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IDA UNIVERSITY SCIENTISTS PROGRAM (USP)
1990

Nancy P. Licato
Maile E. Smith

September 1990

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IDA Independent Research Program

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The IDA University Scientists Program (USP) is an IDA-funded program to create and maintain a multidisciplinary talent bank of outstanding scientists and engineers in the university community. The program provides an extension to the Defense Science Study Group (DSSG). The USP seeks to use the talents of the graduates of the DSSG as technical reviewers on IDA programs, to maintain and stimulate their continuing interest in national defense problems, and to promote and encourage their service as technical advisors to agencies of the Department of Defense (DoD). This report summarizes the FY 1990 activity of the University Scientists Program and documents the technical review requested of its members on the IDA Advanced Simulation Technology Center.

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I. INTRODUCTION

A. BACKGROUND

In October 1985 IDA created a program called the Defense Science Study Group (DSSG) with sponsorship by the Defense Advanced Research Projects Agency (DARPA). The aim of this program was to identify 10 to 20 of the most talented young scientists and engineers in the country and to introduce them to technical issues related to national defense. The goals of the program were to provide this select group of individuals with an exposure to a broad range of critical defense-related scientific and technical problems, encourage their personal involvement in finding solutions, and provide the Department of Defense (DoD) with a new source of technical advisors and informed critics.

The participants spend up to 3 years in the program, each year to contain a total of 20 days divided into three to four sessions. IDA Paper P-2310, *Summary of the Defense Science Study Group, 1985-1988*, gives a detailed summary of the first 3 years of the program. At the completion of their tenure in the program, the participants become consultants to IDA where they may use their expertise in defense issues gained from the DSSG. After IDA's initial guidance and introduction, it is also expected that program participants will have a role in the defense advisory community.

IDA management believes there is a benefit to be gained in continuing its interaction with this elite group of scientists. Group members will be asked to advise IDA on new programs. IDA seeks the continuing involvement of DSSG members in defense-related scientific and technical problems.

II. UNIVERSITY SCIENTISTS PROGRAM

Recognizing the need to continue, on a smaller scale, the exposure of graduates of the DSSG to defense issues, IDA established the IDA University Scientists Program (USP) in November 1989. This project was funded by the IDA Central Research Program.

A. OBJECTIVE

The objective of the USP is to foster and maintain ties between outstanding scientists and engineers in the university community and IDA. The USP members are graduates of the DSSG program who as a group seek to accomplish the following goals:

- Maintain and stimulate their continuing interest in national defense problems
- Promote and encourage their service as technical advisors
- Inform them on the latest technology and current problems of national defense
- Maintain and strengthen links between IDA and the university community
- Use their talents as technical reviewers on select IDA programs.

B. MEMBERSHIP

The 16 graduates of the DSSG were surveyed to ascertain their interest in participating in this program. All responded positively and took an active part in helping to design a program to match their interests with IDA's needs. A list of USP members is found in Appendix A.

C. APPROACH

The approach was to organize a one and a half day program divided into three sessions. The first session was designed to use the multidisciplinary range of talents of this group by presenting them with an IDA initiative and requesting their review of IDA's plan and their suggestions for its future potential. The second session would introduce the group to other programs of the DoD and IDA in order to continue members' exposure to current defense problems, to obtain their views of the technology, and to solicit their potential involvement in finding solutions. In the third session, DSSG graduates would

discuss their involvement in and contributions to defense-related activities since graduation from the DSSG.

D. PROGRAM

The meeting of the USP was held at IDA on April 27-28, 1990. All 16 USP members attended. The agenda of the meeting can be found in Appendix B.

1. Session One

The IDA initiative presented to the members of the USP was the proposed Advanced Simulation Technology Center at IDA. This initiative is designed to develop and apply advanced simulation technologies to the analysis of problems faced by OSD, JCS, the CINCS, and other defense agencies in the development, procurement, and use of advanced military systems and forces. The opportunity to work in this area was made possible by IDA's recent association with SIMNET (Large Scale Simulator Networking Program).

SIMNET provides extended practice in warfighting skills and thus supplements the training provided by field exercises. The SIMNET system consists of tank and aircraft simulators, communication networks, command posts, and data processing facilities. Each weapon is operated by its regular full crew. Local area and long haul communication networks permit all of the simulators to operate on the same area of terrain. Some of the simulator crews act as an enemy force. The crews plan and perform maneuvers and engagements in SIMNET as they would during field exercises. This is training on a large scale and is intended to prepare military forces for combat in combined operations at the task force level. The SIMNET is not a tank or flight trainer because all crews must know how to operate their vehicles before using SIMNET for engagement training.¹

The members of the USP visited the IDA SIMNET facility and received an overview of the advanced simulation technology by Dr. Jesse Orlansky (IDA/STD) and a demonstration of the SIMNET capability by Mr. Robert Clover (IDA/STD). Dr. David Sparrow (IDA/STD) briefed the group on the plans to initiate the Advanced Simulation Technology Center at IDA and arranged briefings of current or proposed IDA studies using SIMNET as a new tool for linking it with the analysis. The studies include: Applications

¹ Orlansky, J. and J. Thorpe, "SIMNET - An Engagement Training System for Tactical Warfare," OASD (Public Affairs), Case No. 88-2915, 7 July 1988.

of SIMNET to Weapon Systems Evaluation by Mr. James Graves (IDA/SED), Integrating SIMNET with Theater Level Combat Assessments by Dr. Peter Brooks (IDA/SF&RD), and Languages for Specifying Tactics by Mr. Stephen Edwards (IDA/CSED).

The group members were asked to assess the current utility and future potential of SIMNET and its relationship to other technologies and DoD needs. The questions posed were:

- Is IDA using SIMNET to its best advantage?
- How can IDA best utilize this Center?
- What other uses can SIMNET offer in this Center?

The response of the USP participants to these questions is found in Section III of this report.

2. Session Two

Briefings were presented on technical studies by the DoD and IDA in order to maintain USP members' exposure to current defense problems. A presentation on the B-2 was given by a representative of the Air Force. Dr. George Koleszar of the System Evaluation Division (SED) of IDA gave a briefing on the IDA Strategic Bomber Penetration Studies following Dr. David Randall's overview of SED. Dr. Paul Schneck gave an overview of the Supercomputer Research Center (SRC) of IDA, following which Mr. William Holmes of SRC gave a description of the SPLASH program and discussed potential applications. SPLASH is a reconfigurable systolic engine that resides in two slots of a SUN workstation. One of the candidate applications is DNA pattern matching. The session concluded with Mr. Richard Bergemann presenting the activities of the second group of participants to the DSSG program.

3. Session Three

Dr. Philip Marcus moderated a discussion in the final session which began with presentations by those USP members who have participated in defense-related activities as a result of their tenure in the DSSG. All past and current involvement are listed in Appendix C.

The purpose of this part of the session was twofold: to assess the success of the DSSG program by ascertaining the extent and value of members' activities as technical advisors to the DoD; and to maintain and stimulate interest among those members who have

not yet had an opportunity to participate. Based on the presentations given by members on their various activities, the program was found to be highly successful, as well as informative and enjoyable.

The USP members then engaged in discussions of SIMNET. Their overall reaction was that "this is a promising capability with great potential for extending analytical studies." They felt it "is well suited to basic research" in three areas and formed subcommittees in those areas: Data Analysis, Evaluating and Prototyping, and Extending SIMNET to Larger Scale Actions, chaired by Dr. R. Stanley Williams, Dr. Philip Marcus and Dr. Deborah Joseph, respectively. The chairs submitted their subcommittee's comments to IDA through Dr. Russel Caflisch, the Review Coordinator. Chapter III contains the USP review of the Advanced Simulation Technology Center.

III. REVIEW OF THE ADVANCED SIMULATION TECHNOLOGY CENTER

**IDA University Scientists
Russel E. Caflisch, Coordinator**

In April 1990 the members of the University Scientists Program (USP) were briefed on the current SIMNET initiative at IDA and given a demonstration of the "Magic Carpet" facility. The USP was then asked by Bob Roberts to provide some comments on IDA's plans for SIMNET and to make suggestions for additional projects involving SIMNET.

The USP sees three main roles for IDA in its use of SIMNET. The first is in extraction and analysis of data from SIMNET exercises. Second, IDA can use SIMNET for evaluating and prototyping new weapon systems and tactics. Finally, IDA could attempt to expand the scope of SIMNET engagements and improve the use of semiautomated forces (SAFORS). These three topics are described in three subsections.

A. DATA ANALYSIS

**R. Stanley Williams, Chair
Steven E. Koonin
Frederick K. Lamb
Nathan S. Lewis
Thomas F. Rosenbaum**

After briefings on the IDA SIMNET/Advanced Simulation Technology Center, we met on April 28 to discuss the possible applications of SIMNET to weapons prototyping and tactics evaluation. We realized that a tool that was designed primarily for training may not be an optimum choice for other uses, and that careful validation of applications of SIMNET to weapons systems evaluation and theater level combat assessments was necessary. We also noted that a tremendous amount of data has been and is being gathered during the course of exercises with SIMNET and at the National Training Center (NTC). We feel that this data is extremely valuable, and that IDA should devote significant resources to its analysis. Quantitative analyses of both SIMNET and NTC data will allow IDA to validate SIMNET as a test and evaluation environment, guide the Advanced Simulation Technology Center in the use of SIMNET, and optimize the use of simulations for prototyping and evaluation.

The specific recommendations of our subcommittee are as follows:

- IDA should acquire or create sufficient computer hardware and software capabilities to flexibly extract and analyze quantitative information from both SIMNET and NTC.
- IDA should use these capabilities to identify important variables that allow a quantitative comparison of SIMNET exercises with those at NTC and that enable meaningful evaluations of weapons systems. Issues would likely include but not be limited to the following: fratricides, fuel consumption, firing rate, mean survival time, mean distance at first shot, kill probability, and spatial distributions of forces during engagements.
- IDA will need access to SIMNET to run controlled experiments with defined initial conditions in order to provide credibility for SIMNET when used for analysis as opposed to training. Such access need not conflict with the basic training role of SIMNET.

- Analytical models should then be compared to SIMNET results and any discrepancies reconciled.
- A key issue for credible larger level simulations is identification of the variables that can be averaged, and over what scales the averages are valid, as opposed to those that must be tracked explicitly.
- For large scale applications, controlled experiments that vary the proportion of semiautomated forces in an engagement are necessary, in order to make certain that the SAFORS models are realistic and scale appropriately.

B. EVALUATING AND PROTOTYPING

Philip S. Marcus, Chair
Steven K. Case
Katherine Faber
Bruce Hajek
Steven J. Sibener
Daniel L. Stein
W. Hugh Woodin

The members of the University Scientists Program believe that there is an important role for IDA to play in expanding the capabilities of SIMNET for evaluating and prototyping new weapons and technologies. The group was impressed with IDA's initial use of SIMNET to study the use of Wide Area Mines (WAMs) and smart minefields in an effort to study their potential effectiveness. The members feel that significant contributions can be made along similar lines.

With proper development and stringent controls, SIMNET could be used as a *first* step in evaluating a new weapons system. This relatively inexpensive form of testing would come before the construction of prototypes and field testing and therefore could be used to make major design changes (or to abandon a program) before a large commitment of resources is made. It should be emphasized that SIMNET should be used in conjunction with field tests and, in fact, integrated into existing testing programs such as those underway at the National Training Center (NTC). Information should be shared so that the data used in SIMNET is continually updated through the field tests and the results of updated simulations reported back to the field.

Credibility of SIMNET's role in evaluating and prototyping can be initially established by replaying and recreating old field tests. However, for the maintenance of credibility and for the cooperation with other groups involved in evaluation there must be a strong interaction with the field tests. For example, it might be useful to ascertain what data NTC needs that is currently unavailable to them but could be simulated by SIMNET. Making this data available to NTC, learning from NTC how accurate and useful this data is for developing new tactics for weapons and sensors, then improving the simulations on

SIMNET by using the new data from the field tests could prove to be a very useful iterative procedure.

One of the best applications of SIMNET in prototyping might be to examine the marginal utility with respect to costs of incremental changes in weapons and sensors. For example, knowing how the performance of a weapon increases with the range of its sensors (e.g., linearly, exponentially, exponentially followed by a flat plateau) would be useful in optimizing designs of systems.

Another task easily carried out on SIMNET that would be impractical with field tests is to explore how new technologies can lead to global changes in strategy. For example, dog fight simulations at Miramar suggest that the introduction of a new generation of fire-and-forget weapons with long range may change the standard picture of air-to-air combat. The concept of a dog fight may be replaced by the scenario of a stealthy approach, firing of weapons from a distance, and a hasty retreat with no second encounter. Similarly, the introduction of an inexpensive artillery shell with surveillance capabilities (POPEYE) might obsolete conventional tank tactics. Simulations on SIMNET could verify or refute this conjecture.

To close on a note of caution, the members of the University Scientists Program believe that to make SIMNET time and cost effective for evaluating and prototyping, SIMNET must use software that is designed to allow for quick and on-site (at IDA) changes in the simulated system parameters and for the introduction of new weapons and sensors.

C. EXTENDING SIMNET TO LARGER SCALE ACTIONS

**Deborah A. Joseph, Chair
Russel E. Caflisch
Randy L. Katz**

In its current configuration the SIMNET system allows relatively small groups of individuals (at most a few hundred) to train in a simulated battlefield environment. However, because of the relative inexpensiveness of the hardware and the software possibilities presented by the use of semiautomated forces (SAFORS), it is reasonable to explore the possibility of extending the SIMNET system to larger scale actions. Such an exploration should be made in light of several considerations.

1. At what scale is the SIMNET paradigm appropriate?
2. What architectural constraints limit the expansion of SIMNET? What modifications would be necessary, or desirable, in the hardware of an expanded SIMNET system?
3. What role would SAFORS play in an expanded SIMNET? How should these forces be modeled? Is a "language" needed for managing the SAFORS?

At What Scale Is the SIMNET Paradigm Appropriate?

The first issue that must be resolved in evaluating extensions of the SIMNET system is the scale of simulation that is best modeled in a SIMNET-like environment. The current system models engagements in which at most a few hundred individuals are involved. Even if we assume no hardware and software limitations, the SIMNET system would have to be very different if extended to model regiment, division or theater scale engagements. Global issues of battlefield strategy would come into play, the time for individual engagements might no longer be measured in minutes and hours, and logistic and financial constraints would require significant use of SAFORS. Despite the complexities posed by an expansion of SIMNET, the training benefits gained from the ability to model larger engagements seem promising. For instance, it seems clearly beneficial to expand the nature of the coordinated interservice operations that can be modeled.

The SIMNET Architecture

To understand the extent to which SIMNET can be expanded one needs a better understanding of the current limitations of the architecture (hardware). What, if any, are the current limiting factors? If the system is scaled using its current hardware configuration, where will bottlenecks develop? We suspect that even financially the limitations in scaling SIMNET do not come primarily from the hardware, but this suspicion needs to be born out in evaluation. However, a scaled system modification of the architecture may be beneficial. To provide both robustness and flexibility it may be useful to have a collection of networks that can be individually isolated, as well as configured in a variety of logical schemes. To allow the integration of new hardware the SIMNET system should be configured as a heterogeneous network of processors.

Semiautomated Forces

For practical reasons simulations of large scale engagements will need to rely on SAFORS. Currently, the SAFORS are managed directly by humans. However, in an expanded system it is reasonable to assume that some of these forces will be purely computer simulated. To maintain the usefulness of SIMNET as a training facility and to insure confidence in it for weapons evaluation, the SAFORS should respond in a fashion consistent with their human counterparts. However, the extent to which they must be "indistinguishable" from their human-commanded counterparts needs to be carefully studied.

Alan Turing introduced what is now called the "Turing test": a computer passes the Turing test if a human asking questions of it cannot distinguish the answers given by the computer from those given by a human being. Needless to say, no machine has been built that can pass the Turing test. Thus, it seems an overly ambitious goal for the SAFORS. On the other hand, it is important to identify qualitatively and quantitatively the parameters that must be modeled in the SAFORS.

The current plan for SAFORS modeling permits the SAFORS models access only to local information. The reason for this is an attempt to parallel the information available to the soldiers fighting within the SIMNET simulators. However, from the standpoint of building an accurate SAFORS model this seems an undue restriction. For instance, we suspect that measures of fatigue, morale and leadership are important for good SAFORS modeling. Modeling these effects on performance may be best done using global information of the battle.

A further issue involved in SAFORS modeling is that of identification. Here global information must be used, as the SAFORS program cannot have the eyes and ears of its human counterpart. Nevertheless, exact identification is rarely possible on even the SIMNET battlefield and fratricide is common. Although modeling this phenomenon presents an added complexity, it also presents an opportunity for studying what appears to be a serious battlefield problem.

Finally, the proposal of a "SAFORS language" (a software language to facilitate human interface with the SAFORS program) needs careful consideration. The role of the SAFORS within the current system and their proposed role in an extended system should be well understood before such a language is designed. Questions such as whether one needs to be able to model individual as well as aggregate behavior need to be answered before a language is designed. Also, its role as a human interface needs to be carefully thought out: Who will its users be? What will their expectations be from the SAFORS?

In conclusion, the extension of SIMNET to a modeling system for larger scale engagements seems promising. However, it also presents a large number of challenges primarily in the area of the SAFORS modeling.

APPENDIX A

UNIVERSITY SCIENTISTS PROGRAM (USP) MEMBERS

UNIVERSITY SCIENTISTS PROGRAM (USP) MEMBERS

RUSSEL E. CAFLISCH	Mathematics University of California, Los Angeles
STEVEN K. CASE	Electrical Engineering University of Minnesota
KATHERINE T. FABER	Materials Science and Engineering Northwestern University
BRUCE HAJEK	Electrical Engineering University of Illinois
DEBORAH A. JOSEPH	Computer Science University of Wisconsin
RANDY L. KATZ	Computer Science University of California, Berkeley
STEVEN E. KOONIN	Physics California Institute of Technology
FREDERICK K. LAMB	Physics University of Illinois
NATHAN S. LEWIS	Chemistry California Institute of Technology
PHILIP S. MARCUS	Mechanical Engineering University of California, Berkeley
THOMAS F. ROSENBAUM	Physics University of Chicago
STEVEN J. SIBENER	Chemistry University of Chicago
DANIEL L. STEIN	Physics University of Arizona
WARREN S. WARREN	Chemistry Princeton University
R. STANLEY WILLIAMS	Chemistry University of California, Los Angeles
W. HUGH WOODIN	Mathematics University of California, Berkeley

APPENDIX B

AGENDA

IDA UNIVERSITY SCIENTISTS PROGRAM

April 27-28, 1990

AGENDA

Friday, April 27

SIMNET/Advanced Simulation Technology Center

8:00 a.m.	Vans depart IDA building	
8:30	Arrive SIMNET facility	
8:40	Welcome	Nancy Licato
8:45	Overview of Advanced Simulation Technology Task	Jesse Orlansky
9:15	Demonstration of SIMNET Capability	Robert Clover
10:15	Advanced Simulation Program/Center at IDA	David Sparrow
10:45	Depart for IDA	
11:05	Arrive IDA, Room 203N	
11:15	Applications of SIMNET to Weapon Systems Evaluation	James Graves
11:45	Integrating SIMNET with Theater Level Combat Assessments	Peter Brooks
12:15 p.m.	Languages for Specifying Tactics	Stephen Edwards
12:45	Lunch in Commons Room	
	<u>Current Defense Programs</u>	Board Room
1:50	Introduction to SED & Bomber Penetration Study	David Randall
2:00	IDA Strategic Bomber Penetration Studies	George Koleszar
2:30	Discussion	
2:40	B-2 and Current Technology	Lt. Col. Ryan Dow, USAF
3:10	Discussion	
3:30	Break	

IDA UNIVERSITY SCIENTISTS PROGRAM

April 27-28, 1990

AGENDA (Continued)

Friday, April 27

3:40	Introduction to SRC and SPLASH	Paul Schneck
3:50	SPLASH: Description and Application	Bill Holmes
4:20	Discussion	
4:30	DSSG Program	Richard Bergemann
5:00	IDA Reception	Board Room

Saturday, April 28

	<u>University Scientists' Session</u>	Board Room
8:30 a.m.	DSB Summer Study on Improving Testing and Evaluation Effectiveness	Kathy Faber Tom Rosenbaum
8:45	DSB Summer Study on National Security Space Launch Strategy	Dan Stein
9:00	JASON/ICF Review	Steve Koonin
9:15	Verification	Fred Lamb
9:30	Break	
9:40	Round Table Discussions	
	Review of Advanced Simulation Technology Center	
	Future Activities	
	Other topics as desired	
12:30 p.m.	Lunch	
1:30	Wrap-up	
2:00	Depart	

APPENDIX C

DEFENSE-RELATED ACTIVITIES OF USP MEMBERS

DEFENSE-RELATED ACTIVITIES OF USP MEMBERS

CAFLISCH, RUSSEL

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

Principal investigator on an AFOSR research grant concerned with analysis and computation for vortex dynamics and rarefied gas--10/1/89.

Principal investigator in the AFOSR-sponsored University Research Initiative Center for Analysis of the Heterogeneous and Nonlinear Media--10/15/86-10/15/89.

CASE, STEVEN

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

Working on classified security issues for a Government agency.

FABER, KATHERINE

Participant in the Defense Science Board Summer Study Task Force on Improving Testing and Evaluation Effectiveness--1989.

HAJEK, BRUCE

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

JOSEPH, DEBORAH

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

KATZ, RANDY

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

KOONIN, STEVEN

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

Member of the JASON for over 2 years, studying a variety of topics including: Brilliant Pebbles, technology for arms control verification, weapon-effects simulators, and tagging explosives for countering terrorists.

Defense Science Board Summer Study Task Force on Strategic Sensors--1990.

Chairman of a large review of Inertial Confinement Fusion (ICF) for the National Research Council. This study was performed (early 1990) at the request of the Secretary of Energy as mandated by House Armed Services Committee (HASC). Briefed both the HASC and Secretary Watkins.

LAMB, FREDERICK

Working on verification of underground nuclear tests that began in 1986 due to briefings received on arms control while a member of the DSSG.

Working with the Congressional Office of Technology Assessment to examine methods to measure the yield of underground nuclear tests; a DARPA/NMRO and Air Force Geophysics Laboratory (AFGL) funded program. This program examines hydrodynamic methods for measuring the yield, and in particular the CORRTEx method.

Working on a DARPA/NMRO-funded program at IDA on assessing methods for monitoring underground nuclear tests.

Participant in a DOE Symposium on Explosion Source Phenomenology at Lake Tahoe in March 1989.

Served on the Red Team for the ACDA/NSC review of the PNET and TTBT Protocols in the summer of 1989.

Serves on the Executive Committee of the University of Illinois Program on Arms Control, Disarmament, and International Security.

Delivered invited lectures on verifying nuclear test bans:

- American Physical Society annual meeting, May 1989.

- 11th Annual DARPA/AFGL Seismic Research Symposium, May 1989, and lecture published in the proceeding.

- American Association for the Advancement of Science, New Orleans Meeting, February 1990.

Co-authored technical papers on shock waves produced by underground nuclear explosions published in:

- The Proceedings of the 11th Annual DARPA/AFGL Seismic Research Symposium.

- The Proceedings of the 6th Topical Conference on Shock Compression of Condensed Matter.

LEWIS, NATHAN

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

Participant in the 1990 JASON CHAMMP Review.

Provided convincing evidence that refuted the widely publicized claims for cold fusion--1989. Collaborated on part of this work with Steven Koonin as a result of meeting through the DSSG.

MARCUS, PHILIP

Participant in a Naval Studies Board (NRC) study on Future Aircraft Carrier Technology--1990.

Principal investigator on an AFOSR research grant on dynamics stability and bifurcation.

Participant in the Special Project Program (Mathematical Sciences) for DARPA and NSF.

Invited to join the JASON in 1988.

ROSENBAUM, THOMAS

Participant in the Defense Science Board Summer Study Task Force on Improving Testing and Evaluation Effectiveness--1989.

SIBENER, STEVEN

Reviewed a materials science paper produced for a DARPA-sponsored task.

Discussed with AFOSR DSSG activities studying oxidation passivation of carbon/carbon composites.

STEIN, DANIEL

Participant in the Defense Science Board Summer Study Task Force on National Security Space Launch Strategy--1989.

WARREN, WARREN

Worked for Dr. Lee Buchanan, Director, DARPA/DSO, on Microwave and Optical Pulse Shaping.

WOODIN, HUGH

Consults at the IDA Center for Communications Research (CCR).

Participant in the 1990 SCAMP Study at CCR-La Jolla.

APPENDIX D

GLOSSARY

GLOSSARY

ACDA	Arms Control and Disarmament Agency
AFGL	Air Force Geophysics Laboratory
AFOSR	Air Force Office of Scientific Research
CCR	Center for Communications Research
DARPA	Defense Advanced Research Projects Agency
DoD	Department of Defense
DOE	Department of Energy
DSO	Defense Sciences Office, DARPA
DSSG	Defense Science Study Group
HASC	House Armed Services Committee
ICF	inertial confinement fusion
NMRO	Nuclear Monitoring Research Office, DARPA
NRC	National Research Council
NSF	National Science Foundation
NTC	National Training Center
PNET	Peaceful Nuclear Explosions Treaty
SAFORS	semiautomated forces
SIMNET	Large Scale Simulator Networking Program
SRC	Supercomputer Research Center
TTBT	Threshold Test Ban Treaty
USP	University Scientists Program
WAM	Wide Area Mine