Literature: NSWC TR 83 296, *An Inexpensive Vector Thin Film Magnetometer*, 1 May 1984

13a. Literature Available From: Mr. Leonard J. Schwee, NAVSWC/WO, Code R41, (301) 394-2690
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903 5000

13b. Description:

The detection of magnetic fields is a common function of many systems. Magnetometers of various types find their way into torpedoes, mines, buoys, intrusion detectors, vehicle detectors, and magnetic anomaly detectors to name a few systems. There are wide ranges in the field levels, dynamic ranges, and frequency of fields which must be detected. System level requirements impose constraints such as the maximum power consumption, the physical size, and the environmental conditions. With such a broad "market" for magnetic field sensors, virtually any device which has performance advantages over others will find its technological niche.

The sensor element of the magnetoresistance magnetometer is physically very small and readily amenable to economical mass production techniques such as those used in the fabrication of integrated circuits. Indeed, it is easily conceivable that the necessary support electronics (amplifiers, for example) can be fabricated on the same substrate as the sensor, with an ensuing reduction in size and increase in reliability.

The magnetoresistance magnetometer consists of a small chip with four connections. The chip has a thin film of permalloy deposited on it which is etched to form a "wheatstone bridge." A small permanent magnet is also needed to bias the thin film. The permanent magnet aligns the magnetization of the film along a direction. The field to be measured is directed perpendicular to the field from the permanent magnet. Each arm of the wheatstone bridge is made up of a magnetoresistor which changes resistance when the magnetization rotates. Thus, a field directed perpendicular to the field applied by the permanent magnet and in the plane of the film changes the resistors so the bridge becomes unbalanced in proportion to the field being measured.

For information on licensing of this subject, contact the Naval Surface Warfare Center,
Mr. Ramsey D. Johnson, Code D4T, (301) 394-1505.

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name CROSSTIE RANDOM ACCESS MEMORY

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: Computer Memory

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: _____

A. Date: 5 JULY 1990
B. CUFT #: _____
C. LAB #: NSWC-TAA-90-002
D. Descriptors:
Nonvolatile Memory
Radiation Hardened

E. Applications:
Space
Missiles
Weapons

7. Potential Support: (exclusive license) (consulting) (joint venture) drawings, tooling, computer prog., economic study, training, adaptive eng., other: _____

8. What Problem Does It Solve and How? The Crosstie Random Access Memory (CRAM) is a nonvolatile computer memory which can be made very resistant to radiation effects if hardened circuitry is used.

9. Other Uses: Space, weapons, etc.

10. Main Advantages: Nonvolatile and radiation hardened.

11. Production Information: _____

12. Descriptive Literature: IEEE Transactions on Magnetics, Vol. MAG-18, No. 6, Nov 1982, pp. 1776-1778.

13a. Literature Available From: Mr. Leonard J. Schwee, NAVSWC/WO, Code R41, (301) 394-2690
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

The Crosstie Random Access Memory (CRAM) has the potential to replace core memories with the added feature of nondestructive readout. It will cost less, have much less weight, and need less volume. If we consider a 4K (64 x 64) array, we can have a 50 nsec write time and about a 200 to 500 nsec read time. Decoders and drivers must be on the same chip. Since only one lead is required for the amplifier, it does not have to be on the chip. Larger arrays are possible with increased access time. An access time of less than 200 nsec can be obtained if the parasitic capacity is balanced out.

The above access times were estimated at room temperature and they will become longer at higher temperatures.

The CRAM could be written with coincident current pulses as short as 20 nsec. Nondestructive reading was accomplished in 800 nsec and this can be improved considerably with better design.

There are several versions of the CRAM. In one version, permalloy film is etched into proper shapes so a crosstie-Block-line pair is used to store a "one," the absence of the crosstie-Block-line pair signifies a "zero." The resistance of the memory element differs depending on whether a crosstie-Block-line pair is present or not. This difference in resistance is used to read out the memory. Another version moves a Block line between two stable positions.

For information on licensing of this technology disclosure, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4T, (301) 394-1505.

TECHNOLOGY APPLICATION ASSESSMENT

1. Laboratory NAVAL SURFACE WARFARE CENTER

2. Contact (ORTA) RAMSEY D. JOHNSON (Code D4T)
   Phone (301) 394-1505 Autovon 290-1505

3. Address SILVER SPRING, MD 20903-5000

4. Technology Name FERROELECTRIC RAM

5. Technology Type: (a) Process (b) Apparatus (c) Material (d) Service (e) Study (f) Other: Random Access Memory

6. Users: (a) Federal Government (b) State Government (c) Local Government (d) Small Industry (e) Medium Industry (f) Large Industry (g) Consultant (h) Other: Homes

A. Date: 5 JULY 1990
B. CUFT #:
C. LAB #: NSWC-TAA-90-003
D. Descriptors:
Ferroelectric Memory
Nonvolatile Memory
Nonvolatile RAM

E. Applications:
Robots
Home Uses
Home Appliances
Commercial Uses
Space
Weapons

7. Potential Support: (exclusive license) (consulting) (joint venture) drawings, tooling, computer prog., economic study, training, adaptive eng., (other:) Will support all computers.

8. What Problem Does It Solve and How? The ferroelectric RAM is a nonvolatile, radiation hardened memory. It can be turned off without the loss of data. It takes less power than a DRAM, can have comparable density, and can be made radiation hardened. Its principal uses are for space and strategic applications. It may eventually become cheap enough for application in home computers.

9. Other Uses: Robots, industrial applications, tactical aircraft, mines, sonobuoys, ships, subs, missiles, etc.

10. Main Advantages: Low cost, fast read and write, nonvolatile, lightweight, low power, small volume.

11. Production Information: Concept was proven by Krysalis Microelectronics and Ramtron Inc. Better ferroelectric materials are being developed.

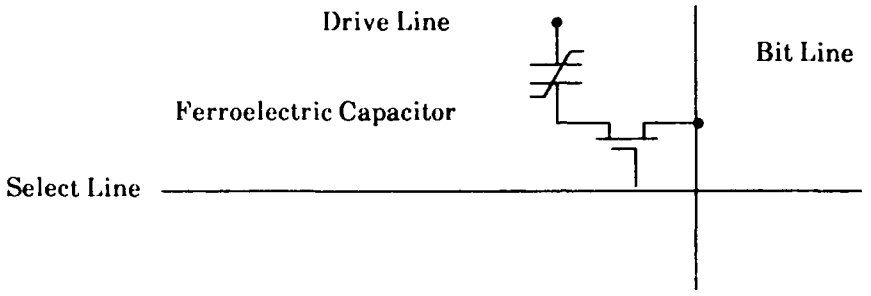
12. Descriptive Literature: U.S. Navy Case Number 69097.

13a. Literature Available From: Mr. Leonard J. Schwee, NAVSWC/WO, Code R41, (301) 394-2690
Naval Surface Warfare Center
10901 New Hampshire Avenue
Silver Spring, MD 20903-5000

13b. Description:

Recently, a considerable amount of well-deserved attention has been devoted to ferroelectric random access memories. The attention is appropriate because the ferroelectric RAM has more potential than any other nonvolatile RAM. Its success will revolutionize military systems and weapons. The ferroelectric RAM is a modification of the most successful memory ever, the Dynamic (DRAM).

The memory element used in the ferroelectric RAM or FRAM uses a single transistor and a ferroelectric capacitor. The circuit is as shown:



The circuit is the same as is used in a dynamic RAM except that a ferroelectric material is used in the capacitor and the top of the capacitor is active. By active it is meant that the top plate can be taken high or low. In other words, the drive line can go to +5 volts or ground. The transistor in each cell allows the capacitor to be isolated from all other memory elements in the circuit.

The memory has been demonstrated by both Krysalis and Ramtron using P2T as the ferroelectric material. Unfortunately, P2T fatigues and has retention problems. Other materials are being investigated such as lead germanate.

For information on licensing of this subject, contact the Naval Surface Warfare Center, Mr. Ramsey D. Johnson, Code D4T, (301) 394-1505.

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