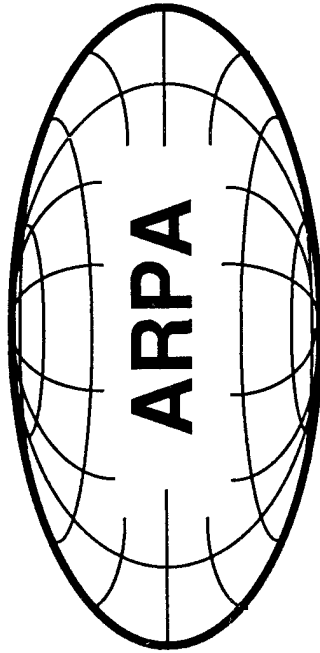


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**Program Objectives Memorandum
(POM 96-01)
RDT&E Descriptive Summaries**



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ADVANCED RESEARCH PROJECTS AGENCY
 3701 NORTH FAIRFAX DRIVE
 ARLINGTON, VA 22203-1714



JUN 10 1994

MEMORANDUM FOR THE SECRETARY OF DEFENSE

SUBJECT: POM 96-01 Submission

Attached is the ARPA Program Objectives Memorandum submission covering RDT&E requirements for FYs 1996-2001. In keeping with the Defense Planning Guidance, this budget submission is focused on pursuing technologies to maintain our technological superiority and to achieving this through acquisition strategies that will assist in the conversion of defense-unique companies to dual-use production. Funding levels are in accordance with the fiscal guidance.

Gary L. Denman
 Director

Attachment

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ADVANCED RESEARCH PROJECTS AGENCY

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Advanced Research Project Agency Executive Summary

The mission of the Advanced Research Projects Agency (ARPA) is to pursue high risk, technologically challenging research and development that will provide the basis for next generation weapons systems, tactics, and training, while strengthening and maintaining the Defense industrial base. The ARPA POM fully complies with fiscal guidance and funds the following efforts in support of Departmental goals and objectives.

- Basic Research (6.1) funding is maintained at the FY 1995 President's Budget level that funds inflationary impacts but does not provide real program growth.
- The Technology Reinvestment Program continues the funding profile presented in the FY 1995 President's Budget. The program funding declines in the FY 2000-2001 timeframe on the presumption that the program objectives, to enhance and stabilize the defense industrial base, will have been accomplished by the turn of the century.
- ARPA's share of the Tier III Unmanned Aerial Vehicle Program is funded.
- The ARPA portion of the ASTOVL - Common Affordable Lightweight Fighter Phase III Demonstration Aircraft program is funded.
- Departmental initiatives such as the High Definition Display Systems program, Demining program, Operations Other-Than-War program, the Computer-aided Acquisition and Logistics System, and the ongoing Advanced Technology Demonstrations and Advanced Concept Technology Demonstrations are funded.

Research activities funded by the FY 1996 POM can be broadly categorized into such areas as basic research; High Performance Computing/software; sensor technologies; advanced simulation; warfare/weapons development; special access activities; and manufacturing science and technology. Included within these categories is the funding necessary to continue core research programs to maintain technological primacy, and to continue the new initiatives that began in FY 1995 such as the Microwave and Analog Front End Technology (MAFET) program, the Military Medical and Trauma Care program, and several Manufacturing Technology demonstrations. In recognition of the Administration's interest in retaining an Advanced Lithography industrial base, the POM projects the availability of \$50 million annually for Lithography-related requirements.

Core Programs

The funding levels for basic research reflect the importance of "pure" science. Research centering on advanced materials, ultra-fast communications and electronic information processing, intelligent information systems and robotics is funded within this category.

Major programs in the area of computers and software are the High Performance Computing and Communications project and the Intelligent Systems and Software program. ARPA is the technological coordinator of the multi-agency Federal High Performance Computing program that is the cornerstone of the National Information Infrastructure. The ARPA focus is on harnessing the potential power of such computer architectures as scalable massively parallel systems and developing the software necessary to efficiently operate them.

The premier sensor technology program is WAR BREAKER, a comprehensive effort to identify, track and prosecute time critical targets. Other sensor-related activities funded in the POM include the Air Defense Initiative and Anti-Submarine Warfare research.

The FY 1996 National Guard simulation program and the Synthetic Theater of War program funding has been maintained at FY 1995 funding levels in the POM.

The Manufacturing Technology program represents approximately 50 percent of ARPA's core program. Although the major, and most publicized project is the Technology Reinvestment Program, other dual-use projects are also funded in the technology areas of materials processing, electronics processing, electronic modules, and high definition systems, as well as continued participation in the SEMATECH consortium.

New Starts

ARPA has been required to absorb funding requirements for MARITECH, the Technology Reinvestment Program, ASTOVL and Tier III. These program adjustments preclude the establishment of any major new starts; however, smaller-scale new programs will be initiated in mobile wireless computing, Ultra II Optoelectronics, information systems security, and physical optics.

ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
SUMMARY BY BUDGET ACTIVITY
(\$ in Thousands)

POM 96-01

Budget Activity	Title	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
1	Basic Research	86,457	87,706	90,137	93,064	95,444	99,386	103,531	110,286
2	Exploratory Development	756,092	823,729	807,270	852,752	951,004	976,143	1,091,216	1,242,152
3	Advanced Development	1,685,345	1,716,658	1,813,997	1,794,385	1,815,546	1,741,771	1,694,803	1,614,262
6	RDT&E Management Support	<u>31,141</u>	<u>33,593</u>	<u>35,896</u>	<u>37,499</u>	<u>38,806</u>	<u>40,400</u>	<u>42,850</u>	<u>44,400</u>
	TOTAL RDT&E - DIRECT	2,559,035	2,661,686	2,747,300	2,777,700	2,900,800	2,857,700	2,932,400	3,011,100
	Reimbursements	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>	<u>10,000</u>
	TOTAL PROGRAM	2,569,035	2,671,686	2,757,300	2,787,700	2,910,800	2,867,700	2,942,400	3,021,100

**DEPARTMENT OF DEFENSE - MILITARY
ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
DETAIL BY BUDGET ACTIVITY
(\$ in Thousands)**

POM 96-01

Element Code	Title	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate
1									
6.1	Basic Research								
0601101E	Defense Research Sciences	86,457	87,706	90,137	93,064	95,444	99,386	103,531	110,286
		86,457	87,706	90,137	93,064	95,444	99,386	103,531	110,286
2									
6.2	Exploratory Development								
0602301E	Computing Systems & Communications Tech	756,092	823,729	807,270	852,752	951,004	976,143	1,091,216	1,242,152
0602702E	Tactical Technology	321,416	419,608	402,799	431,230	478,524	482,931	516,003	553,339
0602708E	Integrated Command & Control Tech	88,652	111,343	96,455	98,452	104,224	122,120	154,620	195,620
0602712E	Materials & Electronics Technology	84,800	67,950	68,000	68,000	68,000	68,000	68,000	68,000
		261,224	224,828	240,016	255,070	300,256	303,092	352,593	425,193
3									
6.3	Advanced Development								
0603226E	EEMIT	1,685,345	1,716,658	1,813,997	1,794,385	1,815,546	1,741,771	1,694,803	1,614,262
0603569E	Advanced Submarine Technology	560,308	609,331	655,721	661,874	631,639	576,484	684,584	801,798
0603570E	Defense Reinvestment	44,194	25,261	19,473	24,311	28,449	36,230	46,230	54,530
0603739E	Electronics Manufacturing Technology	474,000	625,000	650,000	675,000	700,000	725,000	500,000	250,000
0603744E	Advanced Simulation - National Guard	380,236	346,129	377,904	348,500	385,458	359,057	448,989	489,934
0603745E	Semiconductor Manufacturing Technology	27,107	20,937	20,899	14,700	20,000	15,000	15,000	18,000
0603746E	MARITIME Technology	89,500	90,000	90,000	70,000	50,000	30,000	0	0
0603747E	Electric Vehicles	38,750	0	0	0	0	0	0	0
0603748E	Natural Gas Vehicles	46,250	0	0	0	0	0	0	0
0603749E	Earth Conservancy	15,000	0	0	0	0	0	0	0
		10,000	0	0	0	0	0	0	0
6									
6.5	RDI&E Management Support								
0605114E	Blacklite	31,141	33,593	35,896	37,499	38,806	40,400	42,850	44,400
0605898E	Management Headquarters (R&D)	4,875	4,875	4,778	4,730	4,683	5,000	5,000	5,000
		26,266	28,718	31,118	32,769	34,123	35,400	37,850	39,400
	Total ARPA	2,559,035	2,661,686	2,747,300	2,777,700	2,900,800	2,857,700	2,932,400	3,011,100

ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PROJECT LEVEL SUMMARY REPORT
(\$ in millions)

POM 96-01

FE	PROJ	TITLE	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
61101E	CCS-02	INFORMATION SCIENCES	33.677	24.322	26.030	31.628	32.623	32.300	34.500	35.700
	ES-01	ELECTRONIC SCIENCES	28.853	41.934	42.126	40.835	40.560	42.333	43.778	47.533
	MS-01	MATERIALS SCIENCES	23.927	21.450	21.981	20.601	22.261	24.753	25.253	27.053
	61101E	DEFENSE RESEARCH SCIENCES	86.457	87.706	90.137	93.064	95.444	99.386	103.531	110.286
62301E	ST-01	JASONS	1.240	1.227	1.218	1.203	1.190	1.200	1.200	1.200
	ST-11	INTELLIGENT SYSTEMS & SOFTWARE	68.193	93.656	102.727	106.284	134.994	135.907	138.407	158.407
	ST-19	HIGH PERFORMANCE COMPUTING	192.157	243.700	233.075	253.800	265.260	266.462	289.034	303.484
	ST-22	SOFTWARE ENGINEERING TECHNOLOGY	37.550	40.223	19.562	19.205	18.678	20.250	23.250	25.136
	ST-23	COUNTER PROLIFERATION TECHNOLOGY	22.276	40.802	46.217	50.738	58.402	59.112	64.112	65.112
	62301E	COMPUTING SYS & COMM TECHNOLOGY	321.416	419.608	402.799	431.230	478.524	482.931	516.003	553.339
62702E	TT-03	NAVAL WARFARE TECHNOLOGY	26.459	33.383	36.687	37.728	39.830	41.407	51.407	66.407
	TT-04	ADVANCED LAND SYSTEMS TECHNOLOGY	14.900	33.239	34.654	31.500	34.986	50.186	54.686	66.686
	TT-05	ADVANCED TARGETING TECHNOLOGY	8.303	5.848	0.000	0.000	0.000	0.000	0.000	0.000
	TT-06	ADVANCED TACTICAL TECHNOLOGY	26.285	38.873	25.114	29.224	29.408	30.527	48.527	62.527
	TT-07	AERONAUTICS TECHNOLOGY	12.705	0.000	0.000	0.000	0.000	0.000	0.000	0.000
	62702E	TACTICAL TECHNOLOGY	88.652	111.343	96.455	98.452	104.224	122.120	154.620	195.620
62708E	IC-03	HIGH DEFINITION SYSTEMS	84.800	67.950	68.000	66.000	68.000	68.000	68.000	68.000
62712E	MPT-01	MATERIALS PROCESSING TECHNOLOGY	129.104	106.824	114.085	122.140	152.506	148.139	157.640	194.240
	MPT-02	ELECTRONICS PROCESSING TECHNOLOGY	94.332	88.471	93.931	104.928	114.252	116.453	151.453	183.453
	MPT-06	HIGH TEMP SUPERCONDUCTIVITY/HTSC	37.788	14.238	4.000	0.000	0.000	0.000	0.000	0.000
	MPT-07	MILITARY MEDICAL/TRAUMA CARE TECHNOLOGY	0.000	15.295	28.000	28.002	33.498	38.500	43.500	47.500
	62712E	MATERIALS & ELECTRONICS TECHNOLOGY	261.224	224.828	240.016	255.070	300.256	303.092	352.593	425.193
63226E	EE-21	COMM & CONTROL INFORMATION SYSTEMS	0.500	24.712	39.750	25.700	30.000	39.237	41.687	46.034
	EE-24	ASTOVL/COTL COMMON AFFORD LIGHTWEIGHT FIGHTER	25.712	20.014	30.954	83.148	83.922	19.000	16.000	10.000
	EE-27	ADVANCED SPACE TECHNOLOGY PROGRAM	28.662	5.925	0.000	0.000	0.000	0.000	0.000	0.000
	EE-34	GUIDANCE TECHNOLOGY	10.144	10.870	18.937	18.000	17.000	17.000	17.000	17.000
	EE-36	ADVANCED ASW TECHNOLOGY	17.180	15.885	16.533	16.903	22.614	22.550	33.050	39.050
	EE-37	ADVANCED SIMULATION	59.216	79.280	76.897	54.675	51.000	59.653	83.253	85.353
	EE-39	UNMANNED UNDERSEA VEHICLE SYSTEMS	23.850	17.839	17.900	17.570	17.395	18.115	21.115	26.115
	EE-40	CRITICAL MOBILE TARGETS	117.268	132.960	135.103	125.000	121.987	132.360	135.360	141.360
	EE-41	AIR DEFENSE INITIATIVE	24.642	38.600	45.600	45.000	55.000	56.000	67.000	89.000

ADVANCED RESEARCH PROJECTS AGENCY
RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
PROJECT LEVEL SUMMARY REPORT
(\$ in millions)

POM 96-01

FE	PROJ	TITLE	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
	EE-45	GLOBAL GRID COMMUNICATIONS	19,209	48,487	45,671	44,842	43,592	15,435	22,935	24,549
	EE-46	DEFENSE SIMULATION INTERNET (DSI)	31,617	15,855	26,200	37,000	0,000	0,000	0,000	0,000
	EECLS	CLASSIFIED	202,308	198,904	202,176	194,036	189,129	197,134	247,184	323,337
	63226E	EEMIT	560,308	609,331	655,721	661,874	631,639	576,484	684,584	801,798
	63569E	AS-01	ADVANCED SUBMARINE TECHNOLOGY	44,194	25,261	19,473	24,311	28,449	46,230	54,530
	63570E	PT-01	DUAL USE TECHNOLOGY PARTNERSHIPS	150,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-03	COM-MIL INTEGRATION PARTNERSHIPS	100,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-04	REGIONAL TECHNOLOGY ALLIANCES	100,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-06	AGILE MFG/ENTERPRISE INTEGRATION	35,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-07	ADVANCED MATERIALS PARTNERSHIP	30,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-08	ADVANCED MANUFACTURING TECH PARTNERSHIPS	30,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-10	MFG ENGINEERING EDUCATION PROGRAM	24,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-12	U.S. JAPAN MGMT TRAINING	5,000	0,000	0,000	0,000	0,000	0,000	0,000
		PT-13	MARITECH	0,000	40,000	50,000	50,000	50,000	0,000	0,000
		PT-99	DEFENSE REINVESTMENT	0,000	585,000	600,000	625,000	650,000	500,000	250,000
	63570E	DEFENSE REINVESTMENT	474,000	625,000	650,000	675,000	700,000	725,000	500,000	250,000
	63739E	MT-01	MICROELECTRONICS MANUFACTURING	0,000	0,000	0,000	14,946	29,500	70,550	73,900
		MT-02	MMC	79,881	25,183	0,000	0,000	0,000	0,000	0,000
		MT-03	INFRARED FOCAL PLANE ARRAY	41,429	44,809	38,200	19,400	0,000	0,000	0,000
		MT-04	ELECTRONIC MODULE TECHNOLOGY	117,580	130,930	136,512	112,826	151,087	200,472	222,522
		MT-05	TACTICAL DISPLAY SYSTEMS	9,382	16,210	21,161	20,169	29,735	18,500	32,500
		MT-06	MICROWAVE & ANALOG FRONT END TECHNOLOGY	0,000	24,475	54,489	55,296	54,981	55,201	68,012
		MT-07	CENTERS OF EXCELLENCE	23,837	15,000	15,000	10,000	0,000	0,000	0,000
		MT-08	MANUFACTURING TECHNOLOGY INITIATIVES	6,741	14,342	27,800	29,112	35,920	25,000	25,000
		MT-09	DUAL-USE DESIGN & MANUFACTURING TECH	0,000	25,180	39,742	41,751	34,235	20,000	23,000
		MT-10	ADVANCED LITHOGRAPHY	58,386	10,000	25,000	30,000	35,000	40,000	45,000
		MT-11	COMPUTER AIDED ACQ AND LOGISTICS SUPPORT (CALS)	43,000	40,000	20,000	15,000	15,000	0,000	0,000
	63739E	ELECTRONICS MANUFACTURING TECHNOLOGY	380,236	346,129	377,904	348,500	385,458	359,057	448,989	489,934
	63744E	SM-01	ADVANCED SIMULATION - NATIONAL GUARD	27,107	20,937	20,899	14,700	20,000	15,000	18,000
	63745E	EM-01	SEMICONDUCTOR MANUFACTURING TECHNOLOGY	89,500	90,000	90,000	70,000	50,000	0,000	0,000
	63746E	MR-01	MARITIME TECHNOLOGY	38,750	0,000	0,000	0,000	0,000	0,000	0,000

ADVANCED RESEARCH PROJECTS AGENCY
 RESEARCH, DEVELOPMENT, TEST AND EVALUATION, DEFENSEWIDE
 PROJECT LEVEL SUMMARY REPORT
 (\$ in millions)

POM 96-01

FE	PROJ	TITLE	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
63747E	EV-01	ELECTRIC VEHICLES	46.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63748E	GV-01	NATURAL GAS VEHICLES	15.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
63749E	EC-01	EARTH CONSERVANCY	10.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
65114E	BL-01	BLACKLITE	4.875	4.875	4.778	4.730	4.683	5.000	5.000	5.000
65898E	MH-01	MANAGEMENT HEADQUARTERS (R&D)	26.266	28.718	31.118	32.769	34.123	35.400	37.850	39.400
		AGENCY TOTAL	2559.035	2661.686	2747.300	2777.700	2900.800	2857.700	2932.400	3011.100
	BA-01	TOTAL	86.457	87.706	90.137	93.064	95.444	99.386	103.531	110.286
	BA-02	TOTAL	756.092	823.729	807.270	852.752	951.004	976.143	1091.216	1242.152
	BA-03	TOTAL	1685.345	1716.658	1813.997	1794.385	1815.546	1741.771	1694.803	1614.262
	BA-06	TOTAL	31.141	33.593	35.896	37.499	38.806	40.400	42.850	44.400
		AGENCY TOTAL	2559.035	2661.686	2747.300	2777.700	2900.800	2857.700	2932.400	3011.100

SECTION II

MODERNIZATION AND INVESTMENT

UNCLASSIFIED

FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Date: June 1994
 PE Title: Defense Research Sciences Budget Activity: 1. Basic Research

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>To Complete Program</u>	<u>Total Program</u>
CCS-02 Information Sciences	33,677	24,322	26,030	31,628	32,623	32,300	34,500	35,700	Continuing	Continuing
ES-01 Electronic Sciences	28,853	41,934	42,126	40,835	40,560	42,333	43,778	47,533	Continuing	Continuing
MS-01 Materials Sciences	23,927	21,450	21,981	20,601	22,261	24,753	25,253	27,053	Continuing	Continuing
TOTAL	<u>86,457</u>	<u>87,706</u>	<u>90,137</u>	<u>93,064</u>	<u>95,444</u>	<u>99,386</u>	<u>103,531</u>	<u>110,286</u>		

B. (U) BRIEF DESCRIPTION OF ELEMENT: The Defense Research Sciences program element is budgeted in the Basic Research Budget Activity because it provides the technical foundation for long-term improvements through the discovery of new phenomena and the exploration of the potential of such phenomena for military, national security and commercial applications. It supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in information, electronic and materials sciences.

(U) The Information Sciences project supports the scientific study and experimentation that is the basis for more advanced knowledge in software technology, intelligent systems technology, human-computer interaction technology, facets of microelectronic sciences, and varied aspects of high performance computing.

UNCLASSIFIED

FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

Date: June 1994

PE Title: Defense Research Sciences

Budget Activity: 1. Basic Research

(U) The Electronic Sciences project explores and demonstrates electronic and optoelectronic device, circuit, and processing concepts that will provide: (1) new technical options for future electronic and optical systems used in information transmission, gathering and processing; and (2) a substantial increase in performance and cost reduction per function.

(U) The Materials Sciences project is concerned with the development and exploitation of: biosensor for battlefield trauma care; development of high power/energy density electrochemical power sources (Batteries and fuel cells). Other areas of focus are research on the disposal of toxic chemical wastes, waste source reduction for DoD-relevant manufacturing processes and training of DoD personnel in hazardous waste management; and development of advanced algorithms and associated technologies for detecting and identifying targets hidden in foliage. In addition research is focused on novel sensors and imaging technologies for non-destructive evaluation (NDE) of materials.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: CCS-02 Date: June 1994
PE Title: Defense Research Sciences Budget Activity: 1. Basic Research

A. (U) RESOURCES: (\$ In Thousands)

Project: Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
CCS-02 Information Sciences	33,677	24,322	26,030	31,628	32,623	32,300	34,500	35,700	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in Information Sciences related to long-term national security and commercial needs.

(U) Develops advanced concepts for methods and tools to produce high assurance software, language concepts that facilitate the rapid specification and evolution of systems, and techniques to manage shared complex structured data objects in larger heterogeneous, distributed information systems. Intelligent systems technology focuses on advanced techniques for knowledge representation, reasoning, and machine learning to enable computer understanding of spoken and written language and images, to advance methods for planning, scheduling, and resource allocation. Human computer interaction technology focuses on design methods and enabling technology for more natural interaction between people and computers. Microelectronic science calibrates fundamental concepts to produce reliable, testable, and high performance design. High Performance Computing (HPC) science generates concepts and methods for validating and verifying design components, and unique approaches to rapidly develop high performance libraries across multiple HPC architectures.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Developed benchmark problems, metrics, and test data sets for advanced research in information sciences. (\$2.4M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

Project Number: CCS-02

Date: June 1994

PE Title: Defense Research Sciences

Budget Activity: 1. Basic Research

- (U) Developed advanced concepts for machine learning, automated reasoning, and knowledge representation for spoken language understanding, written language understanding, image understanding and large-scale planning, scheduling, and resource allocation methods. (\$1.7M)
- (U) Explored the utility of advanced information processing methods in spoken language understanding, written language understanding, and automated planning systems. (\$5.8M)
- (U) Developed design concepts for interactive, dialogue-based human computer interaction. (\$4.3M)
- (U) Developed process model approaches for prototyping large-scale software systems. (\$1.0M)
- (U) Developed advanced concepts for image understanding, high assurance, and software system composition. (\$5.2M)
- (U) Developed advanced concepts for heterogeneous, distributed software system architectures and tools to support construction and maintenance of software systems. (\$2.9M)
- (U) Developed design concepts of advanced components needed for highly reliable computing systems including mobile, high performance, and graphical systems. (\$6.1M)
- (U) Developed advanced concepts for high performance libraries to support multiple parallel architectures and integrated with compiler technology. (\$4.3M)

(U) FY 1995 Planned Program:

- (U) Provide internet access to benchmark problems, metrics, and test data sets and conduct experimental evaluations involving multiple intelligent systems and software technologies. (\$2.0M)
- (U) Develop initial prototype of reusable machine learning, automated reasoning, and knowledge representation methods for spoken language understanding, written language and image understanding, and large-scale planning, scheduling, and resource allocation methods. (\$1.6M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: CCS-02 Date: June 1994
PE Title: Defense Research Sciences Budget Activity: 1. Basic Research

- (U) Experimentally evaluate advanced information processing methods in spoken language understanding, written language understanding, and automated planning systems. (\$5.9M)
- (U) Develop initial tool kits for interactive, dialogue-based human computer interaction. (\$4.4M)
- (U) Develop initial language-based methods for image understanding, high assurance, and software system composition. (\$4.7M)
- (U) Develop initial prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. (\$3.8M)
- (U) Experimentally evaluate library research that supports multiple parallel architectures. (\$1.9M)

(U) FY 1996 Planned Program:

- (U) Refine and enhance benchmark problems, metrics, and test data sets and conduct experimental evaluations involving multiple intelligent systems and software technologies, utilizing knowledge acquisition. (\$3.9M)
- (U) Experimentally evaluate prototype implementations of reusable machine learning, automated reasoning, and knowledge representation methods for spoken language understanding, written language understanding, and large-scale planning, scheduling, and resource allocation methods. (\$1.6M)
- (U) Enhance advanced information processing methods in spoken language understanding, written language understanding and automated planning systems. (\$5.6M)
- (U) Experimentally evaluate tool kits for interactive, dialogue-based human computer interaction. (\$5.7M)
- (U) Experimentally evaluate language-based methods for image understanding, high assurance, and software system composition. (\$3.3M)
- (U) Refine and begin experimental evaluation of design technology to include high performance computational prototyping of systems. (\$4.6M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: CCS-02

Date: June 1994

Budget Activity: 1. Basic Research

- (U) Experimentally evaluate prototypes for heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced intelligent systems. (\$1.3M)
- (U) FY 1997 Planned Program:
 - (U) Develop initial tools and tool kits for development and evaluation of highly interactive, agent and dialogue-based human computer interactions. (\$4.5M)
 - (U) Demonstrate a multi-language architecture definition and simulation framework for software composition. (\$1.5M)
 - (U) Provide suite of tools to generate focused software, on demand, for image understanding. (\$1.6M)
 - (U) Develop new methods for integrating diverse mathematical formalism utilized in heterogeneous National Information Infrastructure (NII) applications. (\$4.5M)
 - (U) Advance the capabilities of spoken and written language understanding to solve real-world problems and provide widely usable human-computer interface functionality. (\$5.9M)
 - (U) Extend and evaluate large-scale statistical modeling, machine learning, and knowledge representation methods for spoken and written language understanding. (\$1.6M)
 - (U) Continue the experimental evaluation of design technology for high performance computational prototyping of systems. (\$6.0M)
 - (U) Experimentally evaluate and develop prototypes for the NII in the area of heterogeneous, distributed software system architectures and tools to support construction and maintenance of advanced software and intelligent systems. (\$5.0M)
 - (U) Develop hub formalization that will infuse existing programming languages with new advances in formal methods. (\$1.0M)

(U) Program to Completion: This is an ongoing research project that supports the scientific study and experimentation that is the basis for more advanced knowledge and understanding in Information Sciences related to long-term national security and commercial needs.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: CCS-02 Date: June 1994
PE Title: Defense Research Sciences Budget Activity: 1. Basic Research

- D. (U) WORK PERFORMED BY: University of Southern California, Information Sciences Institute, Marina Del Rey, CA; Stanford University, Palo Alto, CA; Massachusetts Institute of Technology, Cambridge, MA; University of California at Berkeley, CA; Carnegie Mellon University, Pittsburgh, PA; University of Massachusetts at Amherst, Amherst, MA; and Northwestern University, Evanston IL.
- E. (U) RELATED ACTIVITIES: The technologies developed in this project provide the foundation for further development in PE 0602301E, Computing Systems and Communications Technology. There is no unnecessary duplication of effort with other Department of Defense research activities.
- F. (U) OTHER APPROPRIATION FUNDS: None.
- G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: ES-01 Date: June 1994
 PE Title: Defense Research Sciences Budget Activity: L. Basic Research

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ES-01 Electronic Sciences	28,853	41,934	42,126	40,835	40,560	42,333	43,778	47,533	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project explores and demonstrates electronic and optoelectronic device, circuit, and processing concepts that will provide: (1) new technical options for future electronic and optical systems used in information transmission, gathering and processing; and (2) a substantial increase in performance and cost reduction per function. Research areas include new electronic device and circuit concepts, innovative optical arrayed interconnects and smart pixels, optical memory research, artificial neural network (ANN) research, and microelectromechanical systems (MEMS) technology. This basic research project creates the vital new concepts for advanced electronic, optoelectronic, and MEMS components to meet future DoD needs.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
- (U) Determined applicability of lattice gas computing architecture to nanoelectronics. (\$1.0M)
 - (U) Demonstrated self-assembled molecular wiring of 10 nanometer lengths. (\$.7M)
 - (U) Delivered process simulator computer program with two-dimensional capability for GaAs and silicon-based devices. (\$2.0M)
 - (U) Demonstrated fabrication of abrupt semiconductor interfaces using limited reaction processing. (\$1.0M)
 - (U) Fabricated array of <15 nm channels with <25 nm spacing using nanochannel glass. (\$.5M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E
PE Title: Defense Research Sciences

Project Number: ES-01
Budget Activity: 1. Basic Research

Date: June 1994

- (U) Completed design for compressed-size, two-dimensional edge detector using nanoelectronics. (\$1.0M)
- (U) Demonstrated fabrication steps for lateral resonant tunneling. (\$1.3M)
- (U) Explored applicability of single electron transistors to ultra-dense logic and memory. (\$1.0M)
- (U) Demonstrated nanometer scale critical dimensions of devices grown on patterned substrates. (\$.5M)
- (U) Fabricated SiGeC samples to explore use in silicon-based nanoelectronics. (\$.4M)
- (U) Demonstrated patterning using self-assembled monolayers. (\$.3M)
- (U) Demonstrated 10X reduction in ultra-low-power laser size. (\$2.0M)
- (U) Demonstrated components for chip-to-chip and on-chip optical interconnects. (\$2.9M)
- (U) Developed semiconductor laser diodes with minimum relative intensity noise (RIN) for analog modulation. (\$1.0M)
- (U) Investigated charge transport across quantum well interface for high speed photonic operation. (\$1.0M)
- (U) Investigated crystalline and quantum well nonlinear polymer devices. (\$1.0M)
- (U) Developed biologically-based neural network algorithms for early vision processing. (\$1.2M)
- (U) Developed novel neural network techniques for pattern recognition, temporal processing, and adaptive control applications. (\$1.7M)
- (U) Developed microsensor CAD/CAM and process simulation tools and initiate multi-project, common fabrication infrastructure for Microelectromechanical Systems (MEMS). (\$8.3M)

(U) FY 1995 Planned Program:

- (U) Develop voltage measurement capability suited to nanoelectronics (better than 100 nanometer spatial resolution and 50GHz temporal resolution). (\$.5M)
- (U) Demonstrate power reduction by a factor of five through the combination of nanoelectronics and conventional devices. (\$.7M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

Project Number: ES-01

Date: June 1994

PE Title: Defense Research Sciences

Budget Activity: 1. Basic Research

- (U) Explore compressed circuitry using multi-valued logic and nanoelectronics. (\$2.0M)
- (U) Demonstrate utility of nanochannel glasses in fabricating nanoelectronic structures. (\$0.5M)
- (U) Demonstrate improved process control of molecular beam epitaxy (MBE), controlling temperature to within 2 degrees and thickness to within 1 nm. (\$1.5M)
- (U) Utilize nanostructures for high resolution electron and ion-beam technology. (\$3.5M)
- (U) Determine optimum materials system for fabricating silicon-based nanoelectronics. (\$2.8M)
- (U) Demonstrate three-terminal lateral resonant tunneling transistor. (\$1.0M)
- (U) Demonstrate feasibility of magnetic memory with nanometer scale devices. (\$1.6M)
- (U) Develop chemical self-assembly techniques for electronically active materials. (\$1.5M)
- (U) Develop material for short wavelength light emitters and demonstrate green/blue light emitting diodes. (\$2.0M)
- (U) Demonstrate smart pixel arrays capable of input-output and simple logic functions. (\$3.0M)
- (U) Demonstrate optical interconnect for shared memory application. (\$3.0M)
- (U) Develop functional optoelectronic modules for free space optoelectronic processor. (\$2.8M)
- (U) Develop low-power, high-speed analog neural network hardware for accelerating early vision processing algorithms. (\$1.5M)
- (U) Establish theoretical foundations for specific neural network architectures, and develop improved architectures for pattern recognition, temporal processing, and adaptive control applications. (\$1.2M)
- (U) Develop high-yield, high-uniformity fabrication processes for microelectromechanical system (MEMS) devices and merge MEMS with related fabrication technologies in optics, optoelectronics and microwave devices. Initiate low-bandwidth, large-scale MEMS-based sensor networks. (\$7.8M)
- (U) Initiate low-power electronics technology. (\$5.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: ES-01

Date: June 1994

Budget Activity: 1. Basic Research

(U) FY 1996 Planned Program:

- (U) Demonstrate analog neural network hardware on image recognition applications. (\$1.0M)
- (U) Demonstrate materials and device designs to achieve ultra low threshold, high speed direct modulated laser. (\$1.0M)
- (U) Demonstrate high speed optoelectronic technologies for optical switching applications. (\$3.0M)
- (U) Demonstrate photonic device applications of non-semiconductor thin films doped with optically active ions. (\$2.0M)
- (U) Explore applications of multi-valued logic to special purpose processing. (\$5.0M)
- (U) Explore fundamental limits of coherent light sources for optical communication applications. (\$2.0M)
- (U) Explore material technologies for monolithically integrated optoelectronic components. (\$2.0M)
- (U) Fabricate electron-beam microcolumn. (\$1.4M)
- (U) Demonstrate functional silicon-based nanoelectronic devices. (\$3.0M)
- (U) Demonstrate submicron pattern transfer using low-cost elastopolymeric stamps. (\$2.0M)
- (U) Demonstrate compressed-area multi-valued logic adder with binary input and output. (\$1.0M)
- (U) Explore self-assembled monolayers for nanoelectronics and for protection of semiconductor wafers. (\$5.0M)
- (U) Continue development of high-density integrated electrical/mechanical systems along with requisite developments of CAD tools, materials data base, test and characterization methods, and manufacturing processes. (\$7.2M)
- (U) Develop CAD tools incorporating component and subsystem power estimation and algorithm driven, low power circuit synthesis rules. (\$6.0M)
- (U) Explore novel concepts for high performance infrared images. (\$.5M)

(U) FY 1997 Planned Program:

- (U) Optimize silicon-based nanoelectronics fabrication and device design. (\$5.5M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

Project Number: ES-01 Date: June 1994

PE Title: Defense Research Sciences

Budget Activity: 1. Basic Research

- (U) Demonstrate monolithically integrated optoelectronics for information processing. (\$3.0M)
- (U) Demonstrate precision process control of semiconductor heterostructures for advanced optical and electronic devices. (\$5.0M)
- (U) Demonstrate potential for chemical self-assembled films' use in nanoelectronics and optoelectronics. (\$6.0M)
- (U) Design combined nanoelectronic and conventional circuits for information processing. (\$4.0M)
- (U) Demonstrate all optical routing of signals through switch modules. (\$1.0M)
- (U) Demonstrate feasibility of three-dimensional optically addressed memory. (\$2.0M)
- (U) Determine the limits of high speed modulation of semiconductor lasers. (\$1.3M)
- (U) Select for fabrication promising high performance infrared imagers. (\$2.0M)
- (U) Explore concepts for ultra high density memory. (\$5.0M)
- (U) Develop and demonstrate efficient low-voltage conversion/distribution circuits and self-regulating, use-driven power allocation systems. (\$6.0M)

(U) Program to Completion:

- (U) Demonstrate the feasibility of three dimensional optical computing.
- (U) Identify the physical limitations on size and threshold current density of semiconductor lasers.
- (U) Identify the optimum materials and device structures for optical switching.
- (U) Demonstrate utility and potential for cost effectiveness of chemical self-assembly for nanoelectronic and optoelectronic fabrication.
- (U) Assess applicability of combined nanoelectronic and conventional circuits for information processing and memory.
- (U) Demonstration of selected mixed signal (radio frequency, analog and digital) electronics for low power applications with more than two orders of magnitude reduced power consumption over present system.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: ES-01

Budget Activity: 1. Basic Research

Date: June 1994

D. (U) WORK PERFORMED BY: California Institute of Technology, Pasadena, CA; Stanford University, Palo Alto, CA; Analog Devices, Cambridge, MA; University of Michigan, Lansing, MI; University of California at Santa Barbara, CA; Honeywell, Minneapolis, MN; Texas Instruments, Dallas, TX; Massachusetts Institute of Technology, Cambridge, MA; and Cornell University, Ithaca, NY.

E. (U) RELATED ACTIVITIES: Efforts in this project are coupled to the Services' program through use of Service agents, annual DoD-wide program reviews, and review by the Advisory Group on Electron Devices (AGED). These activities assure that no unnecessary duplication of effort occurs. This project provides a research base for program element 0602712E, project MPT-02, Electronics Processing Technology.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: MS-01 Date: June 1994
 PE Title: Defense Research Sciences Budget Activity: L. Basic Research

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
MS-01 Materials Sciences	23,927	21,450	21,981	20,601	22,621	24,753	25,253	27,053	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project is concerned with the development and exploitation of: biosensors for battlefield trauma care; development of high power/energy density electrochemical power sources (batteries and fuel cells). Other areas of focus are research on the disposal of toxic chemical wastes, waste source reduction for DoD-relevant manufacturing processes and training of DoD personnel in hazardous waste management; and development of advanced algorithms and associated technologies for detecting and identifying targets hidden in foliage. In addition research is focused on novel sensors and imaging technologies for non-destructive evaluation (NDE) of materials.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
- (U) Electrochemistry (\$15.5M). Develop high energy density/power density electrochemical power sources for a variety of military applications. Utilized supercritical water oxidation to destroy DoD toxic wastes.
 - (U) Demonstrated high efficiency direct oxidation fuel cell power module.
 - (U) Demonstrated prototype rechargeable solid state military battery. Delivered 20 prototypes for evaluation.
 - (U) Constructed supercritical water oxidation (SCWO) processor for destruction of toxic wastes. Demonstrated both live, agent, agent stimulant and propellant destruction using SCWO technology.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: MS-01

Date: June 1994

Budget Activity: 1. Basic Research

- (U) Initiated a hazardous substance research centers program to train DoD and DOE personnel in hazardous waste management and other related specialties.
- (U) Initiated a program to develop a logistic fuel cell for mobile electric power. Evaluated fuel reformer catalysts and processor components.
- (U) Biotechnology (\$5.1M). Utilized biological technologies to enhance various aspects of military medicine.
- (U) Initiated a program in medical technology concerned with developing medical sensors and the use of advanced information technologies to enhance battlefield trauma care.
- (U) Demonstrated binding affinity, reagent stability, and cellular uptake of oligonucleotide reagents for infections.
- (U) Biomedical (\$2.0M).
- (U) Developed anatomy simulation in virtual environments for training of military surgeons in surgical procedures for battlefield casualties.
- (U) Optical materials (\$1.4M). Developed aluminum-free laser diode arrays.
- (U) Demonstrated multiple page fully digital holographic data storage system.

(U) FY 1995 Planned Program:

- (U) Electrochemistry (\$10.9M). Concentrates on use of logistic fuels (hydro-carbon based) in advanced energy sources (fuel cells).
- (U) Evaluate novel logistics fuel catalysts, electrolytes and electrodes.
- (U) Develop logistic fuel cell components and demonstrate near ambient temperature operation.
- (U) Construct a pilot plant, supercritical water oxidation reactor (1 gal./min.) and begin testing for the destruction of chemical warfare agents, propellants and other DoD hazardous wastes.
- (U) Biomedical (\$10.6M).
- (U) Further modular development on the personnel status monitor (PSM) to produce secondary sensors of non-invasive blood chemistries; initial miniaturization of power supply and electronic packaging; involves field testing and evaluation. Development of field medical communication

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: MS-01 Date: June 1994
PE Title: Defense Research Sciences Budget Activity: 1. Basic Research

network of cellular and regional control units; integration of small antenna design; asynchronous transfers mode protocol and electronic firmware and software development. MS-01 represents component and modular additions to the Personnel Status Monitor (PSM) in development in PE 0602712E, project MPT-07.

- (U) Develop advanced monitoring for the critical care pod and horizontally integrate with telecommunications throughout the battlefield over wireless networking.
- (U) Develop miniaturized direct digital imaging technologies; begin electronic miniaturization and packaging.
- (U) Develop battlefield surgical simulation for injuries to the torso, including complex physiologic representation.
- (U) Continue development of virtual environment for the individual soldier in order to test and evaluate the efforts of training, equipment, etc. on the health of the soldier.
- (U) Develop and incorporate advanced manipulation and sensory feedback into a telepresence surgery system; explore methods for diminishing latency in tele-manipulation; field testing and evaluation.

(U) FY 1996 Planned Program:

- (U) Electrochemistry (\$15.0M).
 - (U) Develop a high efficiency fuel reformer to process logistics fuel for fuel cell applications.
 - (U) Demonstrate fuel cell operation on methanol with performance adequate for electric vehicle and soldier applications.
 - (U) Novel direct oxidation logistics fuel cell tested.
- (U) Biomedical (\$2.0M).
 - (U) Develop miniaturized power supply source for the PSM by the continued research involving conformal design, and rechargeable polymer power sources.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E Project Number: MS-01 Date: June 1994
PE Title: Defense Research Sciences Budget Activity: 1. Basic Research

- (U) Develop pharmacologic mixture to support capability of a suspended animation, hibernant for vital organs following battlefield trauma.
- (U) Non-Destructive Evaluation (NDE) (\$5.0M)
- (U) Initiate program on novel sensors and imaging technologies for NDE and health monitoring of materials and structures.

(U) FY 1997 Planned Program:

- (U) Electrochemistry (\$11.6M)
 - (U) Develop integrated fuel cell stack and reformer operating on logistics fuel.
 - (U) Demonstrate direct, liquid feed methanol fuel cell stack operation with performance adequate for electric vehicles and soldiers.
 - (U) Demonstrate high performance hydrogen/air fuel cell with a power density of 1 kw/kg.
- (U) Biomedical (\$2.0M)
 - (U) Develop knowledge based control algorithms for the Personnel Status Monitor (PSM).
 - (U) Develop "smart"-catheters for blood chemistry assessments.
- (U) Non-Destructive Evaluation (NDE) (\$7.0M)
 - (U) Design and fabricate critical components for NDE and health monitoring of materials and structures.

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: Massachusetts Institute of Technology, Cambridge, MA; California Institute of Technology, Pasadena, CA; GA Technologies, La Jolla, CA; International Fuel Cells, South Windsor, CT; Northwestern University, Evanston, IL; Georgetown University, Washington, DC; Sarcos Corporation, Salt Lake City, UT; Sandia Laboratory, Albuquerque, NM; and General Electric Medical R & D Center, Schenectady, NY.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0601101E

PE Title: Defense Research Sciences

Project Number: MS-01

Budget Activity: 1. Basic Research

Date: June 1994

E. (U) RELATED ACTIVITIES: ARPA's research in Materials Sciences, Electrochemistry, Biotechnology and Biomedicine is coordinated within the DoD and with other federal agencies via Office of Science and Technology Policy (OSTP), and various Director Defense Research and Engineering (DDR&E)-sponsored topical workshops on advanced materials, electrochemistry and biotechnology and biomedicine. These activities assure that no unnecessary duplication of effort occurs.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E Date: June 1994
 PE Title: Computing Systems and Budget Activity: 2. Exploratory Development
Communications Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete Program	Total
ST-01	JASON 1,240	1,227	1,218	1,203	1,190	1,200	1,200	1,200	Continuing	Continuing
ST-11	Intelligent Systems & Software 68,193	93,656	102,727	106,284	134,994	135,907	138,407	158,407	Continuing	Continuing
ST-19	High Performance Computing (HPC) 192,157	243,700	233,075	253,800	265,260	266,462	289,034	303,484	Continuing	Continuing
ST-22	Software Engineering Technology 37,550	40,223	19,562	19,205	18,678	20,250	23,250	25,136	Continuing	Continuing
ST-23	Counterproliferation Technology 22,276	40,802	46,217	50,738	58,402	59,112	64,112	65,112	Continuing	Continuing
TOTAL	321,416	419,608	402,799	431,230	478,524	482,931	516,003	553,339		

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element is budgeted in the Exploratory Development Budget Activity because it funds projects directed toward the application of advanced, innovative computing systems and communications technologies. These programs include:

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and Communications Technology

Date: June 1994

Budget Activity: 2. Exploratory Development

(U) ARPA leadership of the Federal High Performance Computing and Communications Initiative to develop technologies to allow computer systems to function at a trillion operations per second and a billion bits per second networking to ensure availability for future defense needs. This technology will be incorporated into advanced applications to solve critical defense problems such as distributed C³ systems.

(U) The efforts funded in the Intelligent Systems and Software project focus on the development of new information processing technology concepts that lead to fundamentally new software and intelligent system capabilities. Emphases are in autonomous systems, interactive problem solving, source integration, software development, and manufacturing automation and design engineering.

(U) Software Engineering Institute (SEI) and Software Technology for Adaptable, Reliable Systems (STARS). SEI works to transition, introduce and promulgate modern software in the defense industry. The STARS program develops large-scale software products that have commercial as well as military capabilities.

(U) The Counterproliferation Technology project addresses a national effort for a Comprehensive Test Ban (CTB) Verification Readiness Program to enhance U.S. surveillance capabilities for monitoring worldwide nuclear explosions and a focused program to develop technologies for detecting the production, testing and storage of nuclear materials and weapons.

(U) The JASON studies support the national security community.

(U) The programs contained in Projects ST-11, ST-19 and ST-22 reflect the Department's initiative to support dual-use technologies.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E Project Number: ST-01 Date: June 1994
PE Title: Computing Systems and Budget Activity: 2. Exploratory Development
Communications Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
ST-01 JASON	1,240	1,227	1,218	1,203	1,190	1,200	1,200	1,200	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project supports the JASONS, an independent group of distinguished scientists and technical researchers that provides analysis of critical National Security issues. JASON membership is carefully balanced to provide a wide spectrum of scientific expertise and technical analysis in theoretical and experimental physics, materials, information sciences, and other allied disciplines. The JASON process ensures senior government leaders have available the full range of U.S. academic expertise on issues critical to National Security involving all classified and unclassified information.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Conducted extensive technical investigations in areas such as: advanced sensors for surveillance and strike; shallow water acoustic Anti-Submarine Warfare (ASW); advanced concepts for lightweight survivable combat vehicles; advanced materials; and signal processing.
 - (U) Specific conclusions on counterproliferation, radar technology and automated target recognition had provided the foundation for the definition of research objectives and programs in these areas.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-01 Date: June 1994

PE Title: Computing Systems and
Communications Technology

Budget Activity: 2. Exploratory Development

- (U) FY 1995 Planned Program:
 - (U) Continue investigations involving: structural acoustics; advanced land combat vehicles; precision strike; ASW; nuclear weapon proliferation; counterproliferation; joint U.S.-Russian space exploration and global surveillance and communications.
- (U) FY 1996 Planned Program:
 - (U) Continue studies in: nuclear and chemical weapons proliferation, precision strike weapons, global surveillance and communications; counter drug surveillance techniques; shallow water ASW; and advanced signal processing.
- (U) FY 1997 Planned Program:
 - (U) Continue studies in: counterproliferation of nuclear, chemical and biological weapons, precision deep strike weapons, counter drug and law enforcement surveillance techniques; third world shallow water ASW; advanced sensor technologies; global surveillance and intelligence.
- (U) Program to Completion: This is a continuing project.
- D. (U) WORK PERFORMED BY: MITRE Corporation, McLean, VA supports the JASON group.
- E. (U) RELATED ACTIVITIES: Not applicable.
- F. (U) OTHER APPROPRIATION FUNDS: None.
- G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E Project Number: ST-11 Date: June 1994
 PE Title: Computing Systems and Communications Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
ST-11 Intelligent Systems and Software	68,193	93,656	102,727	106,284	134,994	135,907	138,407	158,407	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: Develop new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information systems (involving both humans and computers) to more effectively accomplish decision-making tasks in stressful, time sensitive situations and create efficient software systems supporting computer and software intensive defense systems. Major areas of technical emphasis are in: (a) intelligent systems (artificial intelligence) including autonomous systems, image understanding, interactive problem solving and intelligent integration of information from heterogeneous sources; (b) software development technology including languages, algorithms, data and object bases, domain specific software architectures, software prototype technology, software design tools, software reuse, and advanced software engineering environments; and (c) manufacturing automation and design engineering, including the development of advanced software systems which support sharing of engineering knowledge, advanced product and process design representations, integrated product and process design, software tools for design process management, manufacturing process planning, manufacturing process control and demonstrations.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Developed test case scenarios and internet accessible software testbeds that typify the type of advanced information processing requirements in DoD systems such as autonomous systems, command and control, and manufacturing systems. (\$9.4M)

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- (U) Experimentally evaluated the integration of multiple intelligent systems and software technologies in an autonomous vehicle. (\$.9M)
 - (U) Released the beta version of the Image Understanding Environment (IUE) and developed advanced methods for vision guided navigation, photo-intelligence cartographic modelling, and target detection and identification. (\$15.6M)
 - (U) Developed initial capabilities for human-aided machine translation, document understanding, and robust speech understanding in adverse acoustic conditions. (\$12.1M)
 - (U) Developed advanced real-time planning and control algorithms. (\$3.8M)
 - (U) Developed knowledge-based decision aids to support the rapid construction of crisis action plans. (\$3.8M)
 - (U) Developed advanced methods for information fusion, aggregation, summarization, and explanation. (\$3.7M)
 - (U) Developed initial language-based methods for describing domain-specific software architecture and tools that facilitated composing a software system based on a domain specific architecture. (\$6.7M)
 - (U) Developed initial advanced software environment that supports tools for composing softwares, integration, and software development and testing using animation techniques. (\$3.1M)
 - (U) Developed fundamental evaluation and design concepts to support highly distributed, wide bandwidth information processing applications that require persistent objects. (\$3.4M)
 - (U) Enhanced agent-based architectures for sharing design knowledge, manufacturing process planning, and manufacturing control. (\$3.2M)
 - (U) Integrated persistent object base, case-based reasoning and physics-based simulation models in an integrated product/process design (IPPD) testbed. (\$2.5M)
- (U) FY 1995 Planned Program:
- (U) Experimentally evaluate the integration of multiple advanced intelligent systems and software technologies in multiple autonomous vehicles. (\$5.6M)

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Budget Activity: 2. Exploratory Development

- (U) Upgrade the Image Understanding Environment (IUE) based on FY 1994 evaluations and develop prototype implementations of advanced methods for vision guided navigation, cartographic modelling, photo-intelligence target detection and identification. (\$12.0M)
- (U) Develop initial prototype implementations for human-aided machine translation, document understanding, and robust speech understanding in adverse acoustic conditions. (\$13.0M)
- (U) Develop initial prototype implementations of advanced real-time planning and control algorithms. (\$4.0M)
- (U) Enhance knowledge based decision aids to support the rapid construction of multiple crisis action plans. (\$10.6M)
- (U) Develop concepts and implement prototype of scalable machine intelligent algorithms for autonomous associate and assistant intelligent systems. (\$1.0M)
- (U) Design and prototype a domain specific software architecture for a weapons system crew station associate system. (\$1.0M)
- (U) Develop initial prototype implementations of advanced methods for information fusion, aggregation, summarization, and explanation. (\$5.0M)
- (U) Experimentally evaluate language-based methods for describing domain specific software architecture and tools that facilitate composing a software system based on a domain specific architecture. (\$5.9M)
- (U) Experimentally evaluate advanced software environment that supports composition tools for composing softwares, integration, and software development and testing using animation techniques. (\$4.0M)
- (U) Develop prototype to support highly distributed, wide bandwidth information processing applications that require persistent objects. (\$5.2M)
- (U) Enhance the IPPD testbed to include intelligent product and process representations and a scalable framework to invoke and attach design tools for electro-mechanical systems. (\$3.0M)
- (U) Develop information infrastructure services for manufacturing, including network access to engineering analysis and rapid prototyping services. (\$6.0M)

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- (U) Experimentally evaluate agent-based architectures for sharing design knowledge, manufacturing process planning, and manufacturing control. (\$7.4M)
 - (U) Initiate study measuring the impact of technology aids on teacher, staff, and student performance. Evaluate technology in selected teaching clusters and use model school districts (such as Val Verde & Port Hueneme) to transfer high technology concepts of use to other clusters. (\$4.0M)
 - (U) Initiate development of a modular testbed for human computer interaction technology insertion for testing, evaluating and demonstrating. (\$6.0M)
- (U) FY 1996 Planned Program:
- (U) Enhance (and use in wide spread community experiments) test case scenarios and internet accessible software testbeds that typify the type of advanced information processing requirements in DoD systems such as autonomous systems, command and control, and manufacturing systems. (\$8.0M)
 - (U) Enhance advanced methods for vision guided navigation, cartographic modelling, and target detection and identification, and facilitate transition and adoption of the resulting technology. (\$3.0M)
 - (U) Experimentally evaluate implementations for human-aided machine translation, document understanding, and robust speech understanding in adverse acoustic conditions. (\$7.0M)
 - (U) Experimentally evaluate implementations of advanced real-time planning and control algorithms. (\$3.0M)
 - (U) Evaluate knowledge-based decision aids to support the rapid construction of multiple crisis action plans in an operational exercise. (\$7.8M)
 - (U) Experimentally evaluate advanced methods for information fusion, aggregation, summarization, and explanation. (\$5.0M)
 - (U) Experimentally evaluate scalable machine intelligent methods for machine learning, automated reasoning and real time problem solving. (\$10.0M)
 - (U) Experimentally evaluate weapons system crew associate systems. (\$10.0M)

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- (U) Evaluate use of autonomous vehicles in operational field exercises (with scout platoons at Ft. Hood) and determine what additional research and development is required to deploy advanced development prototypes. (\$2.5M)
- (U) Enhance advanced software environment that supports composition tool integration and software development and testing using animation techniques and facilitate transition. (\$5.0M)
- (U) Experimentally evaluate prototype implementations to support highly distributed, wide bandwidth information processing applications that require persistent objects. (\$5.0M)
- (U) Enhance agent-based architectures to include machine learning techniques and advanced information processing methods to facilitate sharing design knowledge, manufacturing process planning, and manufacturing control. (\$5.0M)
- (U) Demonstrate feasibility of authoring tools in creating domain specific multimedia curriculum in key DoD applications, and virtual labs and learning by simulation approaches in key DoD applications. Architecture will include intelligent layering to integrate and manage education tools in several pilot clusters. Measure student performance with and without technology aids in several key DoD applications. (\$1.5M)
- (U) Experimentally evaluate the use of advanced design spreadsheets and integrated tool sets to optimize product and process designs for Advanced Technology Demonstration (ATD) applications. (\$4.0M)
- (U) Expand network design and manufacturing services to include factory simulation and reusable product/process design libraries. (\$8.0M)
- (U) Demonstrate agent-based interconnection of multiple heterogeneous ATD design environments for cooperative use of tools and data. (\$8.0M)
- (U) Continue the human computer interaction heterogeneous testbed development and insertion. Test, evaluate and demonstrate enhancements to the user community. (\$10.0M)

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(U) FY 1997 Planned Program:

- (U) Continue development of human-computer interaction, heterogeneous testbed products and insertion. Test, evaluate and demonstrate enhancements to the developer and user communities. (\$12.0M)
- (U) Experimentally evaluate Real Time Planning and Control algorithms for multi-agent systems. (\$2.0M)
- (U) Evaluate distributed design tools and demonstrate multi-agent manufacturing process planning and manufacturing control. (\$21.4M)
- (U) Explore active vision/task-oriented vision -- directing Image Understanding (IU) based on task at hand, with application to autonomous vehicles, ATR. (\$3.0M)
- (U) Evaluate qualitative vision: analysis of image content without accurate photogrammetry for use in unmanned ground vehicle. (\$2.0M)
- (U) Investigate the use of context, collateral text, and other knowledge to direct IU for intelligence applications. (\$3.0M)
- (U) Develop education and training technologies sufficiently to produce three key demonstrations: (1) graphical collaborative software; (2) 3D animated storyboarding; and 3) rapid development tools and environment for creating educational intelligent mentors, monitors, and tutors. (\$5.0M)
- (U) Develop modular Human Language Technologies to support easy, low-cost, rapid technology transfer and application development for Document Understanding, Machine Translation, and Speech Understanding. (\$13.0M)
- (U) Demonstrate and evaluate reuse technology in operational test beds. (\$3.0M)
- (U) Develop, in the Intelligent Integration of Information area, formal languages to express, manipulate and assemble the primitives which are viable and implementable. (\$5.0M)
- (U) Transition planning and decision aids tools to appropriate ATDs - test and evaluate. (\$5.0M)
- (U) Develop collaborative design technologies, systems and applications for distributed (remote) teams. (\$7.0M)

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- (U) Pursue software engineering of real-time systems that would lead to a significant reduction in development costs. (\$5.0M)
- (U) Demonstrate and evaluate modular software in critical DoD and commercial applications. (\$5.0M)
- (U) Develop, collaboratively, core technologies (computer science and electronic communications) to dramatically enhance the productivity of the DoD and commercial research communities. (\$5.0M)
- (U) Demonstrate the potential of combining inductive (pattern matching) with deductive (rule-based) reasoning to support the generation of plans, designs, and systems. (\$5.0M)
- (U) Continue research at the Software Institute, Johnstown, PA. (\$4.9M)

(U) Program to Completion: This is an ongoing effort that will provide for the development of new information processing technology concepts that lead to fundamentally new software and intelligent systems capabilities. This will enable advanced information and intelligent systems (involving both humans and computers) to more effectively accomplish decision making tasks in stressful, time sensitive situations and create efficient software systems supporting computer and software-intensive defense and commercial systems.

D. (U) WORK PERFORMED BY: Stanford University, Palo Alto, CA; University of Southern California, Information Sciences Institute, Marina Del Ray, CA; Carnegie Mellon University, Pittsburgh, PA; Harvard University, Cambridge, MA; University of Massachusetts, Amherst, MA; Computational Logic, Inc., Austin, TX; University of California at Berkeley, CA; VCOE, Fairfax, VA; Teleos Corporation, Palo Alto, CA; ISX Corporation, Woodland Hills, CA; General Electric, Schenectady, NY; Martin Marietta, Denver, CO; IBM, Oswego, NY; GTE, Chantilly, VA; Honeywell, Minneapolis, MN; and Rice University, Houston, TX.

E. (U) RELATED ACTIVITIES: Builds upon the new high performance computing technologies being produced under project ST-19 in this program element.

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F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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Program Element: #0602301E
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A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total Program	
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate		
ST-19																		Continuing
	High Performance Computing																	Continuing
		192,157	243,700	233,075	253,800	265,260	266,462	289,034	303,484									

B. (U) BRIEF DESCRIPTION OF PROJECT: This project develops the computing, networking, and associated software technology base underlying the solutions to computational and information-intensive applications for future Defense and Federal needs. These technologies lead to successive generations of higher performance and more cost-effective systems scalable to a trillion operations per second (teraops) systems and billion bits per second (gigabits) networking, associated software technologies, advanced information infrastructure technology and prototype experimental applications leading to national-scale efforts across the Federal government. Results will be used in other ARPA and Defense programs for experimental application to critical defense problems.

(U) High Performance Computing (HPC) develops software and hardware technologies leading to a scalable computing and communications technology base for systems configured over a wide performance range, from mobile handheld devices to desktop workstations to the largest-scale, highest performance systems, including embedded versions of these systems. The Scalable Computing Systems component develops, demonstrates, and evaluates for early experimental use a variety of advanced scalable parallel systems at the frontier of computing, including embeddable HPC technologies for migrating commercial HPC systems into military embedded applications. The Microsystems component develops design tools, environments, and infrastructure to support the research and development of advanced scalable parallel computing components and systems for large-scale computing systems, embedded computing systems, and wireless computing systems. Microsystems also supports innovative system prototyping techniques in hardware and software as

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well as early small-scale architecture experiments leveraging scalable computing technology, micro-architectures, low-energy components and processes, optimization techniques, and advanced packaging technology. The compilers, tools, and environments to enable the effective use of the new high performance computing technologies. The Information Infrastructure Software and Services component develops underlying technologies to support large, complex and distributed applications; such as privacy and trust mechanisms, remote resource sharing and information security. The Information Infrastructure Application Demonstrations component develops early prototype experiments of important large-scale, distributed applications in conjunction with various Defense and Federal programs. The Networking component develops high performance networking technologies and associated capabilities. The Defense Technology Integration and Infrastructure component applies the new computing technologies to solve specific defense problems in innovative ways.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- Scalable Computing Systems. (\$48.8M)
- (U) Developed foundations for petaoperations (10^{15}) per second and terabits (10^{12}) systems.
- (U) Demonstrated first multicomputer system containing multiprocessor nodes.
- (U) Demonstrated software and hardware compatibility between scalable commercial HPC systems and embeddable versions.
- (U) Demonstrated scalable mass storage systems and associated system services and input/output channels.
- (U) Developed 10 gigaflops/cu.ft. militarized, embeddable scalable computing system.

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- Microsystems. (\$35.0M)
 - (U) Developed and demonstrated semiconductor virtual process design coupled to actual fabrication line for real-time process control.
 - (U) Enhanced and demonstrated direct support of rapid prototyping of MCM technology.
 - (U) Fabricated operational submicron diameter vertical Field Effect Transistor (FET) for ultra high density read-only memory.
 - (U) Demonstrated 200 Mhz superpipelined processor as part of continuing architectural exploration of high performance system.
 - (U) Developed and demonstrated tools and environments to support the design of low power and wireless computing systems.
 - (U) Demonstrated enhanced fabrication services integrated with library management tools and extended system synthesis capabilities.
- Scalable Software. (\$27.3M)
 - (U) Demonstrated scalable libraries for defense-critical problems, such as computational physics and image processing.
 - (U) Developed and distributed HPC software, documentation, performance measurements, and prototype applications using a wide area file system.
 - (U) Demonstrated distributed ADA on scalable HPC systems.
 - (U) Prototyped HPC programming environments for standard languages like C++ and Fortran, while developing new languages like dataflow, advanced functional languages, and advanced object-oriented languages.
- Information Infrastructure Software and Services. (\$10.1M)
 - (U) Extended Privacy Enhanced Mail (PEM) to include abilities for multimedia attachments, multiple encryption methods, and alternative digital signature algorithms.
 - (U) Developed prototype suite of advanced data storage and access tools, such as distributed and replicated file systems supporting intermittent communications, trusted and secure operations, more sophisticated access semantics, and multilevel storage management.

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PE Title: Computing Systems and Communications Technology

Budget Activity: 2. Exploratory Development

- Information Infrastructure Applications Demonstrations. (\$3.8M)
 - (U) Demonstrated initial national-level digital library for exchange of technical reports between five major universities, ARPA, and the Library of Congress.
 - (U) Initiated, in conjunction with NSF and NASA, a broader initiative to expand digital library technology in the areas of information indexing, remote access, and storage management.
- Networking. (\$40.2M)
 - (U) Demonstrated C3 systems technology with scalable high performance network technology enabling full multimedia real-time information exchange using early gigabit networks.
 - (U) Demonstrated prototypes of gigabit SONET/ATM technology operating over fiber and satellite media.
 - (U) Conducted demonstration of all-optical Local Area Networks (LANs).
 - (U) Demonstrated medical, terrain visualization, and modeling applications on 100 Mbit and Gbit-class networks.
- Defense Applications and Infrastructure. (\$27.0M)
 - (U) Developed initial prototype of C3 and weapons systems using embeddable high performance technologies for Navy application.
 - (U) Developed initial experimental capabilities employing advanced high performance computing technologies for Defense users.
 - (U) Demonstrated networked technologies and capabilities for education, training, and human resource development pilot projects.

(U) FY 1995 Planned Program:

- Scalable Computing Systems. (\$60.3M)
 - (U) Demonstrate teraops-class modules covering major models of scalable computing, spanning shared and distributed memory models and fine and coarse grain parallelism, that have the potential for being the foundation for next-generation and cost-effective units in computing systems.
 - (U) Demonstrate 10 gigaflop/cu.ft. militarized HPC system.

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Communications Technology

- (U) First release of distributed real-time operating system for embeddable HPC.
- Microsystems. (\$44.7M)
 - (U) Extend network-accessible design and fabrication services to include computational prototyping concepts.
 - (U) Develop early module-level synthesis capabilities.
 - (U) Demonstrate wireless computing design environments through the design of early prototype, high bandwidth, pico cellular, and wireless access points to the wireline infrastructure.
 - (U) Design components supporting more flexible cache-to-cache and cache-to-memory interactions.
 - (U) Continue development and standardization of process representations.
 - (U) Demonstrate higher levels of process optimization to include low energy.
 - (U) Initial demonstrations of micro-architectures for advanced packaging and scalable units of replication.
- Scalable Software. (\$29.7M)
 - (U) Demonstrate real-time operating system support tools for scalable, distributed HPC systems.
 - (U) Demonstrate software development environments for distributed heterogeneous systems on workstation-based tenth-scale teraops systems.
 - (U) Experimentally characterize input/output requirements for large- and small-scale computing systems on scalable parallel systems.
 - (U) Demonstrate prototype integrated HPC programming environment for Fortran and C++; demonstrate that significant user applications can be transparently run on several distinct scalable computer architectures without change.
 - (U) Develop portable, real-time fault tolerant operating system software which is compatible with embeddable and commercial scalable HPC systems.
- Information Infrastructure Software and Services. (\$27.1M)
 - (U) Develop unified underlying storage mechanisms for network service directories, distributed file systems, and object-oriented database systems. Demonstrate

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- (U) their ability to support the input/output performance and storage capacity needs of advanced, distributed applications.
- (U) Prototype a common authentication, authorization, accounting, and usage metering service infrastructure based on digital signatures, public key cryptosystems, and privacy enhanced mail.
- (U) Prototype generalized software applications approaches for discovering and interacting with services in a complex internetworked environment.
- (U) Develop generalized applications building blocks and mechanisms to support application function partitioning and migration among multiple computer nodes of the internet worked environment.
- Information Infrastructure Applications Demonstrations. (\$6.7M)
 - (U) Select and experimentally characterize focused National Challenge applications testbeds leveraged on high performance network testbeds and major information technologies in high performance computing.
 - (U) Prototype technologies for distributed digital libraries, incorporating techniques for scalable storage management and data repositories, persistent object bases, and multimedia objects.
 - (U) Proof of concept prototype of copyright management system, based on Privacy Enhanced Mail (PEM), which demonstrates fully-electronic copyright registration, recordation, rights transfer and management.
- Networking. (\$43.2M)
 - (U) Deploy small-scale, nationwide gigabit research infrastructure in support of high performance computing applications.
 - (U) Demonstrate cross-country gigabit networking technologies.
 - (U) Demonstrate more advanced internet capabilities including more diverse bitways, such as cable and wireless links, with embedded intelligence to improve ease of use.
 - (U) Demonstrate techniques for rate-adaptive quality of service negotiation in asymmetric networks.

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- (U) Demonstrate bandwidth and service reservation guarantees for networks in support of real-time and critical services.
- (U) Demonstrate network infrastructure protocols that improve security, beginning with routing protocols as a means of providing a reliable infrastructure.
- Defense Applications and Infrastructure. (\$32.0M)
 - (U) Develop initial prototype of advanced C3 and weapons systems using advanced embeddable and high performance computing technologies.
 - (U) Demonstrate integrated experimental capabilities employing advanced HPC technologies for Defense users.
 - (U) Prototype networked and high performance computing capabilities for education, training, and human resource development projects.

(U) FY 1996 Planned Program:

- Scalable Computing Systems. (\$57.4M)
 - (U) Demonstrate foundations for next-generation distributed systems with small-scale teraops class systems and individual gigaops processors.
 - (U) Demonstrate embedded computing capable of 50 billion operations per second per ft³ and scalable to systems capable of several hundred billion operations per second.
 - (U) Demonstrate first embeddable fine-grained HPC System.
 - (U) Prototype embedded computing system modules with scalability concepts containing memory hierarchy and power on a single unit of replication.
 - (U) System-level demonstration of more flexible memory controller building blocks. Microsystems. (\$42.1M)
 - (U) Demonstrate initial network-based computational prototyping services.
 - (U) Demonstrate integrated module-level synthesis capability.
 - (U) Demonstrate design environments supporting simulation and synthesis of wireless systems spanning from integrated circuits to network applications.
 - (U) Demonstration of fault tolerant and reliability design tools for large-scale HPC systems.

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Budget Activity: 2. Exploratory Development

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- Scalable Software. (\$25.3M)
 - (U) Demonstrate integrated HPC programming environment for Fortran and C++.
 - (U) Develop second-generation of scalable, portable libraries.
 - (U) Laboratory-scale demonstration of seamless integration of real-time, replication, and limited fault tolerance in OS via modular capabilities for range of computing applications from desktop to largest scalable heterogeneous systems.
 - (U) Demonstrate integrated compiler and operating systems services supporting multiple resources.
- Information Infrastructure Software and Services. (\$27.0M)
 - (U) Demonstrate toolkits to prototype adaptive application development.
 - (U) Develop file and operating system services supporting wide area collaborative work.
 - (U) Develop and demonstrate new service extensions based on previously developed service architectures and standards.
- Information Infrastructure Applications Demonstrations. (\$10.9M)
 - (U) Demonstrate first-generation experiments based on selected modest-scale National Challenge application testbeds.
 - (U) Develop a prototype market for information and services as a "proof of concept" testbed for advanced electronic commerce and digital libraries, including experimental recharge mechanisms.
 - (U) Develop universal, widely available, multimedia, privacy-enhanced electronic mail to drive the development of the underlying service layers.
 - (U) Deploy electronic copyright management system to Library of Congress.
- Networking. (\$41.4M)
 - (U) Prototype networks at 10-100 Gbit speed using optical technologies and verify scalable network protocols.
 - (U) Demonstrate national/international scale extensions of existing high performance network architecture.

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- (U) Develop a scalable, heterogeneous computing prototype based on proxy and distributed network computing services as a first step towards distributed metacomputing.
- (U) Demonstrate secured nomadic computing architecture.
- (U) Deploy protocol-independent multicast network-level infrastructure as basis for development of advanced services.
- (U) Demonstrate robust network-level infrastructure protocols to include directory services and resource allocation.
- Defense Applications and Infrastructure. (\$29.0M)
 - (U) Demonstrate advanced Defense-specific functionality by incorporating real-time voice, video, and simultaneous processing of information intensive computing.
 - (U) Provide experimental testbed services employing advanced high performance computing technologies for Defense users.
- (U) FY 1997 Planned Program:
 - Scalable Computing Systems. (\$53.2M)
 - (U) Demonstrate prototype systems capable of scaling to 0.5 teraflops.
 - (U) Demonstrate scalable embeddable HPC based on heterogeneous nodes.
 - (U) Demonstrate enhanced feature, real-time distributed operating systems for embeddable HPC.
 - (U) Demonstrate single machine image across physically distributed individual nodes.
 - Microsystems. (\$45.1M)
 - (U) Demonstration of network-enabled services for system design and implementation, coupling computational prototyping with remote experimentation capabilities.
 - (U) Demonstrate microprocessor architectures augmented with multiprocessing features.
 - (U) Demonstrate high performance computing backbone components for local area networking.
 - (U) Develop innovative design technologies for complex systems.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E

Project Number: ST-19 Date: June 1994

PE Title: Computing Systems and
Communications Technology

Budget Activity: 2. Exploratory Development

- Scalable Software. (\$29.5M)
 - (U) Demonstrate advanced programming languages (i.e., functional programming) as a viable environment for developing operating systems and other system software.
 - (U) Demonstrate optimizing compilers with 5-to-10 times code improvement through partial compilation and late optimization during program execution.
 - (U) Demonstrate advanced object management systems to support operating systems and applications achieving efficient use of memory while enhancing execution speed.
- Information Infrastructure Software and Services. (\$31.0M)
 - (U) Demonstrate advanced resource registration and discovery services available to applications, providing a common programming and user interface across diverse servers and protocols.
 - (U) Demonstrate rapid adaptation to new service providers, such as publishers and repositories.
 - (U) Demonstrate adaptive environment software toolkit for more rapidly developing complex, distributed applications.
- Information Infrastructure Applications Demonstrations. (\$19.4M)
 - (U) Demonstrate fee-for-service testbed for U.S. financial system.
 - (U) Demonstrate digital library and fee-for-service infrastructures applied to computational prototyping demonstrations.
 - (U) Demonstrate an integrated infrastructure for active catalogs, rights management, and usage fees.
- Networking. (\$43.1M)
 - (U) Deploy common base set of network-based infrastructure protocols and services necessary for secure and reliable network operation.
 - (U) Demonstrate initial cross-country 40 Gigabit transmission technologies.
 - (U) Complete development of scalable, electronic access control system and toolkit, forming the protective technology base for future network-based applications.
 - (U) Develop advanced multicast-based services to include refinements of collaboration systems and autonomous network processes.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E

PE Title: Computing Systems and Communications Technology

Project Number: ST-19

Date: June 1994

Budget Activity: 2. Exploratory Development

- Defense Applications and Infrastructure. (\$32.5M)
 - (U) Full-scale deployment of testbed services for secure, computationally-intensive application of interest to DOD users.
 - (U) Demonstrate use of collaborative networked-based infrastructure and high performance computing capabilities for advanced education, training, and human resource development projects.

D. (U) WORK PERFORMED BY: Massachusetts Institute of Technology, Cambridge, MA; Intel Corp, Hillsboro, OR; Carnegie Mellon University, Pittsburgh, PA; Thinking Machines Corporation, Cambridge, MA; MadenTech Consulting, Inc., Arlington, VA; University of California/Berkeley, Berkeley, CA; Cray Research, Chippewa Falls, WI; and University of Southern California/Information Sciences Institute, Los Angeles, CA.

E. (U) RELATED ACTIVITIES: Program Element 0602301E, Project ST-11, Intelligent Systems and Software; PE 0603739E, Project MT-04, Electronic Module Technology; and PE 0603226E, Project EE-45, Experimental Evaluation of Major Innovative Technologies.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E Project Number: ST-22 Date: June 1994
 PE Title: Computing Systems and
Communications Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
ST-22 Software Engineering Technology	37,550	40,223	19,562	19,205	18,678	20,250	23,250	25,136	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: Software technology is a top item on the DoD Key Technologies list because of continually increasing demands for quality software in DoD software-intensive systems, and the need for an advanced state of software engineering practice in their production. This project funds the Software Engineering Institute (SEI) and the Software Technology for Adaptable, Reliable Systems (STARS) program to address the Department's software requirements. SEI and STARS efforts are aimed at enabling future DoD software intensive weapon systems to meet mission requirements quickly and affordably.

(U) The SEI is a Federally Funded Research and Development Center (FFRDC), established in 1984, that conducts programs in software engineering. The SEI is composed of world class software engineers whose efforts are directed at transitioning technology and enhancing acceptance of modern software engineering techniques and methods, promulgating their use throughout the defense industry, and establishing standards of excellence for the software engineering profession.

(U) The STARS program is a technology development, integration and transition program to demonstrate a process driven, domain specific, reuse-based approach to software engineering that is supported by appropriate tool and environment technologies. STARS is generating three key integrating elements toward a family of large-scale "software factory" products: a set of

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Software Engineering Environments (SEEs); a set of modern adaptable software life-cycle process building blocks; and a software asset library capability to facilitate software productivity. The SEEs will be composed of commercially-supported products with open interfaces to stimulate the Computer Aided Software Engineering (CASE) tools marketplace. The SEEs will reinforce use of modern process models, have seamless interfaces to asset libraries, and will be evaluated on current DoD programs. FY 1995 is the last year of STARS program funding.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Participated with and support Services in STARS demonstration projects. (\$7.0M)
- (U) Refine STARS concepts, processes, methods, and tools based on demonstration projects results. (\$5.5M)
- (U) Continued the development and integration efforts in process and reuse technology. (\$2.7M)
- (U) Operated and enhanced ASSET capabilities. (\$3.8M)
- (U) Refined technology transition strategies; continue support for the Technology Transition affiliates program; continue commercialization initiatives; and refine and extend software development plan 2000. (\$2.0M)
- (U) Produced updated Software Process Assessment and Software Capability Evaluation instruments. (\$4.5M)
- (U) Documented architecture studies in Guidebook for Real-Time Air Vehicle simulators. (\$4.5M)
- (U) Developed/conducted Risk Identification Training Course. (\$4.0M)
- (U) Initiated development of a "Technology Maturity Model" and "Human Resources Maturity Model". (\$3.5M)

(U) FY 1995 Planned Program:

- (U) Continue support to Services in STARS demonstration projects. (\$6.0M)

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Program Element: #0602301E

Project Number: ST-22 Date: June 1994

PE Title: Computing Systems and
Communications Technology

Budget Activity: 2. Exploratory Development

- (U) Test and evaluate software architectures and application code developed using STARS Technologies on demo projects. (\$5.4M)
 - (U) Finalize STARS concepts, processes, methods, tools based on demonstration projects results. (\$4.0M)
 - (U) Refine technology transition strategies, continue support for the Technology Transition affiliates program; continue commercialization initiatives; and software development plan 2000 available for wide-spread use. (\$3.8M)
 - (U) Operate and enhance ASSET capabilities. (\$2.0M)
 - (U) Develop initial version of "Process Value Method" for determining anticipated business value of a process change. (\$2.0M)
 - (U) Develop Risk Evaluation training course. (\$2.0M)
 - (U) Produce guides to best model-based software engineering practice (\$6.0M); to best reengineering practice (\$5.0M); and an Open Systems Architecture Handbook. (\$4.0M)
- (U) FY 1996 Planned Program:
- (U) Develop Capability Maturity Model (CMM) version 2. (\$4.0M)
 - (U) Initiate CMM Validation and tailoring of CMM for small organizations. (\$3.6M)
 - (U) Prepare Software Risk Capability Improvement Guide. (\$3.0M)
 - (U) Develop Guide to Best Practice in system understanding. (\$5.0M)
 - (U) Develop Open Systems Standard for High Performance Networks. (\$4.0M)
- (U) FY 1997 Planned Program:
- (U) Complete the systems engineering capability maturity model and validate with NCOSE. (\$0.8M)
 - (U) Produce assessment training for government and industry acquisition processes. (\$3.1M)
 - (U) Initiate software risk management standards in acquisition practices. (\$3.4M)
 - (U) Provide reference models and methods for evaluation of software architectures. (\$3.3M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602301E
PE Title: Computing Systems and
Communications Technology

Project Number: ST-22 Date: June 1994
Budget Activity: 2. Exploratory Development

- (U) Produce comprehensive network security risk assessment technique and improvement approach. (\$2.8M)
- (U) Produce a Measurement Handbook for software. (\$2.7M)
- (U) Provide an engineering framework for reengineering and continuous evolution of systems. (\$3.1M)

(U) Program to Completion: This is an ongoing effort for the transitioning of software technology (utilizing state of the art software engineering techniques and methods) and promulgating software use throughout the defense industry.

D. (U) WORK PERFORMED BY: The SEI is a Federally Funded Research and Development Center. The contractor is Carnegie Mellon University, Pittsburgh, PA. The STARS prime contractors are Boeing Aerospace Corporation, Kent, WA; IBM Federal Systems Company, Gaithersburg, MD; and Paramax, McLean, Va.

E. (U) RELATED ACTIVITIES:

- (U) 0602301E, Intelligent Systems and Software (ST-11).
- (U) 0601101E, Information Sciences (CCS-02).
- (U) 0603756D, Consolidated DoD Software Initiative (Ada Program).
- (U) 0604740F, Computer Resource Management Technology.

(U) The ARPA PE activities above are managed to ensure that there is no duplication of effort among programs. ARPA ensures that SEI and STARS commonalities are synergetic by supporting a joint STARS/SEI team to work on process element definitions.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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Program Element: #0602301E

Project Number: ST-23 Date: June 1994

PE Title: Computing Systems and

Budget Activity: 2. Exploratory Development

Communications Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
ST-23 Counter-Proliferation Technology	22,275	40,802	46,217	50,738	58,402	59,112	64,112	65,112	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: There are two interrelated components of this project. One addresses the problem of counterproliferation which has been highlighted by the DoD; the other addresses a national effort for a Comprehensive Test Ban (CTB) Verification Readiness Program to enhance U.S. surveillance capabilities for monitoring worldwide nuclear explosions and a focused program to develop technologies for detecting the production, testing and storage of nuclear materials and weapons.

(U) The objective of the counterproliferation effort is to develop new technologies and enhance existing technology to support early detection, monitoring, and interdiction of the proliferation of nuclear, chemical, biological, and advanced conventional weapons. The project will develop and provide early demonstration of advanced sensors, information and intelligence processing, modeling, command and control, and response option technologies to enable the warning, capabilities assessment and tailored counterproliferation options that are required to effectively detect, monitor and neutralize these threats. This effort is critically needed to provide decision-makers with vastly increased flexibility in dealing with potential adversaries acquiring weapons of mass destruction (WMD). The FY 1995 program is focusing and extending programs for countering weapons of mass destruction and related delivery systems in: remote and local sensors; data mining, fusion and decision support; target nomination and battle management; tracking and tagging; and scenario based modeling and simulation. Technology base efforts such as microelectronic mechanical systems, low power sources, wireless communications, networking, computing and information infrastructure are providing enabling technologies for many of the

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PE Title: Computing Systems and
Communications Technology

Budget Activity: 2. Exploratory Development

preceding applications. In parallel with that, rigorous analysis is being done to identify operational requirements and shortfalls to which specific advanced, high-risk technologies can be addressed.

(U) Legislative and administration policy is to complete negotiations of an internationally verifiable CTB by 1996, with a demonstration of a prototype international verification system in 1995. This project provides the advanced research and development of verification technologies that will be needed to negotiate and implement this treaty. Included in this project is the development and testing of key elements of an International Monitoring System and advanced surveillance technologies needed for incorporation into existing operational nuclear monitoring systems. The proliferation of weapons of mass destruction (WMD) and their associated delivery systems constitute the major threat to U.S. armed forces and allies in the Post-Cold War security environment. This project also addresses methods for demonstrating technologies to enhance the monitoring of the Nuclear Non-Proliferation Treaty and its renewal.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Counterproliferation (CP) Program. (\$10.4M)
 - (U) Analyzed requirements across the counterproliferation spectrum, surveyed previous and on-going efforts, and defined the WMD environment.
 - (U) Evaluated technologies for potential CP application which leverage ARPA work in detection and surveillance; information/intelligence exploitation; targeting and battle management; tagging and tracking; and modeling and simulation.
 - (U) Continued development of technologies for detection of trace evidence of nuclear weapon development, including improved laboratory nanoscale particle analysis techniques.
 - (U) Continued development of nuclear radiation detection and imaging sensors, including high-resolution, room temperature sensors.

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Program Element: #0602301E

Date: June 1994

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PE Title: Computing Systems and
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Budget Activity: 2. Exploratory Development

- (U) Began joint non-proliferation technology projects with scientific and engineering groups in the former Soviet Union.
- (U) Developed components for and deployed operational prototype of a global proliferation monitoring system.
- (U) U.S. CTB Verification Readiness Program. (\$11.9M)
 - (U) Developed and tested components of a prototype surveillance system which will be required for CTB monitoring, with focus on advanced signal processing technologies at a data center.
 - (U) Began implementation of technologies for global nuclear threshold monitoring.
 - (U) Developed and tested techniques for automated knowledge acquisition in areas where the U.S. had little previous experience.
 - (U) Explored technologies for automated signal processing, including machine learning and new visualization methodologies.
 - (U) Transferred seismic sensor development technologies to operational agencies.

(U) FY 1995 Planned Program:

- (U) Counter-proliferation Program. (\$25.4M)
 - (U) Extend an existing test and evaluation facility to demonstrate, integrate, and evaluate impact of focused projects and input to new starts selection process.
 - (U) Develop technologies for the detection, tagging, tracking and surveillance of weapons of mass destruction (WMD).
 - (U) Design an underwater vehicle ship disabling application.
 - (U) Design an automated CP toolkit containing: scenario modeling, distributive collaborative planning, text/speech/image fusion, knowledge acquisition, and influence action assessment tools.
 - (U) Design nuclear and chemical/biological weapon modeling and monitoring systems which include: advanced sensors; information processing of open

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Program Element: #0602301E

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PE Title: Computing Systems and
Communications Technology

Budget Activity: 2. Exploratory Development

- (U) source and intelligence data to perform correlations based on nuclear and chemical weapons production vulnerability models; and output activity status and collection recommendations.
- (U) Develop joint chemical-nuclear projects with laboratories in the former Soviet Union.
- (U) Demonstrate the operation of particle and air sampling monitoring system as portions of an open global nuclear proliferation monitoring system.
- (U) Design an underwater chemical sensor/analysis system.
- (U) Design a BW defense regime based on BW vaccines, immunomodulation, genetic targeting, structure based drug design, and therapeutics.
- (U) Demonstrate laboratory nanoscale particle analysis techniques.
- (U) Demonstrate prototype operation of high-resolution room temperature radiation sensors and biosensors.
- (U) Design enhancement and application of generic monitoring and imagery exploitation technology to WMD requirements.
- (U) Conduct modeling and simulation on a saved set of CP scenarios as one means of specifying technology requirements.
- (U) Develop advanced technologies for application of microelectromechanical systems for applications in monitoring roles.
- (U) Identify new starts via integrated methodology composed of expert panels (substantive and technical mix); modeling for candidate technology identification; quantitative impact assessment metrics; and rating schemes. Specify, define and correlate sensor, processing, C3I and response option requirements and relevant technology state-of-the-art to identify technology gaps.
- (U) U.S. CTB Verification Readiness Program. (\$15.4M)
- (U) Develop and test technologies for applying advanced signal processing technologies to large volumes of data from diverse multisensors required for CTB monitoring.

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Program Element: #0602301E

Project Number: ST-23 Date: June 1994

PE Title: Computing Systems and
Communications Technology

Budget Activity: 2. Exploratory Development

- (U) Develop methods of automated signal detection and characterization, especially for small seismic events.
 - (U) Develop advanced computing system architectures and data management techniques for reliable and distributed processing.
 - (U) Continue the transfer of advanced signal processing technologies into operational systems.
 - (U) Develop and incorporate methods for non-seismic technologies into overall event detection and analysis.
 - (U) Begin demonstration of capabilities of global CTB seismic monitoring system.
- (U) FY 1996 Planned Program:
- (U) U.S. Comprehensive Test Ban (CTB) Verification Readiness Program. (\$14.1M)
 - (U) Provide technical support to nuclear test ban treaty negotiations, including those between the five nuclear powers and within the Conference on Disarmament.
 - (U) Continue demonstration of capabilities of global CTB seismic and non-seismic monitoring system.
 - (U) Counterproliferation Program. (\$32.1M)
 - (U) Provide technical support to nuclear proliferation deliberations.
 - (U) Demonstrate radiation sensors in microelectromechanical systems.
 - (U) Provide initial demonstration of generic monitoring and imagery exploitation CP applications.
 - (U) Demonstrate a biological warfare (BW) defense regime based on BW vaccines, immunomodulation, genetic targeting, structure based drug design and therapeutics.
 - (U) Demonstrate an underwater vehicle ship disabling application and tagging technology.

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Program Element: #0602301E

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PE Title: Computing Systems and Communications Technology

Budget Activity: 2. Exploratory Development

- (U) Demonstrate an automated CP toolkit containing: scenario modeling, distributive collaborative planning, text/speech/image fusion, knowledge acquisition, and influence action assessment tools.
- (U) Design application of ground target tracking technology to WMD components.
- (U) Continue focused modeling and simulation, provide proof of concept demo of WMD production process and design end-to-end counter WMD architecture.
- (U) Develop and test new technologies for radiation and chemical sensing devices, such as biosensors, as stand-alone systems for overt or covert operation.
- (U) Conduct proof-of-concept demonstrations and continue to develop high payoff technology areas, e.g., exotic weapons, internetted radiation and chemical sensors and policy option planning aids.
- (U) Continue development of nuclear and chemical weapon modeling, detection and monitoring systems and design extension to biological weapons.
- (U) Design a system/subsystem perspective demonstration which integrates on-going technology with performance of the demonstration in FY 1997.
- (U) Begin identified new starts addressing technology gaps in the 8 OSD-identified functional areas. Demonstrate and continue evaluation of projects focusing on-going technologies on sensor development, intelligence information processing, response option requirements, systems architectures, and decision support.

(U) FY 1997 Planned Program:

- (U) U.S. Comprehensive Test Ban (CTB) Verification Readiness Program. (\$5.4M)
- (U) Complete transfer to USAEDS and international CTB verification system.
- (U) Support required system enhancements required by USAEDS and international system.
- (U) Counterproliferation Program. (\$45.3M)
- (U) Complete development of biosensors and CW agent detection system for water applications.

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Project Number: ST-23 Date: June 1994

PE Title: Computing Systems and Communications Technology

Budget Activity: 2. Exploratory Development

- (U) Complete CW production process phenomenology.
- (U) Complete environmental impact phenomenology of CW and BW agents.
- (U) Complete analysis of BW agent signature for signal processing uses.
- (U) Prototype automated noble gas separator field unit for Comprehensive Test Ban Treaty monitoring purposes.
- (U) Transition projects meeting requisite performance standards in monitoring, intelligence/information processing, response option and decision support and sensors. Continue to develop and evaluate technology projects which enable DoD CP mission areas.
- (U) Transition mature elements of a BW defense regime based on BW vaccines, immunomodulation, genetic targeting, structure based drug design and therapeutics.
- (U) Test and transition mature elements of automated CP toolkit.
- (U) Develop and test an underwater vehicle ship disabling application.
- (U) Conduct evaluation of generic monitoring, imagery exploitation, production process models and end-to-end architecture. Continue development of tracking and tagging technology.

(U) Program to Completion:

- (U) U.S. Comprehensive Test Ban (CTB) Verification Readiness Program
 - (U) The current plan is to complete the program in FY 1997. However, it is expected that the scientific and technical problems related to monitoring a CTB will not become clear until the treaty is in force. Therefore, it is possible that additional work will be required under this program to address new problems that arise.
- (U) Counterproliferation Program.
 - (U) Transition chemical and biological sensors and continue to develop other WMD-signature specific sensor technology. Integrate technology components into sub-system and system demonstrations for evaluation by potential customers and to continue to identify technology gaps in the following CP-

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related areas: detection and surveillance; intelligence and exploitation; target nomination and battle management; tagging and tracking; and scenario based modeling and simulation.

D. (U) Major performers include: Geotech, Garland, TX; Science Applications International Corporation, San Diego, CA; Southern Methodist University, Dallas, TX; California Institute of Technology, Pasadena, CA; Constellation Technologies, Inc, St. Petersburg, FL; Hughes Santa Barbara Research Center, Santa Barbara, CA; and Grumman Aerospace Corp, Bethpage, NY.

E. (U) RELATED ACTIVITIES: Complementary research is conducted by the National Laboratories of the Department of Energy and by the Air Force Technical Applications Center for operational applications. Close coordination of the program is carried out with the many organizations concerned with this issue, e.g., CIA Non-Proliferation Center and Defense Intelligence Agency. The counterproliferation technology effort will build on developments of the Joint DoD Advanced Technology Demonstrations for Global Surveillance and Communications and Precision Strike Thrust Areas, extending the technology specifically developed for the WAR BREAKER Program (PE 0603226E, Project EE-40). There is no duplication of effort.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Agreements with Norway, the Federal Republic of Germany, China, and the Russian Federation call for joint activities in facilities within those countries. The United Nations' Conference on Disarmament, with U.S. concurrence has formally agreed on the development of an international monitoring system and large scale tests of this system and agreements have been made with a large number of countries, including Russia, China, Egypt and Pakistan to support this effort.

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Program Element: #0602702E Date: June 1994
 PE Title: Tactical Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
TT-03 Naval Warfare Technology	26,459	33,383	36,687	37,728	39,830	41,407	51,407	66,407	Continuing	Continuing
TT-04 Advanced Land Systems Technology	14,900	33,239	34,654	31,500	34,986	50,186	54,686	66,686	Continuing	Continuing
TT-05 Advanced Targeting Technology	*8,303	5,848	0	0	0	0	0	0	0	14,366
TT-06 Advanced Tactical Technology	26,285	**38,873	25,114	29,224	29,408	30,527	48,527	62,527	Continuing	Continuing
TT-07 Aeronautics Technology	12,705	0	0	0	0	0	0	0	0	120,330
	88,652	111,343	96,455	98,452	104,224	122,120	154,620	195,620		

* FY 1994 and subsequent year efforts for the WAR BREAKER portion of this project are funded in PE 0603226E, EE-40.
 ** TT-07 consolidated with TT-06 in FY 1995-01.

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element is budgeted in the Exploratory Development Budget Activity because it supports the advancement of concepts and technologies to enhance the next generation of tactical systems. The FY 1996 Tactical Technology program funds a number of projects in the areas of Naval Warfare, Advanced Land Systems and Advanced Tactical technologies.

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Program Element: #0602702E
PE Title: Tactical Technology

Date: June 1994
Budget Activity: 2. Exploratory Development

(U) The Naval Warfare Technology project is focusing on three areas: command, control, communications, and intelligence (C3I)/synthetic environment program; ship system automation; and simulation based design. The C3I/synthetic environment program will create a multi-user maritime network to provide an accurate planning and simulation capability that will improve training, readiness, and operations planning. The Ship Systems Automation program is developing a highly integrated sensor, weapons control, and battle damage suite to reduce costly shipboard manning requirements. Finally, the Simulation Based Design program will provide the tools required to integrate cost, performance, and manufacturing considerations throughout the design process.

(U) The Advanced Land Systems Technology project includes the Battlefield Management and the Operations Other Than War (OOTW) programs. The Battlefield Management program will examine battlefield information and communications requirements to improve situational awareness and contingency force responsiveness. The OOTW program focuses on technological solutions to critical problems of operations such as peacekeeping and non-combatant evacuation.

(U) Finally, the Advanced Tactical Technology project is exploring the application of compact lasers, microwave radiation and advanced mathematical algorithms to enhance the performance of radars, sensors, communications, and electronic warfare systems. The technologies under development will improve infrared countermeasures, enable active infrared suppression, permit faster signal processing, improve target recognition, and create smaller, more capable microwave devices.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-03 Date: June 1994
 PE Title: Tactical Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
TT-03 Naval Warfare Technology	26,459	33,383	36,687	37,728	39,830	41,407	51,407	66,407	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: The Naval Warfare Technology project develops advanced technologies for application to a broad range of naval requirements. The enabling technologies include: Advanced design processes based on virtual prototyping and advanced modeling; Command, Control, Communications, and Intelligence (C3I)/Synthetic Environments for littoral warfare; and Integrated ship sensor, weapons and platform technologies to demonstrate the feasibility of automation for reduced ship manning.

(U) The Simulation Based Design (SBD) area is developing and demonstrating a prototype system that will enable a revolutionary change in the acquisition process for large, complex systems. SBD will enable establishment of a National Industrial Base, providing true dual-use development capability. The objective of SBD is to integrate the technologies of distributed interactive simulation, physics-based modeling, and virtual environments and apply them to the design, acquisition, and life cycle support processes of complex systems. SBD will utilize virtual prototypes in synthetic environments to enable effective, integrated product and process development. Complete simulation from early in concept formulation through verification of requirements to design, manufacture, operation, training, and logistics will be available prior to initiation of construction. This will permit realistic assessments of a candidate design throughout its lifetime. The system will provide significant cost savings through the reduction of: the number of expensive physical mockups, the total time for product acquisition, and the manufacturing inefficiencies caused by inadequate design.

(U) In the Command, Control, Communication and Intelligence (C3I)/Synthetic Environment (SE) area advanced information and communications technologies are being developed in support of the

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Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-03 Date: June 1994
Budget Activity: 2. Exploratory Development

situational assessment, planning, and mobile communications functions inherent in Commander in Chief (CINC) Command Centers ashore and mobile Joint Task Force (JTF) Command Centers. The prototype system incorporates an embedded internetted simulation capability for collaborative planning, evaluation, and rehearsal with Commander Joint Task Force (CJTF) mobile and fixed units. It also utilizes the Maritime Synthetic Theater of War (MSTOW) for improving training, readiness, and operations planning and rehearsal of the maritime component of U.S. forces. It builds upon existing ARPA-developed planning tools such as the Capability Assessment and Evaluation System (CASES), the Acoustic Warfare Integration Laboratory (AWIL), and the Maritime Anchor Desk, while identifying and incorporating other emerging C3I and information system technologies.

(U) In the Ship Systems Automation (SSA) area, advanced, highly automated sensor, weapons control, and platform systems (including damage control) are being developed and demonstrated for submarine and surface ship applications. Through evolving sequential demonstrations of the technologies and their interactions, efforts in this area will show how an integrated system could achieve a significant reduction in crew size. Because personnel account for about 25% of ship life cycle costs, such a reduction would lead to immediate and long term cost savings for ship acquisition programs. Ship Systems Automation (SSA) technology developments include intelligent command-level decision support components, scalable sensor integration work stations to fuse multi-source data and intelligently display the tactical situation on a tactical situation assessment system, cooperating expert systems conducting mission-context/sensor employment planning, and integrated internal condition sensor and control systems to intelligently display and control ship physical conditions on a ship's internal assessment system.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Conducted the final Simulation Based Design (SBD) feasibility demonstration showing real-time interaction in a virtual environment, seamlessly integrating component production from design through manufacture; initiated the development of key enabling technologies. (\$8.3M)

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Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-03 Date: June 1994
Budget Activity: 2. Exploratory Development

- (U) Initiated development of process models to enable agile manufacturing in shipyards. (\$0.9M)
- (U) Demonstrated a full fidelity acoustic synthetic ocean environment simulation capability and commenced development of a synthetic electromagnetic environment. (\$3.2M)
- (U) Initiated development of an integrated situation assessment, planning, and planning assessment architecture and associated wideband communications antenna technologies for Commander in Chief (CINC) and mobile Commander Joint Task Force (CJTF) command complexes. Demonstrated connectivity and initial assessment capabilities. (\$5.9M)
- (U) Developed the architecture for Ships Systems Automation (SSA) in the four major operator/associate areas of Tactical Scene, Tactical Action, Platform Readiness, and Command & Control; conducted initial laboratory demonstration of the Tactical Scene Operator/Associate area. (\$3.2M)
- (U) Pursued new and follow-on efforts for the Center of Excellence for Research in Ocean Sciences (CEROS) ocean science efforts. This effort was funded by a Congressional addition to the FY 1994 President's Budget. (\$5.0M)

(U) FY 1995 Planned Program:

- (U) Initiate Simulation Based Design (SBD) prototype development and conduct initial demonstration using the facilities of a regional design center. (\$7.0M)
- (U) Conduct interim demonstrations of SBD critical enabling technologies. (\$7.7M)
- (U) Conduct demonstrations of agile manufacturing concepts for shipyards. (\$1.1M)
- (U) Demonstrate an initial integrated Command, Control, Communication, and Intelligence/Synthetic Environment (C3I/SE) architecture in a selected maritime theater-wide planning/planning assessment scenario at a Commander in Chief (CINC) Command Complex and linked at-sea Commander Joint Task Force (CJTF). Conduct laboratory demonstration of advanced technology wideband satellite communications between the CINC and mobile CJTF command complexes. (\$7.0M)
- (U) Expand synthetic environment development to include a complete electromagnetic environment creating a full spectrum Maritime Synthetic Theater of War (MSTOW). (\$2.3M)

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Program Element: #0602702E Project Number: TT-03 Date: June 1994
PE Title: Tactical Technology Budget Activity: 2. Exploratory Development

- (U) Conduct Ship Systems Automation (SSA) demonstrations with emphasis on Tactical Scene Assessment/Presentation and Defensive Warfare Associate, interactive component technologies, and force multiplier technologies that support significantly reduced manning on warships. (\$8.3M)

- (U) FY 1996 Planned Program:
 - (U) Conduct interim Simulation Based Design (SBD) prototype demonstrations on a complex system at a national design center, integrating evolving critical technologies. (\$8.0M)
 - (U) Conduct interim demonstrations of SBD enabling critical technologies. (\$7.1M)
 - (U) Demonstrate full spectrum Maritime Synthetic Theater of War (MSTOW) in an advanced demonstration. (\$2.1M)
 - (U) Demonstrate Command, Control, Communication and Intelligence, Synthetic Environment (C3I/SE) collaborative planning, Commander in Chief (CINC) to Commander Joint Task Force (CJTF), in conjunction with WARBREAKER demonstration. (\$6.3M)
 - (U) Conduct land-based Navy laboratory simulation/stimulation demonstration of SSA interactive component technologies. (\$7.3M)
 - (U) Demonstrate advanced SSA algorithm and integration verification in coordination with Navy and university laboratories. (\$4.6M)
 - (U) Investigate and begin development of sonar system based on biological sonar architectures. (\$0.2M)
 - (U) Perform feasibility analysis for and begin development of critical synoptic sensors and communications architectures. (\$0.3M)
 - (U) Begin development of predictive models and small scale testing to exploit the increased efficiencies and technological benefits of advanced engines and propulsion components, including vortex devices. (\$0.3M)
 - (U) Initiate development of a full fidelity transportation synthetic environment that will permit distributed visualization and interaction with all phases, elements and components of the military/commercial transportation infrastructure, to support policy, planning, acquisition and real time operations and replanning. (\$0.5M)

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(U) FY 1997 Planned Program:

- (U) Conduct interim Simulation Based Design (SBD) prototype demonstrations on complex system integrating evolving critical technologies. (\$8.5M)
- (U) Conduct interim demonstrations of SBD enabling critical technologies. (\$7.6M)
- (U) Complete development of and demonstrate C3I/SE maritime mission planner. (\$4.2M)
- (U) Demonstrate at sea a two-band, multi-mode satellite antenna with functional linkage to a grid ashore. (\$2.1M)
- (U) Demonstrate a synthetic electromagnetic environment for ship defense systems. (\$2.2M)
- (U) Conduct an integrated, fully-reactive land-based demonstration of all Ship Systems Automation (SSA) Operator/Associate pairs in the Combat Information Center (CIC) of the Future facility. (\$13.1M)

D. (U) WORK PERFORMED BY: Lockheed Missiles & Space Co., Palo Alto, CA; General Dynamics, Electric Boat Division, Groton, CT; Orincon Corp., San Diego, CA; AT&T Bell Laboratories, Whippany, NJ; and Charles Stark Draper Laboratories, Cambridge, MA and Arlington, VA.

E. (U) RELATED ACTIVITIES: This program is coordinated with the Office of Naval Research, Space and Naval Warfare Systems Command, and Naval Sea Systems Command.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-04 Date: June 1994
 PE Title: Tactical Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Program
TT-04 Advanced Land Systems Technology	14,900	33,239	34,654	31,500	34,986	50,186	54,686	66,686	Continuing
									Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project is intended to develop technologies for contingency missions and military Operations-Other-Than-War to make U.S. combat forces more deployable, effective, survivable, and affordable. This project supports three main efforts: Operations-Other-Than-War (OOTW); Battle Management Architecture, Data-Base Modeling and Technology Development; and Small Low-cost Interceptor Device (SLID). In addition, during FY 1994, a number of efforts from the Armor/Antiarmor program were being completed.

(U) Military Operations-Other-Than-War (OOTW) is the aspect of military operations that focuses on deterring war, resolving conflicts and promoting peace. Example activities are peacekeeping, counterterrorism, counterdrug, noncombatant evacuation operation and support to insurgency. Military OOTW missions share many common characteristics with Law Enforcement (LE) missions and share a similar vision: Protecting the lives of friendly forces as they perform their mission; minimizing collateral damage to noncombatants; and operating in a multinational/multilingual environment. Technologies will be developed to provide both civil and military usage. ARPA will focus on technology solutions that will improve our ability to conduct OOTW, both nationally and internationally.

(U) The ARPA OOTW program intends to increase military effectiveness in multi-national and multi-lingual OOTW operations through affordable, advanced technologies. Technology developments in personal extremities armor, non-lethal weapons, sensor surveillance through wall and covered enclosures, concealed weapon detection, non-English speech interpretation/translation, miniature geo-location, navigation and data transfer subsystems, countermine/demining, and anti-

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PE Title: Tactical Technology

Budget Activity: 2. Exploratory Development

mortar/anti-sniper sensors. Those technologies that minimize response time to achieve mission goals will be emphasized. The OOTW program will exploit the simulation technologies developed under the ARPA War Breaker Program and elsewhere, to help define technology requirements, working with the potential user from day one. Memorandums of Understanding are in place, or under negotiation, with the Department of Justice and U.S. Special Operations Command.

(U) The Battle Management Architecture, Data-Base Modeling and Technology Development program addresses command and control problems of highly mobile, joint contingency forces. On-the-move units currently cannot obtain a joint common picture of the battlefield or any graphics or imagery, and have limited planning tools available. The goal of this effort is to determine commander's information needs and to develop technologies to allow synchronized Battle Management and to improve the situation awareness and response option generation of highly mobile joint contingency forces commanders at all levels. This project will provide the information, interface and interconnect technology base for the Command and Control Information Systems project in PE 0603226E, project EE-21. The information processing display and communications capabilities will be exercised and tested in a Battle Management Architecture Evaluation Model. The Battle Management project is related to advanced architecture and data-base modeling in project EE-37 which serves as one test and evaluation mechanism.

(U) The Small Low-cost Interceptor Device (SLID) program will develop and test a system for providing protection against missiles and projectiles with explosive warheads. This system will detect, track, and intercept these threats at a standoff distance sufficient to render them ineffective. Applications for the SLID system include self-defense of vehicles, high value fixed sites such as command centers, aircraft hangars, radars, and perhaps aircraft.

. C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Conducted studies and simulation of multi-level joint Battle Management information needs and technical approaches for on-the-move collaborative planning and situation awareness. (\$2.2M)

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Program Element: #0602702E

PE Title: Tactical Technology

Project Number: TT-04

Date: June 1994

Budget Activity: 2. Exploratory Development

- (U) Continued exploration of commercial communications leveraging opportunities and conduct brassboard test of applicability to dismounted/mounted operations. (\$4.0M)
- (U) Integrated helicopter detection and classification algorithms into the Army's wide area mine (WAM). Transition to Army. (\$1.5M)
- (U) Terminated Turbo-Roto-Compound engine and transitioned technology to industry. (\$1.0M)
- (U) Began risk-reduction phase of the Small Low-cost Intercept Device (SLID) program. (\$2.1M)
- (U) Developed and demonstrated selected simulation-based design tools required to simultaneously address performance and producibility of new weapons concepts. Defined concept for integrated system of design workstations. Transition program to PE 0603226E, EE-37. (\$2.7M)
- (U) Completed testing of armor concepts. (\$0.4M)
- (U) Acquired exhaust and projectile acoustic and infrared signatures from mortars and sniper rifles against various background clutter situations. (\$0.1M)
- (U) Identified and assessed potential means of providing extremities protection using advanced ARPA ceramic and other composite materials. (\$0.2M)
- (U) Identify and assess potential sensors for performing countermine operations, wall penetration and weapon detection. (\$0.2M)
- (U) Assessed potential means for advanced computerized speech processing and translated exploiting ARPA High Performance Computing and Intelligent Systems technologies. (\$0.1M)
- (U) Assessed potential technologies for geolocating/data transfer devices. (\$0.1M)
- (U) Assessed potential technologies for non-lethal weapons. (\$0.1M)
- (U) Exploited computer simulation for OOTW requirements and technology assessment. (\$0.2M)

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Program Element: #0602702E

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PE Title: Tactical Technology

Budget Activity: 2. Exploratory Development

(U) FY 1995 Planned Program:

- (U) Develop information processing, interface and interconnect technology to support Command and Control Information System in EE-21 and have evaluation conducted by Battle Management Evaluation environment of EE-37. Transition technology. (\$4.9M)
- (U) Continue Phase I (risk reduction) efforts in the SLID program and perform downselection for Phase II. (\$8.6M)
- (U) Identify and assess potential means of performing mortar and sniper localization using acquired signature data. (\$0.9M)
- (U) Initiate program in demining and conduct first demining trials. (\$10.0M)
- (U) Develop techniques and a testbed for advanced computerized speech processing and translation. (\$1.2M)
- (U) Develop advanced extremities protection technologies. (\$1.0M)
- (U) Initiate advanced non-lethal weapons technology development. (\$0.2M)
- (U) Develop and test advanced countermine, wall penetrating and weapon detection sensor concepts. (\$1.6M)
- (U) Develop advanced geolocating/data transfer technologies. (\$3.9M)
- (U) Continue OOTW Simulation and Assessment studies with users to confirm technology meets Service needs. (\$0.9M)

(U) FY 1996 Planned Program:

- (U) Transition best demining systems from prior field trials to operational tests. Conduct second round of competitive field trials with newly developed systems. (\$7.5M)
- (U) Initiate SLID phase II effort with remaining contractors. Perform sub-system tests leading to static system tests. (\$9.6M)
- (U) Continue to develop technologies for anti-mortar and anti-sniper operations. (\$2.0M)
- (U) Continue to develop techniques and the testbed for advanced computerized speech processing and translation. (\$2.0M)
- (U) Continue to develop advanced extremities protection technologies. (\$2.0M)

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Program Element: #0602702E

PE Title: Tactical Technology

Project Number: TT-04

Date: June 1994

Budget Activity: 2. Exploratory Development

- (U) Continue advanced non-lethal weapons technology development. (\$2.5M)
- (U) Continue to develop and test advanced countermine, wall penetrating and weapon detection sensor concepts. (\$3.0M)
- (U) Continue to develop advanced geolocating/data transfer technologies. (\$5.0M)
- (U) Continue OOTW Simulation and Assessment studies with users to confirm technology meets Service needs. (\$1.1M)

- (U) FY 1997 Planned Program:
 - (U) Transition winners of second demining competition to operational trials. Continue technology development and system upgrades of most promising approaches. (\$5.0M)
 - (U) Continue SLID phase II effort. Conduct full system static tests and tests against slowly moving targets. Prepare for live-on-live tests. (\$12.5M)
 - (U) Continue to develop technologies for anti-mortar and anti-sniper operations. (\$2.0M)
 - (U) Continue to develop techniques and the tested for advanced computerized speech processing and translation. (\$1.5M)
 - (U) Continue to develop advanced extremities protection technologies. (\$2.0M)
 - (U) Continue advanced non-lethal weapons technology development. (\$2.5M)
 - (U) Continue to develop and test advanced countermine, wall penetrating and weapon detection sensor concepts. (\$2.0M)
 - (U) Continue to develop advanced geolocating/data transfer technologies. (\$4.0M)

(U) Program to Completion:

- (U) Demonstrate the Small Low-cost Intercept Device (SLID) program to affordably and reliably protect high value assets at standoff. Demonstrate capability to neutralize missiles and protect light vehicles, radars and mobile headquarters.
- (U) Continue technology development for Operations-Other-Than-War, focusing on nonlethal weapons and detection of weapons of mass destruction.
- (U) Continue development, testing and transition of best demining systems.
- (U) Demonstrate and transition anti-mortar and anti-sniper localization system.
- (U) Demonstrate and transition computerized speech translation system.

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PE Title: Tactical Technology

Project Number: TT-04

Date: June 1994

Budget Activity: 2. Exploratory Development

- (U) Demonstrate advanced extremities protection technologies.
- (U) Demonstrate advanced countermine and wall penetrating sensors.
- (U) Demonstrate advanced geolocating/data transfer technologies.

D. (U) WORK PERFORMED BY: The major performers include Hughes Aircraft, El Segundo, CA; Raytheon, Lexington, MA; Textron Defense, Wilmington, MA; Lawrence Livermore Laboratories, Livermore, CA; University of Iowa, Iowa City, IA; Texas Instruments, Dallas, TX; TRW, Redondo Beach, CA; Allied Signal, Towson, MD; Rockwell International, Duluth, GA; Naval Command, Control and Ocean Surveillance Center, San Diego, CA; Army Research Laboratory, Adelphi, MD; Science Applications International Corporation, Arlington, VA; and MIT Lincoln Laboratory, Lexington, MA.

E. (U) RELATED ACTIVITIES: Not applicable.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-05 Date: June 1994
PE Title: Tactical Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
TT-05 Advanced Targeting Technology	8,303	5,848	0	0	0	0	0	0	0	28,814

B. (U) BRIEF DESCRIPTION OF PROJECT: By integrating advanced algorithms (automatic target recognizers) and processing technologies with multiple imaging sensors, autonomous intelligent submunitions will enhance U.S. force projection by providing a flexible and accurate delivery of munitions on a wide range of targets. Damocles will demonstrate a lower cost, intelligent, and effective submunition against these targets. It will have the ability to cover a large footprint (greater than 1 kwz) once deployed from a carrier vehicle and automatically search for, detect, and recognize sparsely positioned targets, such as SCUDS, SS-21s, and their support vehicles.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Completed Damocles hardware and software integration into test fixture. (\$1.0M)
 - (U) Performed captive carry tests to collect data and test hardware and software integration. (\$5.8M)
 - (U) Performed initial free flight experiments. (\$1.5M)
- (U) FY 1995 Planned Program:
 - (U) Complete Damocles experiments/tests. (\$5.8M)
- D. (U) WORK PERFORMED BY: Textron Defense Systems, Wilmington, MA and Sensors Science Corporation (SENSCI), Alexandria, VA.

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Program Element: #0602702E

Date: June 1994

Project Number: TT-05

PE Title: Tactical Technology

Budget Activity: 2. Exploratory Development

- E. (U) RELATED ACTIVITIES: None.
- F. (U) OTHER APPROPRIATION FUNDS: Not applicable.
- G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602702E Project Number: TT-06 Date: June 1994
 PE Title: Tactical Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	To	Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
TT-06 Advanced Tactical Technology	26,285	38,873	25,114	29,224	29,408	30,527	48,527	62,527		Continuing Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project focuses on the technology and applications of compact lasers, microwave radiation sources, and mathematical algorithms for signal processing to dramatically improve the performance of radars, sensors, and systems for electronic warfare and communications. Five broad technology areas are being investigated: (a) compact, efficient, frequency-agile, diode-pumped, solid-state lasers for infrared countermeasure, laser radars and sensors; (b) compact high density data storage for high bandwidth image processing; (c) high performance, pulsed radio frequency (RF) radiation sources for smaller and better microwave tubes; (d) fast computational algorithms for signal processing, target recognition, electro-magnetic and acoustic propagation in nonlinear medium; (e) passive infrared signature suppression to counter the predominate air-to-air missile threats; and (f) precision optics components and systems for critical DoD applications. In addition, as an enabler of electronic warfare decoy concepts, the SENGAP propulsion system will be flight tested to validate the successful ground bench tests and integration with a decoy air vehicle.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Compact Laser (\$5.9M): Performed technology demonstration of power laser operation at one micron; semiconductor diodes for laser pumping; and active target acquisition for infrared countermeasure and laser radars.

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Program Element: #0602702E

Project Number: TT-06 Date: June 1994

PE Title: Tactical Technology

Budget Activity: 2. Exploratory Development

- (U) Demonstrated one kilowatt average power one micrometer wavelength laser with output at 10 joule/100 Hertz (Hz), 10 nanosecond pulse length.
- (U) Demonstrated new semiconductor laser diodes operating at 808 nanometer wavelength.
- (U) Demonstrated wavefront aberration corrections for active pointing and tracking.
- (U) Demonstrated design concepts for high repetition rate infrared countermeasure laser.
- (U) Holographic Data Storage (\$2.5M): Demonstrated new hologram fixing and multiplexing techniques for holographic data storage system.
- (U) Pulsed Radio Frequency (RF) (\$10.1M): Designed and fabricated advanced RF radiation sources for radar and RF countermeasure.
- (U) Designed and fabricated electronic system to demonstrate cooperative angle jamming technique.
- (U) Designed and fabricated 44 gigahertz (GHz) solid state, high efficiency amplifiers for space applications.
- (U) Designed microwave power tube using microcathode to operate at 10 GHz.
- (U) Demonstrated high performance 94 GHz amplifier operation and began prototype design.
- (U) Designed, fabricated and demonstrated ultra high resolution radar operation using electromagnetic shockline technology.
- (U) Designed reconfigurable antenna.
- (U) Fast Computational Algorithms (\$7.8M): Began to develop novel algorithms for automatic detection and recognition of difficult-to-find objects.
- (U) Developed wavelet-based multi-resolution methods and design tools for new digital filters.
- (U) Demonstrated wavelet methods for detection of transient signals in sonar systems and for multisensor fusion.
- (U) Demonstrated robust methods for direction finding and interference reduction in airborne platforms.
- (U) Developed code for fast computation of electromagnetic scattering.

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Program Element: #0602702E

Project Number: TT-06 Date: June 1994

PE Title: Tactical Technology

Budget Activity: 2. Exploratory Development

(U) FY 1995 Planned Program:

- (U) Compact Lasers (\$5.0M): Demonstrate breadboard systems of compact high power lasers at one micron, tunable mid infrared lasers, aluminum free laser diodes and active tracking systems at mid infrared wavelengths.
- (U) Demonstrate transportable breadboard one kilowatt average power one micrometer wavelength laser with output at 10 Joule/100 Hertz (Hz), 10 nanosecond pulse length.
- (U) Demonstrate laser diode bar arrays at continuous wave and quasi-continuous wave output at 808 nanometers.
- (U) Demonstrate laboratory breadboard tunable mid infrared lasers for U.S. Army advanced technology infrared countermeasure program.
- (U) Demonstrate and test a laboratory breadboard active tracking system for mid infrared wavelengths.
- (U) Holographic Data Storage (\$7.0M): Technology demonstration of page-format, high density input and readout capability.
- (U) Demonstrate prototypes of test charge coupled devices, spatial light modulators and experimental validation of concept for holographic recording through waveguides.
- (U) Pulsed Radio Frequency (RF) (\$7.5M): Continue fabrication and integration of advanced RF amplifiers and power combining techniques.
- (U) Fabricate triode amplifier using microcathode operating at 10 gigahertz (GHz).
- (U) Fabricate prototype high performance 94 GHz power amplifier.
- (U) Demonstrate high efficiency power combining technique of solid state devices operating at 44 GHz.
- (U) Fabricate reconfigurable antenna using microtip technology.
- (U) Field test cooperative angle jamming technique and high resolution radar.
- (U) Fast Computational Algorithms (\$12.6M): Continue development of novel algorithms for automatic target detection, materials and microelectronics processing.

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Program Element: #0602702E

Project Number: TT-06 Date: June 1994

PE Title: Tactical Technology

Budget Activity: 2. Exploratory Development

- (U) Develop and test novel wavelet-based algorithms and tools for digital processor and filters.
- (U) Develop methods for multiresolution synthetic aperture radar and adaptive waveform design.
- (U) Apply wavelet design tools to tactical communications and target recognition.
- (U) Demonstrate fast multipole radar cross section code for an order-of-magnitude increase in capability.
- (U) Develop simulation tools, signal processing and modern control methods for in-situ sensing and real-time control of materials and microelectronics processing.
- (U) Develop optimal phase-shift mask design methods.
- (U) Miniature SENGAP turbine engine (\$4.0M): Flight test miniature SENGAP engine to validate successful bench testing and integration with decoy air vehicle concept.
- (U) Advanced Infrared Signature Suppression (\$2.8M): Complete Phase 2 of longwave infrared (LWIR) program.
- (U) FY 1996 Planned Program:
 - (U) Compact Lasers (\$7.0M): Demonstrate compact lasers and active tracking systems at mid infrared wavelengths for infrared countermeasures.
 - (U) Demonstrate mid infrared lasers at 2 watt output with 10 Kiloherzt (KHz) pulse repetition rate, packaged for cable car testing.
 - (U) Demonstrate and test compact active tracking system brassboard for mid infrared wavelengths.
 - (U) Holographic Data Storage (\$6.0M): Technology demonstration to establish system trade-offs of various candidate materials for holographic data storage.
 - (U) Demonstrate proof-of-principle holographic data storage devices to establish the capability of various multiplexing methods and error detection and correction schemes.
 - (U) Precision Optics (\$1.6M): Precision refractive and reflective optics for critical DoD applications.

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Program Element: #0602702E
PE Title: Tactical Technology

Project Number: TT-06 Date: June 1994
Budget Activity: 2. Exploratory Development

- (U) Create high precision, flexible computer controlled fabrication of refractive and reflective optics.
 - (U) Pulsed Radio Frequency (RF) (\$1.0M): Continue fabrication and demonstration of advanced RF amplifiers and power combining techniques.
 - (U) Demonstrate low voltage operation of microtriode amplifier operating at high frequency.
 - (U) Demonstrate high efficiency power combining technique of solid state amplifiers.
 - (U) Fast Computational Algorithms (\$5.6M). Complete development of novel algorithms for automatic target detection and recognition; validate and begin transition.
 - (U) Demonstrate wavelet-based methods for data compression and clutter/noise removal.
 - (U) Demonstrate wavelet-based methods for automatic target detection and recognition.
 - (U) Demonstrate multiresolution methods and adaptive waveforms for image formation and processing.
 - (U) Advanced Infrared Signature Suppression (\$3.9M): Initiate development of advanced infrared (IR) suppression technologies for advanced aircraft.
- (U) FY 1997 Planned Program:
- (U) Compact Lasers (\$7.0M): Demonstrate breadboard systems of compact high power tunable mid infrared lasers, and laser diodes operating at mid infrared wavelengths.
 - (U) Demonstrate laboratory breadboard tunable mid infrared lasers at 10 watt output with 10 Kiloherztz (KHz) pulse repetition rate for large aircraft infrared countermeasures.
 - (U) Demonstrate mid infrared laser diodes.
 - (U) Holographic Data Storage (\$5.0M): Technology demonstration to establish functional limits of holographic data storage.
 - (U) Demonstrate holographic data storage testbeds for functional evaluation of write once read many (WORM) storage systems.

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Program Element: #0602702E

Project Number: TT-06 Date: June 1994

PE Title: Tactical Technology

Budget Activity: 2. Exploratory Development

- (U) Precision Optics (\$6.3M)
 - (U) New methodology for unconventional optics such as gradient index optics or diffractive optics.
- (U) Fast Computational Algorithms (\$6.0M). Transition novel algorithms for automatic target detection and recognition to selected applications.
 - (U) Complete final algorithm selection and validation for system insertion.
- (U) Advanced Infrared Signature Suppression (\$4.9M): Continue development of advanced IR suppression technologies for advanced aircraft.

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: Major performers include: Hughes Aircraft Company, El Segundo, CA; Science Research Laboratory, Somerville, MA; TRW, Redondo Beach, CA; Lockheed/Sanders, Nashua, NH; Varian Associates, Palo Alto, CA; Honeywell, Bloomington, MN; Northrop Corporation, Hawthorn, CA; Northrop, Pico Rivera, CA; McDonnell Douglas, St Louis, MO; and Sundstrand Power System, San Diego, CA.

E. (U) RELATED ACTIVITIES: All programs are coordinated with Services' R&D programs to promote technology transfer and avoid duplication of effort.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Advanced Research Projects Agency (ARPA) is also an active participant in the US-UK Information Exchange Program on laser technology and effects.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602708E Project Number: IC-03 Date: June 1994
 PE Title: Integrated Command and Control Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: High Definition Systems (HDS)

Popular Name	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
IC-03	84,800	67,950	68,000	68,000	68,000	68,000	68,000	68,000	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element is budgeted in the Exploratory Development Budget Activity because it develops the technology and manufacturing capability for high definition displays and is important for virtually all DoD applications that involve visual and graphic information. Major components of this program include: projection, head mounted and direct view displays based on multiple technologies; display architectures and processors; compression algorithms; and high speed data transmission. These efforts will establish a domestic technical capability and demonstrate the manufacturing capability of components necessary for military systems that capture, process, store, distribute and display high resolution images.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
- (U) Continued development of flat panel and projection displays for aircraft cockpit, shipboard and mobile computing and communications applications. (\$19.6M)
 - (U) Continued development of enabling technology critical to high projection display performance. (\$13.7M)
 - (U) Developed imaging systems and processes needed to realize high information throughput. (\$6.5M)
 - (U) Completed active matrix liquid crystal display (AMLCD) Pilot Demonstration Facility. (\$25.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602708E

Project Number: IC-03 Date: June 1994

PE Title: Integrated Command and Control Technology

Budget Activity: 2. Exploratory Development

- (U) Initiated second AMLCD manufacturing testbed facility. (\$20.0M)

- (U) FY 1995 Planned Program:
 - (U) Continue development of flat panel and projection displays for aircraft cockpit applications, mobile computing displays, and shipboard and landbased command and control centers. (\$28.0M)
 - (U) Continue enabling material and component technologies for performance and cost goals for liquid crystal materials, polymer electroluminescent materials, light weight optics, polarizers, color filters, flat backlights, projection lamps, field emitter materials and structures, and phosphors. (\$8.0M)
 - (U) Develop manufacturing equipment and processes for the affordable production of high definition displays. Flat panel display manufacturing equipment will be scaled up to handle larger substrates at higher throughputs with improved process capability. (\$7.0M)
 - (U) Design and fabricate radio-based communications modules and components. (\$8.0M)
 - (U) Develop displays with integrated computation and image processing. (\$4.0M)
 - (U) Develop U.S. display infrastructure and help foster new domestic display business by reducing business risk and dependence on foreign suppliers. (\$8.0M)
 - (U) Develop improved phosphor materials and deposition processes for emissive displays (electroluminescent, field emission and plasma displays), and train people in phosphor technology. (\$5.0M)

(U) FY 1996 Planned Program:

- (U) Continue development of flat panel and projection displays for aircraft cockpit applications, mobile computing displays, and shipboard and landbased command and control centers. (\$30.0M)
- (U) Continue development of enabling material and component technologies including liquid crystal materials, electroluminescent materials, phosphors, laser illumination sources, projection screens, projection lamps, thin film transistors and color filters to meet display cost and performance goals. (\$7.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602708E

Project Number: IC-03 Date: June 1994

PE Title: Integrated Command and Control Technology

Budget Activity: 2. Exploratory Development

- (U) Continue development of manufacturing equipment and processes for the affordable production of high definition displays. Printing processes and equipment will be developed to deposit and pattern photoresist, metals, insulators and semiconductors over large areas in a single step. (\$8.0M)
- (U) Continue development of U.S. display manufacturing supplier infrastructure. (\$13.0M)
- (U) Develop technologies that will increase display system functionality while constraining cost by integrating microprocessors, memory, sensors and new features into displays. (\$4.0M)
- (U) Continue developing imaging systems technology to realize high information throughput display systems. (\$6.0M)

(U) FY 1997 Planned Program:

- (U) Continue development of flat panel and projection displays for aircraft cockpit applications, mobile computing displays, and shipboard and landbased command and control centers. (\$26.0M)
- (U) Continue development of enabling material and component technologies including liquid crystal materials, electroluminescent materials, phosphors, laser illumination sources, projection screens, projection lamps, thin film transistors and color filters to meet display cost and performance goals. (\$6.0M)
- (U) Continue development of manufacturing equipment and processes for the affordable production of high definition displays. Printing processes and equipment will be developed to deposit and pattern photoresist, metals, insulators and semiconductors over large areas in a single step. (\$10.0M)
- (U) Continue development of US display manufacturing supplier infrastructure. (\$11.0M)
- (U) Develop technologies that will increase display system functionality while constraining cost by integrating microprocessors, memory, sensors and new features into displays. (\$7.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602708E

PE Title: Integrated Command and Control Technology

Project Number: IC-03

Date: June 1994

Budget Activity: 2. Exploratory Development

- (U) Continue developing imaging systems technology to realize high information throughput display systems. (\$8.0M)

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: The major performers are: Xerox Corporation, Palo Alto, CA; Photon Dynamics, Inc., San Jose, CA; XMR, Inc., Santa Clara, CA; Texas Instruments, Dallas, TX; MRS Technology, Inc., Chelmsford, MA; Planar Systems, Beaverton, OR; Sarnoff Research Center, Princeton, NJ; Zenith Corporation, Chicago, IL; Silicon Video, Cupertino, CA; Micron Display, Boise, ID; and Optical Imaging Systems, Troy, MI.

E. (U) RELATED ACTIVITIES: This project is coordinated with the advanced display technology being developed by the Army Electronics Devices and Technology Laboratory and the Air Force Aircraft Cockpit Integration Directorate and Manufacturing Technology (MANTECH) Directorate at Wright Laboratory. There is no unnecessary duplication within DoD.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Date: June 1994
 PE Title: Materials and Electronics Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
MPT-01 Materials Processing Technology	129,104	106,824	114,085	122,140	152,506	148,139	157,640	194,240	Continuing	Continuing
MPT-02 Electronic Processing Technology	94,332	88,471	93,931	104,928	114,252	116,453	151,453	183,453	Continuing	Continuing
MPT-06 High Temperature Superconductivity (HTSC)	37,788	14,238	4,000	0	0	0	0	0	0	91,487
MPT-07 Military Medical/Trauma Care Technology	0	15,295	28,000	28,002	33,498	38,500	43,500	47,500	Continuing	Continuing
TOTAL	<u>261,224</u>	<u>224,828</u>	<u>240,016</u>	<u>255,070</u>	<u>300,256</u>	<u>303,092</u>	<u>352,593</u>	<u>425,193</u>	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element is budgeted in the Exploratory Development Budget Activity because its objective is to develop technology related to those materials, electronics, and medical devices that make possible a wide range of new military and commercial capabilities. Many of the programs contained in this Program Element reflect the Department's initiative to support dual-use technologies.

(U) The Materials Processing project (MPT-01) concentrates on the development of novel materials, processing techniques, and fabrication strategies for production of higher performance advanced structural and electronic materials manufactured at a lower cost. It includes research on composite materials, synthesis of diamond films; insertion of ceramics into military system components; flexible solid freeform manufacturing; toxic waste elimination; modeling and

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Date: June 1994

Budget Activity: 2. Exploratory Development

simulation of vapor phase processing of thin film materials; development of high power, high temperature semiconductors; and adaptive ("smart") materials and structures.

(U) The Electronics Processing project (MPT-02) develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, and materials for infrared devices. Areas of emphasis include high-performance analog-to-digital converters, military optical processors, novel optoelectronic devices, artificial neural network technology, low power electronics and semiconductor process design and synthesis.

(U) The High Temperature Superconductivity project (MPT-06) materials have reached a stage of development when specific applications have been identified in thin-film electronic devices and circuitry for military avionics with concomitant benefit to commercial electronics.

(U) Military Medical/Trauma Care Technology project (MPT-07) is an initiative to significantly improve battlefield trauma care. The Advanced Biomedical Technology portion focuses on the human factors of advanced technology concepts in a front-line battlefield environment through development of body-worn monitors, field-portable digital imaging equipment, and battlefield surgical simulators. The Health Care Information segment concentrates on development of physician, medic, and community information associates for utilization by both medics during combat care scenarios and physicians during patient visits.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-01 Date: June 1994
 PE Title: Materials and Electronics Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MPT-01 Materials Processing Technology	129,104	106,824	114,085	122,140	152,506	148,139	157,640	194,240		Continuing Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: The major goals of this project are to develop novel affordable materials, processing techniques, and fabrication strategies for production of advanced structural and electronic materials and components and devices with improved performance and at lower manufacturing costs. A major area of concentration is the application of process modeling, sensors, and advanced control to materials manufacturing thin film processing, large area multichip module manufacture, and flexible fabrication and assembly. Other predominant areas include: biosensors for chemical surveillance and digital imaging systems for battlefield trauma care; research on composites (metal matrix, polymer matrix, ceramic matrix, carbon-carbon and microlaminate) for advanced aerospace structural materials to upgrade gas turbine engine and airframe components. Additional areas of focus are synthesis of diamond films for thermal management in electronic packaging; high temperature semiconductors, such as silicon carbide for high power applications in aircraft and electric vehicles; insertion of state-of-the-art ceramics into military system components (bearings, gas turbine engine components); precision machining of high strength alloys, composites and ceramics using laser and electron beam energy sources; flexible energy delivery systems; and process diagnostic tools. Flexible solid freeform manufacturing capabilities are being developed for high performance structural materials (especially ceramics), which will fabricate functional components directly from Computer Aided Design (CAD) files and not require part-specific tooling or operator intervention. Environmental research includes DoD-related toxic waste elimination and "green" manufacturing, which seeks to eliminate or minimize toxic waste produced by manufacturing of products relevant to the DoD.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics Technology

Project Number: MPT-01

Date: June 1994

Budget Activity: 2. Exploratory Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Biotechnology (\$7.9M): Utilized biological technologies to develop sensors and imaging systems for battlefield trauma care.
- (U) Evaluated duration/magnitude of immune response to ultrasonically altered infectious organisms.
- (U) Initiated development of portable digital x-ray imaging system for battlefield trauma care.
- (U) Optimized fluidics subsystem, optimize dynamic range for cell-based biosensor.
- (U) Demonstrated detection of anti-metabolic agents in re-hydrated cells.
- (U) Completed toxicity and efficacy studies in models (Lyme disease demonstration application); completed cloning of parasitic antigens and initiated studies (malaria demonstration application).
- (U) High Temperature Structural Materials (\$46.0M): Developed and demonstrated in affordable components, structural materials (composites, ceramics, alloys) for jet engines, airframes, missiles and other DoD systems.
- (U) Identified preliminary on-line sensing concepts for composite density enhancement during direct conversion of liquid hydrocarbon to pyrolytic carbon composite matrix; developed reaction chemistry for incorporation into computational process model.
- (U) Demonstrated feasibility for an order of magnitude increase in materials utilization efficiency during vapor deposition of titanium matrix in the manufacture of silicon carbide reinforced titanium matrix composites using metal matrix composite model factory.
- (U) Demonstrated the upgrade potential of the M1A2 tank dual-axis head mirror assembly with silicon carbide mirrors which replace nickel-coated beryllium metal and thereby improve durability while decreasing environmental liabilities.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics
Technology

Project Number: MPT-Q1

Date: June 1994

Budget Activity: 2. Exploratory Development

- (U) Initiated a program on manufacturing of silicon carbide fiber reinforced titanium alloys for components in aircraft gas turbine engines.
- (U) Material and Device Manufacturing (\$19.0M): Fabricated functional prototype components directly from Computer Aided Design (CAD) files. Reduced cost of final machining and assembly of composites and other structures. Developed processing technologies for manufacturing multi-chip modules.
- (U) Demonstrated solid freeform fabrication machine capability to produce particulate reinforced metal matrix composites with mechanical properties comparable to those manufactured by conventional methods.
- (U) Developed concepts of flexible manufacturing to actively correct machine error using adaptive materials.
- (U) Initiated a cross-disciplinary materials research program, which included research on electro-optics, catalysts for hazardous and toxic substance disposal, diamond film growth, and durable protective oxidation-resistant coatings for superalloys.
- (U) Developed concepts for flexible methods for laser shaping materials that undergo plastic flow.
- (U) Identified large format manufacturing materials and critical unit processes and initiated materials and equipment development for multi-chip module (MCM) manufacturing.
- (U) Advanced Materials and Processing (\$18.9M): Reduced processing cost of advanced composites, electronic/photonic materials, and smart materials/structures. Incorporate simulation, modeling and intelligent processing of materials concepts.
- (U) Initiated program in high temperature, high power semiconductor for aircraft and electric vehicle applications.
- (U) Initiated program to model and simulate vapor processing of materials and plasma etch processes.
- (U) Initiated program to develop theoretical models to predict mechanical properties of compositionally modulated multilayer structural composites.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01

Date: June 1994

PE Title: Materials and Electronics
Technology

Budget Activity: 2. Exploratory Development

- (U) Initiated program to develop intelligent processing production of materials for smart structures.
- (U) Initiated program to develop smart materials mechanics theories.
- (U) Batteries (\$6.3M): Improved energy density of military batteries.
- (U) Continued program on rapid prototyping of solid polymer electrolyte rechargeable ambient temperature batteries to provide power for a wide range of manportable military electronic equipment, in addition to laptop computers, cellular phones, and other portable electronics.
- (U) Vapor Phase Processing (\$12.5M): Developed low-cost processing of diamond films and photovoltaics for electronic applications.
- (U) Demonstrated on-line sensors and feedback control of chemical vapor deposition reactors; implemented second-generation control systems on direct current (DC) arc reactor systems; increased diamond manufacturing throughput with increased deposition rate, area and yield.
- (U) Demonstrated feasibility for low-cost, high-rate, high materials utilization efficiency manufacturing of copper-indium-diselenide multilayer photovoltaics using cylindrical magnetron sputtering.
- (U) Environmental Science (\$13.5M)
 - (U) Initiated program to develop new casting practices which reduce the emissions of foundaries in anticipation of Clean Air Act standards for benzene, formaldehyde, and hydrocarbons focusing on emissions measurements, core and mold making technology, metal melting treatments and handling, sand reclamation, and emissions control.
- (U) Coal Utilization (\$5.0M)
 - (U) Continued research for further reductions in gaseous and particulates emissions when firing coal-based fuels in industrial-scale boilers.
 - (U) Developed coal-based fuel/waste co-firing technologies.
 - (U) Identified and tested coal-based technologies that are suitable for small-scale heat and/or power applications.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01 Date: June 1994

PE Title: Materials and Electronics Technology

Budget Activity: 2. Exploratory Development

(U) FY 1995 Planned Program:

- (U) Biotechnology (\$1.9M): Complete program and transition to Advanced Biomedical Technology Program. (Project MPT-07 and PE 0601101E project MS-01)
- (U) Demonstrate biosensor device gain by modulation of intrinsic cellular amplification system (second messenger system) and complete cell-based biosensor.
- (U) High Temperature Structural Materials (\$24.9M): Develop affordable composites using intelligent processing of materials and automated manufacturing concepts.
- (U) Demonstrate on-line sensing of critical product and process variables and multivariable feedback control of the rapid densification manufacturing process for carbon-carbon composites, and for binder burnout for metal and ceramic powder products.
- (U) Demonstrate economic polymer composite manufacturing using advanced fiber placement techniques.
- (U) Develop advanced electron beam curing process suitable for on-line production of polymer matrix composites.
- (U) Develop cost effective manufacturing process for silicon carbide fiber reinforced titanium for turbine engine components.
- (U) Demonstrate the reduced mean time between failure (MTBF) associated with the upgrade of glass optical domes to spinel optical domes used in the Angle Rate Bombing Set (ARBS) of the AV-8B Harrier aircraft.
- (U) Material and Device Manufacturing (\$33.7M): Extend program to address hard and soft tooling, laser cutting and manufacturing capabilities for multi-chip modules.
- (U) Develop prototype design for adaptively-controlled machine tools, including a control scheme to correct machine errors.
- (U) Characterize thermo-mechanical properties of laser shaped parts; develop real-time process controls for laser shaping.
- (U) Develop and apply sensor technologies for on-line process control for the large-format and roll-to-roll unit manufacturing tools identified for development of multi-chip modules.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01 Date: June 1994

PE Title: Materials and Electronics
Technology

Budget Activity: 2. Exploratory Development

- (U) Demonstrate performance of large format unique materials in the manufacture of multichip modules.
- (U) Utilize selected laser sintering and 3-D printing solid free-form fabrication, demonstrate structural ceramic and metal components with strengths comparable to what can be produced using mass manufacturing methods.
- (U) Advanced Materials and Processing (\$24.8M): Continue processing developments for affordable materials.
 - (U) Improve defect density in semiconducting silicon carbide boules to optimize electrical properties and increase yield.
 - (U) Develop vapor phase simulation code architecture along with process modeling and simulation kernels.
 - (U) Develop computer models for plasma sprayed metal matrix composites.
 - (U) Demonstrate smart materials manufacturability.
 - (U) Develop theoretical and computational methods to predict structural and electro-optic properties for semiconductor superlattices.
- (U) Vapor Phase Manufacturing (\$10.5M): Develop intelligent processing technologies to scale-up cost-effective manufacturing of thin film photovoltaics, multilayer turbine engine coatings, and field effect emitters.
 - (U) Demonstrate vapor deposition process models for physical and chemical vapor deposition.
 - (U) Demonstrate on-line sensing to detect critical process and product parameters in the manufacture of thin film functional multilayer structures.
 - (U) Initiate development of plasma modeling and simulation tools for vapor deposition technologies.
 - (U) Demonstrate cost-effective manufacturing and pilot line scale-up of thin film photovoltaics.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials and Electronics
Technology

Project Number: MPT-01

Date: June 1994

Budget Activity: 2. Exploratory Development

- (U) Environmental Sciences (\$11.0M): Eliminate DoD toxic waste using supercritical water oxidation (SCWO). Reduce toxic waste production as by-products of DoD-related manufacturing processes ("green" manufacturing).
 - (U) Exploit SCWO technology and initiate construction of transportable SCWO system capable of processing 1,000 gallons per day.
 - (U) Develop alternative electronic manufacturing processes for minimization/elimination of toxic wastes.
 - (U) Conduct survey of casting emissions and install research foundry.

- (U) FY 1996 Planned Program:
 - (U) High Temperature Structural Materials (\$17.4M)
 - (U) Demonstrate full-scale rapid densification of carbon-carbon composite components.
 - (U) Demonstrate a five-fold improvement in the life of the roll reaction control (RRC) valve bearings on the AV-8B Harrier aircraft due to the upgrade of the all metal bearings with ceramic hybrid bearings.
 - (U) Validate the Resonant Ultrasonic Inspection Nondestructive Evaluation (NDE) technique for ceramic rolling elements through beta site testing at a commercial ball bearing finisher.
 - (U) Select electron beam curing technology for prototype polymer matrix composite structure demonstration.
 - (U) Evaluate strength and stiffness of metal matrix composite (ceramic fiber reinforced titanium) hollow fan blade for jet engines.
 - (U) Material and Device Manufacturing (\$4.3M)
 - (U) Demonstrate prototype multichip modules with laminate technology compatible with roll to roll manufacturing.
 - (U) Demonstrate the use of X-ray tomography and develop software to generate CAD files from solid objects compatible with requirements of solid freeform manufacturing.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01 Date: June 1994

PE Title: Materials and Electronics Technology

Budget Activity: 2. Exploratory Development

- (U) Develop the machine capability to produce silicon nitride components using the fused deposition method with silicon nitride powder loaded wax filaments.
- (U) Demonstrate the capability to fabricate molds for slip casting structural ceramics using the 3-D printing technology.
- (U) Demonstrate application of smart materials to reconfigurable machines and tooling hardware.
- (U) Advanced Materials and processing (\$25.9M)
 - (U) Develop a Chemical Vapor Deposition (CVD) process for the fabrication of particulate and chopped fiber reinforced composites with 10X increase in composite growth rate over normal CVD processing; and demonstrate the utility of the fabricated composites for the die casting of copper alloys.
 - (U) Design, fabricate and evaluate fiber reinforced ceramic matrix composites fins for the US Army's Line of Sight Anti-Tank (LOSAT) missile with a 50% weight savings over the current materials (steel).
 - (U) Develop simulation codes for vapor processes and validate on industrial processes and reactors.
 - (U) Develop feedback control methods for plasma sprayed metal matrix composites.
 - (U) Demonstrate greater than 50 fold increase in CVD diamond deposition rate (from 60 mg/hr to greater than 3000 mg/hr) with a large area and high rate deposition system.
 - (U) Develop stable contacts for high temperature, high power semiconductors.
 - (U) Demonstrate material sensor and activator components manufacturability utilizing piezoelectric ceramics and electrostrictors.
- (U) Vapor Phase Processing (\$11.6M)
 - (U) Demonstrate automated pilot line manufacture of thin film photovoltaic panels.
 - (U) Demonstrate an order of magnitude improvement in jet engine compressor blade erosion resistance with multilayer coatings.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-01 Date: June 1994
PE Title: Materials and Electronics Technology Budget Activity: 2. Exploratory Development

- (U) Environmental Sciences (\$14.9M)
 - (U) Design a supercritical water oxidation system for shipboard use in waste disposal.

- (U) FY 1997 Planned Program
 - (U) High Temperature Structural Materials (\$19.6M)
 - (U) Evaluate rapidly densified carbon-carbon composites as rotating jet engine components.
 - (U) Demonstrate the operational reliability and an increased mean time between failures (MTBF) greater than 2X, associated with the upgrade of carbon engine starter oil face seals on aircraft (C-5, A-10, KC135R, F-111, C-130 and C-141) with ceramic face seals.
 - (U) Design, build and test a solid-state ceramic oxygen membrane generating system (COGS) for aircraft use.
 - (U) Demonstrate commercial feasibility of electron beam curing polymer matrix composite large-scale structures.
 - (U) Materials and Device Manufacturing (\$42.4M)
 - (U) Demonstrate the capability to produce ceramic components with complex geometry and dimensional tolerances and mechanical properties comparable to mass manufactured advanced ceramics using the Jet Printer technology (3-D printing).
 - (U) Develop a new solid freeform build method for ceramic components based on layer by layer photolithography utilizing either large area liquid crystal display, or a light emitting diode display technology for electronic/programmable photomasks.
 - (U) Test reconfigurable machines and tools in shop floor beta test sites.
 - (U) Demonstrate fabrication process for microintegrated smart materials.
 - (U) Demonstrate roll to roll pilot line manufacture of laminate multichip modules.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01 Date: June 1994

PE Title: Materials and Electronics Technology

Budget Activity: 2. Exploratory Development

- (U) Advanced Materials and Processing (\$31.3M)
 - (U) Determine the economic viability of Templated Grain Growth (TGG), where solid phase epitaxy of crystallographically oriented seeds on near net shaped polycrystalline components is used for growth of single crystal like oxides.
 - (U) Determine the performance characteristics of low cost, damage tolerant fibrous monolith components in engine environments.
 - (U) Demonstrate control of plasma sprayed metal matrix processing and extend models to physical vapor deposition of metal coated fibers.
 - (U) Complete development of a plasma/ion etch computer code.
 - (U) Demonstrate predictive capability of high-pressure chemical vapor deposition low-order models and demonstrate feedback control to a desired wafer state.
 - (U) Optimize processing parameters to demonstrate chemical vapor deposition (CVD) diamond manufacturing costs of about \$2.00 per sq. cm.
 - (U) Grow single crystal boules for three inch diameter silicon carbide semiconductor wafers by scaling up the reactor and developing larger seed crystals.
 - (U) Demonstrate vibration reduction in machine tools via specially designed sensor/actuator elements to enhance machining tolerances by a factor of ten.
- (U) Vapor Phase Processing (\$12.9M)
 - (U) Demonstrate a 5X cost reduction with thin film manufacture of photovoltaic modules.
 - (U) Demonstrate feasibility of cost effective manufacture of field emission device components.
- (U) Environmental Sciences (\$15.9M)
 - (U) Demonstrate a supercritical water oxidation pilot plant for waste treatment aboard a naval vessel.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-01 Date: June 1994

PE Title: Materials and Electronics
Technology

Budget Activity: 2. Exploratory Development

(U) Program to Completion:

- (U) This is a continuing program.

D. (U) WORK PERFORMED BY: Major performers are: United Technologies Research Center, East Hartford, CT; General Electric Corporation, Schenectady, NY; Sandia Laboratories, Livermore, CA; Norton Company, Northboro, MA; 3M Corporation, St. Paul, MN; Allied Signal Aerospace Company, Phoenix, AZ; Pratt & Whitney, West Palm Beach, FL; Lanxide Corporation, Newark, DE; General Dynamics, Groton, CT; Raytheon Corporation, Tewksbury, MA; Textron Special Materials, Lowell, MA; University of Texas, Austin, TX; Massachusetts Institute of Technology, Cambridge, MA; Aracor Corp, Sunnyvale, CA; Martin Marietta Laboratories, Baltimore, MD; McDonnell Douglas Aerospace, St. Louis, MO; Boeing Military Aircraft, Seattle, WA; and General Atomics, LaJolla, CA.

E. (U) RELATED ACTIVITIES: ARPA's research on Materials Processing is coordinated within DoD and with other federal agencies via the Office of Science and Technology Policy Committee on Civilian Industrial Technology (CIT), Materials Technology (Mat Tech) Subcommittee and various DoD and other topical workshops on materials and materials processing.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-02 Date: June 1994
 PE Title: Material and Electronics Technology Budget Activity: 2. Exploratory Development

(U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total Program
	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	
MPT-02 Electronics Processing Technology	94,332	88,471	93,931	104,928	114,252	116,453	151,453	183,453	Continuing	Continuing							

B. (U) BRIEF DESCRIPTION OF PROJECT: This project develops advanced electronic and optoelectronic devices, semiconductor process tools and methodologies, materials for optoelectronics and infrared devices. Areas of emphasis include high-performance analog-to-digital converters (ADCs), military optical processors, novel optoelectronic devices and modules, artificial neural network technology, low power electronics and semiconductor process design and synthesis. This optoelectronic development project creates the technology base for advanced electronic and optoelectronic components to meet DoD needs. In this project the feasibility of promising research results are developed to the point where their military utility can be determined. Many of the tasks in this project culminate in a subsystem prototype insertion demonstration.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Tested first iteration GaAs heterojunction bipolar transistor (HBT)-based ADCs for sampling speed and dynamic range. (\$7.0M)
- (U) Completed design and demonstration of GaAs HBT-based ADCs support components, such as multiplexers and demultiplexers. (\$4.0M)
- (U) Initiated effort to develop a design system for circuits operating above 10 GHz. (\$ 2.4M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Material and Electronics
Technology

Project Number: MPT-02

Date: June 1994

Budget Activity: 2. Exploratory Development

- (U) Initiated development of neural network-based systems for signal processing applications (including signal demodulation, noise removal, face recognition, character recognition, large-vocabulary speech recognizers and multi-modal command systems for computer interfaces). (\$4.0M)
- (U) Developed neural network automatic target recognizer for future insertion into the Comanche Helicopter. (\$0.8M)
- (U) Demonstrated electronic neural network hardware boards with speeds of up to 10 billion operations per second, and developed component technologies for optoelectronic systems that promise up to 10 trillion operations per second. (\$3.0M)
- (U) Completed studies on requirements and candidate hardware/software designs for an Advanced Vision System (AVIS) that will accelerate image processing and recognition algorithms. (\$2.9M)
- (U) Demonstrated optically controlled phased arrays and fiber-optic-based bistatic radar. (\$2.7M)
- (U) Demonstrated optical pattern recognition modules. (\$2.2M)
- (U) Demonstrated acousto-optic pulse compression signal processor and jammer nulling processor. (\$2.5M)
- (U) Demonstrated optical electronic warfare channelizer and precision direction finder. (\$1.7M)
- (U) Developed packaged optoelectronic-microwave modules for microwave transmission. (\$1.0M)
- (U) Developed integrated monolithic tunable laser arrays. (\$2.7M)
- (U) Initiated efforts to develop low-cost optoelectronic module manufacturing technologies. (\$16.5M)
- (U) Developed optoelectronic packages that incorporate passive alignment techniques between fibers and component input/output (I/O). (\$4.5M)
- (U) Established consortia for rapid automated optical alignment packaging and for accelerated development of blue lasers for insertion into laser memory disk systems. (\$8.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-02 Date: June 1994

PE Title: Material and Electronics Technology

Budget Activity: 2. Exploratory Development

- (U) Improved ferroelectric memory cell performance, especially imprint characteristics. (\$1.4M)
- (U) Initiated optical and electrical characterization of III-V bulk materials for optoelectronic and infrared device applications. (\$2.5M)
- (U) Initiated fabrication and evaluation of wide bandgap II-VI blue emitters produced on III-V substrates. (\$4.0M)
- (U) Completed design of crystal growth system for 1kg InGaAs boule for 50mm diameter substrates. (\$3.0M)
- (U) Initiated program to optimize computer architecture and supporting design systems that fully exploit area array interconnects and multi-chip-module packaging. (\$8.5M)
- (U) Initiated program to demonstrate speed optimization with cryo cooling. (\$7.0M)
- (U) Initiated a program to demonstrate a large format plasma processing of chemical vapor deposition (CVD) diamond. (\$2.0M)
- (U) FY 1995 Planned Program:
 - (U) Validate high speed heterojunction bipolar transistor (HBT) technology by manufacturing components on pilot production lines. (\$17.5M)
 - (U) Demonstrate the high-speed HBT process via components in a system application. (\$2.7M)
 - (U) Establish transitions for mature neural network signal processing systems (including signal demodulators and adaptive filters), and continue development of high-performance end-to-end systems (including speech recognizers, human computer interfaces, and image recognizers). (\$4.5M)
 - (U) Comprehensively test neural network target recognizer in preparation of insertion into Comanche Helicopter. (\$1.0M)
 - (U) Perfect electronic neural network boards and demonstrate on realistic applications; demonstrate optoelectronic hardware at 1 trillion operations per second. (\$3.7M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-02 Date: June 1994

PE Title: Material and Electronics
Technology

Budget Activity: 2. Exploratory Development

- (U) Establish the Advanced Vision Systems (AVIS) architecture framework and design custom chips. (\$5.0M)
- (U) Establish AVIS software requirements and initiate software development (including custom compilers, languages, debuggers, case tools, libraries, and environments). (\$2.9M)
- (U) Develop key components for affordable optoelectronic modules. (\$10.0M)
- (U) Field demonstration of optical pattern recognition modules, optical real-time synthetic aperture radar processor and pulse compression signal processor. (\$1.0M)
- (U) Demonstrate advanced serial and parallel optoelectronic busses. (\$6.7M)
- (U) Initiate insertion of prototype optoelectronic modules into system applications. (\$5.0M)
- (U) Establish manufacturing infrastructure for optoelectronic modules. (\$5.0M)
- (U) First pass design of process synthesis framework architecture. (\$5.7M)
- (U) Development of the process synthesis architecture database methodology. (\$5.3M)
- (U) Development of reliability prediction simulation. (\$1.3M)
- (U) Develop 3.3 volt silicon on insulator (SOI) technology. (\$8.0M)
- (U) Develop unit simulation CAD tools. (\$3.2M)

(U) FY 1996 Planned Program:

- (U) Deliver fully tested analog to digital converters, digital to analog converters, and multiplexers and demultiplexers. (\$2.5M)
- (U) Initiate prototype projects using heterojunction bipolar transistor components. (\$5.5M)
- (U) Establish transitions for high-performance neural network systems (including speech recognizers, human computer interfaces, and image recognizers). (\$4.0M)
- (U) Develop neural network sensor fusion techniques for automatic target recognition for future insertion into Comanche and other platforms. (\$1.5M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-02 Date: June 1994

PE Title: Material and Electronics Technology

Budget Activity: 2. Exploratory Development

- (U) Establish transitions for electronic neural network hardware boards and demonstrate full-scale optoelectronic systems at 10 trillion operations per second. (\$3.2M)
- (U) Fabricate and test custom hardware for the Advanced Vision Systems (AVIS) program; develop packaging and integration strategies. (\$4.6M)
- (U) Develop first generation AVIS software (including custom compilers, languages, debuggers, case tools, libraries, and environments). (\$5.0M)
- (U) Develop critical subassemblies for digital optoelectronics processors. (\$2.5M)
- (U) Develop key components of an optical backplane. (\$9.0M)
- (U) Develop packaged affordable serial output (serial or parallel data in) optoelectronic modules. (\$10.0M)
- (U) Develop packaged cost effective parallel output (parallel in, parallel out) optoelectronic modules. (\$10.0M)
- (U) Initiate development of analog optoelectronic modules for microwave/millimeter transmission. (\$10.0M)
- (U) Demonstrate reliability and cost predictors for mainstream IC manufacturing processes. (\$1.9M)
- (U) Demonstrate product prototype using process synthesis framework in an IC manufacturing environment. (\$2.8M)
- (U) Develop integrated process simulator for semiconductor integrated circuit manufacturing. (\$10.0M)
- (U) Develop 1.5 volt silicon on insulator (SOI) technology. (\$8.0M)
- (U) Develop circuit synthesis CAD tools. (\$1.7M)
- (U) Demonstrate self-clocking circuits. (\$1.7M)

(U) FY 1997 Planned Program:

- (U) Develop integrated CAD tool set. (\$7.6M)
- (U) Initiate demonstration of high speed analog to digital prototype. (\$12.0M)
- (U) Complete Advanced Vision Systems (AVIS) hardware modules. (\$3.0M)
- (U) Refine and complete AVIS software based on user feedback. (\$4.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-02 Date: June 1994
PE Title: Material and Electronics Budget Activity: 2. Exploratory Development
Technology

- (U) Demonstrate AVIS on image recognition application. (\$0.9M)
- (U) Demonstrate optoelectronic processor breadboard. (\$2.0M)
- (U) Demonstrate neural network data fusion techniques in systems concept. (\$8.0M)
- (U) Demonstrate blue/green lasers with 25 hour lifetime. (\$3.0M)
- (U) Demonstrate packaged serial optoelectronic modules and identify dual use applications. (\$8.0M)
- (U) Demonstrate packaged affordable parallel output (parallel in, parallel out) optoelectronic modules. (\$8.0M)
- (U) Demonstrate optical backplane compatible with electronic packaging approaches. (\$9.0M)
- (U) Continue development of analog optoelectronic modules for radio frequency (RF) transmission and develop millimeter wave-optical RF distribution antenna network. (\$15.0M)
- (U) Using benchmarking, compare process synthesis to conventional approach for integrated circuit design. (\$9.0M)
- (U) Documentation of process synthesis framework design and implementation procedures. (\$2.0M)
- (U) Develop 0.9 volt silicon on insulator (SOI) technology. (\$9.0M)
- (U) Complete development of multi-GHz simulation tools. (\$2.0M)
- (U) Field test low power subsystem. (\$2.4M)

(U) Program to Completion:

- (U) Complete the development of a high speed heterojunction bipolar transistor technology base for system applications.
- (U) Complete development and demonstration of analog optoelectronic modules; demonstrate optical cellular radar, multiple aperture phased array and processing system and millimeter wave-optical beamforming/imaging system.
- (U) Demonstrate architectural design tools to reduce power dissipation in integrated circuits.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-02

Date: June 1994

PE Title: Material and Electronics Technology

Budget Activity: 2. Exploratory Development

- (U) Transition low power silicon integrated circuit technology to SEMATECH (PE 0603745E).
- (U) Establish key producers which have capability to lower cost (by factor of 10) of serial and parallel optical interconnects via passive and active alignment and exploiting new optoelectronic devices such as Vertical Cavity Surface Emitting Lasers (VCSELs).
- (U) Demonstrate optical backplane for distribution of clock and data in higher performance systems compatible with electronic processing approaches.
- (U) Develop reliable blue/green laser technology for high density memory and established potential producer.
- (U) Demonstrate viable approach to a free space based reconfigurable optoelectronic parallel processor.
- (U) Demonstrate operation of Advanced Vision System (AVIS) accelerator modules in high performance computing and workstation host environments.

D. (U) WORK PERFORMED BY: Johnson Matthey, Spokane, WA; Rockwell, Anaheim, CA; University of Michigan, Lansing, MI; Honeywell, Minneapolis, MN; Lawrence Livermore National Laboratory, Livermore, CA; Lincoln Lab, Lexington, MA; TRW, Los Angeles CA; University of Utah, Salt Lake City, UT; University of Arkansas, Little Rock, AR; Worcester Polytechnic Institute, Worcester, MA; Hughes Research Laboratory, Malibu, CA; Harris, Melbourne, FL; Hughes Aircraft Company, Malibu, CA; and Texas Instruments, Dallas, TX.

E. (U) RELATED ACTIVITIES: The work is coordinated with Service research efforts through the Advisory Group on Electron Devices and via annual government-wide program reviews. These activities assure that no duplication of effort occurs.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-06 Date: June 1994
PE Title: Materials and Electronics Budget Activity: 2. Exploratory Development
Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
MPT-06 High Temperature Superconductivity (HTSC)	37,788	14,238	4,000	0	0	0	0	0	0	91,492

B. (U) BRIEF DESCRIPTION OF PROJECT: High temperature superconducting (HTS) materials have reached a stage of development where specific applications can be identified in thin-film electronic devices and circuitry for military avionics, with concomitant benefit to commercial electronics. The ARPA program is building specific insertions for radar and electronic detection systems with extremely wide bandwidth and dynamic range, general avionics, and airframe guidance subsystems, while continuing with the development of the underlying fabrication technology for thin films, bulk wire and other forms. Particular demonstrations include a switched filterbank for the B-1B radar warning receiver, superconducting electronic packages for electronic intelligence (ELINT) and electronic warfare suites in reconnaissance aircraft, and safe and economical devices for riveting and clamping sheet metal sections for aircraft manufacturing.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) High Temperature Superconductors/Analog and Digital Applications (\$23.5M): Addressed insertions for HTS materials in thin-film analog and digital electronic devices and circuitry. Transitioned the technology to applications such as computer-aided engineering (CAE) software tools for HTS circuit characterization and optimization, and integration of available cryogenic refrigerators with HTS devices.
- (U) Continued development of optically-switched 30 element HTS filterbank to enable signal discrimination in radar warning receivers (RWR) in a dense countermeasures environment.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-06 Date: June 1994

PE Title: Materials and Electronics Technology

Budget Activity: 2. Exploratory Development

- (U) Improved acoustical damping of stabilized oscillator (STALO) based upon high-Q high temperature superconducting (HTS)/sapphire resonant cavity; to achieve a factor of 100 improvement over current radars.
- (U) Characterized performance criteria for radar receiver to detect sea-skimming missiles at adequate ranges in sea clutter, based upon HTS reference source and preselective filterbank integrated with low-noise antenna driver and appropriate closed-cycle cryogenic cooling system.
- (U) Undertook development of an HTS crossbar switch to provide very high connectivity and performance enhancement (X5) over current capability, for application to mainframe computers and telecommunications.
- (U) Fabricated digital circuits such as an asynchronous transfer mode (ATM) switch for the DoD global grid network and/or the commercial information infrastructure.
- (U) Incorporated HTS analog components in cellular telephone and personal communications networks, utilizing the high-power handling and discrimination capability of thin-film HTS tuned filterbanks, delay lines and other components to provide enhanced coverage with better unit isolation.
- (U) Developed wide-bandwidth HTS antennas and high-efficiency HTS coupling networks for application as miniaturized radio frequency (RF) sensors and transmitters in electronic warfare scenarios.
- (U) High Temperature Superconductors/Multi-Chip Modules (MCM) (\$14.3M): Demonstrated a fully functional module utilizing approximately 50 complementary metal oxide semiconductor (CMOS) chips which will operate with X2 greater speed in a more compact form.
- (U) Extended materials processing capabilities to develop ion etching as a planarization technique for insulating dielectric layers and develop photoresist and etching procedures to attain fully reproducible 2 micron interconnect linewidth.
- (U) Developed technology infrastructure by extending commercial computer-aided engineering (CAE) tools for normal metal interconnects to accommodate high temperature superconducting (HTS) interconnects, transitioning such capability to HTS vendors and multi-chip modules (MCM) manufacturers.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-06 Date: June 1994
PE Title: Materials and Electronics Technology Budget Activity: 2. Exploratory Development

- (U) Developed alternate HTS MCM architectures such as the dual-offset mesh plane process.
 - (U) Integrated closed-cycle cryofrigerator with MCM module for a complete push-button system.
- (U) FY 1995 Planned Program:
- (U) High Temperature Superconductors/Analog and Digital Applications (\$14.2M): Select the most promising HTS applications to achieve the planned ramping down of the program:
 - (1) filterbank for suppressing radio warning receivers (RWR) saturation, (2) high resolution radar receiver development, (3) crossbar switch as a component in computers, and (4) analog components applied to communication networks.
 - (U) Extend the switched HTS filterbank to be fully compatible with the RWR requirements of several aircraft Electronic Warfare (EW) suites.
 - (U) Integrate the stabilized oscillator (STALO) with the low-noise antenna driver and preselective filterbank to determine if the noise floor meets performance requirements to detect sea-skimmers.
 - (U) Undertake Complimentary Metal Oxide Semiconductor (CMOS) optimization according to the design proven with gallium arsenide components in room temperature crossbar switch and characterize performance at low temperature with HTS interconnects.
 - (U) Demonstrate function of filter networks, delay lines and other components according to specifications in subscale versions of communication networks.

- (U) FY 1996 Planned Program:
- (U) High Temperature Superconductors/Analog and Digital Applications (\$4.0M): In this final year of the high temperature superconducting (HTS) Program, the focus will be on five insertion opportunities:
 - (U) Provide fully-integrated 32-element filterbank with refrigerator to F-15 project office for aircraft demonstration. Provide 96 element filterbank to B-1B project office for utilization.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-06 Date: June 1994

PE Title: Materials and Electronics Technology

Budget Activity: 2. Exploratory Development

- (U) Complete evaluation of cryo-radar with HTS stabilized oscillator (STALO) and preselective filterbank, and determine performance specifications for low target cross-section detection.
- (U) Complete efforts on crossbar switch and cryo-workstation to insert cryo-optimized packaged semiconductor integrated circuits (IC) in computers.
- (U) Complete funding for Consortium for Superconducting Electronics, with demonstration of prototype cellular base station and Superconducting Quantum Interference Device (SQUID) array for magnetocardiography.
- (U) Demonstration of a high-performance 8x8 asynchronous transfer mode (ATM) cryogenic switch in a wide area network.

(U) FY 1997 Planned Program: Project ends in FY 1996.

D. (U) WORK PERFORMED BY: Major performers include: Superconductor Technologies, Inc., Goleta, CA; Conductus, Inc., Sunnyvale, CA; Massachusetts Institute of Technology, Cambridge, MA; N-Chip, San Jose, CA; E-Systems, Falls Church, VA; Honeywell Corporation, Minneapolis, MN; Boeing Corp., Seattle, WA; Westinghouse Corporation, Baltimore, MD; and DuPont Corporation, Wilmington, DE.

E. (U) RELATED ACTIVITIES: Research is coordinated within DoD and with other federal agencies via the Office of Science and Technology Policy (OSTP) Committee on Materials (COMAT), High Temperature Superconducting (HTS) Coordinating Committee, and numerous workshops involving industry, universities and government laboratories, ensuring that there is no unnecessary duplication of effort.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATION AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-07 Date: June 1994
 PE Title: Materials & Electronics Technology Budget Activity: 2. Exploratory Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
MPT-07 Military Medical/Trauma Care Technology	0	15,295	28,000	28,002	33,498	38,500	43,500	47,500	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF PROJECT: This project is a continuation and consolidation of work previously cited under Program Element 0601101E (MS-01, ES-01, CCS-02), 0602301E (ST-11), and 0602712E (MPT-01). The objective is to revolutionize far-forward battlefield trauma care. The project recognizes that planned downsizing of U.S. forces creates concomitant pressure to ensure force readiness, skill mix, and effective joint doctrine at a time when battlefield casualties carry both strategic importance and tactical relevance. A review of combat casualty care has shown: (1) that 90% of combat deaths occur in the zone of close combat prior to medical or surgical intervention; (2) that fratricide continues at casualty rates as high as 20%-30%; (3) that casualty location is a continuing battlefield problem; (4) that less than 5% of U.S. Army active-duty physicians have treated combat casualties; (5) that realistic peacetime combat medical/surgical training is minimal; and (6) that medical theater-of-war communications are archaic and non-functional.

(U) This project exploits ARPA's unique leadership role in the electronics and information sciences to project advanced medical and surgical care into the far-forward battlefield area to effect early, successful, clinical intervention. Work will develop light-weight personnel status monitors (PSMs) permitting remote non-invasive clinical diagnosis, casualty localization, and friend-foe identification. The PSM, which would be worn by all soldiers as part of their combat uniforms, is further augmented with low power, secure, wireless communications. The PSM would monitor the soldiers' clinical vital signs continuously, but would remain otherwise passive unless either queried by an operational commander or the soldiers' vital signs departed from

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials & Electronics
Technology

Project Number: MPT-07

Date: June 1994

Budget Activity: 2. Exploratory Development

established clinical norms. Use of the personnel status monitor (PSM) should reduce mortality in three ways: (1) it will prevent or reduce casualties from friendly fire by increasing command awareness of precisely where soldiers are located on the battlefield; (2) it will enable combat medics to initiate triage within moments of a soldier's wounding and, because the precise location of the wounded soldier and the critical level of injury or shock is known, will allow medics and surgeons to optimize available treatment and evacuation; and (3) it will identify dead soldiers and thus obviate the need to send evacuation teams into hostile environments.

(U) The program will develop the technology base for (early) far-forward medical/surgical intervention. The goal is to preserve critical organ system function, prevent exsanguination, reverse systemic shock, and prevent hypoxia by use of automatically controlled devices to provide immediate mechanical or pharmacologic therapy. Once pharmacologic or early surgical stabilization has been achieved, the patient will be evacuated in a critical care pod (CCP). The CCP will allow long-range evacuation under controlled physiologic and closed cycle environmental conditions, and will function like a hospital intensive care unit. The CCP will have the capacity for intrasit monitoring of vital signs, will preserve stability by administering fluids, drugs, or summoning human intervention, will mechanically support vital functions, and will provide protection from natural or militarily hostile environments. It will develop enhanced, field portable, digital imaging capabilities for critical examination of wounded combatants, and facilitate real-time transmission of high resolution clinical imagery for analysis by specialists located outside the far-forward combat zone. Initial efforts will focus on the realization of field-portable battlefield digital X-ray imaging systems. This project further develops and exploits capabilities in telemedicine.

(U) This program will develop and exploit advanced simulation technology to improve the training of battlefield health care providers and to ensure skill currency. The objectives of this effort are to provide for the virtual representation of human structure and function; insure near-seamless transition from training to clinical practice; and to permit simulation of combat-casualty medical care within the framework of operational battlefield requirements. In a setting that forgives mistakes, residents and surgeons can practice surgical approaches or plan

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #06027112E
PE Title: Materials & Electronics
Technology

Project Number: MPT-07 Date: June 1994
Budget Activity: 2. Exploratory Development

the strategy for the next day's surgery while the simulator illustrates the consequences of their surgical judgments. The broad sweep of physical examination, clinical diagnosis, and the pharmacologic consequences of intervention can be made part of a seamless human learning experience that permits the physician to go from a "review" on the simulator to direct interaction with the patient. The broader impact of whole-body virtual simulation on undergraduate and continuing medical education programs will allow medical students to integrate traditionally separate academic disciplines and dramatically reduce the need for human cadavers and live-animal experimentation.

(U) The development of an advanced healthcare information infrastructure supports the entire trauma care technology base. Medical information must flow seamlessly and transparently on all levels of patient care. For this to occur, a platform-independent medical record system, such as the battlefield electronic patient record (BEPR), will insure immediate continuity, distribution, and accessibility of medical information from the forward battlefield to the rear echelon support in U.S. based medical centers. This information will be archived in multimedia heterogeneous databases of laboratory studies, radiologic and pathologic images, inpatient medical records, and be available over a world wide telecommunication system for real-time interactive collaboration among physicians. In addition, the infrastructure will provide a clinical associate system which is an intelligent system that assists physicians, nurses, corpsmen and paramedics in assessing and treating patients.

(U) All elements of this project have application to the civilian health care system with the promise of improving physical accessibility to care, improving quality of care, ensuring continuity of care, and reducing health care costs.

(U) This work does not duplicate any efforts of the military services or the National Institutes of Health. For planning and coordination, see section E "Related Activities."

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E Project Number: MPT-07 Date: June 1994
PE Title: Materials & Electronics Budget Activity: 2. Exploratory Development
Technology

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments: Not applicable.

(U) FY 1995 Planned Program:

- (U) Advanced Biomedical Technology. (\$5.4M) The basic research portion of this effort is found under PE 0601101E, Project MS-01.
- (U) Continue development of the personnel status monitor (PSM) primary life state sensors; executive (controller) breadboard; PSM sensor algorithm, code and system integration; medic/command data management and decision support; miniaturized personal communications for Global Positioning Satellite system (GPS) module; interface and integrate communications to controller subsystem; involves in-house and field testing.
- (U) Develop battlefield surgical simulation for lower extremities with emphasis on kinematic realism, soft tissue deformation, muscle contractility and simple bleeding (virtual environment).
- (U) Initiate exploratory studies of telepresence surgery (on experimental model) by wireless link between contingency field hospital and remote field operating room; critical care pod with integrated vital signs monitoring and closed cycle environmental control.
- (U) Health Care Information Infrastructure. (\$9.9M)
 - (U) Develop software architecture for a user-oriented associate system that captures ambulatory care data directly from physicians during patient visits.
 - (U) Develop associate system that provides trauma guidelines directly to medics during emergencies and combat care scenarios.
 - (U) Demonstrate shared electronic, graphic based planning and collaboration tools for multiple users in a distributed health and human services associate system.

(U) FY 1996 Planned Program:

- (U) Advanced Biomedical Technology (\$16.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MPT-07 Date: June 1994

PE Title: Materials & Electronics
Technology

Budget Activity: 2. Exploratory Development

- (U) Continuation in the development of the Personnel Status Monitor (PSM). Development of enhanced diagnostic capabilities that survey behavioral state of the soldier. Continue evaluation of novel transcutaneous non-invasive biosensor monitoring. Integrate closed-loop control algorithms for fluid infusion and mechanical ventilation support. Design probable conformat versions of the soldier-worn units. Design dismounted combatant version of the PSM for use in dismounted soldier tactical simulation exercises.
- (U) Continue development of battlefield surgical simulation by the incorporation of trauma mimicry to the trauma extremity simulator simulating physiologic shock and vital organ hypoxia and compromise.
- (U) Continue development of a working prototype of Remote Telepresence Surgery by the integration of haptic feedback, and orbital lag-time solutions. Develop the structure of the biosensors-based critical care pod into likely form of working prototype that is fully an autonomous critical care system for advanced medivac.
- (U) Development of battlefield/trauma ultrasonic imaging enhancement to reduce spurious reflections for unambiguous 3D interpretation of body structures.
- (U) Continued development of the portable Stat-Lab by additional blood chemistry parameter analytic modules. Development of integrated analytic modules involving optical absorption and absorption assay technology, and cell counting by scattered light.
- (U) Health Care Information Infrastructure (\$12.0M)
 - (U) Integrate user-task models and knowledge-based decision support tools.
 - (U) Demonstrate hands-free capture of patient data during emergencies.
 - (U) Provide one-stop shopping for geographically dispersed human services clients.
 - (U) Create reference architecture for generalized associate system.
 - (U) Continued development of user-oriented associate systems that allow seamless integration of database sources and user interface development.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

PE Title: Materials & Electronics
Technology

Project Number: MPT-07

Date: June 1994

Budget Activity: 2. Exploratory Development

(U) FY 1997 Planned Program:

- (U) Advanced Biomedical Technology (\$19.0M)
- (U) Continuation in the development of the Personnel Status Monitor (PSM). Further miniaturization of the Global Positioning Satellite (GPS) module of the PSM in a superchip design which couples a radio data communication chip, for the transmission of vital sign and situational awareness data to battalion level command. Miniaturization of prototype design will continue in coordination with the soldier regalia parameters of the 21CLW program of Secretary of the Army, Research, Development & Acquisition (SARDA). Develop simulation interface of the dismounted soldier's behavioral parameters as measured through the PSM.
- (U) Continued development of battlefield surgical simulation by the incorporation of trauma mimicry, and morphing of the axial trunk musculoskeletal and organ system simulator. Axial trunk simulation of physiological shock, exsanguination and vital organ hypoxia and will focus on the development of an enhanced education and training prototype for the combat medic and the combat surgeon.
- (U) Integration of axial trunk and extremity simulators to form entire human body surgical/trauma simulator. A packaging and functional integration between body regions which allows multiple injury response and physiologic mimicry.
- (U) Continued development of a working prototype of Remote Telepresence Surgery. Develop surgical tools for remote telepresence, robotically controlled, and coupled in force-feedback loops for enhanced operational dexterity. Develop fluid and blood sensor-based administration devices for the critical care pod. Develop pharmacologic hibernant sensor-based administration device for drug cocktail injection for the individual combatant. Test of the pharmacologic hibernant under controlled trauma simulations to determine physiologic response with drug-induced reversibility.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0602712E

Project Number: MFT-07 Date: June 1994

PE Title: Materials & Electronics
Technology

Budget Activity: 2. Exploratory Development

- (U) Continued development in medical imaging involving portable Magnetic Resonance Imaging microscope for tissue examination and assessment of pathology. Develop image enhanced chips for application to ultrasonic 3D interpretation. Extend the development of portable digital X-ray to 20x20 cm detector array, for field use.
- (U) Continued development of the assembly of the analytic modules for biological waste, recycling of fluids and the executive controller modules.
- (U) Health Care Information Infrastructure (\$9.0M)
 - (U) Demonstrate protocol based care in all outpatient clinics.
 - (U) Facilitate transition of combat care associate to emergency services.
 - (U) Demonstrate improved life cycle systems management via SEP/DSSA.
 - (U) Demonstrate performance gains of advanced software engineering collaborators.

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: To be determined. Broad Area Announcement (BAA) is expected to be published during the second quarter of FY 1994.

E. (U) RELATED ACTIVITIES: Work coordinated with the U.S. Army (Medical) Advanced Technology Process Action Team, tri-service Medical R/D components, tri-service Medical R/D Command Council, the Surgeons General of the tri-services, the National Library of Medicine, the National Institutes of Health, the National Science Foundation, the Uniformed Services University of the Health Sciences, the Joint Special Operations Command School of Medicine, and the U.S. Army Warfighting Simulation Center Dismounted Landwarrior (TRADOC) Testbed.

F. (U) OTHER APPROPRIATION FUNDS: None.

G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E Date: June 1994
 PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
 Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Number & Title</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>
EE-21	Command and Control Information Systems									
	500	24,712	39,750	25,700	30,000	39,237	41,687	46,034	Continuing	Continuing
	1 (6,769)									
EE-24	ASTOVL/CTOL									
	25,712	20,014	30,954	83,148	83,922	19,000	16,000	10,000	0	293,520
EE-27	Advanced Space Technology Program									
	28,662	5,925	0	0	0	0	0	0	0	224,191
EE-34	Guidance Technology									
	10,144	10,870	18,937	18,000	17,000	17,000	17,000	17,000	Continuing	Continuing
EE-36	Advanced ASW Technology									
	17,180	15,885	16,533	16,903	22,614	22,550	33,050	39,050	Continuing	Continuing
EE-37	Advanced Simulation									
	59,216	79,280	76,897	54,675	51,000	59,653	83,253	85,353	Continuing	Continuing
EE-39	Unmanned Undersea Vehicle Systems									
	23,850	17,839	17,900	17,570	17,395	18,115	21,115	26,115	Continuing	Continuing
EE-40	Critical Mobile Targets									
	117,268	132,960	135,103	125,000	121,987	132,360	135,360	141,360	Continuing	Continuing

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Program Element: #0603226E Date: June 1994
 PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
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EE-41	Air Defense Initiative	24,642	38,600	45,600	45,000	55,000	56,000	67,000	89,000	Continuing	Continuing
EE-45	Global Grid Communications	19,209	48,487	45,671	44,842	43,592	15,435	22,935	24,549	Continuing	Continuing
EE-46	Defense Simulation Internet	31,617	15,855	26,200	37,000	0	0	0	0	0	110,672
EE-CLS		202,308	198,904	202,176	194,036	189,129	197,134	247,184	323,337	Continuing	Continuing
		<u>560,308</u>	<u>609,331</u>	<u>655,721</u>	<u>661,874</u>	<u>631,639</u>	<u>576,484</u>	<u>684,584</u>	<u>801,798</u>		

Previously funded in PE 0602702E

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element is budgeted in the Advanced Development Budget Activity because its purpose is to demonstrate and evaluate advanced research and development concepts. Eleven projects are funded within this program element such as the Air Defense Initiative, Critical Mobile Targets, Advanced Simulation, and Global Grid Communications projects. A number of advanced concept technology demonstrations are funded within these twelve activities and several projects have dual-use applications. A discussion of the most significant projects follows.

(U) The Air Defense Initiative (ADI) is examining innovative technologies to counter the airborne threat posed by cruise missiles and manned aircraft. Technologies under evaluation include sensor upgrades, data integration and identification improvements, and radar-absorbent materials research. Advanced infrared measurement and high resolution digital imagery systems are also under development, and a simulation and modelling effort is included to test and demonstrate ADI concepts.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of
Major Innovative Technologies

Date: June 1994

Budget Activity: 3. Advanced Development

(U) Advanced Simulation efforts will provide a distributed, scalable seamless warfighting environment at the weapon level of detail that will ultimately provide a massive synthetic theater of war capable of supporting such requirements as readiness training, doctrine refinement, requirements analysis, battle management simulation, and contingency planning. Communications and data infrastructures, range instrumentation and computer image generation are just a few of the developmental activities funded in the Advanced Simulation program.

(U) The Critical Mobile Targets (WAR BREAKER) project is developing a comprehensive system of sensors, communication suites, and information processing systems to detect, identify, and prosecute high value, time-critical fixed and mobile targets such as theater ballistic missiles, tanks, and artillery.

(U) The Global Grid Communication project will develop and demonstrate advanced communications technologies needed for defense and intelligence operations for the 21st century. The ultimate goal is deployment of a gigabit network that will be interoperable with commercial, optical and secure wireless networks.

(U) This program element also includes efforts in Command and Control Information Systems, advanced ASW technologies, Unmanned Undersea Vehicles, advanced Guidance/Targeting technologies, and the Defense Simulation Internet.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-21 Date: June 1994
PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

Project Title:	Command and Control Information Systems					Total				
Popular Name	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	To	
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	
EE-21	Command Control Information Systems									
	500	24,712	39,750	25,700	30,000	39,237	41,687	46,034	Continuing Continuing	
	*(6,733)	*(0)								
	** (3,000)	(5,925)								

*Speakeasy was funded in PE 0602702E, (TT-07) in FY 1994.

**IMPACT was funded in PE 0603226E (EE-27) in FY 1994 and FY 1995.

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: Operations Desert Storm and Provide Hope demonstrated that current theater command, control, communications and intelligence/information systems lack the ability to support critical interoperable, joint/combined, wide-area multi-media communications to the mobile commander. Additionally, these systems fail to provide joint in-time situational awareness, decentralized battle execution capability, and flexible interfaces. These infrastructure shortfalls are particularly acute during early entry operations when the availability of situational awareness information and military communications assets is most limited.

(U) On-going Advanced Technology Demonstrations being conducted by the Army will provide enhancements based on existing communication systems (e.g., SINGARS) that will allow horizontal integration of Army elements and the synthesis of electronic maps showing the location of all friendly Army units. The programs in this descriptive summary will extend this capability to include data and information concerning enemy forces and provide joint, wide-area, multimedia information and processing. This program will provide a rapidly-deployable, affordable system covering a large (~200 mile) operational area and capable of providing a joint common situation

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #06032226E

Project Number: EE-21 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

awareness picture, battlefield synchronization tools, and multi-media information interfaces to on-the-move users.

(U) This program comprises four projects: the Commercial Communications Technology Testbed, the multi-band, multi-mode radio (Speakeasy), IMPACT, and the Command and Control Information System (C²IS) (formerly Battle Command Initiative).

(U) The Commercial Communications Technology Testbed (C²T²) will extend the capabilities developed in the C²IS, which are initially intended primarily for use by commanders, down to individual dismounted soldiers. The C²T² focus will be on providing local coordination and targeting information as well as a system and a process for evaluating commercial communications products for dismounted applications through a "plug and play" interface. The system will provide dismounted soldiers with a wearable suite including heads-up and wrist-mounted displays and micro-processors to provide position/location and image transfer capabilities. Because the system will have both short and long-range communications, it will be used to evaluate multi-squad coordination, soldier interactions with remote sensors and weapons, and special situations such as air/ground data transfer for rapid-response coordinated attacks on snipers, mortars, and ambush teams. This project is being performed in conjunction with the Army's Twenty-First Century Land Warrior, and is expected to provide an evaluation of applicable products and improved definition of system requirements.

(U) Speakeasy is a program to develop a multi-band, multi-mode programmable digital radio capable of communicating with a wide variety of existing military and civilian radios. Initially, this will allow units to communicate across the Services. As Speakeasy is proliferated, it will allow increased rates of data transfer to occur. This will improve data flow within and across Services and result in long-term cost savings by allowing a common tri-Service radio which is interoperable with existing systems in each of the Services. Speakeasy will inter-operate with all elements of the C²IS as well as with existing legacy systems to provide enhanced connectivity, and will provide service in situations where commercial

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Program Element: #0603226E

Project Number: EE-21 Date: June 1994

PE Title: Experimental Evaluation of
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Budget Activity: 3. Advanced Development

communications may be inadequate, for example, where special anti-jam or low-probability of intercept communications are needed.

(U) IMPACT, formerly in EE-27, is a multi-disciplinary project to enhance SATCOM support to Command and Control by leveraging advanced technology to reduce the life-cycle costs of all military satellite communications (MILSATCOM) terminals with associated reductions in size, weight, and power consumption and increased performance, reliability and capability. The project focuses on broad technology efforts that span all MILSATCOM terminal programs with initiatives to enable next generation terminals. IMPACT thrusts will benefit all MILSATCOM terminals and many commercial products. Thrusts include: affordability (personnel cost avoidance through autonomous operation); interoperability (programmable radio architectures to enable simultaneous multi-mode, multi-band operations); enhanced mobility (via miniaturization) and high performance capabilities (very high data rate communications). IMPACT will provide support across the spectrum (UHF, SHF, and EHF) and across all terminal classes (fixed site, mobile, manpack, airborne, shipborne, etc.).

(U) C²IS will develop battlefield synchronization tools and technology to support joint in-time situational awareness, decentralized battlefield execution, flexible man-machine interfaces, and wide-area multi-media data access and communications for on-the-move tactical users. The development focus is on Early Entry capability and technology gaps. On-going Service and other analyses indicate that there are shortfalls in information/intelligence, man-machine interfaces, and in interconnections/communications. C²IS addresses these shortfalls as specified by mission, enemy, terrain, troops available and time (METT-T). For each METT-T function, C²IS will develop display, assessment, projection, and planning capabilities to enhance battlefield synchronization and also address varying requirements of different echelons, e.g., timeliness and resolution. C²IS serves as the integrating concept and mechanism for the functional and communications capabilities being developed in the other projects in this PE. To achieve affordability, the effort will leverage commercial and consumer technologies to the extent possible (e.g., emerging spread spectrum cellular communications and personal data assistants). These will pass information to and from battlefield systems such as the Common Ground Station and the Battle

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-21 Date: June 1994
PE Title: Experimental Evaluation of
Major Innovative Technologies Budget Activity: 3. Advanced Development

Command Vehicle to provide the necessary data access and correlation capabilities. This effort will be conducted in conjunction with an architecture and database evaluation environment performed in EE-37, which will be incorporated in this PE in FY 1997, and will use technologies developed in Program Element 0602702E, project TT-04.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishment:

- (U) C2IS: Leveraged TT-04 Korea Initiative to begin data gathering for operational and tactical commanders' information requirements and data loads; conducted studies and panels to analyze operational requirements and evaluate technology state-of-the-art to identify and project Early Entry technology gaps. (\$2.0M funded in PE 0602702E, TT-04)
- (U) Investigated advanced fire detector systems and fire suppressants for metal fires. (\$.25M)
- (U) Investigated innovative methods and techniques for monitoring nuclear waste. (\$.25M)

(U) FY 1995 Planned Program:

- (U) Perform detailed analysis of C2IS and its information, interface and interconnect requirements, technology and subsystems; use Early Entry scenarios to identify technology gaps for all METT-T functions; evaluate and select technology being developed in TT-04 in C2IS system context. (\$2.4M)
- (U) C2T2: Conduct squad level demonstrations of leveraged advanced civilian personal communications and computation technology for dismounted soldiers and vehicles, in military operational training/test environment. Link helicopter reconnaissance and mine detection to ground units for prosecution. (\$9.3M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-21 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Speakeasy: Complete the development and integration of the advanced technology modules into the Speakeasy Advanced Development Model (ADM), Phase I; demonstrate a fully integrated ADM; award Speakeasy Phase II contract. (\$7.1M)
- (U) Continue technology developments for IMPACT and conduct technology design reviews. (\$5.9M)
- (U) FY 1996 Planned Program:
 - (U) Design and develop display and assessment capabilities for mission, enemy, terrain, troops available, and time functions; design projection and planning subsystems. Evaluate component concept demonstrations with Early Entry scenarios at the operational level. Design and plan demonstration of integrated C²IS, Speakeasy, C²T², and IMPACT technology at operational and tactical level. (\$14.2M)
 - (U) Continue the development of advanced technologies for the Speakeasy Prototype Radio and hold preliminary design review. Conduct operational concept demonstration with emphasis on full electronic reprogrammability to achieve interoperability with existing military radios. (\$9.7M)
 - (U) Demonstrate C²T² in the integrated demonstration provided by the battle management environment. Evaluate C²T² impact on integrated execution of SOF and tactical operations for efficiency of concurrent operations and fratricide avoidance. (\$7.7M)
 - (U) Continue technology developments for IMPACT and complete developments for Low-Cost, Low-Power Vocoder, Advanced Multi-mode Modem Study, Low Noise Amplifier, Fast-Hopping, Low-Power Digital Synthesizer. (\$8.1M)
- (U) FY 1997 Planned Program:
 - (U) Continue development of component C²IS technology and conduct initial integrated demonstration by inserting C²T² into C²IS with focus on information flow from brigade to dismounted soldier in Early Entry scenario. (\$8.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E
PE Title: Experimental Evaluation of Major Innovative Technologies
Project Number: EE-21 Date: June 1994
Budget Activity: 3. Advanced Development

- (U) Continue development of hardware and software technology for the Speakeasy Prototype Radio and conduct critical design review. Transition technology. (\$9.7M)
- (U) Complete integration of C2T2 and transfer stand-alone technology. (\$2.2M)
- (U) Continue technology development for IMPACT and complete development for Advanced MILSATCOM Maintenance Software for Diagnostics/Fault Isolation, Integrated Photonic Time Delay Module. (\$5.8M)

(U) Program to Completion:

- (U) To ensure transition, demonstrate integration of and test and evaluate C2IS, Speakeasy, and IMPACT technology in the battle management environment with Early Entry scenarios for both operational and tactical echelons. Evaluation shall be done on each project individually as well as on the integrated system of which they are components.
- (U) Continue technology developments for IMPACT and award testbed terminal contracts.

D. (U) WORK PERFORMED BY: The major performers include MITRE, Boston, MA and Washington, DC; Stanford Research Institute, Menlo Park, CA; Harris Technologies, Arlington, VA; Hazeltine, Greenlawn, NY; and Army Communications/Electronics Command, Ft Monmouth, NJ.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY:

1. TECHNICAL CHANGES: IMPACT has been incorporated to facilitate integration of advanced communications technology with other interconnect technology projects in this PE and to demonstrate synergism with its information and interface components.
2. SCHEDULE CHANGES: While incorporation of IMPACT eases the interconnect/linkage schedule, enabling C2IS technology expected from TT-04 will not be forthcoming, resulting in no change in the top-level schedule.

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Program Element: #0603226E Project Number: EE-21 Date: June 1994
PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
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3. COST CHANGES: Increase from IMPACT incorporation noted above.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Phase II of the Speakeasy program is jointly funded under Air Force PE 0603789F and Army PE 0602782A.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Oct-Dec 95	Soldier testing of commercial communications system for dismantled operations and assessment of alternative missions.
Mar 96	Preliminary design review of Phase II Speakeasy system.
Sep 96	Conduct demonstrations of C ² IS METT-T display and analysis subsystems with Early Entry scenarios.
Sep 96	Complete low-cost low power vocoder.
Oct-Dec 96	Demonstrate novel advanced warfighting concepts using the commercial communications testbed.
Mar 97	Critical design review demonstration of Phase II Speakeasy.
Aug-Sep 97	Demonstrate integration of C ² T ² and C ² IS and evaluate information flow in Early Entry scenario.
Sep 97	Complete MILSATCOM maintenance software.
Sep 98	Concept demonstrations of system enhancements and novel concepts using information from C ² IS to enhance fire control and asset management.
Dec 98	Complete fabrication of IMPACT hardware.
Sep 99	Conduct IMPACT testbed terminal demonstration.
Sep 00	Evaluation of integrated C ² IS technology in joint Service exercise focusing on Early Entry.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #06032226E Project Number: EE-24 Date: June 1994
 PE Title: Experimental Evaluation of Major Budget Activity: 3. Advanced Development
 Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> STOVL/CTOL Affordable Lightweight Fighter											
<u>Popular Name</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>FY 1996</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>Total</u>		
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Program</u>		
EE-24	STOVL/CTOL Common Affordable Lightweight Fighter	25,712	20,014	30,954	83,148	83,922	19,000	16,000	10,000	0	293,520

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES:

The STOVL/CTOL Affordable Lightweight Fighter project is investigating a single engine, lightweight, affordable strike aircraft to potentially replace the AV-8B, F-16, and F/A-18. The aircraft will have two variants: a Short Takeoff, Vertical Landing (STOVL) variant for the Navy and Marine Corps, and a Conventional Takeoff and Landing (CTOL) variant for the Air Force. These variants would share a common engine, airframe and avionics. The STOVL propulsive lift system would be eliminated from the Air Force variant and replaced with additional fuel capacity. Major performance goals include: Weight Empty: <24,000 lb; Size: <F-18C; Powerplant: derivative of the F-119 or YF-120 Advanced Tactical Fighter Engine; maneuvering and airspeed flight envelope equal to or greater than the F-18; Flyaway cost: significantly less than the F-18C. Performance levels will be traded against cost to ensure affordability of the aircraft. This aircraft will be modular to the extent that the propulsive lift system will be designed to be removed and replaced with additional fuel capacity for Air Force CTOL use. The Air Force derivative aircraft is envisioned to be almost 100% part common with the Navy and Marine Corps STOVL variant in terms of airframe, engine, and avionics.

(U) The ongoing ARPA/Navy critical technology validation design refinements, analyses, and testing are directed toward risk reduction which, if successful, will set the stage in FY 1996 for ARPA, The Joint Advanced Strike Technology (JAST) Program, and the British Ministry of Defence to cooperatively develop and flight test a prototype strike aircraft. A competitive procurement to select a single prime contractor for this effort is planned to be conducted early

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in FY 1996 as soon as large scale testing results are available. It is planned to use the ARPA Agreements Authority as the contracting vehicle for development of this prototype.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Conducted small scale wind tunnel model testing and large scale propulsion model fabrication for the Shaft Coupled Lift Fan Concept. (\$9.9M)
- (U) Conducted small scale wind tunnel model testing and large scale propulsion model fabrication for the Gas Coupled Lift Fan Concept. (\$9.8M)
- (U) Performed direct lift concept design analysis and small scale component testing. (\$6.0M)

(U) FY 1995 Planned Program:

- (U) Initiate large scale wind tunnel tests and large scale propulsion system tests for the Shaft Coupled Lift Fan Concept. (\$11.4M)
- (U) Initiate large scale wind tunnel tests and large scale propulsion system tests for the Gas Coupled Lift Fan Concept. (\$8.6M)

(U) FY 1996 Planned Program:

- (U) Complete critical technology validation program for the Shaft and Gas Coupled Lift Fan Concepts. (\$1.9M)
- (U) Conduct detailed demonstrator aircraft design. (\$6.1M)
- (U) Begin long lead procurement and fabrication of propulsion system components. (\$23.0M)

(U) FY 1997 Planned Program:

- (U) Begin engine ground testing, complete detailed demonstrator aircraft design and begin aircraft fabrication. (\$83.1M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-24 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

(U) Program to Completion:

- (U) Complete fabrication and flight test two technology demonstrator aircraft. It is estimated that this program will be completed in 2001.

D. (U) WORK PERFORMED BY: Lockheed Advanced Development Company, Palmdale, CA; McDonnell Douglas Aerospace, St. Louis, MO; The Boeing Company, Seattle, WA; Northrop Corporation, Pico Rivera, CA; NASA Ames Research Center, Moffett Field, CA; NASA Langley Research Center, Hampton Roads, VA; and NASA Lewis Research Center, Cleveland, OH.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: The program has been revised to include FY 1996 and out year funding for initiation of the technology demonstrator aircraft design, fabrication, and flight test following critical technology validation program.

F. (U) PROGRAM DOCUMENTATION:

- (U) Department of the Navy desired operational characteristics, 1988.
- (U) Joint ARPA/Navy project established by Memorandum of Agreement (MOA) dated 16 March 1993.
- (U) Joint ARPA/NASA project established by MOA dated 4 June 1993.

G. (U) RELATED ACTIVITIES: Program Element: 0603217N (Air Systems Advanced Technology Development). This is a joint program with the Navy established by MOA. The Navy is contributing \$22.5 million in FY 94-FY 96 to support the critical technology validation portion of the program. The technology demonstration portion of the program will be jointly managed and funded by ARPA and JAST. An MOA between ARPA and JAST is in process.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: An MOU for United Kingdom participation in FY 1994-1996 is in staffing. Authority to conclude has been requested from the Departments of Defense, State, and Commerce. Congressional notification is in staffing at DoD. The UK will provide \$12

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-24 Date: June 1994
PE Title: Experimental Evaluation of Major Budget Activity: 3. Advanced Development
Innovative Technologies

million of program funding in FY 1995 and 1996. A separate US/UK MOU is planned for the aircraft technology demonstration program for FY 1996 and beyond.

J. (U) MILESTONE SCHEDULE:

<u>Planned</u>	<u>Milestones</u>
May 95	Jet Induced Effects Model Testing Complete.
Jun 95	Propulsion System Component Testing Complete.
Jul 95	Commence Large Scale Propulsion Model Testing.
Jan 96	Large Scale Propulsion Model Testing Complete.
Mar 96	Technology Demonstrator Aircraft Proposals Submitted by Contractors.
May 96	Begin Aircraft Design, Fabrication, and Flight Test.
Oct 97	Begin Engine Testing.
Apr 99	Complete Aircraft Fabrication and Ground Testing on First Engine.
Sep 99	First Flight.
Mar 01	Flight Testing Completed.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E Project Number: EE-27 Date: June 1994
 PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
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A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Advanced Space Technology Program							<u>Total</u>			
<u>Popular Name</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>FY 1996</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>To</u>	<u>Complete</u>	<u>Program</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	
EE-27	Advanced Space Technology Program	28,662	5,925	*0	0	0	0	0	0	224,191

*In FY 1996 and subsequent years the IMPACT Program is funded in PE 0603226E, project EE-21.

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: The Advanced Space Technology Program (ASTP) is aimed at achieving an affordability breakthrough in the development, launch and operation of satellite systems. To date, the goals have been to demonstrate low cost access to space with small launch vehicles; reduce the size, weight, power and cost of satellite components; and demonstrate first-generation lightweight satellite capabilities. This phase has formed a prerequisite technology foundation and has produced two new launch vehicles (the Pegasus Air-Launched Vehicle and the Taurus Standard Small Launch Vehicle), 10 small satellites and numerous advanced, miniaturized components. This phase of the program will conclude with the launch of Taurus, on-orbit demonstration of DARPASAT and completion of the remaining technology projects.

(U) IMPACT is a multidisciplinary development program aimed at leveraging advanced technologies to reduce the life-cycle costs of all military satellite communications (MILSATCOM) terminals with associated reductions in size, weight and power consumption of MILSATCOM terminals and increased performance, reliability and capabilities. The program addresses broad technology efforts that span all MILSATCOM terminal programs with technology initiatives in support of next-generation terminals.

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Project Number: EE-27 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

(U) The themes and objectives of the IMPACT program will benefit all MILSATCOM terminals, as well as many commercial products. These themes include affordability (personnel cost avoidance through autonomous operation), interoperability (programmable radio architectures to enable simultaneous multimode, multiband operations), enhanced mobility (via miniaturization) and high-performance capabilities (very high data rate communications). The program will provide support across the spectrum (UHF, SHF and EHF) and across all terminal classes (fixed-site, mobile, manpack, airborne, shipborne, etc.).

(U) The Congressionally directed Tactical Signals Intelligence (SIGINT) Satellite (TSS) program is oriented to the demonstration of a tactically responsive, capable SIGINT satellite that would be characterized by direct user control and access to mission data. Additional goals of this program include the reduction of satellite acquisition time and cost, simplification of ground operations, and the reduction of O&M costs.

(U) The Congressionally directed Launch Vehicle Technologies program is oriented towards identification and demonstration of unique and innovative launch concepts (e.g. parafoils) and launch subsystems (e.g. hybrid propellants) which would not otherwise be explored within the launch community. The goal of this effort is to demonstrate technologies which would enable significant cost reduction in acquisition and O&M to enhance vehicle reliability responsiveness assuring rapid access to space.

(U) The Congressionally directed Large Millimeter Wave Telescope is a potential joint United States/Mexico program to build and operate an adaptive, high precision, wide bandwidth, 50-meter aperture millimeter wave radio telescope. The sites being considered in Mexico offer low humidity and ability to view both northern and southern skies. This telescope is being designed for a 1 arcsec pointing accuracy, which, if achieved, would better the current state-of-the-art for radio telescopes.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

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PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
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- (U) FY 1994 Accomplishments:
 - (U) Conducted the launch of Taurus; initiate demonstration program for DARPASAT. (\$2.4M)
 - (U) Continued technology development for IMPACT. (\$2.9M)
 - (U) Initiated development of the TSS program. (\$9.9M)
 - (U) Initiated development of launch vehicle technologies. (\$9.8M)
 - (U) Initiated the Large Millimeter Wave Telescope design study. (\$3.0M)
 - (U) Built and tested a miniature version of the current shortwave infrared sensor. (\$.6M)

- (U) FY 1995 Planned Program:
 - (U) Continue technology developments for IMPACT; conduct technology design reviews. (\$5.9M)

- (U) Program to Completion:
 - (U) The IMPACT program incorporated into EE-21, Command & Control Information Systems.

- D. (U) WORK PERFORMED BY: Orbital Sciences Corporation, Fairfax, Virginia; Space Applications Corporation, Vienna, Virginia; EMS Technologies, Inc., Norcross, Georgia; Ball Aerospace Corporation, Boulder, Colorado; Honeywell, Minneapolis, Minnesota; Hughes Space and Communications, Los Angeles, California; Phillips Laboratory, Kirtland Air Force Base, New Mexico; Rome Laboratory, Rome, New York; Air Force Space and Missile Systems Center, Los Angeles, California; Western Test Range, Vandenberg Air Force Base, California; and others associated with the IMPACT program (contracts under negotiation; none awarded yet).

- E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: In FY 1996 and subsequent years the IMPACT Program will be funded in PE 0603226E, project EE-21.

- F. (U) PROGRAM DOCUMENTATION: None.

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G. (U) RELATED ACTIVITIES: ARPA has MOAs with the Army, Navy, Air Force, BMDO (SDIO) and others for ARPA space technology projects. There is no unnecessary duplication of effort within DoD.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestone</u>
Aug 94	Complete demonstration of DARPASAT.
Nov 94	Transition the DARPASAT to user.
Dec 95	Complete IMPACT Design Reviews.

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PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
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A. (U) RESOURCES: (\$ In Thousands)

Project Title:	FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total		
Name	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	
EE-34																			
Guidance Technology	10,144	10,870	18,937	18,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000	17,000

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: Fire-and-forget stand-off weapons need precise targeting information if critical fixed and mobile targets are to be eliminated effectively and with minimal collateral damage and minimum cost-per-kill. This requires that: (1) military surveillance and targeting systems geo-locate targets accurately in the same targeting grid in which the weapon system navigates; (2) the weapon system has a precision navigation and guidance system on-board, plus weapons with effective endgame seekers; and (3) navigation and target location systems cooperate day/night and in adverse weather. In addition, future systems designed to accomplish precision strike missions must be significantly more affordable. The achievement of these characteristics in an integrated system is the goal of this program. The advanced navigation and guidance technologies being developed in support of this goal are the Global Positioning System (GPS) Guidance Technology Package (GGP) and Common Grid.

(U) GGP is the core component of the guidance technology project. It tightly integrates a miniature GPS receiver (MGR) and an all solid state, low cost, navigation-grade, interferometric fiber optic gyroscope (IFOG) based miniature inertial measurement unit (MIMU) with an advanced navigation computer into a potentially low cost, precision navigation system. GGP Phase 1 addresses the technology issues involved in: (1) miniaturizing inertial grade inertial measurement units (IMUs) into a compact, manufacturable configuration; and (2) developing a multi-channel-on-chip, high dynamics MGR.

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(U) Common Grid will develop a set of low cost, local Global Positioning System (GPS) reference broadcast stations to coordinate precision targeting with weapon delivery systems. Common Grid will augment the baseline GPS capability within a theater of operations. It enables the passing of very accurate targeting data (1-to-3 meters CEP relative location error) without the need for real time direct communications between specific sensors and specific shooters. Common grid addresses the technology issues associated with (1) developing a miniature, low power atomic clock; (2) integrating the GPS receiver with the atomic clock and other supporting equipments; and (3) appropriately modeling the impact of phenomenological variations, staleness of ephemeris data and relaxation of user location precision after leaving the grid's coverage.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Completed GPS Guidance Package (GGP) Phase 1 brassboard fabrication and laboratory tests. (\$5.2M)
- (U) Initiated GGP Phase 2 contracts to further reduce GGP in size, weight, power consumption and cost. (\$0.3M)
- (U) Completed Multifunction Self-Aligned Gate (MSAG) technology for military applications. (\$4.0M)
- (U) Initiated preparation activities to test GGP on Army Fire Support Team Vehicle (FISTV). (\$0.6M)

(U) FY 1995 Planned Program:

- (U) Complete preparation and test of GGP on Army FISTV. (\$0.6M)
- (U) Initiate and complete Government laboratory and field evaluations of GGP Phase 1 brassboards. (\$0.4M)
- (U) Develop GGP Phase 2 critical components and conduct preliminary design review. (\$6.9M)
- (U) Design Common Grid elements and demonstrate critical subsystem feasibility. (\$3.0M)

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PE Title: Experimental Evaluation of
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Budget Activity: 3. Advanced Development

(U) FY 1996 Planned Program:

- (U) Conduct Global Positioning System (GPS) Guidance Package (GGP) Phase 2 critical design review. (\$1.5M)
- (U) Develop GGP Phase 2 brassboard demonstration unit. (\$11.6M)
- (U) Continue Common Grid component feasibility demonstrations. (\$3.6M)
- (U) Initiate Common Grid system brassboard development. (\$2.2M)

(U) FY 1997 Planned Program:

- (U) Continue Common Grid system brassboard development and begin testing. (\$6.8M)
- (U) Continue GGP Phase 2 fabrication and integration testing. (\$11.2M)

(U) Program to Completion:

- (U) Complete and deliver GGP Phase 2 units.
- (U) Conduct user specific (e.g., surface and airborne vehicle) field evaluations of GGP units.
- (U) Complete and deliver Common Grid brassboard units.
- (U) Demonstrate Common Grid precision targeting and weapon delivery accuracy in field evaluations.

D. (U) WORK PERFORMED BY: Naval Command, Control and Ocean Surveillance Center, San Diego, CA; Army Missile Command, Huntsville, AL; Charles Stark Draper Laboratory, Boston, MA; The RAND Corporation, Washington, DC; Galaxy Scientific Corporation, Philadelphia, PA; Litton Industries, Woodlawn Hills, CA; and Rockwell International, Collins Division, Cedar Rapids, IA.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY:

1. Technical Changes: Inclusion of Army Fire Support Team Vehicle (FISTV) field evaluation of Global Positioning System (GPS) Guidance Package (GGP).

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2. Schedule Changes: Global Positioning System (GPS) Guidance Package (GGP) Phase 2 milestones per acquisition plan. New Common Grid milestones.

3. Cost Changes: Outyear field evaluation of GGP Phase 2 units and Common Grid by Military Services.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: No other organizations are developing and integrating technologies for high-precision, tightly-coupled, advanced solid-state miniature inertial measurement unit/miniatre GPS receiver (MIMU/MGR) equipment. In addition, ARPA is developing low-cost seeker technologies and improved methods for low cost Interferometric Fiber Optic Gyroscope (IFOG) manufacturability with funds from Electronics Manufacturing Technology, PE 0603739E.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Sep 94	Global Positioning System (GPS) Guidance Package (GGP) Phase 1 Brassboard delivery.
Sep 94	Government Brassboard Tests Begin.
Sep 94	GGP Phase 2 Award.
May 95	GGP Phase 2 Preliminary Design Review.
Apr 95	Initiate Common Grid Design.
Jan 96	GGP Phase 2 Critical Design Review.
May 96	Complete Common Grid component feasibility demonstration (Initiate System Brassboards).

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Sep 97	GGP Phase 2 Contractor Testing.
Apr 98	GGP phase 2 Brassboard Delivery.
May 98	Common Grid government Brassboard Tests Begin.

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Program Element: #0603226E

Project Number: EE-36 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Anti-Submarine Warfare (ASW) Technology		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total	
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Program
EE-36	ASW Technology	17,180	15,885	16,533	16,903	22,614	22,550	33,050	39,050	Continuing	Continuing	Continuing	Continuing	Continuing	

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The most likely environment in which Anti-Submarine Warfare (ASW) will be conducted has changed from the deep ocean to shallow water (littoral warfare). Consequently, the focus of this project has shifted from examining innovative technologies for operations in the deep ocean to those employed in acoustically complex shallow water. This project develops acoustic sensor and signal processing technologies that will significantly enhance naval and maritime capabilities in littoral warfare environments.

(U) The project focuses on two areas of development: sonar technology and ASW scene management. The sonar technology area demonstrates applications of advanced object detection, classification, and localization technologies using high performance computing (HPC). In particular, this area focuses on demonstrating automatic simultaneous target detection, localization, and tracking algorithms in distributed active and passive sensors. Efforts in this area produce a demonstration of multi-platform/sensor fusion coupled with automatic detection and classification algorithms utilizing all sensor data including both active and passive acoustic data; and provide a capability to display, geographically, a complete description of the tactical scene. In addition, vertically-directive low frequency source arrays of both a continuous and impulsive nature are being developed and demonstrated. The ASW Scene Management area develops advanced signal processing techniques which integrate real-time information with background intelligence to provide a complete picture of the shallow water operational situation.

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PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Completed testing to determine the limits of shallow water multistatic sonar. Continued development of automatic multistatic active shallow water processors for tactical sonars. Incorporated advanced shallow water processing technologies into the Advanced Deployable System (ADS) proof-of-concept system. (\$5.1M)
- (U) Planned and initiated conduct of the active ADS proof-of-concept test. Initiated planning efforts and fleet liaison for a fleet Anti-Submarine Warfare (ASW) demonstration of shallow water processing technologies. (\$2.3M)
- (U) Applied signal processing techniques to diesel electric submarine echoes and radiated noise measurements and began development of automatic classifiers for diesel electric submarines. (\$0.4M)
- (U) Initiated shallow water ASW total scene management efforts. (\$1.2M)
- (U) Developed and initiated testing of a polymer-based transducer. (\$2.7M)
- (U) Completed development and testing of shallow water impulsive source technology. (\$1.0M)
- (U) Planned for development and demonstration of vibration cancellation and seaway motion imbalance control techniques for aeroderivative gas turbine engine. (\$4.5M)

(U) FY 1995 Planned Program:

- (U) Continue development and testing of autonomous multistatic active processors for shallow water tactical sonars. (\$4.6M)
- (U) Complete conduct of ADS proof-of-concept tests and assess performance of multistatic active processing technologies. Complete planning of fleet Anti-Submarine Warfare (ASW) demonstration. Develop processor for demonstration and initiate conduct of demonstration. (\$3.7M)

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- (U) Continue development of autonomous diesel electric submarine detection and classification technologies and conduct laboratory demonstration of candidate systems. (\$0.9M)
- (U) Apply scene management technologies to the multistatic active Deployable System (ADS) system and test high frequency tactical active sonar processing and scene generation capability. (\$3.5M)
- (U) Continue development and testing of polymer transducer array. (\$1.7M)
- (U) Continue development of impulsive sources by extending to very shallow water and environmental adaptability. (\$1.5M)
- (U) FY 1996 Planned Program:
 - (U) Complete development of multistatic active adaptive processing for shallow water tactical sonars. (\$3.9M)
 - (U) Conduct fleet Anti-Submarine Warfare (ASW) demonstration of multistatic active tactical processor. (\$1.5M)
 - (U) Initiate development of ADS prototype system. (\$3.2M)
 - (U) Complete ASW scene management design and develop scene management system. (\$6.8M)
 - (U) Initiate planning for ASW scene management demonstrations. (\$1.1M)
- (U) FY 1997 Planned Program:
 - (U) Conduct final at-sea ASW demonstration of environmentally adaptive shallow water active sonar technology. (\$2.5M)
 - (U) Complete prototype of ADS and plan for FY 1998 demonstrations. (\$7.2M)
 - (U) Conduct ASW total scene management tests and demonstrations. (\$7.2M)
- (U) Program to Completion: This is a continuing program.

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D. (U) WORK PERFORMED BY: Areté Engineering Technologies Corporation, San Diego, CA; BBN Systems and Technologies, Arlington, VA; Raytheon Company, Portsmouth, RI; SRI International, Arlington, VA; and ORINCON Corporation, San Diego, CA.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: Outyear planned program and milestones have been updated to reflect program progress. No substantive program changes have been made.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: This program has been fully coordinated with the following programs to ensure no duplication of effort:

- (U) Program Element 0602301E; Computing Systems and Communications Technology.
- (U) Program Element 0603555N; Navy Enhanced Advanced Technology Demonstration (EATD) (Shallow Water Technology Initiative).
- (U) Program Element 0603747N; Navy Advanced Anti-Submarine Warfare (ASW) Technology.
- (U) Program Element 0604784N; Navy Distributed Surveillance Systems (Advanced Deployable System/Fixed Distributed System).

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan Milestones

- Jun 94 Complete laboratory scale testing of low frequency (LF) acoustic sources.
- Aug 94 Conduct multistatic active/passive system testing demonstration in a shallow water environment.

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- Sep 95 Conduct at-sea testing of an active acoustic system for shallow water environment.
- Sep 95 Conduct testing for polymer transducer array
- Sep 95 Continue development and testing of Anti-Submarine Warfare (ASW) scene management system.
- Jun 96 Complete ASW scene management system development.
- Jul 96 Complete development of multistatic active adaptive processing for shallow water tactical sonars.
- Nov 96 Conduct final at-sea demonstration of an active acoustic system for shallow water environment.
- Jun 97 Conduct ASW scene management system at-sea demonstrations.
- Jun 97 Complete ADS prototype.
- Jul 97 Complete development and demonstration of adaptive arrays.
- Jul 98 Conduct ASW scene management system at-sea transition demonstrations.

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PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
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A. (U) RESOURCES: (\$ In Thousands)

Project Title:	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	To	Total
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-37	Advanced Simulation	59,216	79,280	76,897	54,675	51,000	59,653	83,253	85,353	Continuing Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Advanced

Distributed Simulation (ADS) program develops advanced interoperable technologies to enable a distributed, seamless warfighting simulation environment at the weapon system level of detail. The ultimate goal is to provide the tools and standards necessary to create, on demand, a robust synthetic theater of war capable of supporting the following functions: Joint/Service readiness training; Joint/Service Doctrine refinement and development; requirements analysis; design, prototyping and manufacturing; and contingency planning, operations, after action review, early entry command and control information system for battle management and historical analysis. The focus is on the development and integration of key technologies such as environmental representation, semi-automated forces, simulation scaleability, information technologies, range instrumentation, and simulation based engineering. As technologies mature, they will be demonstrated and tested in joint theater war exercises of increasing size, complexity and utility, e.g. STOW 97, which includes all forms of tactical simulation on a seamless synthetic battlefield.

(U) The environmental representation programs concentrate on the creation of the digital environments for simulation including representation of terrain, environmental phenomenology, diurnal variations and dynamic terrain. The semi-automated forces create a scaleable computer-generated military force that is representative and behaviorally accurate with resolution of battle outcome at the weapon system level of detail. Scaleability efforts investigate and develop technological solutions to create a robust network interconnection capable of

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accommodating a wide range of simulation goals and network demands. The information technology development concentrates research and development in areas contributing to providing the communications infrastructure capable of supporting 100,000 entities interoperating with each other in perceptible real time. The early entry command and control information systems technology development relates to development of a robust simulation environment capable of situational representations facilitating evaluations of a multi-level, joint battle management system. The range instrumentation project addresses the problem of interfacing live vehicles to the synthetic environment. The integrated product and process development simulation provides a linked, distributed toolbox of simulation tools for concurrent engineering of land vehicles.

(U) The Advance Simulation Technology developments support the DDR&E Science and Technology initiatives. The Synthetic Theater of War program demonstration scheduled for calendar year 1997, an integral element of the Advanced Simulation Technology Program, has been designated an Advance Concept Technology Demonstration (ACTD) by the Deputy Under Secretary of Defense for Advanced Technology.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Demonstrated, produced, tested, and prototyped interim expanded network information flow technologies capable of supporting up to 3,500 interactive, dynamic entities on the synthetic battlefield. Demonstrated the simulation technologies enabling the interoperation of higher-level aggregated simulation (classical simulations) with company networks of individual platform level simulators and company/battalion-level semi-automated forces. Prototyped network analysis and scenario initialization tools. (\$4.0M)
- (U) Demonstrated prototype rapid terrain generation system capability to produce 100 kilometer square terrain in 14 days; developed prototype high tailored terrain for analysis; initiated environmental representation research. (\$3.7M)

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- (U) Demonstrated working semi-automated forces for a limited range of combat specific entities that were behaviorally accurate at a primitive level; initiated development of a synthetic forces sub-architecture capable of supporting the creation of a complex joint simulations. (\$13.2M)
 - (U) Demonstrated interoperation of simulated warfighting environment with service C3I systems in large-scale simulated maneuver exercises. (\$0.8M)
 - (U) Demonstrated integration of virtual warfighting simulation, constructive and live instrumented ranges. Initiated development of future Advanced Distributed Simulation Architecture. (\$19.8M)
 - (U) Initiated the development of a Distributed Interactive Simulation (DIS) based architectural framework in which to demonstrate critical simulation technologies enabling cost effective, large scale, distributed simulations capable of addressing a broad range of defense functions. The function of the architecture is to serve as an integrating framework for existing sub-architectures and new sub-architectures as required. (\$2.4M)
 - (U) Demonstrated interactivity of high performance aviation in a virtual simulation. (\$0.4M)
 - (U) Initiated the Congressionally directed virtual Brigade Program for the development of a training development program to determine the optimum mix of training aids, devices, simulations, simulators and field training to intensify conventional training methods for an armored brigade. (\$14.9M)
- (U) FY 1995 Planned Program:
- (U) Initiate and design, analyze and test, and demonstrate solutions promoting the growth of robust network accommodating the unique demands of 5,000 interactive, dynamic entities operating in a coherent manner distributed across local, metropolitan, and wide area networks. Provide technical solutions promoting dial-up networking of heterogeneous simulations, simulators, and operational equipment. (\$6.1M)

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- (U) Initiate development of an interoperable environmental sub-architecture to support advanced distributed simulation development; demonstrate working model of a system capable of generating 100 kilometer square terrain in 7-10 days to include a limited range of terrain feature data and increased terrain resolution; demonstrate prototype environmental representation integrated with the simulated entities; prototype a limited local high resolution terrain database in an operational scenario; initiate development of interactive terrain, database compression, and global environmental representation. Initiate development of synthetic environment data bases to support the Synthetic Theater of War (STOW) 1997 exercise. (\$8.8M)
- (U) Demonstrate prototype synthetic forces architecture and creation of baseline software entities within that architecture capable of supporting a distributed virtual simulation of command entities. Develop and demonstrate increasingly more capable working Synthetic Forces representing a wider range of combat forces characterized by more accurate behavioral representation. (\$16.2M)
- (U) Develop a capability to support seamless land/sea/air warfighting simulation environment representing 15,000 entities operating with a high degree of realism, fully integrated and supporting service and joint operational concepts. (\$17.6M)
- (U) Develop a prototype, DIS based simulation architecture accommodating the evolution of advanced distributed simulation technology. (\$2.0M)
- (U) Initiate development of advanced simulation technologies to provide improved capability to the post STOW-97 synthetic environment. These include improved synthetic forces functionality; higher-level command entities; improved theater level functionality (e.g. logistics, electronic warfare, etc.); and deployable range instrumentation. (\$15.4M)
- (U) Develop and demonstrate an initial capability for an early entry command and control information systems environment capable of situational representations facilitating evaluations of battle management concept. (\$7.6M)
- (U) Develop concurrent engineering work stations and plan demonstration to assess adequacy of land vehicle design concepts. (\$5.6M)

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(U) FY 1996 Planned Program:

- (U) Demonstrate expanded information technologies supporting interaction of as many as 10,000 entities on the synthetic battlefield in a coordinated exercise, networking individual platform level simulators with company/battalion level synthetic forces. (\$0.5M)
- (U) Develop a prototype interoperable environmental sub-architecture; demonstrate a prototype environmental battlefield representation to include increased fidelity of terrain and environmental effects (e.g. fog, smoke, haze, diurnal effects, etc.); continue development of techniques for required rapid generation of terrain; continue development of environmental data bases to support STOW 1997. (\$7.0M)
- (U) Continue development of synthetic forces command entities; expand development of synthetic forces to include representations of combat support and combat service support elements; continue to improve functionality of other synthetic forces. Develop and test a set of standard interface specifications capable of accommodating a variety of technical architectures which represent service unique command and operational features. (\$18.2M)
- (U) Continue development of simulation operating systems, testing and integration of technologies, and development of the ACTD legacy systems to support the STOW-97 ACTD. (\$18.3M)
- (U) Continue to develop and refine the DIS based simulation Architecture testing an approach capable of addressing defense functions to include training and readiness and existing standards and some legacy systems. (\$2.0M)
- (U) Continue development of advanced simulation technologies to include improved synthetic forces functionality, higher level command entities, improved theater level functionality and deployable range instrumentation systems. (\$19.2M)
- (U) Expand development of a capability for an early entry command and control information systems capable of situational representations facilitating evaluations of battle management concepts. (\$6.9M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-37 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Demonstrate concurrent-engineering applications on land vehicle design, link to synthetic battlefield, and tie requirements to design. (\$4.7M)

- (U) FY 1997 Planned Program:
 - (U) Design and test expanded information technologies supporting a wide range of LAN, MAN, WAN bandwidth demands created by the exercise of greater than 50,000 entities operating in a coherent, coordinated manner on the synthetic battlefield. (\$1.5)
 - (U) Demonstrate an environmental sub-architecture capable of supporting coordinated advanced distributed simulation exercises; continue technology research on working production models of a system capable of generating 100 square Kilometers terrain in 4 days or less, continue development of environmental technologies capable of supporting a robust environmental battlefield to include interactive, fog haze, battlefield obscurant, diurnal effects; complete and transition STOW-1997 synthetic environment. (\$5.0M)
 - (U) Continue to develop and transition a broad range of Synthetic Forces representing most combat elements as entity and small unit commanders, integrate with a simulation architecture supporting a distributed command and control structure portraying in simulation the influence of one command level on the actions of the subordinate formations. Continue to develop and demonstrate increasingly more sophisticated behaviors representing an extended set of battlefield reactions such as situational awareness, reaction to the environment and planning. (\$15.0M)
 - (U) Demonstrate and transition to the ACTD a prototype Joint Synthetic Theater of War system supporting a seamless land/sea/air warfighting simulation environment capable of representing greater than 50,000 entities with a high degree of realism, supporting service and joint operational concept while retaining the arbitration of battle outcomes at the entity level of detail. (\$8.9M)
 - (U) Develop and demonstrate a robust set of interface specifications defining a technical architecture representing service unique command and operational features. The architecture will support heterogeneous elements that interact with each other; a range of combat actions at the entity level of detail; activities

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Budget Activity: 3. Advanced Development

addressing the functionality of a joint theater of war; and be able to accommodate a wide range of military operations from mid-intensity operations to operations other than war. (\$1.0M)

- (U) Continue development of advanced simulation technologies and deployable range instrumentation systems. Demonstrate those technologies which are sufficiently mature in STOW-97. (\$15.4M)
- (U) Demonstrate a concurrent engineering applications on land vehicle design, link to synthetic battlefield, and tie requirements to design. Integrate engineering applications with hardware test and evaluation tools and with the manufacturing modeling environment. (\$7.9M)

(U) Program to Completion:

- (U) Demonstrate, and transition network information flow technologies capable of providing a seamless land/sea/air warfighting simulation environment capable of supporting an exercise consisting of up to 100,000 interactive entities operating with a high degree of realism, fully integrated and supporting service and joint operational concepts and resolving battle outcomes at the entity level of detail.
- (U) Transition to the ACTD user (USACOM) the STOW-97 legacy simulation system capable of representing a Joint Task Force through a combination of live, virtual and constructive simulations. Provide contractor support to operate this legacy system while gaining user experience through USACOM exercises. Upgrade STOW-97 legacy systems as advanced technologies mature.
- (U) Demonstrate and transition to the Services, Synthetic Forces that are robust, behaviorally accurate, scaleable to all echelons of command, and integrated with other distributed simulation technologies.
- (U) Develop and transition to the Services an ADS architecture capable of integrating the full range of defense functions to include Acquisition Support, Doctrine Development, Requirements Definition, Contingency Planning, and Test & Evaluation.

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The architecture will support a range of activity from combat actions at the entity level of detail to activities addressing the full functionality of a joint theater of war.

- (U) Develop a robust capability to simulate an environment capable of situational representations facilitating evaluations of battle management concept, and of evaluating utility of developments contributing to battle management concept systems.
- (U) Demonstrate concurrent engineering applications on land vehicle design, and provide quantifications of improvements.
- (U) Continue to develop and transition to the services advanced technologies to support the full range of defense functions in a fully functional synthetic theater of war. Transition to the Services the technologies support a fully deployable live instrumentation system.

D. (U) WORK PERFORMED BY: Loral Advanced Distributed Simulation, Cambridge, MA; Los Alamos National Laboratory, Los Alamos, NM; MITRE Corporation, McLean, VA; University of Michigan, Ann Arbor, MI; ETA Technologies, San Diego, CA; Naval Command and Control, Oceans Surveillance Center, Research and Development, (NRad) San Diego, CA; INK (USA Engineering Topographic Center), Ft Belvoir, VA; SAIC, Alexandria, VA; and Institute for Defense Analyses, Alexandria, VA.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: Memorandum of Agreement will be prepared for major projects conducted in cooperation with other government agencies, such as with Fort Knox and USAREUR. Program development plans will be prepared for each major project.

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G. (U) RELATED ACTIVITIES: Related work in technology development is closely coordinated with the Defense Modeling and Simulation Office to ensure that unnecessary duplication does not occur; Close Combat Tactical Training, STRICOM; and Tactical Combat Training System (TCTS), PMA205.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan Milestones

Jul 94

Demonstrate second generation synthetic forces.

Nov 94

Demonstrate integration of live virtual and constructive forces in a joint warfighting simulation at the entity level of detail working up to 3,500 entities.

Apr 95

Demonstrate prototype ADS Architecture.

Sep 95

Demonstrate command entity synthetic forces operating in a partially

intergrated environment with up to 10,000 entities in perceptible real time.

Sep 95

Demonstrate working concurrent engineering toolbox for vehicle design.

Sep 96

Demonstrate higher level command entity synthetic forces operating in a more robust dynamic environment.

Sep 96

Demonstrate the capability to support 50,000 entities in perceptible real time through dynamic multi-casting.

Nov 97

Demonstrate the STOW-97 ACTD synthetic theater of war capable of representing a JTF through combination of live, virtual and constructive simulation with a high degree of realism and with outcomes arbitrated at the entity level of detail.

Sep 98

Demonstrate Battalion level (or equivalent) fully automated command forces.

Oct 99

Demonstrate an improved STOW Legacy system.

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| Jun 99 | Demonstrate tactical relevant dynamic environments. |
| Oct 99 | Demonstrate prototype communication technologies capable of accommodating 100,000 interactive entities. |
| Oct 99 | Demonstrate brigade level (or equivalent) command forces. |
| Jun 2000 | Demonstrate deployable range instrumentation technology. |
| Oct 2000 | Expand command forces technologies to all echelons of command. |
| Jan 2000 | Transition Legacy STOW system to USACOM. |
| Oct 2001 | Demonstrate an expanded architecture capable of supporting acquisition, test and evaluation, and contingency planning. |
| Oct 2001 | Demonstrate full functionality of a joint Theater of War. |

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Program Element: #0603226E

Project Number: EE-39 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Unmanned Undersea Vehicle Systems

Popular Name	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
EE-39	23,850	17,839	17,900	17,570	17,395	18,115	21,115	26,115		Continuing Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES:

The increasing stockpile of underwater mines and the proliferation of weapons of mass destruction throughout the world present a threat in both littoral warfare and strategic warfare situations. The objective of this project is to develop and demonstrate fully autonomous maritime systems and technologies to counter this threat. Work is focused in two areas: (1) mine countermeasures (MCM) and (2) enabling technologies for unmanned undersea vehicles' (UUV) and other taskable machines. In the MCM area, the Autonomous Minehunting and Mapping Technology (AMMT) Program is developing technologies in support of Navy clandestine mine warfare requirements that will enable the autonomous location and classification of mines with sufficient precision for detailed minefield mapping and subsequent reacquisition by a neutralization system. This capability will also be applicable for commercial undersea environmental survey and sampling. The project is also developing additional MCM technologies, including a synthetic aperture sonar to increase search rate; small autonomous vehicles for mine countermeasures in the surf zone; and an acoustic communications network that will enable tether-free control of minehunting UUVs. Enabling technologies being addressed include electromagnetic communications for use in shallow water, atomic interferometers for precision navigation, and high energy density power systems to provide the range and endurance required for longer UUV missions. These efforts are closely coordinated with the Navy's prioritized UUV acquisition programs promulgated in the FY 1994 Navy UUV Program Plan.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-32 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Refurbished ARPA Unmanned Undersea Vehicle (UUV); conducted technical analyses. (\$2.2M)
- (U) Investigated technologies for maritime counterproliferation. (\$0.1M)
- (U) Continued development of autonomous minehunting and mapping technology (AMMT) and small taskable machines. (\$4.5M)
- (U) Investigated synthetic aperture sonar minehunting technology. (\$0.1M)
- (U) Conducted at-sea multi-sensor data collection and validated software design; developed multi-node acoustic communication network. (\$1.8M)
- (U) Conducted at-sea test with testbed magnetic communication system. (\$0.3M)
- (U) Completed bench testing of proton exchange membrane fuel cell power plant; completed design and started construction of aluminum-oxygen fuel cell power plant. (\$3.3M)
- (U) Continued development of atomic interferometer inertial sensor. (\$0.2M)
- (U) Developed molten carbonate fuel cells and 200kW phosphoric acid fuel cell system. Investigated technologies for proton exchange membrane and solid oxide fuel cells. (\$11.4M)

(U) FY 1995 Planned Program:

- (U) Configure Unmanned Undersea Vehicle (UUV) for at-sea testing; conduct modeling/simulation analysis. (\$3.6M)
- (U) Investigate application of electro-magnetic pulse technology and other technologies for special operations and operations other than war. (\$0.6M)
- (U) Continue Autonomous Minehunting and Mapping Technology (AMMT) development; conduct Phase I at-sea demonstration of mine detection, classification, identification and mapping; test small taskable machines and modes of locomotion. (\$7.9M)
- (U) Develop synthetic aperture sonar algorithms and models to increase minehunting area search rates. Conduct proof-of-principle demonstration. (\$1.3M)

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Program Element: #0603226E

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PE Title: Experimental Evaluation of
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Budget Activity: 3. Advanced Development

- (U) Continue high energy density power system program. Construct and demonstrate aluminum-oxygen fuel cell power plant on land and prepare for at sea-testing in a Unmanned Undersea Vehicle (UUV). (\$2.7M)
- (U) Conduct in-water test of 10-node acoustic communications network. (\$1.1M)
- (U) Conduct at-sea test of prototype magnetic communication system. (\$0.3M)
- (U) Continue development of atomic interferometer inertial sensor. (\$0.3M)

- (U) FY 1996 Planned Program
 - (U) Examine concepts for maritime counterproliferation, including tagging of vessels carrying weapons of mass destruction. (\$0.6M)
 - (U) Integrate aluminum-oxygen fuel cell in UUV; conduct modeling/simulation. (\$3.3M)
 - (U) Investigate technologies for mine neutralization by autonomous vehicles. (\$0.8M)
 - (U) Continue Autonomous Minehunting and Mapping Technology (AMMT) Phase II development of adaptive vehicle and sensor control and integration of the environmental data collection package for at-sea testing; continue testing of small taskable machines. (\$7.2M)
 - (U) Continue development of synthetic aperture sonar for minehunting. (\$3.1M)
 - (U) Continue high energy density power system program, including development of a thermophotovoltaic power convertor. Demonstrate aluminum-oxygen fuel cell at sea in a UUV. (\$2.7M)
 - (U) Test brassboard atomic interferometer inertial sensor. (\$0.2M)

- (U) FY 1997 Planned Program:
 - (U) Continue maintenance of ARPA Unmanned Undersea Vehicle; integrate technology improvements; prepare for at-sea testing. (\$2.9M)
 - (U) Continue development of stealthy special operations forces delivery vehicles. (\$1.2M)
 - (U) Conduct Phase II at-sea testing of AMMT. (\$7.0M)

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Program Element: #06032226E

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PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Test prototype synthetic aperture sonar concurrent with AMMT at-sea testing. (\$3.9M)
- (U) Develop prototype small taskable machine for minehunting and mine neutralization in very shallow water and the surf zone. (\$1.5M)
- (U) Continue development of a thermophotovoltaic power convertor. (\$1.1M)

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: Charles Stark Draper Laboratory, Cambridge, MA; Applied Research Laboratory, University of Texas, Austin TX; Loral Defense Systems, Akron, OH; Applied Remote Technology, San Diego, CA; and Woods Hole Oceanographic Institution, Woods Hole, MA.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY:

1. TECHNICAL CHANGES: The aluminum-oxygen fuel cell development and testing on land and at-sea in a Unmanned Undersea Vehicle (UUV) have been delayed because of component test failures, all of which have been corrected. In FY 1995, activities in deployable surveillance system technologies will be refocused from development of a multi-sensor buoy system to the development of a synthetic aperture sonar (SAS) system which will enhance our mine-hunting capability.

2. SCHEDULE CHANGES: Redefined objectives for Autonomous Minehunting and Mapping Technology (AMMT) program in support of Navy UUV Plan and established schedule for a two-phase program with at-sea demonstrations in FY 1995 and FY 1997. Delayed demonstration of the small autonomous prototype legged vehicle to FY 1996 due to funding constraints. Delayed testing of the brassboard atomic interferometer inertial sensor to FY 1996 due to funding constraints.

3. COST CHANGES: None.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

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PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

G. (U) RELATED ACTIVITIES: The Navy has established an UUV Program Management Office (PMO403) to transition these projects to the Navy.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Aug 94	Complete Proton Exchange Membrane (PEM) fuel cell power plant test.
Mar 95	Complete Phase I of Magnetic Communications Program.
May 95	Demonstrate acoustic communications network.
Sep 95	Begin Autonomous Minefield Mapping Technology Phase I at-sea testing.
May 96	Demonstrate small autonomous prototype legged vehicle in surf environment.
Oct 95	Begin at-sea testing of integrated Unmanned Undersea Vehicle (UUV) aluminum-oxygen fuel cell power system.
Sep 96	Demonstrate prototype atomic interferometer inertial sensor.
Jul 97	Begin Autonomous Minefield Mapping Technology Phase II at-sea testing.
Sep 97	Begin Synthetic Aperture Sonar (SAS) at-sea testing.
May 98	Conduct test of small autonomous vehicle with mine neutralization package.
Jul 98	Conduct Interferometric SAS at-sea testing.
Dec 98	Demonstrate brassboard 30KW thermophotovoltaic power convertor.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #06032226E

Project Number: EE-40 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Critical Mobile Targets (WAR BREAKER)	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	To	Total
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-40	117,268	132,960	135,103	125,000	121,987	132,360	135,360	141,360	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: Prosecution of time-critical fixed and mobile targets has long been a concern of the Services as evidenced by past efforts in the areas of Strategic Relocatable Targets and Smart Weapons. Our experience in Desert Storm has dramatically demonstrated our current inability to prosecute these targets, particularly Tactical Ballistic Missile (TBM) launchers. ARPA's WAR BREAKER program will develop advanced technology and systems to enable the detection, identification and prosecution of a wide range of high value, time-critical fixed and mobile targets including TBM launchers, mobile command posts, Mobile Air Defense Units, tanks and artillery. This project serves as the framework for maturing and integrating advanced technologies, as well as developing and demonstrating systems concepts supporting the prosecution of these targets. Key technology areas include advanced surveillance, target acquisition, advanced automatic target detection and recognition, automated intelligence correlation, battlefield management, information distribution, terrain data generation technologies, advanced high throughput sensor processing, multi-sensor fusion, data fusion, image understanding, text understanding and sensor component technologies. Of these, the Intelligence and Planning component of WAR BREAKER is comprised of: Intelligence Correlation (IC), Multiple Access Intelligence and Nomination System (MAINS), Local Attack Controller (LAC), Terrain and Feature Generation (TFG), Internetted Unattended Ground Sensors (IUGS), and TOPSIGHT.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

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Program Element: #0603226E

Project Number: EE-40 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

(U) FY 1994 Accomplishments:

- (U) Continued Automatic Target Detection/Recognition (ATD/R) technology development and assessment of potential target discriminants for prosecution of deep hide targets and initiated advanced Moving Target Indicator/Synthetic Aperture Radar (MTI/SAR) ATD/R algorithm tests. (\$7.2M)
- (U) Conducted Multi-sensor Target Recognition System (MUSTRS) captive flight tests on a helicopter and began fixed wing aircraft tests. (\$9.2M)
- (U) Awarded contract(s) to begin development of Low Cost Radar (LoCoR) technology. (\$10.6M)
- (U) Analyzed and assessed the performance of algorithms in detecting man-made targets in foliage from imaging radar and Ultra-Wideband (UWB) SAR data. (\$6.5M)
- (U) Completed current multi-spectral Electro-optical/Infrared (EO/IR) and low-cost focal plane array technologies efforts. (\$5.1M)
- (U) Completed development of WAR BREAKER distributed simulation baseline system known as SIMCOR Release-0. (\$20.9M)
- (U) Continued development of components/systems which extract, correlate, fuse, and display intelligence information to determine changes in force status, order of battle, and operational doctrine of time critical targets. (IC) (\$13.5M)
- (U) Initiated development of dynamic intelligence processor, tracking, and battle management functions for the Local Attack Controller (LAC). Demonstrated initial capabilities in Army Deep Operations and Joint STARS environments. (\$7.5M)
- (U) Demonstrated technology to rapidly access historical intelligence information from multiple heterogeneous databases. (MAINS) Initiated development of mission nomination, distributed database and fusion technologies. Conducted User Test Assessments of Imagery Exploitation System enhancement of completeness, correctness and speed. (\$8.4M)
- (U) Conducted initial tests of three dimensional (3-D) Digital Terrain Elevation (DTE) and provide interferometric SAR (IFSAR) mapping and terrain analysis data to the state of California. (\$11.5M)

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Budget Activity: 3. Advanced Development

- (U) Initiated the design and development of the Terrain and Feature Generation (TFG) system. Developed algorithms for multi-spectral, IFSAR, optical and infrared sensor data processing for automatic feature extraction. Developed control and database structures for cartographic data fusion. (\$1.6M)
- (U) Initiated Internetted Unattended Ground Sensor (IUGS) technology development. (\$6.0M)
- (U) Applied advanced processing/processors to National Technical Means exploitation. (TOPSIGHT) (\$4.5M)
- (U) Completed current efforts in Gamma-Gamma resonance imaging development. (\$4.8M)
- (U) FY 1995 Planned Program:
 - (U) Complete final development of WAR BREAKER distributed simulation and deliver the SIMCOR version-1 load module. Exercise analytical distributed simulation and systems engineering tools in support of WAR BREAKER system concept. (\$19.0M)
 - (U) Continue development, test, integration and demonstration of Intelligence Correlation (IC) technologies, components, and systems to include a natural language processor, force/target tracker, force status assessor, and integration of two single intelligence correlators and a multiple intelligence correlator. (\$19.2M)
 - (U) Continue development, test, and integration of Local Attack Controller (LAC) components. Demonstrate initial integration of dynamic intelligence processor and battle management decision aids in an Air Force (CTAPS) environment. (\$13.2M)
 - (U) Continue development, test, and begin integration of the Multiple Access Intelligence and Nomination System (MAINS) to include demonstration of integrated query/fusion technologies and a mission nominator. (\$10.3M)
 - (U) Complete software development and integration of the Imagery Exploitation System (IES). Conduct demonstration, test, and evaluation of the automatic processing of multiple sensors and context to detect and classify units. (\$2.7M)

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PE Title: Experimental Evaluation of
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Budget Activity: 3. Advanced Development

- (U) Continue development, test and integration of the Terrain and Feature Generation (TFG) system. Integrate technologies into TFG testbed for end-to-end evaluation, database development, and user assessment. (\$6.6M)
- (U) Continue to apply advanced fusion and vision algorithms on high performance processors for National Technical Means exploitation (TOPSIGHT). Integrate search and automatic target recognition capabilities. (\$8.5M)
- (U) Continue development and evaluation of enabling technologies for the Internetted Unattended Ground Sensors (IUGS). Examine additional technologies for performing precision air delivery and data fusion. (\$4.8M)
- (U) Continue development, data analysis, and evaluation of Automatic Target Detection and Recognition (ATD/R) algorithms within selected universities. (\$9.4M).
- (U) Complete critical component design development and test of the low cost radar and begin fabrication of a brassboard system. (\$23.2M)
- (U) Complete test and evaluation of Multi-Sensor Target Recognition System (MUSTRS) Technology. (\$4.7M)
- (U) Complete aircraft modification and surveillance systems installation in the P-3 testbed. (\$3.3M)
- (U) Continue data analysis and assessment of the performance of advanced algorithms for detection targets in foliage from high resolution high frequency/ultra high frequency (HF/UHF) ultra-wideband Synthetic Aperture Radar (SAR) data. (\$3.5M)
- (U) Continue technologies to provide rapid three dimensional digital terrain elevation data using interferometric SAR (IFSAR). (\$4.6M)

(U) FY 1996 Planned Program:

- (U) Conduct distributed simulation analysis and modeling of two nearly simultaneous Major Regional Conflicts (MRCs) with current Services' capabilities, with Services' new developed systems, and with ARPA new development Surveillance & Targeting/Intelligence & Planning systems. (\$16.0M)
- (U) Continue development, test, integration and demonstration of Intelligence Correlation (IC) technologies, components, and systems to include integration of

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Date: June 1994

Project Number: EE-4Q

PE Title: Experimental Evaluation of

Budget Activity: 3. Advanced Development

Major Innovative Technologies

- (U) the natural language processor with intelligence correlators, and the target tracker with the force status assessor. (\$21.5M)
- (U) Continue development, test and integration of Local Attack Controller (LAC) components. Demonstrate preliminary LAC prototypes in Army (Deep Operations), Air Force (CTAPS) and Airborne (JSTARS) environments. (\$12.8M)
- (U) Continue development, test and integration of the Multiple Access Intelligence and Nomination System (MAINS). Demonstrate query/fusion integration, "Cold Start" database build, distributed database, and mission nomination capabilities. (\$9.3M)
- (U) Continue development, test, and integration of the Terrain and Feature Generator (TFG) system for rapid processing of spatial data. Continue testbed technology insertion and evaluation. (\$5.2M)
- (U) Continue to apply advanced fusion and vision algorithms on high performance processors for National Technical Means exploitation (TOPSIGHT). Demonstrate initial integrated, cross-sensor search and automatic target recognition capabilities in a laboratory environment. (\$8.4M)
- (U) Demonstrate Internettted Unattended Ground Sensors (IUGS) component technologies to determine the performance gains in target classification and identification and the potential for an internettted system. (\$5.3M)
- (U) Continue to develop and evaluate automatic target recognition and automatic target detection algorithms to enhance surveillance and targeting systems' performance. University and industry involvement will be used. (\$11.2M)
- (U) Continue development and fabrication of the Low Cost Synthetic Aperture Radar (SAR) for surveillance and targeting. (\$30.2M)
- (U) Continue to modify and use the P-3 flying test bed to evaluate SAR and electro-optical/infrared (EO/IR) sensors singularly and when paired with automatic target detection/recognition (ATD/R) correlators. (\$7.5M)
- (U) Continue to evaluate and develop the best long wave, ultra-wideband SAR for penetration of foliage, camouflage or other unhardened concealment. Continue the multi-mode development article evaluation. (\$3.3M)

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Program Element: #0603226E

Project Number: EE-40 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Continue to develop the interferometric SAR (IFSAR) for both domestic and military use. Evaluate the best design for military delimitation determination and the potential for target detection functions. (\$4.4M)
- (U) FY 1997 Planned Program:
 - (U) Continue to conduct distributed simulation analysis and modeling of two nearly simultaneous Major Regional Conflicts with current Services' capabilities, with Services' new developed systems, and with ARPA new development Surveillance & Targeting/Intelligence & Planning systems. (\$14.5M)
 - (U) Continue to develop, test, and integrate and demonstrate Intelligence Correlation (IC) technologies, components, and systems. Demonstrate an initial fully integrated prototype in a laboratory environment. (\$19.5M)
 - (U) Continue development, test, and integration of the Multiple Access Intelligence and Nomination System (MAINS). Demonstrate an initial integrated prototype in an operational environment. (\$8.5M)
 - (U) Continue development, test and integration of Local Attack Controller (LAC) components and integrated prototypes. Integrate distributed database technologies from MAINS. Demonstrate initial integrated prototypes in multiple heterogeneous operational environments. (\$10.8M)
 - (U) Continue development, test, and integration of the Terrain and Feature Generator (TFG) system. Demonstrate an integrated initial prototype in an operational environment. (\$5.0M)
 - (U) Continue to apply advanced fusion and vision algorithms on high performance processors for National Technical Means exploitation (TOPSIGHT). Demonstrate advanced integrated, cross-sensor search and automatic target recognition capabilities in a laboratory environment. (\$8.0M)
 - (U) Begin integration of Internettted Unattended Ground Sensor (IUGS) component technologies, refine algorithmic approaches to signal processing and data fusion. Initiate fabrication of prototype sensor systems for future field testing. (\$5.1M)

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PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Continue to develop and implement automatic target recognition and detection algorithms to provide better quality information to the warfighter as operator aids, thereby increasing performance. (\$10.3M)
 - (U) Continue development and fabrication of the Low Cost Synthetic Aperture Radar (SAR) for use of programs such as TIER II+ and TIER III unmanned aerial vehicle (UAV). (\$23.5M)
 - (U) Continue to use the P-3 Flying Test Bed to evaluate the performance of SAR and electro-optical/infrared (EO/IR) sensor combinations to best ascertain optimal packaging and application of the developing automatic target detectors/recognizers. (\$12.9M)
 - (U) Continue to develop and evaluate the best band and wave length combination to address surveillance and targeting requirements in potential conflict areas wherein foliage and concealment hinders use of X and Ku band SAR. (\$3.0M)
 - (U) Continue to develop the interferometric SAR (IFSAR) for inexpensive and accurate topography to support both civil and military application. (\$3.9M)
- (U) Program to Completion:
- (U) Demonstrate advanced automatic target detection/recognition (ATD/R) algorithms for MTI/SAR radars and EO/IR sensors.
 - (U) Continue the development and fabrication of Internetted Unattended Ground Sensors to meet both warfighting requirements and to support Counter Proliferation initiatives.
 - (U) Complete Ultra-wideband foliage penetration radar development.
 - (U) Demonstrate the capability to correlate all-source intelligence for detection, tracking, targeting, and destruction of time critical targets.
 - (U) Demonstrate integrated intelligence correlation and battle management to facilitate local attack control.
 - (U) Demonstrate technology to build and distribute over a wide area network, terrain and feature and intelligence and object data for a 1 million square KM theater.
 - (U) Demonstrate technology for Low Cost SAR.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #Q603226E

Project Number: EE-40 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

D. (U) WORK PERFORMED BY: Hughes Missile Systems, San Diego CA; Martin Marietta, Orlando, FL; ERIM, Ann Arbor, MI; Lincoln Laboratory, Lexington, MA; BDM International, McLean, VA; Science Application International Corporation, Arlington, VA; Boeing Corp., Seattle, WA; Toyon Research Corporation, Goleta, CA; Naval Command, Control and Ocean Surveillance Center, (RDT&E Division), San Diego, CA; US Army Missile Command, Redstone Arsenal, AL; Rockwell International, Anaheim, CA; SRI International, Menlo Park, CA; Loral Systems, Phoenix, AZ; Sandia National Laboratory, Santa Fe, NM; Lockheed Missile Systems, Austin, TX; Atlantic Aerospace, Greenbelt, MD; Northrop Grumman; Melbourne, FL; Logicon, San Pedro, CA; Booz, Allen, and Hamilton, McLean, VA; Pacific Sierra Research, Santa Monica, CA; Science Research Laboratory, Inc., Somerville, MA; Grumman Aerospace Corporation, Bethpage, NY; Science Application International Corporation, Santa Clara, CA; Interactive Television Corporation, Arlington, VA; Electric Computing Concepts, Plato, TX; Engineering Research Associates, McLean, VA; and others to be determined.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No Change.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: The WAR BREAKER Program is coordinated with each Service Developing Agency via Memorandum of Agreements (MOAs) to preclude unnecessary duplication of effort. Separate MOAs exist with the Air Force Air Combat Command and the Directorate of Modeling, Simulation, and Analysis (AF/XOM) for similar purposes.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

PE Title: Experimental Evaluation of Major Innovative Technologies

Project Number: EE-40

Date: June 1994

Budget Activity: 3. Advanced Development

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Jun 94	Complete Multi-sensor Target Recognition System (MUSTRS) flight experiment (Helicopter).
Jan 95	Complete MUSTRS flight test (Fixed-Wing Aircraft).
Jun 95	Complete WAR BREAKER SIMCOR analysis/distributed simulation tool set.
Nov 95	Demonstrate automapping capability using interferometric Synthetic Aperture Radar (IFSAR).
Nov 95	Initial demonstration of automatic cue development from contextual analysis of Moving Target Indicator (MTI) radar data.
Nov 97	Demonstrate technology to build and distribute over a wide area network, terrain, feature, intelligence, and object data for a 1 million square KM theater.
Nov 97	Demonstrate integrated intelligence correlation and battle management to facilitate local attack control.
May 98	Conduct integrated wide area/focused surveillance system demonstration.
Sep 98	Demonstrate multi-spectral and IFSAR processing feature extraction and elevation data fusion and real-time modification of theater terrain data.
Nov 98	Demonstrate capability to correlate all-source intelligence to detection, tracking, targeting, and destruction of time critical targets.
Sep 99	Continue to develop and spin off products to the Services for evaluation and incorporation.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #06032226E

Project Number: EE-41 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Air Defense Initiative (ADI)		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		To		
Popular		Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
EE-41	Air Defense Initiative	24,642	38,600	45,600	45,000	55,000	56,000	67,000	89,000	Continuing		Continuing		Continuing		Program

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: Air Defense Initiative programs form a critical part of the Advanced Research Project Agency's (ARPA) program to ensure defense against cruise missiles, manned aircraft, and theater ballistic missile threats. The rapid evolution and proliferation of cruise missile systems and technologies require new approaches and technologies to effectively and efficiently counter future airbreathing threats to troops in regional theaters.

(U) ARPA Mountain Top's purpose is to accelerate the enhanced understanding, effective development and practical application of real-time adaptive processing techniques. The program develops and disseminates a phenomenology and propagation data base and analysis tools, develops advanced adaptive processing hardware and algorithms, and supports integrated testing. The program is currently evaluating the limitations of conventional sensors to combat advanced targets, and studies adaptive signal processing techniques for multi-channel airborne radars. It presently employs a 14 channel, UHF radar at an elevated ground-based location (White Sands Missile Range) as a surrogate for an airborne surveillance radar.

(U) HAVE DUNGEON enhances the capability to provide data integration and identification techniques for aerospace defense. Advanced hardware and software is developed to exploit data provided by intelligence sensors and collateral surveillance systems to provide near-real-time warning, attack assessment, and track history for the engagement of hostile targets.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-41 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

(U) The Simulation and Modeling Program investigates and demonstrates new air defense technologies and concepts, and their integration into theater force structure. It emphasizes and illustrates concepts to counter the cruise missile and other airbreathing threats, and allows warfighters to test and demonstrate technology concepts. The program interacts with the existing Air Force Theater Air Command and Control Simulator Facility (TACCSF) and the Navy Weapons and Tactics Analyses Center (WEPTAC) for man-in-the-loop simulation exercises. This initial simulation environment will be extended as part of ARPA's WAR BREAKER Defense Distributed Simulation System.

(U) The Special Materials Analysis program is investigating a new class of absorption materials developed from coated microballoons to determine their effectiveness and utility for a broad spectrum of applications.

(U) The Airborne Infrared Measurement System (AIRMS) program will provide improved scientific understanding of the fundamental limits of infrared technologies and will develop analytical tools, models and design methodologies, and associated signal processing algorithms and architectures. The program employs the existing AIRMS testbed, airborne infrared imaging sensor, and aircraft to collect high resolution digital imagery of airborne vehicles, background clutter, clouds, and other phenomenology.

(U) The Advanced Fire Control Radar (AFCR) program will evaluate and demonstrate advanced fire control systems against future postulated threats including manned aircraft, cruise missiles and tactical ballistic missiles. The program will evaluate the application of advanced technologies including adaptive signal processing, unique antenna array approaches, highly stable reference sources, and innovative electronic counter-countermeasure techniques.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-41 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) The Mountain Top program collected and analyzed a multi-channel radar data base that emulates data from an airborne surveillance radar. This data base was and continues to be distributed to the user community for evaluation of advanced adaptive processing techniques. The program also characterized the radar cross sections of tactical ballistic missiles and their plumes. This information will be used to study the capability of airborne sensors to counter the TBM threat. Studies and analyses were conducted for a joint surveillance Space-Time Adaptive Processing (STAP) processor meeting the needs of the Navy, Air Force, Army and advanced joint applications. (\$14.6M)
- (U) HAVE DUNGEON's Proof-of-Concept Aerospace Defense Location participated in an interactive Theater Missile Defense wargame with Air Force and Navy simulation facilities, and demonstrated the integration of overhead and undersea surveillance. (\$3.0M)
- (U) The Simulation and Modeling Program developed a prototype simulation system supporting both analyses and man-in-the-loop exercises, including distributed exercises. (\$5.1M)
- (U) The Special Materials Analysis program continued investigation of the microballoon absorbing materials, ensured strict materials processing controls, and performed specific comparisons of these new materials with existing absorbers. (\$1.9M)

(U) FY 1995 Planned Program:

- (U) The Mountain Top program will complete its move to the Pacific Missile Range Facility (PMRF), Hawaii and begin collecting multi-channel radar data of advanced, low-flying targets in over-water and littoral environments. Emphasis will be on studying the impact of jamming, clutter and multipath on the detection of sea skimming cruise missiles. The program will design and advanced STAP processor utilizing Commercial Off-The-Shelf (COTS) technology for implementation of STAP

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-41 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

- algorithms. STPA analysis tools developed under the Mountain Top program as well as the data base, will be transferred to a high performance computing center (HPCC). The user community will be expanded to include academia. Joint sensor concepts, fire control, engagement and dual use applications of adaptive processing will be investigated. (\$12.6M)
- (U) HAVE DUNGEON will establish the utility of integrated intelligence and conventional data source integration in the tactical environment. (\$2.0M)
- (U) The Simulation and Modeling Program will complete incorporation of ADI models in the simulation system. Man-in-the-loop exercises will address the value of new air defense technology concepts. (\$10.0M)
- (U) The Airborne Infrared Measurement System (AIRMS) will perform initial target data collection flights, and begin evaluation of operational algorithms for target detection and tracking. (\$14.0M)

(U) FY 1996 Planned Program:

- (U) The advanced Space-Time Adaptive Processor will be incorporated into the Mountain Top radar for breadboard evaluation. The processor will be evaluated in terms of its potential for meeting the next-generation airborne radar requirements for the services. The on-line data base and analysis tools hosted at the HPCC will be upgraded for real time use. Consideration will be given to the applicability of the adaptive processing techniques developed under the Mountain Top program to commercial needs (e.g. cellular communications, medical imaging). Pilot projects for fire control, engagement and innovative sensors will be initiated. (\$13.1)
- (U) The Simulation and Modeling Program will hold distributed exercises and demonstrations to verify performance of additional advanced sensor and netting in support of Advanced Concept Technology Demonstration concepts from the EE-CLS/ADI program element. (\$8.2M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-41 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) The Advanced Infrared Measurement System (AIRMS) program will perform advanced target data collection flights, employ the data in the evaluation of algorithms, and perform near real time demonstrations with operational algorithms. (\$4.3M)
- (U) The Advanced Fire Control Radar (AFCR) program will conduct the initial series of check-out tests and will begin demonstration of performance against manned aircraft, cruise missiles, and tactical ballistic missiles. (\$20.0M)

(U) FY 1997 Planned Program:

- (U) The Mountain Top program will continue collecting and analyzing phenomenology and target data. The advanced, joint STAP processor will transition to the brassboard phase of development. The user data base and analysis tools will be coupled with the Mountain Top hardware for user-in-the-loop investigations. Promising innovative sensors, fire control, engagement and dual-use applications will be pursued. (\$11.8M)
- (U) The Simulation and Modeling Program will provide Advanced Concept Technology Demonstration models to distributed exercises to support man-in-the-loop demonstration and test activities. (\$10.0M)
- (U) The AIRMS will demonstrate real time detection and tracking of airborne targets. (\$3.2M)
- (U) The AFCR program will continue with demonstration tests against advanced threats in an electronic countermeasure environment (\$20.0M)

D. (U) WORK PERFORMED BY: The primary contractors for the efforts are: Hughes Aircraft; MIT/Lincoln Laboratories, Bedford, MA; SAIC, McLean, VA and San Diego, CA; Martin-Marietta, Orlando and BDM, McLean, VA. USAF Rome Laboratories, USAF Electronic Systems Command, USAF Wright Laboratories, USAF Theater Air Command and Control Simulation Facility (TACCSF), Naval Air Warfare Center, Aircraft Division and Weapons Division (NAWC/AD and NAWC/WL) provide agent support.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-41 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

- E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: The Advanced Fire Control program was not previously funded in EE-41. HAVE DUNGEON completes in FY 1995.
- F. (U) PROGRAM DOCUMENTATION: ADI Program Plan, August 1993.
- G. (U) RELATED ACTIVITIES: The EE-41 air defense effort is coordinated with related air defense test and simulation efforts through the DDR&E, and is part of a larger air defense technology program that includes EE-CLS funds.
- H. (U) OTHER APPROPRIATION FUNDS: None.
- I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not Applicable.
- J. (U) MILESTONE SCHEDULE:

Plan Milestones

Mountain Top Program:

- Oct 94 Testing begins at the Pacific Missile Range Facility.
- Nov 94 Data base on-line at HPCC.
- Jun 95 User tools on-line at HPCC.
- Jul 95 Sensor employed in Navy Wide Area Defense Demo.
- Sep 96 Install STAP processor breadboard on sensor at PMRF.
- Jan 97 Begin real-time testing of clutter and jamming rejection techniques utilizing new processor.
- Jul 98 Brassboard processor completed.

Simulation and Modeling Program:

- Jun 94 Conduct on site Simulation Program exercises with Air Force and complete ADI-specific RF and IR baseline models.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603226E

Project Number: EE-41 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

- Aug 95 Complete two additional simulation baseline models and the prototype system.
- Jul 96 Conduct distributed Air Defense Initiative exercises demonstrating new concepts from EE-CLS/ADI program element.
- Jun 97 Apply prototype system to ACTD models to concept planning and development.
- May 98 ACTD distributed exercises through distributed exercise support to sting activities.
- Feb 99 Perform exercises involving prototype evaluation.

HAVE DUNGEON:

- Jun 95 Prototype the system in exercise or operational demonstration.

Airborne Infrared Measurement System Program:

- Aug 95 Perform the initial target data collection flights, and begin evaluation of operational algorithms for target characterization and recognition.
- Jun 96 Perform advanced target data collection flights, employ the data in the algorithms, and perform near real-time demonstrations with operational algorithms.
- Oct 96 Demonstrate real-time detection and tracking of airborne targets.
- Oct 97 Conduct real-time experiments to support the development of other advanced sensor platforms.

Advanced Fire Control Program:

- Apr 96 AFCR system integration complete.
- May 96 Initial system check-out tests.
- Jun 96 Initiate demonstration tests against advanced threats.
- Jun 97 Initiate demonstration tests to evaluate system performance against low-flying cruise missiles in an ECM environment.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603226E Project Number: EE-45 Date: June 1994
PE Title: Experimental Evaluation of Budget Activity: 3. Advanced Development
Major Innovative Technologies

A. (U) RESOURCES: (\$ In Thousands)

Project: Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
EE-45 Global Grid Communications	19,209	48,487	45,671	44,842	43,592	15,435	22,935	24,549	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This program develops and demonstrates advanced communications technologies needed for defense and intelligence operations for the 21st century. The program will develop advanced information processing concepts to support a geographically dispersed staff for crisis management. Services for an enhanced information infrastructure to support command and control will be developed and shown to be applicable to advanced, high performance (and commercially available) networks. This program will demonstrate that commercial communications resources and technologies can be integrated with advanced optical components developed in this program as well as DoD tactical and satellite technologies developed elsewhere. The key elements are:

- (U) Applications such as intelligent decision aids, that enable a geographically distributed planning staff to develop and analyze a course of action within 4 hours.
- (U) Advanced services such as scalable file systems, databases, and distributed computing support that are integrated with high performance computing, and free applications from the necessity to work down to the raw data transport level.
- (U) Demonstration networks that validate the Research and Development (R&D) and enable early application development and technology transition into DoD efforts such as Defense Information System Networks.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603226E

Project Number: EE-45 Date: June 1994

PE Title: Experimental Evaluation of
Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Develop network controls pertaining to management, and security software technologies to enable sensor-to-shooter applications combining all network media.
- (U) Develop advanced optoelectronic network component technology and network architecture for scalable and modular networks. The aggregate network bandwidth will be in the range of tera bits per second and the network will handle Multi Media service for both digital and analog signals.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Designed the software architecture and conducted initial tests for joint task force planning/execution including weather, intelligence, strike planning and logistics. (\$10.7M)
- (U) Initiated network management, control, signaling efforts and demonstrated interoperability between commercial and DoD network assets. (\$4.9M)
- (U) Initiated optoelectronic network component technology development: switch, multiplexer, filter, amplifier and synchronizer. (\$3.6M)

(U) FY 1995 Planned Program:

- (U) Design and conduct initial assessments of information services for the defense internet; evaluate prototype software components in a software engineering testbed and during an operational exercise. (\$25.5M)
- (U) Integrate DoD and commercial networks and demonstrate services and network management in support of DoD experimental application with military attributes such as crypto surge capability. (\$5.0M)
- (U) Demonstrate advanced optical network capability and demonstrate multi-wavelength reconfigurable network architecture. (\$18.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603226E

Project Number: EE-45 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

(U) FY 1996 Planned Program:

- (U) Demonstrate evolving software development practices and the migration of software applications and information services to higher bandwidth networks in an operational exercise involving multiple JTFs. (\$19.2M)
- (U) Demonstrate integration on a CONUS/International scale of all networks and demonstrate end-to-end secure transmission and signaling at gigabit rates. (\$5.0M)
- (U) Demonstrate high bandwidth operation of critical multi-wavelength components. (\$12.5M)
- (U) Field test local area network application of multi-wavelength analog and digital signal transmission. (\$9.0M)

(U) FY 1997 Planned Program:

- (U) Identify control and protocol issues for operation of multi-wavelength networks. (\$3.6M)
- (U) Demonstrate advance integrated optoelectronic network component operations. (\$10.7M)
- (U) Complete multi-wavelength network architecture and control planning; and initiate field-trial network deployment for long-distance and wide area applications. (\$13.4M)
- (U) Demonstrate integration with advanced optical testbeds; large scale planning demonstrations; and deployable JTF C3 (mobile C3, plan rehearsal and refinement during deployment, intelligent interfaces). (\$17.1M)

(U) Program to Completion: This is continuing program.

D. (U) WORK PERFORMED BY: Competitive award of contracts. Major performers will include telecommunications, electronic and computing companies.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #06032226E

Project Number: EE-45 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: This program is consistent with the FY 1995 Descriptive Summary.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: The program is coordinated with: The national High Performance Computing and Communication Program (that will provide theory and limited-area experience), the ARPA consortia on all-optical network and optoelectronic components, the component crypto development by NSA, and the JDL C3 and Computer Science panels.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Planned	Milestones
Apr 95	Demonstrate optical component prototypes.
Jul 95	Multiple crisis scenario (integrated simulation and modeling tools, more powerful trade-off analysis).
Sep 95	Integrate defense high performance networks with crosscountry backbone using SONET/ATM. Early planning support demonstrations.
May 96	Demonstrate network combining crypto, commercial communications, and defense secure wireless, satellite.
May 97	Demonstrate integration with advanced optical testbeds. Large scale planning demonstrations.
Jul 97	Deployable JTF C3 (mobile C3, plan rehearsal and refinement during deployment, intelligent interfaces).
May 98	Cross-country demonstration of optical and advanced network management.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #603226E

PE Title: Experimental Evaluation of Major Innovative Technologies

Project Number: EE-46

Date: June 1994

Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title:	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	Total
Popular Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Program Complete
Defense Simulation Internet (DSI)									
EE-46	31,617	15,855	26,200	37,000	0	0	0	0	110,672

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The goal of the Defense Simulation Internet (DSI) program is to research, develop and test at scale (worldwide), a network infrastructure capable of enabling distributed, real-time, multi-media (video, voice, shared data and work spaces) simulation that will seamlessly integrate all simulation and modeling functions from early design to battle rehearsal enroute to the conflict. In its current state, the DSI is a collection of individual technologies that must be matured into a communications system. The communications needs of the distributed, real-time, multi-media simulation community cannot be met with any available technology. Commercial vendors are pursuing some of the required technologies but development is too slow to accommodate the immediacy of the Department of Defense's simulation requirements. The DSI program is therefore accelerating the commercial development of the technologies needed by the simulation community for distributed work environments worldwide. Nearly 100 nodes currently extend the DSI to each of the Services, most of the Commanders-in-Chief (CINCs) and other Government affiliated sites. These locations constitute the network's test sites; they provide valuable feedback on the technologies and methodologies being pursued.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Implemented interim upgrade to the network backbone (to 6 megabits per second (Mbps)) within the continental United States (CONUS) and installed new backbone routers. (\$2.8M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #603226E

PE Title: Experimental Evaluation of Major Innovative Technologies

Project Number: EE-46

Date: June 1994

Budget Activity: 3. Advanced Development

- (U) Upgraded the transatlantic and transpacific circuits and continued to lease current other outside-CONUS (C-CONUS) circuits. (\$2.3M)
- (U) Continued to lease approximately 100 communications lines currently connecting the Defense Simulation Internet (DSI) sites to the network backbone and leased an additional 40 new lines for additional sites. (Collectively referred to as tail circuits.) (\$3.1M)
- (U) Continued to operate the Network Operations Center (NOC); and provided network engineering support, exercise engineering and onsite support worldwide, security management and oversight, user training and hotline support, network configuration management including inventory control, and network equipment maintenance. (Collectively referred to as Operations Support) (\$8.6M)
- (U) Initiated development of end-to-end encryption system that is protocol independent and capable of supporting extremely high speed, high bandwidth demand networks. (\$4.8M)
- (U) Developed open system communications software services supportive of real-time, distributed, multi-media simulation requirements such as multi-casting, resource and network management, and implemented them on commercial-off-the-shelf devices. (\$3.4M)
- (U) Developed premise devices: capable of handling extremely high data rates and communications protocols; capable of being installed, used and maintained at thousands of locations without onsite engineering support teams; with a cost reduction of at least 50% per device. (\$6.6M)
- (U) FY 1995 Planned Program:
 - (U) Implement upgrade to the network backbone to 45 Mbps (T3) within the CONUS. A T3 is the first phase of migration of the network to Asynchronous Transfer Mode (ATM) and the most immediate task in upgrading the network in preparation for transition to a life cycle support agency. Procure and install new backbone switches. (\$3.3M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #603226E

Project Number: EE-46 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Continue to lease CONUS, O-CONUS circuits, 140 tail circuits plus 40 new sites to be added annually to the network. It is anticipated that as newer technologies become available, the average cost of a T1 will decrease in CONUS. As the decrease in CONUS circuit occurs, additional capacity and upgrade will be purchased for the Pacific and Atlantic O-CONUS areas, offsetting the cost. (\$5.4M)
- (U) Continue to provide operations support using the Joint Program Office's consolidated Network Operations Center (NOC). During the period of transition from the current DSI NOC to the consolidated NOC, network operations must support all protocols; Internet Protocol (IP) and Stream 2 (ST2) Protocol, to the new ATM based DSI. User tools will be developed and brought online, decreasing cost and network operations complexity as the older system is transitioned into the new. (\$4.3M)
- (U) Continue to support and provide service to the user community by the Customer Service Center (CSC) through technical assistance, training, event/exercise planning and support, and maintenance. A large percentage of the CSC costs are born by the user sites. (\$2.9M)
- (U) FY 1996 Planned Program:
 - (U) Implement upgrade to the network backbone to 155 Mbps (OC3) within the CONUS. As the number of new sites moves rapidly upward by forty per year, and as all sites become more experienced in using the distributed features of the network, the backbone traffic is increasing exponentially. A T3 backbone will be inadequate for the DSI by FY96. An OC3 backbone within the CONUS, with multicasting and resource guarantee protocols in place, will be necessary for the DSI at least as early as FY96. This backbone upgrade will coincide with the insertion of ATM premise devices and the ATM E3 devices at user sites which will significantly increase their performance capabilities. (\$6.5M)
 - (U) Continue to lease CONUS, O-CONUS circuits, 180 tail circuits plus 40 new sites, and upgrade high use sites to higher lines speeds. (\$9.9M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #603226E

Project Number: EE-46 Date: June 1994

PE Title: Experimental Evaluation of Major Innovative Technologies

Budget Activity: 3. Advanced Development

- (U) Continue to provide operations support to include scheduling, training, maintenance, deployment services, exercise/event support. (\$9.8M)
- (U) FY 1997 Planned Program:
 - (U) Continue to lease CONUS network backbone circuits, OCONUS circuits, 220 tail circuits plus 40 new sites. (\$18.9M)
 - (U) Continue to provide Operations Support. The operations objective is to maintain and operate the DSI in a manner consistent with the DSI user community requirements. Operations include the Network Operations Center (NOC), configuration control, circuit provisioning, network security, exercise/event engineering, exercise on-site support, exercise/event scheduling and coordination, equipment maintenance, and a 24-hour help desk. (\$18.1M)
- (U) Program to Completion:
 - (U) 1997 is target date for transition of the DSI from ARPA to DISA. The Advanced Information Technology Services Joint Program Office will assist in the transition of the DSI network to DISA.
- D. (U) WORK PERFORMED BY: Bolt, Beranek, and Newman in Cambridge, MA; Houston Associates, Incorporated in Arlington, VA and Leavenworth, KS; Titan Corporation in San Diego, CA; and Science Applications International Corporation in Arlington, VA.
- E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change.
- F. (U) PROGRAM DOCUMENTATION:
Various Installation, Maintenance, User and Training Manuals, 1993.
Stream II Protocol Release Notes, December 1993.
- G. (U) RELATED ACTIVITIES: None.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #603226E Project Number: EE-46 Date: June 1994
PE Title: Experimental Evaluation of Major Budget Activity: 3. Advanced Development
Innovative Technologies

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Feb 94	Transitioned operations to Joint Program Office.
May 94	Completed Interium Backbone Upgrade (6 Mbps).
Sep 94	Award contracts for Encryption Efforts, Communications Services.
Nov 94	Award contracts for Premise Devices.
Jan 95	Complete T3 Backbone upgrade (45Mbps).
Jul 96	Complete OC3 Backbone upgrade (155Mbps).
Sep 97	Complete network transition to DISA.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603569E Project Number: AS-01 Date: June 1994
 PE Title: Advanced Submarine Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Advanced Submarine Technology									
<u>Popular Name</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>Total Program</u>
AS-01									
	SUBTECH								
	44,194	25,261	19,473	24,311	28,449	36,230	46,230	54,530	Continuing
									Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This program element is budgeted in the Advanced Development Budget Activity because its objectives are to develop and demonstrate advanced concepts and to pursue critical enabling technologies for future ship classes. The evolving worldwide threat of quiet diesel submarines and the proliferation of sophisticated submarine and weapons capabilities available to third world countries necessitates that the U.S. continue to maintain a superior submarine force. U.S. submarine technologies must keep pace with changing threats and remain immune to technological surprises, but declining resource availability mandates that this be done affordably. Therefore, the main thrust of this project is to provide far-term solutions to increase ship affordability and provide enhanced capability to operate in this new environment by means of advances in structural vibration control, fluid/structure boundary interaction control and advanced materials.

(U) This project continues to develop and demonstrate innovative technologies initiated under active structural control, hydrodynamic control, advanced materials/structures, and structural acoustics efforts to reduce ship observables. These technologies will significantly enhance submarine stealth and survivability. They form the basis for efforts addressing affordability through improvements in ultra-high precision machinery used for fabricating shipboard noise-critical applications, structural acoustic design capabilities, innovative machinery mounting systems, active structural control and high reliability propulsion systems. Under the thick section composites and embedded sensors efforts, the advanced structural fabrication processes and strength monitoring capabilities necessary to introduce affordable advanced lightweight structural materials into ship construction programs are being demonstrated.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603569E

Project Number: AS-01 Date: June 1994

PE Title: Advanced Submarine Technology

Budget Activity: 3. Advanced Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Fabricated non-autoclave cure thermoplastic-stiffened composite cylinders and spheres; began testing thermoplastic cylinder and thermoset sphere; continued development of material properties characterization tools and Non-Destructive Evaluation (NDE) methods. (\$7.8M)
- (U) Continued fabrication of SUPRELITE components; completed SUPRELITE one-year fatigue test. (\$5.5M)
- (U) Continued design and fabrication of fiber placement cylinder and resin transfer molding (RTM) articles with embedded sensors. (\$2.5M)
- (U) Implemented automatic 3-D mesh generator for the Stealth Designer's Workbench (SDW). (\$0.3M)
- (U) Developed Active Structural Control (ASC) techniques for: a) shock attenuation and design of a concept demonstration system for Special Warfare Craft, b) suppression of blade resonance and resulting high cycle turbine fatigue failure, and c) active vibration isolation of electronics cabinets; and initiated concept demonstration system design. This effort was funded by a Congressional addition to the FY 1994 President's Budget. (\$8.0M)
- (U) Demonstrated feasibility of ASC chatter and vibration control for high speed, high precision machining operations. Formulated concepts for ASC of chatter in precision milling operations. (\$2.0M)
- (U) Demonstrated active sound isolation through magnetic levitation. (\$3.4M)
- (U) Completed 50:1 scale model tests and numerical simulations for hull response to lightweight structures and completed truss beam damping tests, design of truss attachment, and numerical simulations. (\$6.0M)
- (U) Fabricated and tested active smart skin and Electromagnetic Turbulence Control (EMTC) concepts. (\$3.4M)
- (U) Expanded on technology developed in thick composites program and initiated fabrication of one Dry Deck Shelter (DDS) and test vehicle. This effort was funded by a Congressional addition to the FY 1994 President's Budget. (\$4.3M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603562E

Project Number: AS-01 Date: June 1994

PE Title: Advanced Submarine Technology

Budget Activity: 3. Advanced Development

- (U) Evaluated advanced stealth, signature control, communications, materials, and producibility technologies to enhance submarine performance in littoral warfare. (\$1.0M)
- (U) FY 1995 Planned Program:
 - (U) Develop and test active shock attenuation techniques. Initiate design of a thermally-boostered acoustic source for stealth applications. (\$2.5M)
 - (U) Conduct a full scale demonstration of Active Structural Control (ASC) for turning and boring applications. Initiate feasibility demonstration of ASC concepts for high speed milling. Develop ASC grinding operations. (\$1.1M)
 - (U) Demonstrate active compliant structure control concepts at laboratory scales. (\$1.0M)
 - (U) Complete design and fabrication of 1/4-scale model for lightweight structures and complete truss testing and numerical simulations. (\$5.0M)
 - (U) Complete fabrication and initiate installation of SUPRELITE. (\$2.4M)
 - (U) Complete fabrication, assembly and test of thick composite subscale components and a cylinder with embedded sensors, and refinement of sensor demodulation and non-destructive evaluation (NDE) methods. (\$4.0M)
 - (U) Develop large scale, curved surface application of Electromagnetic Turbulence Control (EMTC). (\$4.0M)
 - (U) Conduct initial demonstrations of individual submarine stealth and littoral warfare operational enhancing technologies. (\$5.3M)
- (U) FY 1996 Planned Program:
 - (U) Demonstrate Active Structural Control (ASC) shock attenuation techniques on full-scale platform. Develop and test a demonstration system to validate the design of a thermally-boostered acoustic source for stealth applications. (\$2.5M)
 - (U) Demonstrate full scale Active Structural Control ASC of high speed milling applications. Initiate feasibility demonstration to validate ASC concepts for active control in high speed grinding. (\$1.5M)
 - (U) Integrate truss and hull structure at 1/4-scale. (\$4.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603569E

Project Number: AS-01 Date: June 1994

PE Title: Advanced Submarine Technology

Budget Activity: 3. Advanced Development

- (U) Complete assembly and installation of SUPRELITE components and conduct at-sea test. (\$0.4M)
- (U) Conduct an at-sea demonstration of drag reduction and control of Electromagnetic Turbulence Control (EMTC) on a large scale vehicle. (\$4.0M)
- (U) Demonstrate feasibility of integrating littoral warfare mission enhancements and stealth technologies into concepts for enhancing submarine shallow depth operations. (\$6.5M)
- (U) FY 1997 Planned Program:
 - (U) Perform concept feasibility demonstration for special warfare weapon stabilization and isolation system. (\$1.4M)
 - (U) Demonstrate active mount technology for shock and vibration suppression of turbine rotating components on large-scale vehicle or platform. Perform concept feasibility demonstration on ASC system for turbine engine external structural components. (\$3.4M)
 - (U) Complete full-scale demonstration of ASC system for precision grinding operation on noise-critical component. (\$1.2M)
 - (U) Perform large scale demonstration of dynamically stiffened maritime structures and concept feasibility demonstration of ASC system for robotic manipulators. (\$5.3M)
 - (U) Demonstrate and validate 1/4-scale truss design. (\$6.0M)
 - (U) Perform large scale demonstration of integrated stealth technologies, mission enhancements, and communications capabilities in submarine littoral warfare. (\$7.0M)

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: AT&T Bell Laboratories, Whippany, NJ; GEC-Marconi, United Kingdom; Los Alamos National Laboratory, Los Alamos, NM; Metron Inc., Reston, VA; and Pennsylvania State University/Applied Research Laboratory, State College, PA.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603569E Project Number: AS-01 Date: June 1994
PE Title: Advanced Submarine Technology Budget Activity: 3. Advanced Development

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: This program is the continuation of the Congressionally-mandated Submarine Technology Program (STP).

1. TECHNICAL CHANGES: None.
2. SCHEDULE CHANGES: None.
3. COST CHANGES: None.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: This program has been coordinated with the Program Executive Officer, Submarines (PEO-SUB-R) to ensure there is no duplication of effort and that developed technologies are properly transitioned to the Navy.

(U) The Special Warfare Craft Stealth and Habitability program is coordinated through the U.S. Naval Special Operations Command's (SOCOM) Advanced Technology Development Office and Naval Special Warfare Development Group.

(U) The Damping of Lightweight Structures program is cosponsored by the Navy through an MOU signed on July 23, 1993.

(U) Active Control of Turbine/Propulsion Systems Vibration and Machine Tool Vibration Programs are coordinated with the Air Force's Integrated High Performance Turbine Engine Technology (IHPTET) Initiative and DoD's multi-service Manufacturing Technology Program, respectively.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603569E

PE Title: Advanced Submarine Technology

Project Number: AS-01 Date: June 1994

Budget Activity: 3. Advanced Development

J. (U) MILESTONE SCHEDULE:

Plan Milestones

Sep 94	Concept feasibility demonstration of precision machining turning and boring operations.
Nov 94	Concept feasibility demonstration of electronics cabinet vibration isolation system.
Nov 94	Complete fabrication of full scale SUPRELITE rotor.
Dec 94	Concept feasibility demonstration of active shock attenuation system.
Apr 95	Installation and initial at-sea test of full scale SUPRELITE rotor. Transition to Navy.
Aug 95	Factory floor demonstration of precision machining turning and boring operations.
Sep 95	Concept feasibility demonstration of active control of turbine blade resonance vibrations.
Sep 95	Demonstrate feasibility of individual stealth technologies in submarine design concepts optimized for littoral operations.
Feb 96	Full-scale demonstration of active shock attenuation system.
Jun 96	Complete testing of integrated 1/4-scale lightweight truss structures.
Jul 96	Concept feasibility demonstration of thermoacoustic source noise cancellation system.
Aug 96	Full-scale demonstration of active control of turbine blade resonance vibration.
Aug 96	Large-scale demonstration of mission enhancements and stealth technologies in submarine design concepts.
Sep 96	Factory floor demonstration of precision machining milling operation.
Jun 97	Full-scale demonstration of thermally boosted acoustic source for stealth applications.
Jul 97	Demonstration of Integrated Stealth Technologies for submarine concepts.
Aug 97	Demonstration of active vibration control system for precision grinding operation.
Aug 98	Full-scale demonstration of turbine active vibration control system for engine mounts and external components.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603570E

Date: June 1994

PE Title: Defense Reinvestment

Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u>	FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		To	Total
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Actual</u>	<u>Estimate</u>	<u>Actual</u>	<u>Estimate</u>	<u>Actual</u>	<u>Estimate</u>	<u>Actual</u>	<u>Estimate</u>	<u>Actual</u>	<u>Estimate</u>	<u>Actual</u>	<u>Estimate</u>	<u>Actual</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
Defense Reinvestment	474,000	625,000	650,000	675,000	700,000	725,000	500,000	250,000	Continuing	Continuing								

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Defense Reinvestment program element is budgeted in the Advanced Development Budget Activity because its purpose is to stimulate development of technologies that will provide both new military capability and new commercial products, and further the integration of commercial and military production the potential for processes. Once developed and deployed, the resulting technologies will increase both national security and the national economy. The program's objectives will be achieved through the application of defense and commercial resources to develop dual-use technologies, provide manufacturing and technology assistance to small firms, and establish education and training programs designed to enhance U.S. manufacturing skills and target displaced defense industry workers. The program consists of multiple projects generally grouped into the following categories:

- Defense Dual-Use Critical Technology Partnerships
- Commercial-Military Integration Partnerships
- Defense Advanced Manufacturing Technology Partnerships
- Manufacturing Engineering Education Grant Program
- Regional Technology Alliances
- Agile Manufacturing/Enterprise Integration Program
- Advanced Materials Synthesis and Processing Partnerships
- U.S.-Japan Management Training Program
- MARITECH
- Small Business Innovation Research

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603570E

PE Title: Defense Reinvestment

Date: June 1994

Budget Activity: 3. Advanced Development

(U) The FY 1995 program will fund that portion of the FY 1994 "highly recommended" proposals that could not be financed in FY 1994 and incorporate the Maritime Technology (MARITECH) initiative, a program to facilitate U.S. penetration of the commercial shipbuilding industry. The FY 1995 program will also solicit proposals in a general competition with emphasis on developing dual-use technologies. The Manufacturing and Dual-use Extension Programs will be reduced in scope.

(U) The FY 1996 and FY 1997 programs continue development programs selected under prior year solicitations and will fund promising, new TRP programs.

(U) Funding for the Small Business Innovation Research (SBIR) Program is included within this Program Element in FY 1994-2001 to strengthen the role of small business in meeting dual-use research and development for both military and commercial applications.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Funded highly successful proposals identified as part of the FY 1993 solicitation. (\$140.0M)
- (U) Conducted a focused technology competition concentrating on 5-7 technology areas and deployment components. (Approximately \$200.0M)
- (U) Identified and established new partnerships through an open, general solicitation. (\$134.0M)

(U) FY 1995 Planned Program:

- (U) Execute FY 1995 increment of ongoing projects begun in FY 1993 and FY 1994.
- (U) Execute highly successful proposals identified as part of the FY 1994 general solicitation.
- (U) Identify and establish new partnerships.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603570E
PE Title: Defense Reinvestment

Date: June 1994
Budget Activity: 3. Advanced Development

- (U) FY 1996 Planned Program:
 - (U) Execute FY 1996 increment of ongoing project begun in FY 1995 and prior.
 - (U) Identify and establish new partnerships.
- (U) FY 1997 Planned Program:
 - (U) Execute FY 1997 increment of ongoing projects initiated in prior years.
 - (U) Identify and establish new partnerships.
- (U) Program to Completion: Continuing.
- D. (U) WORK PERFORMED BY: Partnerships are composed of industry, federal laboratories, institutions of higher education, state government agencies, Government-owned and operated industrial facilities, and other entities that support the activities of the firms or non-profit research corporations.
- E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: Programmed FY 1996-99 funding levels reflect fiscal guidance to fund the program at levels consistent with the FY 1995 request. Resources for the program decline in FY 2000-01, reflecting completion of the effort.
- G. (U) RELATED ACTIVITIES: Ongoing government research projects.
- H. (U) OTHER APPROPRIATION FUNDS: None.
- I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.
- J. (U) MILESTONE SCHEDULE: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1994 Estimate	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
MT-01 Microelectronics Manufacturing	0	0	0	14,946	29,500	45,250	70,550	73,900	Continuing	Continuing	271,940
MT-02 Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC)	79,881	25,183	0	0	0	0	0	0	0	0	196,118
MT-03 IR Focal Plans Array (IRFPA)	41,429	44,809	38,200	19,400	0	0	0	0	0	0	196,118
MT-04 Electronic Module Technology	117,580	130,930	136,512	112,826	151,087	160,106	200,472	222,522	Continuing	Continuing	271,940
MT-05 Tactical Display Systems	9,382	16,210	21,161	20,169	29,735	18,500	25,500	32,500	Continuing	Continuing	271,940
MT-06 Microwave and Analog Front End Technology (MAFET)	0	24,475	54,489	55,296	54,981	55,201	62,467	68,012	Continuing	Continuing	271,940
MT-07 Centers of Excellence	23,837	15,000	15,000	10,000	0	0	0	0	0	0	91,501
MT-08 Manufacturing Technology Initiatives	6,741	14,342	27,800	29,112	35,920	25,000	25,000	25,000	0	0	188,915

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

MT-09	Dual-Use Design and Manufacturing Technology	41,751	34,235	15,000	20,000	23,000	Continuing	Continuing	
0	25,180	39,742							
MT-10	Advanced Lithography	30,000	35,000	40,000	45,000	45,000	Continuing	Continuing	
58,386	10,000	25,000							
MT-11	Computer-aided Acquisition and Logistics Support (CALs)	15,000	15,000	0	0	0	0	133,000	
43,000	40,000	20,000							
Total		<u>380,236</u>	<u>346,129</u>	<u>377,904</u>	<u>348,500</u>	<u>385,458</u>	<u>359,057</u>	<u>448,989</u>	<u>489,934</u>

B. (U) BRIEF DESCRIPTION OF ELEMENT: The Electronics Manufacturing Technology program element is budgeted in the Advanced Development Budget Activity because it seeks to design and demonstrate state-of-the-art manufacturing and process technologies for the production of various electronics and microelectronic devices, sensor systems, actuators, gear drives that have both commercial and military applications. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements and enhance the U.S. industrial base.

(U) The objective of the Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) project is to accelerate the development, manufacturing and demonstration of affordable microwave and millimeter wave analog integrated circuits. This technology will be the basis for the efforts in the Microwave and Analog Front End Technology (MAFET) program (MT-06) beginning in FY 1995. The MAFET program will further enhance microwave and millimeter wave module performance at reduced costs.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

(U) The IR Focal Plane Array project focuses on the establishment of a manufacturing base for advanced infrared sensor arrays for major weapons systems. This base will allow the systems to meet operating requirements at approximately 1% of the current cost.

(U) The goal of the Electronic Module Technology project is to allow for the timely insertion and rapid acquisition of state-of-the-art microsensors and actuators, conformal electronics and affordable, high performance application specific electronic module (ASEM), components into major military systems. These systems include automatic target recognition, electronic counter-measures and Signal Intelligence (SIGINT). This project includes Advanced Technology Demonstrations (ATDS) in ASEM and Rapid Prototyping of Application Specific Signal Processor (RASSP).

(U) Tactical Display Systems projects develop and demonstrate high definition miniature displays to provide visual information to individual combatants and small groups who are remotely located from conventional visual information sources.

(U) The Centers of Excellence program finances demonstration, deployment of and training on advanced manufacturing technologies. The goal of this technology is to reduce unit and life-cycle costs while improving quality.

(U) The goal of the Manufacturing Technology Initiatives program is to reduce the cost and acquisition leadtime of future military systems by integrating manufacturing process considerations during the product design phase, and by demonstrating high efficiency multi-product prototype factories. The project funds two Advanced Technology Demonstrations, the Active Electronically Scanned Arrays (AESA) project and the Flexible Design and Assembly of Missile and Munitions Seekers (FDAMMS) project, to provide practical examples of these concepts.

(U) The Dual-Use Design and Manufacturing project will enable manufacturers to economically produce military variants of their commercial products in limited quantities through the introduction of flexible process technologies. Key concepts that are integral to dual-use manufacturing capability such as advanced design systems scalable components and subsystems,

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Date: June 1994

Budget Activity: 3. Advanced Development

flexible factory systems, and improved manufacturing operations control will be demonstrated in two sub-projects: the Interferometric Fiber Optics Gyroscopes (IFOG) and Manufacturing Systems Technology Electric Drive System (MSTEDS) projects.

(U) Advanced Lithography technology has enabled the dramatic growth of integrated circuit (IC) capability. Advances have led directly to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability.

(U) The goal of the Computer-aided Acquisition and Logistic Support (CALS) initiative is to transition DoD's current paper intensive weapon system support processes to a highly automated and integrated mode of operation. The transition will result in a fundamental change in the way DoD and industry use and distribute technical information, improving the quality and productivity of weapon system development and support.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-01 Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Microelectronics Manufacturing Technology		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total	
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
Microelectronics Manufacturing	0	0	14,946	29,500	45,250	70,550	73,900	Continuing							

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: Microelectronics manufacturing is tightly tied to the development of highly sophisticated, specialized equipment. This program will concentrate on supporting equipment development for the .18 micron penetration of semiconductor technology. Furthermore, the capability to manufacture differentiated integrated circuits (ICs) -- i.e., logic, application-specific ICs, microprocessors -- at the state of the art and in any volume with rapid turnaround is vital to the creation of leading-edge information systems for defense. One focus of this project is on the manufacturing tools and methodologies needed for low-cost, flexible manufacturing to meet Defense needs. Today's microelectronics manufacturing technology is optimized to produce a single part type in large volumes. This project will combine advances in physical equipment (modular cluster tools with real-time model-based process control, ultraclean infrastructure, and cost-effective lithography) with software advances (fully integrated computer-integrated manufacturing (CIM) systems and modeling and simulation tools for designing processes, tools, and factories) to enable state-of-the-art microelectronics manufacturing facilities capable of producing many part types in any volume at low cost. Special attention will also be given to environmentally safe manufacturing techniques.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-01 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1997 Planned Program:

- (U) Initiate development of key equipments and unit processes to enable 0.18 micron semiconductor manufacturing. (\$5.0M)
- (U) Initiate establishment of point-of-use chemistry and distribution for contamination-free manufacturing. (\$2.0M)
- (U) Initiate development and integration of a set of software tools that support process programmability, and first-pass success manufacturing. (\$2.0M)
- (U) Initiate demonstration of factory technology for automated production, including advanced process control. (\$6.0M)

(U) Program to Completion:

- (U) Initiate programs to develop key manufacturing capabilities for robust flexible production of 0.12 micron feature devices.
- (U) Develop software tools that support rapid design with tight coupling to manufacturing.
- (U) Develop critical unit processes for 0.12 micron technology.
- (U) Coordinate wafer fabrication efforts with advanced packaging efforts to ensure maximum device performance.
- (U) Develop key equipment and mechanical handlers for large-wafer diameters.
- (U) Demonstrate modular, flexible tools with imbedded intelligence and process control.
- (U) Demonstrate flexible factories with scalable production volumes.

D. (U) WORK PERFORMED BY: Not applicable.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: This program was not in the FY 1995 Descriptive Summary. However, it constitutes the portion of EM-01 that was devoted to semiconductor equipment development.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-01 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

- F. (U) PROGRAM DOCUMENTATION: Not applicable.
- G. (U) RELATED ACTIVITIES: Not applicable.
- H. (U) OTHER APPROPRIATION FUNDS: None.
- I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.
- J. (U) MILSTONE SCHEDULE:

<u>Plan</u>	<u>Milestone</u>
Dec 97	Defined equipment specifications for major components needed for the .18 micron generation processes.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-02 Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC)										
Popular Name	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	To	Total
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
MT-02		79,881	25,183	0	0	0	0	0	0	271,940

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This project provides for the acceleration of development, manufacturing and demonstration of affordable microwave and millimeter wave analog integrated circuits (ICs). The Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) program is providing previously unavailable microwave and millimeter-wave integrated circuits to enable DoD systems to meet size, weight and power constraints at the lowest possible cost. Its primary thrust is to develop affordable circuits operating in the 1 to 100 GHz frequency range with required characteristics and sufficient quantity to satisfy military systems needs. The use of reliable and maintainable semiconductor devices and circuits for selected system demonstrations will be accelerated and, thus provide the United States with a technological lead in deploying MIMIC-based military systems.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Continued work on MIMIC Phase 2 contracts including delivery of process demonstration wafers, completion of MIMIC Phase 2 chip fabrication and continue assembly of MIMIC modules and brassboards. (\$79.9M)
- (U) FY 1995 Planned Program:
 - (U) Completion of program including delivery of MIMIC chips, modules and brassboards and demonstrations of advanced technology and hardware. (\$25.2M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-02 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

- (U) FY 1996 Planned Program:
 - (U) Not applicable. No funds requested.
- (U) FY 1997 Planned Program:
 - (U) Not applicable. No funds requested.
- (U) Program to Completion:
 - (U) Not applicable. No funds requested.

D. (U) WORK PERFORMED BY: In-house work will be performed by: Army Research Laboratory; Naval Air Systems Command; U.S. Naval Research Laboratory; Air Force Wright Laboratory, and Rome Laboratory. Hardware development phase prime contractors are: Hughes Aircraft Company, El Segundo, CA; General Electric, Syracuse, NY; Martin-Marietta, Orlando, FL; ITT, Roanoke, VA; Raytheon Co., Bedford, MA; Texas Instruments, Dallas, TX; and TRW, Redondo Beach, CA.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change. Program completion in FY 1995.

- F. (U) PROGRAM DOCUMENTATION:
- (U) Management structure for the Microwave/Millimeter Wave Monolithic Integrated Circuits (MIMIC) Program, 9/85.
 - (U) Program Plan for MIMIC, 5/86.
 - (U) Acquisition Plan No. DoD 86-X for MIMIC Program, 10/86.

G. (U) RELATED ACTIVITIES:
Exploratory and advanced development of gallium arsenide monolithic components are being undertaken within the following Army, Navy, Air Force RDT&E program elements:

- (U) Program Element #0602705A, Electronics and Electronic Devices
- (U) Program Element #0602234N, Systems Support Technology
- (U) Program Element #0602204F, Aerospace Avionics

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-02

Date: June 1994

Budget Activity: 3. Advanced Development

(U) The work performed within this project is complementary to the work performed in the Service program elements. MIMIC is a ARPA funded and managed/Tri-Service coordinated program. Each of the Military Departments has set up a MIMIC Program Office to provide management and support for the MIMIC Program's contractual efforts.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Jun 94	Complete fabrication of MIMIC chips.
Jan 95	Deliver MIMIC Phase 2 chips, modules and brassboards.
Jan 95	Complete integrated design/fabrication/test capabilities at MIMIC Phase 2 contractors.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-03 Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> IR Focal Plane Array											
<u>Popular Name</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>To Complete</u>	<u>Total Program</u>	
MT-03	IRFPA	41,429	44,809	38,200	19,400	0	0	0	0	0	196,118

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Infrared Focal Plane Array (IRFPA) project establishes a manufacturing base for advanced infrared (IR) sensor arrays required for major weapon systems. Improvements in infrared materials, detector array fabrication, read-out electronics, cryogenic testing and module assembly are addressed in order to provide affordable infrared sensors to system developers. Systems requiring affordable tactical infrared focal plane arrays include missile seekers, airborne and ground-based target acquisition systems, and infrared search and track systems. Currently, the IRFPAs are produced at low rates and high cost with technology that is just emerging from the laboratory environment. The goal of this project is to produce IRFPAs that meet system requirements with a hundred-fold cost reduction relative to the cost at the beginning of the project, and to provide a capability to produce focal plane array at low cost in low volume.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Demonstrated imaging of a 480x640 long wavelength staring array fabricated on a silicon wafer with improved morphology and low defect density. (\$4.0M)
 - (U) Established repeatability of system compatible 480x4 scanning arrays and 64x64 staring arrays meeting tactical system requirements. (\$15.0M)
 - (U) Designed and fabricated high performance read-out integrated circuit with improved linearity meeting mid and long wavelength requirements. (\$5.4M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-03 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

- (U) Completed evaluation of high speed, long wavelength, 11.0 micron at 68 degrees kelvin for a 480x4 focal plane array for airborne applications. (\$6.0M)
- (U) Completed analytical model of defect formation energies in infrared materials. (\$1.0M)
- (U) Completed design of flexible manufacturing line including laboratory demonstration of processes. (\$10.0M)

(U) FY 1995 Planned Program:

- (U) Demonstration of one-hundred times (X100) cost reduction for 480x4 infrared focal plane arrays useful for ground and airborne applications. (\$9.8M)
- (U) On-line demonstration of electrical functionality probing of detector arrays on wafers. (\$3.0M)
- (U) Demonstration of 128x128 infrared focal plane array with improved spatial uniformity for missile seeker applications. (\$5.0M)
- (U) Integration of completely dry processing into the infrared detector fabrication line. (\$7.0M)
- (U) Laboratory demonstration of cluster tool concept for flexible manufacturing of IRFPA'S. (\$20.0M)

(U) FY 1996 Planned Program:

- (U) Demonstrate automated thin film deposition and etching workcell for multiple focal plane array configurations. (\$5.0M)
- (U) Complete development of standard electronic cells for rapid design and fabrication of infrared read-out integrated circuits. (\$8.0M)
- (U) Verify performance of cryogenic packing vacuum seal; and vacuum bake-out workstation. (\$5.0M)
- (U) Complete development of computer aided design files for rapid prototype of infrared cryogenic packages. (\$5.0M)
- (U) Demonstrate uncooled focal plane arrays hybridized to low noise analog read-out circuits. (\$5.2)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-03 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

- (U) Complete the development of an integrated manufacturing capability for large-area (4-inch diameter) infrared sensitive semiconductor wafers. (\$10.0M)
- (U) FY 1997 Planned Program:
 - (U) Incorporate into the cryogenic factory the capability to rapidly design and build prototypes of new cryogenic packages. (\$3.0M)
 - (U) Demonstrate capability to produce multiple cryogenic package designs on the same manufacturing line. (\$5.4M)
 - (U) Achieve capability to monolithically integrate infrared material on silicon read-out circuits. (\$3.0M)
 - (U) Fabricate infrared read-outs using a 0.8 micron CMOS process, establishing the capability to fabricate high density staring arrays. (\$3.0M)
 - (U) Demonstrate flexible, modular IRFPA manufacturing with the capability to rapidly reconfigure the line to produce 3-5 and 8-12 micron arrays for tactical and space surveillance applications. (\$5.0M)

D. (U) WORK PERFORMED BY: Contractors include: Loral Infrared and Imaging Systems, Lexington, MA; Rockwell, Anaheim, CA; Texas Instruments, Dallas, TX; Hughes Research Lab, Malibu, CA; and Martin Marietta, Orlando, FL and Schenectady, NY.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: Consistent with the FY 1995 Descriptive Summary.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Development of Infrared Focal Plane Array (IRFPA) technology and devices is being undertaken under Army, Navy, Air Force and Advanced Research Projects Agency (ARPA) program elements. The related Service program elements are:

- (U) PE 0602709A, Night Vision Technology.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronics Manufacturing Technology
Project Number: MT-03 Date: June 1994
Budget Activity: 3. Advanced Development

- (U) PE 0603774A, Night Vision System Advanced Development.
- (U) PE 0602234N, Systems Support Technology.
- (U) PE 0602204F, Aerospace Avionics.

(U) The project supports development of flexible IRFPA manufacturing, capable of meeting tri-Service requirements. All Service and ARPA efforts are closely coordinated to assure that there is no duplication of effort.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Aug 95	Demonstrate a 100 times cost reduction in the manufacture of two-dimensional, staring IRFPAs.
Sep 95	Assemble scalable focal plane array facility.
Jan 96	Demonstrate process module concept for multi-purpose scanning arrays.
Jun 96	Demonstrate equipment with flexibility to produce various IRFPA configurations on the same line.
Sep 96	Demonstrate large-area staring and scanning array for search and track, target acquisition, and missile seeker systems.
Sep 97	Demonstrate high-yield IRFPA manufacturing facility capable of varying production rates from small lots to high throughput rates.
Dec 97	Completion of modular infrared focal plane array manufacturing capability, scalable from low volume (single wafer processing) to higher production volume (ten wafer lots @ over 10,000 wafers per year); with single wafer cycle time of ten days.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-04 Date: June 1994
PE Title: Electronic Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Electronic Module Technology		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total	
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
MT-04	Electronic Module Technology	117,580	130,930	136,512	112,826	151,087	160,106	200,472	222,522	Continuing	Continuing				

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Electronic Module Technology Project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the interconnection and physical packaging of various types of digital and analog integrated circuits, as well as other electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards, emerging technologies such as high density multichip modules (MCMs), and revolutionary approaches such as "conformal electronics".

(U) The project has four major objectives: (1) shorten the overall design, manufacture, test, and insertion cycle for advanced electronic subsystems; (2) advance the state-of-the-art in electronic interconnection and physical packaging technology to allow circuits to operate close to their intrinsic maximum speed with less overhead in terms of volume, weight and cost; (3) provide a robust manufacturing infrastructure for electronic modules; and (4) demonstrate the system level payoff of electronic module technology through advanced technology demonstrators (ATDs).

(U) The project has the following major elements: (1) High-Density Physical Packaging; (2) Application Specific Electronic Modules (ASEM); (3) Multichip Integration (MCI); (4) Rapid Prototyping of Application Specific Signal Processors (RASSP); (5) Microelectromechanical Systems (MEMS) and (6) High Density Microwave Packaging (HDMP). High-density physical packaging will

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronic Manufacturing Technology

Project Number: MT-04

Date: June 1994

Budget Activity: 3. Advanced Development

develop and exploit high-density packaging technology for digital and mixed analog/digital electronics with clock rates up to several GHz and manufacturing processes that will lead to the production of complex shape, lightweight, and high density microwave frequency multichip modules and sub arrays. ASEM will reduce the non-recurring engineering time and cost for designing and inserting complex electronic modules. MCI will produce order of magnitude reductions in manufacturing cost and accelerate the acceptance and insertion of multi-chip integration technologies. RASSP is a major ARPA/Tri-Service initiative which seeks to dramatically reduce the development time and lifecycle cost of advanced signal processing capability while ensuring state of the art performance when the processor is fielded, not just when it is first defined. MEMS enables information and control technology for mobile systems/active individuals by developing and using microdynamic devices and systems, wireless/low-power communications and conformal/embedded manufacturing. HDMP is developing microwave frequency, thin, lightweight multi-chip packages for use in applications such as active scanned arrays. It is expected to result in cost reductions of up to 75% compared to present approaches with excellent performance.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Continued development and demonstration of 10-100X packaging density improvement for digital processors, memories, and analog circuits operating at clock rates up to 500 MHz. (\$5.9M)
- (U) Continued the ASEM program with additional support for the flexible-access foundry system focusing on the board level integration of MCMs. Demonstrated 2 month turn-around time for MCM designs. Fabricated MCMs for insertion into computer workstation. (\$25.4M)
- (U) Continued the MCI program with the establishment of large format equipment development programs and the initiation of selected MCM insertions. (\$28.9M)
- (U) Expanded RASSP evaluation and technology base development and demonstrated first versions of design environment. (\$37.3M)
- (U) Initiated environmentally conscious electronics systems manufacturing. (\$20.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Date: June 1994

Project Number: MT-04

PE Title: Electronic Manufacturing Technology

Budget Activity: 3. Advanced Development

(U) FY 1995 Planned Program:

- (U) Develop microwave frequency multichip module housings, internal packaging interconnections, array interconnect technology, module assembly and integration and CAD tools and databases. (\$5.0M)
- (U) Continue the ASEM program with heightened emphasis on mixed signal modules and application demonstrations. Deliver new software tools to streamline the error-free design of MCMS. (\$29.1M)
- (U) Continue the MCI program with further development of manufacturing equipment, with a focus on the delivery of production modules for military aircraft and other dual-use applications. Demonstrate pilot production line for roll-to-roll fabrication of high density laminate MCMS. (\$25.0M)
- (U) Demonstrate improved signal processor design environment incorporating advanced CAD technology, VHDL extensions, and new signal processing algorithms. Complete first RASSP system demonstration prototypes and deliver preliminary RASSP benchmark evaluations. Initiate technology transition activities. (\$46.8M)
- (U) Develop high-yield, high-uniformity, integrated electrical/mechanical fabrication processes for microelectromechanical components and systems and merge with related fabrication technologies in optoelectronics, wireless and microwave devices. (\$25.0M)

(U) FY 1996 Planned Program:

- (U) Complete development of required microwave packaging approaches and interconnection circuitry; produce and demonstrate required multi-chip microwave assemblies. (\$9.4M)
- (U) Demonstrate complete end-to-end RASSP design framework with additional demonstration hardware and benchmark evaluations. Develop accelerated framework standards, improved CAD technology for system testing, and VHDL reuse libraries. Accelerate technology transfer activities. (\$41.1M)
- (U) Increase density of integrated, co-fabricated electrical/mechanical components to enable new MEMS applications in data storage, parts handling, and chemical

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-04 Date: June 1994

PE Title: Electronic Manufacturing Technology

Budget Activity: 3. Advanced Development

- processing. Expand infrastructure development to include MEMS design, manufacture, test and characterization tools. Initiate systems demonstrations. (\$33.0M)
- (U) Continue ASEM program to reach one month turn-around time and \$25K NRE cost for digital MCMs. Demonstrate high volume production technology for producing known-good die. (\$29.0M)
 - (U) Continue multi-chip integration program with the delivery of high volume/low cost laminate MCM technology and develop optimized modules and mixed signal applications. (\$24.0M)

(U) FY 1997 Planned Program:

- (U) Demonstrate microwave packaging array performance of advanced multi-chip assemblies; deliver all required hardware and program documentation. (\$10.0M)
- (U) Demonstrate final end-to-end RASSP signal processor design environment. Complete technology insertion demonstrations, benchmarking analysis, and technology transition activities. (\$5.0M)
- (U) Demonstrate MEMS applications using massively parallel MEMS systems in new dual-use areas including analytical instruments, precision assembly, active structural enhancement, and air vehicle control. (\$42.0M)
- (U) Continue ASEM program and demonstrate new ASEM foundry capability for flexible production of modules with board-level integration. (\$25.8M)
- (U) Continue multi-chip integration program to demonstrate order of magnitude reductions in MCM manufacturing costs and MCM technology insertions. Continue insertion of MCM technology into dual-use products such as workstations, engine control and wireless communications. (\$30.0M)

(U) Program To Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: Major contractors include: Hughes Aircraft Co., El Segundo, CA; Texas Instruments, Dallas, TX; Westinghouse Electric Co., Baltimore, MD; N-chip, San Jose, CA; Motorola

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-04 Date: June 1994
PE Title: Electronic Manufacturing Technology Budget Activity: 3. Advanced Development

Corp., Chandler, AZ; IBM Corp., Manassas, VA and East Fishkill, NY; Martin-Marietta Corp, Moorestown, NJ and Syracuse, NY; Lockheed Sanders Inc., Nashua, NH; and E-Systems Inc., Greenville, TX. Additional contractors will be determined by competitive selection. In-house work, including management and support of contractual efforts will be performed by: Department of the Army, U.S. Army Laboratory Command, Ft Monmouth, NJ; Naval Air Systems Command; and the Air Force, Wright Laboratories.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: This effort will be closely coordinated with Program Element 0602301E, ST-19, High Performance Computing and Communications (HPCC) and Program Element 0603739E, MT-05, Tactical Display Systems (TDS) programs which will provide applications for demonstrating the new technologies.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Feb 95	Demonstrate ASEM \$50,000 non-recurring engineering cost 60 day cycle time for 10 chip Multichip Modules.
Mar 95	Demonstrate MCM insertions in OH-58D Image Processor.
Mar 95	Establish quick-turnaround SEM-E board foundry.
Sep 95	Complete high density microwave packaging (HDMP) initial development of housings, inter-chip and inter-layer interconnections and testing.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E
PE Title: Electronic Manufacturing Technology
Project Number: MT-04 Date: June 1994
Budget Activity: 3. Advanced Development

- Sep 95 Complete HDMP developments of initial versions of specialized microwave packaging CAD tools and databases.
- Mar 96 Demonstrate improved versions of RASSP design environment.
- Jun 96 Complete HDMP final development of housings, interconnect approaches and perform initial module testing.
- Jul 96 Demonstrate ASEM Technology for assuring known-good die.
- Aug 96 Begin assembly of HDMP brassboard array and perform initial testing.
- Sep 96 Deliver MCI Manufacturing Technology to the dual-use market.
- Sep 96 Initiate MEMS system demonstrations.
- Mar 97 Demonstrate microwave packaging array performance.
- Jun 97 Demonstrate final end-to-end RASSP signal processor design.
- Jul 97 Demonstrate new dual-use MEMS applications.
- Sep 97 Demonstrate new mixed signal ASEM foundry capability.
- Apr 98 Insert MEMS Technology into dual-use products and applications.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-05 Date: June 1994
PE Title: Electronics Manufacturing Budget Activity: 3. Advanced Development
Technology

A. (U) RESOURCES: (\$ In Thousands)

Project Title:	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001	To	Total
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program
MT-05 Tactical Display Systems (TDS)	9,382	16,210	21,161	20,169	29,735	18,500	25,500	32,500	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: This project is a major DoD effort to develop the technology for displays and portable information systems for use in a variety of military systems. This technology is important for virtually all DoD applications which involve visual and graphic information. Major applications of this technology include small combat durable displays for head mounted, hand held, or otherwise portable systems that will be used in aircraft and helicopter cockpits, armored vehicles, submarines, AEGIS cruisers, aircraft carrier flight decks, military simulators, command centers and individual infantrymen. This technology will provide greater resolution for the smaller intelligence and reconnaissance platforms required for potential future conflicts and greater combat durability for these display systems based upon modular design concepts. A major objective of this program is to develop small displays and to integrate these into ongoing and future military portable information systems to significantly improve mission effectiveness for individual combatants and small groups.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Completed development of 640 x 480 pixel monochrome liquid crystal display. (\$3.2M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-05 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

- (U) Integrated 640 x 480 pixel monochrome liquid crystal display into a Combat Vehicle Crew head mounted system and demonstrated at the U.S. Army Armor Conference. (\$2.6M)
- (U) Completed all designs and first process runs of 1280 x 1024 pixel liquid crystal and electroluminescent displays. (\$3.6M)

FY 1995 Planned Program:

- (U) Head Mounted Displays - Emphasis will be on demonstrating a Combat Vehicle Crew head mounted display system in an M1A2 tank and initiating a program to develop 2560 x 2048 liquid crystal and electroluminescent displays in a one-square inch format. (\$10.3M)
- (U) Tactical Information Assistants - This effort will develop light, thin, portable information systems for active, mobile users that focus on rapid prototyping with end-users in the design loop. Emphasis will be on modifying a field qualified, hand-held laser rangefinder to provide improved surveillance information gathering and transmission. (\$5.9M)

FY 1996 Planned Program:

- (U) Head Mounted Displays - Emphasis will be on continuing the development of 2560 x 2048 liquid crystal and electroluminescent displays, significantly decreasing the voltage requirements for electroluminescent displays and demonstrating a high-resolution head mounted display for dual-use medical applications. (\$9.2M)
- (U) Tactical Information Assistants - Emphasis will be on demonstration of three systems for use by individuals remotely located from conventional information sources. (\$11.9M)

FY 1997 Planned Program:

- (U) Head Mounted Displays - Complete development of 2560 x 2408 pixel displays and demonstrate in a military head mounted application. (\$8.2M)
- (U) Tactical Information Assistants - Initiate development of TIAs emphasizing the

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-05 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

combination of computation, communication and navigation in a single unit. Initiate an effort to significantly improve the assembly and manufacturing of previously defined TIAs. (\$12.0M)

(U) Program to Completion: This is a continuing program.

D. (U) WORK PERFORMED BY: The major performers are: Kopin Corporation, Taunton, MA; Planar Systems, Beaverton, OR; David Sarnoff Research Laboratory, Princeton, NJ; Honeywell Systems and Research Center, Bloomington, MN; Motorola, Inc., Phoenix, AZ; and MIT, Boston, MA. Service support is provided by U.S. Army Natick RDT&E Center, Natick, MA and a Joint Service Head Mounted Display Working Group consisting of members from Army, Navy, Air Force, and NASA.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: This project is coordinated with the Army, Navy, Air Force and NASA through the Joint Service Head Mounted Display Working Group. There is no joint funding nor any duplication of effort involved with Service efforts in this technology.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan Milestones

Sep 94

(U) Complete development of 1280x1024 pixel 1-inch displays.

Dec 94

(U) Complete development of head mounted mechanical configuration with optics and initiate modification of hand-held laser rangefinder.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-05 Date: June 1994

Budget Activity: 3. Advanced Development

- Nov 94 (U) Initiate super high-resolution display development.
- Dec 94 (U) Demonstrate CVC HMD.
- Jun 95 (U) Demonstrate "eyeglass-like" displays.
- Nov 96 (U) Demonstrate modification of hand-held laser rangefinder.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-06 Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Microwave and Analog Front End Technology (MAFET)									
<u>Popular Name</u>	<u>FY 1994 Actual</u>	<u>FY 1995 Estimate</u>	<u>FY 1996 Estimate</u>	<u>FY 1997 Estimate</u>	<u>FY 1998 Estimate</u>	<u>FY 1999 Estimate</u>	<u>FY 2000 Estimate</u>	<u>FY 2001 Estimate</u>	<u>Total Complete Program</u>
MT-06									
	0	24,475	54,489	55,296	54,981	55,201	62,467	68,012	Continuing
									Continuing

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: The Microwave and Analog Front End Technology (MAFET) program will build upon the established MIMIC technology base to enhance current microwave and millimeter wave technology and manufacturing capabilities. This is the only program of significant size in this technical area and it is the most cost effective and efficient means for meeting the microwave and millimeter wave frequency component needs of the Department of Defense (Army, Navy, Air Force, ARPA, and National Security Agency). The work to be undertaken is essential in order to simultaneously achieve the further cost reductions and performance enhancements of the circuits, modules, and subsystems that will be needed to maintain an adequate level of defense through upgrading current DoD systems. The work is also necessary to allow the cost-effective development of future DoD systems with needed but presently unavailable capabilities.

(U) The program has several objectives: (1) further cost reduction of microwave monolithic integrated circuits and mixed-signal multi-chip assemblies while simultaneously meeting more demanding (e.g. higher power, higher efficiency, higher frequency) system performance requirements and achieving higher levels of component integration. This, in turn, will provide the required performance capabilities at an affordable cost and with maximum portability for systems such as active electronically scanned radars, secure, low power communications, and advanced identification friend-or-foe system; (2) development of low cost advanced millimeter-wave frequency sensors needed to provide currently unavailable and urgently needed DoD system capabilities including increased accuracy smart-weapons and all-weather vision systems; and (3)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-06 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

enhancement of the design, fabrication, testing, and assembly infrastructure capabilities to maintain U.S. world dominance in the microwave and millimeter wave monolithic integrated circuit area.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments: Not applicable.

(U) FY 1995 Planned Program:

- (U) Begin development of advanced design, fabrication, testing and assembly capabilities required to more efficiently produce required microwave and millimeter wave circuits, modules and sub-systems. (\$12.0M)
- (U) Begin development of enhanced millimeter wave frequency integrated circuits that make use of advanced materials such as indium phosphide (InP). (\$8.0M)
- (U) Begin procurement for next stage of Microwave Hardware Description Language development. (\$1.0M)
- (U) Begin development of advanced, low cost, microwave MIMICS. (\$3.5M)

(U) FY 1996 Planned Program:

- (U) Continue development of the comprehensive microwave/millimeter-wave frequency design environment. (\$13.4M)
- (U) Continue development of microwave and millimeter-wave frequency materials (e.g., indium phosphide substrates), high performance/low-cost microwave and millimeter-wave frequency integrated circuits, advanced multi-chip packages, test methodologies. (\$25.0M)
- (U) Conduct solicitation (e.g., issue BAA) for selection of most appropriate system application areas and approaches for benchmarking system performance improvements and cost reductions resulting from use of MAFET design environment and product/component advances--award contracts. (\$16.1M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-06 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

(U) FY 1997 Planned Program:

- (U) Continue development of comprehensive design environment. (\$13.7M)
- (U) Continue development of microwave and millimeter-wave frequency materials (e.g., indium phosphide substrates), high performance/low cost microwave and millimeter-wave frequency integrated circuits, advanced multi-chip packages, test methodologies. (\$25.4M)
- (U) Conduct first benchmarking demonstrations for selected system application areas to quantitatively determine advances in system performance and reductions in system cost that have resulted from application of MAFET design and product developments. (\$16.2M)

(U) Program to Completion:

- (U) Complete comprehensive MAFET design environment.
- (U) Complete development of necessary microwave and millimeter-wave technology advances and methodology improvements for meeting DoD system needs more effectively and at greatly reduced costs.
- (U) Conduct final series of benchmarking demonstrations that unequivocally show the advantages of the MAFET design environment and product/component developments for improving the performance and reducing the cost of DoD systems.

D. (U) WORK PERFORMED BY: All contracts will be competitively selected. In-house work, including management and support of contractual efforts will be performed by: ARPA; Department of the Army, U.S. Army Research Laboratory; Department of the Navy, Naval Air Systems Command and Naval Research Laboratory; and Department of the Air Force, Wright Laboratories and Rome Laboratories.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: None.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-06 Date: June 1994
PE Title: Electronics Manufacturing Budget Activity: 3. Advanced Development Technology

G. (U) RELATED ACTIVITIES: This project provides technology and components that may be used in conjunction with those developed under the following other programs within this PE (Project MT-04) for improvement of DoD systems; Microelectromechanical Systems (MEMS), and RASSP.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Nov 94	Initiate first RFP or BAA for MAFET development contracts.
May 95	Award first MAFET development contracts.
Nov 95	Initiate additional RFP or BAA for MAFET development contracts.
May 96	Award second MAFET development contracts.
Dec 96	Demonstrate enhanced mm-wave frequency integrated circuits.
Dec 96	Demonstrate extensions of design, fabrication, testing and assembly capabilities.
Mar 97	Demonstrate efficient, low cost, manufacturing and assembly approaches for highly integrated microwave circuit and module assemblies.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-07 Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Centers of Excellence	FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total Program
	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	
MT-07 Centers of Excellence	23,837	15,000	15,000	10,000	0	0	0	0	0	0	0	0	0	0	0	0	91,501

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This project provides funding for three Technology Centers of Excellence: The National Center for Coal Utilization at Pennsylvania State University; Robert C. Byrd Institute for Advanced Manufacturing at Marshall University; and the Focus: Hope Center for Advanced Technologies in Detroit, Michigan. The purpose of these Centers is to demonstrate, deploy and provide advanced manufacturing technology to significantly reduce unit production and life cycle costs, improve product quality, and deploy manufacturing training systems.

(U) The National Center of Excellence for Coal Utilization is a consortium whose purpose is to expand the use of anthracite and bituminous coals.

(U) The Institute for Advanced Flexible Manufacturing Systems provides both a teaching factory and initiatives to local area industries to utilize computer-integrated manufacturing technologies and managerial techniques to improve productivity and competitiveness.

(U) The Center for Advanced Technology is a component of the Focus: Hope Project whose purpose is to train technicians/engineers in advanced manufacturing processes and methods, demonstrate state-of-the-art flexible manufacturing and serve as a testbed for emerging manufacturing research. The three program efforts include: development of world-class manufacturing training/education to expand on current programs; development of a world-class flexible computer integrated manufacturing facility supporting education under full-scale production conditions;

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Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-07

Date: June 1994

Budget Activity: 3. Advanced Development

and development of an aggressive technology outreach program, serving to demonstrate the results of manufacturing research and integration technologies under production conditions, and to serve as a technology transfer activity.

(U) The FY 1996-97 program provides continued support for the Center for Advanced Technology. These funds will be used to complete acquisition of computer integrated manufacturing systems including computers, software, scheduling systems, and statistical process control software, and demonstrate and evaluate technology insertion and transfer to manufacturing centers.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Developed contracts, determined manufacturing requirements, purchased the install manufacturing equipment and entered production for the 4th through 7th of the eleven planned manufacturing neighborhoods at NCAT increasing overall defense production rates to 10,000 parts per month. (\$19.8M)
- (U) Institute for Advanced Flexible Manufacturing. Continued the ongoing technology development, technology evaluation, and technology transfer to local business. Provided system integration, supported CALS commercialization, client assistance for federal contracts, technology training through seminars and workshops, and research into dual-use flexible manufacturing. (\$4.0M)

(U) FY 1995 Planned Program:

- (U) Complete the installation of the 8th through 10th of the eleven planned manufacturing neighborhoods at NCAT. (\$15.0M)

(U) FY 1996 Planned Program:

- (U) Complete the outfitting of the NCAT. (\$5.0M)
- (U) Use the NCAT neighborhoods to demonstrate and evaluate technology insertion and

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Date: June 1994

Project Number: MT-07

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

technology transferred to manufacturing centers and industry, with a focus on small to medium manufacturing companies. (\$10.0M)

(U) FY 1997 Planned Program:

- (U) Continue to use the NCAT neighborhoods to demonstrate and evaluate technology insertion, and transferred to manufacturing centers and industry, with a focus on small to medium manufacturing firms. (\$10.0M)

(U) Program to Completion: Transfer of technology will be completed from NCAT. This program will complete in FY 1997.

D. (U) WORK PERFORMED BY: FOCUS: HOPE, Detroit, MI; National Center of Excellence for Coal Utilization, University Park, PA; and Marshall University, Huntington, WV.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Capabilities that will be deployed to centers of excellence include technologies developed under project MT-08, Manufacturing Technology Initiatives.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan Milestones

Sep 94 Complete installation of the 4th through 7th manufacturing neighborhoods.
Sep 95 Complete installation of the 8th through 10th manufacturing neighborhoods.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-07 Date: June 1994

PE Title: Electronics Manufacturing
Technology

Budget Activity: 3. Advanced Development

- | | |
|--------|--|
| Sep 96 | Complete the last manufacturing neighborhood and the final funding for the NCAT. |
| Sep 96 | Identify and initiate transition manufacturing technology to regional manufacturing centers. |
| Mar 97 | Evaluate impact of program on small to medium manufacturing times. |
| Nov 97 | Complete transition of manufacturing technology. |

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-08 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Manufacturing Technology Initiative		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total	
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Program
MT-08															
	Manufacturing Technology Initiative														
	6,741	14,342	27,800	29,112	35,920	25,000	25,000	25,000	25,000	25,000	25,000	25,000	0	188,915	

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: Future military systems, such as sensors and missile seekers, will be affordable only if the manufacturing process is considered as an integral part of product design and if production takes place in flexible, multi-product factories. This program will focus on process technology demonstrations, providing prototype flexible factories with integrated design and manufacturing systems as well as prototype products. The Flexible Design and Assembly in the Missile Manufacturing Sector (FDAMMS), an Advanced Technology Demonstration (ATD), will be initiated in FY 1995.

(U) The FDAMMS program will develop and integrate design and flexible manufacturing systems including automated design-for-assembly tools, factory planning and control systems, advanced factory simulations, and flexible high precision assembly and checkout systems to demonstrate the capability to reduce the cost of complex electro-mechanical products with missile and munition seeker assemblies as initial targets. FDAMMS will develop a multi-missile manufacturing environment to optimize cost across a mix of different missiles. The goal is to reduce existing missile seekers cost by at least 10% and new missile seekers by at least 30%. These programs will establish new benchmarks for cost and schedule reduction in the tactical missile industry sector. Vendor involvement will result in design and manufacturing systems which can be applied to numerous analogous military and commercial applications.

(U) Technology base demonstrations of a prototype networked manufacturing systems infrastructure were completed in FY 1994. The networked infrastructure will link computer aided

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Program Element: #0603739E Project Number: MT-08 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

design, engineering, and analysis with manufacturing systems, and will more effectively integrate dissimilar design and manufacturing systems for both military and commercial use.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) The program to lower the cost of polymer matrix composites via improved manufacturing processes was completed. (\$3.8M)
- (U) A networked infrastructure linking computer-aided design, engineering, and analysis with manufacturing systems was demonstrated. (\$2.9M)

(U) FY 1995 Planned Program:

- (U) Complete baseline and technology insertion assessment studies to determine key leverage points to lower total costs and cycle times for High Performance Electro-Mechanical (HPEM) devices such as missile/munition seekers. Assessments will include dual-use commercial technology. The baseline studies will provide quantitative basis and metrics for the FDAMMS ATD evaluation. Identify and define service design exercises to evaluate new tools and factory processes and develop the user links for the manufacturing capabilities to be developed. (\$2.0M)
- (U) Begin the design and simulation of advanced flexible manufacturing pilot factories using advanced manufacturing processes and tools that are currently available. Identify new tools and methods that will need to be developed in parallel research efforts in advanced engineering tools and flexible factory technologies. In FY 1995/96 these pilot factories will simulate new manufacturing capabilities to assess the effectiveness of factory system design. These factories will integrate product/process (IPPD) design tools for application to infrared seekers and will include an electronic information infrastructure to facilitate the development of a manufacturing enterprise. (\$8.5M)
- (U) Begin the development of advanced engineering tools, methods, and processes for the HPEM devices with application to missile seekers. Release research contracts for the development of advanced cost analysis and risk assessment tools and

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-08 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

methods for design and production of HPEM devices including missile seekers. This work will be the collaboration of industry, university, vendor and government laboratories. (\$3.8M)

(U) FY 1996 Planned Program:

- (U) Continue the work on baselining and benchmarks to measure progress in developing an advanced manufacturing environment. Initiate design exercises defined in FY95 for simulated manufacturing evaluation. (\$3.5M)
- (U) Continue the development and simulation of advanced flexible pilot factories including IPPD, dual-use capability, multiple product (HPEM, missile seeker) capability, electronic enterprise integration, and design and manufacturing tools and processes. Conduct design exercises to validate the IPPD capabilities in representative missile seeker applications. Complete the integration of all available tools and processes for demonstrations of factory capabilities in FY 1997. (\$20.0M)
- (U) Continue work on the development of specialized tools, methods, models, and processes to complete the integrated design and manufacturing environment. Initiate alpha testing of these technologies and start planning for insertion into the pilot factories in FY 1997. (\$4.3M)

(U) FY 1997 Planned Program:

- (U) Continue the work on baselining and benchmarks to measure manufacturing enterprise development progress. Complete the simulation design exercises and begin the definition of the design exercises for the integrated pilot factories. (\$4.0M)
- (U) Demonstrate through simulation the capability of the integrated manufacturing enterprise that has been developed from available tools. At the end of FY 1997 begin the implementation of the pilot factories that have been designed in the initial phase. Significant investment by industry is planned to support the hardware/software for the actual factory implementation. (\$20.0M)
- (U) Complete contractor alpha tests and start system integration of the advanced manufacturing tools that have been developed to complete the flexible factory

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-08

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Budget Activity: 3. Advanced Development

enterprise. Continue the development of additional tools and technology that has been identified by the factory simulations and design exercises. (\$5.1M)

(U) Program to Completion:

- (U) Complete demonstration of design and manufacturing of missile/munition seekers in prototype flexible, multi-product factory.
- (U) Transition design tools and factory control systems for application to a broad range of HPEM applications in military and commercial markets.
- (U) Develop technology for manufacturing tools or processes to fill any remaining gaps in the integrated missile design/manufacturing enterprise.
- (U) Transfer the manufacturing technology to the entire missile development sector.
- (U) Complete commercialization of general purpose manufacturing tools for application to other commercial sectors.
- (U) Research on manufacturing tools and processes will define new challenges for manufacturing enterprises in the year 2000 and beyond. In FY00 the manufacturing experience from FDAMMS in the missile sector will be coupled with advanced infrastructure work from the MADE and DURF programs to define additional features for "world class" factories of the future for complex electro-mechanical systems. This may integrate micro-machining with micro-electronics into a micro electro-mechanical system. Explore new design systems which capitalize on reusable electro-mechanical models similar to VLSI in the electronic sector.
- (U) The pilot flexible factories developed on FDAMMS will demonstrate the impact on weapons affordability in FY99. Beyond flexibility is true agility in weapons design and manufacturing. This will allow custom-designed weapons within the bounds of the agile factory to be produced affordably in very small quantities (Near unity). This will facilitate modernization and accommodation of peculiar weapons needs on an individual basis. The design of an agile weapons factory will be initiated in FY00 and simulated in FY01. This factory will spin-on any developments in the commercial market in complex electro-mechanical devices at that time and ultimately spin-off any accomplishments into the commercial world.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-08 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A goal would be to have weapons with the "snap together" assembly of commercial systems like camcorders.

D. (U) WORK PERFORMED BY: Contractors will be selected competitively. In-house work will be performed by U.S. Air Force Wright Laboratory; Naval Air Systems Command; U.S. Naval Research Laboratory; U.S. Army Missile Command; U.S. Army Research Laboratory; and National Institute of Standards and Technology.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: This program is consistent with the FY 1995 Descriptive Summary.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: These programs complement ongoing ATDs in Rapid Prototyping of Application Specific Signal Processors (RASSP) and Infrared Focal Plane Array Flexible Manufacturing (IRFPA-FM). FDAMMS will build upon ongoing work in the MADE program.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

	<u>Plan</u>	<u>Milestones</u>
Apr 95		Initiate Pilot Flexible Factory Development contracts.
Jun 95		Initiate Advanced Engineering Tool Development contracts.
Jun 96		Complete development and alpha test of advanced CAD tools, process planners and simulation models. Demonstration of design system application to low end missiles.
Jun 96		Simulation demonstrations of advanced manufacturing capabilities.
Sep 96		Flexible factory simulations completed.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-08 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

Jun 97	Initiate development of design systems and flexible factory systems for FDAMMS.
May 98	Begin seeker hardware design exercises and demonstration.
Jul 99	Identify any remaining gaps in the manufacturing tools or processes and initiate efforts to develop.
Sep 99	Deliver final versions of hardware and manufacturing equipment and processes, and transfer technology for both military and commercial use.
Dec 99	Complete missile seeker design exercises with supporting services. Complete demonstration of manufacturing pilot factory and advanced tools and technologies.
Oct 2000	Final contracts for manufacturing tools and processes to fill any gaps. Contracts/managements for tool/process commercialization. Technology transfer initiated from industrial resource centers. Initiate advanced design and manufacturing tools and processes.
Jul 2001	Factory p-tests of all integrated manufacturing tools and processes.
Sep 2001	Complete all tools, processes, and business arrangements for an integrated missile sector enterprise. Complete commercialization of all dual-use tools and processes. Initiate the design of an agile weapons factory to produce custom weapons in very small quantities.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603739E Project Number: MT-09 Date: June 1994
PE Title: Electronics and Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title:	FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total	
Name	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Actual	Estimate	Complete	Program
MT-09 Dual-use Design and Manufacturing Technology	0	25,180	39,742	41,751	34,235	15,000	20,000	23,000	Continuing	Continuing								

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENTS AND SYSTEM CAPABILITIES: An essential element of the new defense strategy is dual-use manufacturing. DoD will increasingly rely on commercial production lines to produce military variants of their products for incorporation into weapon systems. This project focuses on the flexible process technology including advanced design systems, scalable components and subsystems, advanced materials and processing, flexible factory systems and manufacturing operations control needed to implement this strategy. The program will initiate two sub-projects, Interferometric Fiber Optic Gyroscopes (IFOG) and Manufacturing Systems Technology for Electric Drive Systems (MSTEDS) in product areas with a potentially large commercial market. The emphasis will be on achieving the design and manufacturing flexibility required to make low volume Defense access to high volume commercial production economically viable.

(U) Interferometric Fiber Optic Gyroscopes (IFOGs) are emerging as preferred technology for future commercial inertial navigation applications. The Low Cost IFOG Manufacturing project will develop the large throughput robotic assembly, packaging and testing technologies necessary to fabricate miniature navigation-grade (1 nm/hr) IFOG inertial measurement units (IMUs) at <\$1500 per axis as a goal. Miniature navigation-grade IMUs are essential to precision strike weapon systems required to accurately navigate through extended periods of Global Positioning System (GPS) outage due to enemy jamming. Example technology development areas include: (1) low loss, low reflectivity, polarization-preserving optical connectors between optical fiber subassemblies, and optical sources, detectors and miniature integrated optical circuits (MIOCs); (2) rapid,

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603739E
PE Title: Electronics and
Manufacturing Technology

Project Number: MT-02 Date: June 1994
Budget Activity: 3. Advanced Development

precision coil winding machines; (3) geometrically stable, environmentally robust (temperature and vibration) packaging of critical optical subassemblies; (4) large volume Miniature Integrated Optical Circuit (MIOC) foundry processes; and (5) automatic testing machines. Phase 1 will identify Interferometric Fiber Optic Gyroscopes (IFOG) manufacturing requirements. Phase 2A will develop precision robotic interconnection of IFOG optical parts and subassemblies: for environmentally robust, optically stable IFOG component and subassembly packaging facilities; for rapid, precision coil winding machinery; for large batch processing Multifunction Integrated Optical Circuit foundry; and for automatic test equipment. Phase 2B implements the refined manufacturing processes and controls for final configuration IFOG units. Phase 3 designs and establishes a prototype automated, flexible IFOG manufacturing facility, transitioning the manufacturing processes and control from Phase 2B.

(U) The above areas have been identified due to their current dependence on specialized technical labor or because of more stringent requirements for navigational grade gyroscopes as compared with current tactical grade gyroscopes. The current manufacturing technologies for coil winding and multifunction integrated optical circuits fabrication are too slow, too labor intensive and too inconsistent. Improved processes and process controls will be required to lower cost and improve quality.

(U) The Manufacturing Systems Technology for Electric Drive Systems (MSTEDS) targets electric drive systems between 20-750 horse power (HP) for demonstration of advanced design and dual-use manufacturing systems. These devices have broad use in DoD and commercial applications and provide a current application for demonstration of dual-use factories. The project will demonstrate Integrated Product/Process Design systems that will integrate performance and manufacturing process requirements for new designs prior to prototyping; factory simulation systems; physics-based models and control systems for processing advanced materials; advanced cost models; flexible factory planning and control systems for low cost automated manufacture of advanced electric drive systems. This project will leverage significant anticipated industry investment through cooperative efforts which integrate DoD high performance requirements with commercial requirements for low-cost, rapid response and reliability. Dual-use objectives will

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Program Element: #0603739E Project Number: MT-09 Date: June 1994
PE Title: Electronics and Manufacturing Technology Budget Activity: 3. Advanced Development

require concentration on families of subsystems and components designed from the start for flexible manufacturing, and on flexible factory systems.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishment: Project starts in FY 1995.

(U) FY 1995 Planned Program:

- (U) Competitive awards for innovative integrated process and product development of components of motors and motor controllers, including design tradeoffs, simulation of component behavior, and planning of flexible manufacturing processes. (\$3.0M)
- (U) Develop new flexible manufacturing, factory control reference architectures, factory models, and intelligent manufacturing resource planning systems. (\$4.0M)
- (U) Develop innovative materials-based and physics-based manufacturing process models for motor drive components. (\$3.0M)
- (U) Simulation based design of electric drive systems for aircraft, land combat vehicles, and maritime systems; and prepare specifications for prototypes of electric drive parts and assemblies. (\$2.3M)
- (U) Conduct Interferometric Fiber Optic Gyroscope (IFOG) Phase 1 and initiate winding and affordable optical source efforts. (\$4.9M)
- (U) Initiate Phase 2A. (\$8.0M)

(U) FY 1996 Planned Program:

- (U) Continue integrated process and product development of dual-use families of components for motors and motor controls; demonstrate in a simulated dual-use factory and subsequently in a pilot line. (\$2.0M)
- (U) Complete development of first phase factory models, intelligent resource planning systems and process and assembly planners for use in intelligent factory control

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603739E

Project Number: MT-09 Date: June 1994

PE Title: Electronics and Manufacturing Technology

Budget Activity: 3. Advanced Development

- (U) systems. Conduct simulation of dual-use factory for first phase subsystems and components. (\$9.6M)
 - (U) Continue development of materials-based and physics-based manufacturing process models and on-line sensors capable of real time process control. (\$2.2M)
 - (U) Continue development of simulation based design environment for electric vehicle (EV) and electric drive systems for selected aircraft, land combat vehicles, and maritime systems; and prepare specifications for prototypes of electric drive parts and assemblies to be integrated into selected systems. (\$2.0M)
 - (U) Conduct integrated prototype demonstrations of factory control systems in context of specifications provided by vehicle level applications. (\$2.0M)
 - (U) Continue advanced manufacturing process development and controls for components and complete preliminary Interferometric Fiber Optic Gyroscope (IFOG) units. Begin evaluation of assembled Phase 2A units. (\$21.9M)
- (U) FY 1997 Planned Program:
- (U) Demonstrate process and product development of dual use families of components for motors and motor controls; demonstration in dual-use pilot factory. (\$3.5M)
 - (U) Complete development of second phase factory models, intelligent resource planning systems and process, and assembly planners for use in intelligent factory control systems. Conduct evaluation of dual-use factory for first phase subsystems and components. (\$8.5M)
 - (U) Evaluate and implement material-based and physics-based manufacturing process models and on-line sensors capable of real time process control. (\$2.0M)
 - (U) Demonstrate in a realistic environment simulation based design environment for electric vehicle (EV) and electric drive systems for selected air, land and maritime systems; and prepare specifications for prototypes of electric drive parts and assemblies to be integrated into selected systems. (\$2.5M)
 - (U) Continue to conduct integrated prototype demonstrations of factory control systems in context of specifications provided by vehicle level applications. (\$2.5M)
 - (U) Complete evaluation of Phase 2A IFOG units. (\$4.3M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603732E Project Number: MT-02 Date: June 1994
PE Title: Electronics and Manufacturing Technology Budget Activity: 3. Advanced Development

- (U) Conduct Phase 2B. (\$13.4M)
 - (U) Initiate Phase 3 (e.g, procure long-lead items). (\$5.1M)
- (U) Program to Completion:
- (U) Construct and complete a prototype IFOG manufacturing facility.
 - (U) Demonstrate low-rate of production IFOG Inertial Measurement Unit manufacturing.
 - (U) Transition Interferometric Fiber Optic Gyroscope manufacturing technologies to defense and civilian contractors.
 - (U) Demonstrate economic viability of flexible production of electric drive systems for military and commercial markets.
 - (U) Transition Manufacturing Systems Technology for Electric Drive Systems (MSTEDS) flexible manufacturing technologies for use in dual-use electric drive factories and for other multi-product manufacturing applications.

D. (U) WORK PERFORMED BY: This is a new start in FY 1995. Contractors will be selected by competitive awards.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No change.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: The programs complement the Hybrid Electric Drive (Alternate Propulsion) project.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARIES

Program Element: #0603739E

Project Number: MT-09 Date: June 1994

PE Title: Electronics and Manufacturing Technology

Budget Activity: 3. Advanced Development

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Apr 95	Award Interferometric Fiber Optic Gyroscope (IFOG) manufacturability contracts.
Jun 96	Initial demonstrations of IFOG design systems and critical manufacturing processes.
Jul 98	Demonstrate IFOG prototype flexible factory systems.
Oct 98	Deliver final versions of IFOG hardware and manufacturing equipment and processes, and transfer technology for both military and commercial use.
May 99	Demonstrate Manufacturing Systems Technology for Electric Drive Systems (MSTEDS).

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-10 Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Lithography		FY 1994		FY 1995		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total		
Name	Actual	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Estimate	Complete	Program	
MT-10			Advanced Lithography																	
	58,386	10,000	25,000	30,000	35,000	40,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	45,000	Continuing	Continuing	

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: Lithography technology has enabled the dramatic growth of integrated circuit (IC) capability over the past two decades. Advances in lithography lead directly to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability. Advanced microelectronics technology is essential for computing, data and signal processing, and communications for both civilian and military needs. Specific defense applications include smart weapons, radar, electronic warfare, sensing, communications, command and control, and surveillance. Further improvements in areas such as target recognition, autonomous guided missiles and beam forming for sonar and radar will require microcircuits with smaller features in order to meet the power, weight and volume constraints of these systems.

(U) Current microelectronics manufacturing utilizes 0.5 micron minimum feature sizes. This effort develops subsystems and systems to establish manufacturing capability at 0.18 - 0.1 microns for late 1990s manufacturing. Because the optimal cost-effective lithography approach for these future generations of technology is not known today, this effort balances investment in competing approaches with a strong emphasis on the common cross-cutting techniques that will be required. Key developments include mask technology (electron-beam tools for pattern writing, mask fabrication demonstration, mask repair tools, and membranes), improved alignment and overlay techniques, metrology, systems development and integration utilizing various radiation sources (x-ray, electron-beam, ion-beam, and optics), and device demonstrations to establish viability of the developed systems.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-10 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Improved cross-cutting technologies (mask, alignment) leading to 0.18 micron design rules, including demonstration of a 50KV e-beam mask writer. (\$24.0M)
- (U) Initiated efforts to migrate the 0.25 micron aligners to 0.18 micron capability. (\$6.0M)
- (U) Continued efforts in ion-beam, electron-beam, and advanced optical lithography, including characterization of the 193 nanometer, exposure system. (\$7.0M)
- (U) Demonstrated 0.25 micron logic device fabrication with proximity x-ray and demonstrated pattern definition with improved projection x-ray system. (\$16.2M)
- (U) Extended x-ray technology into other applications such as coronary applications. (\$5.2M)

(U) FY 1995 Planned Program:

- (U) Deliver EL-4 mask writer and demonstrate subsystems for 0.1 micron writer. (\$2.5M)
- (U) Develop overlay and processing capabilities for 0.18 micron design rules. (\$1.5M)
- (U) Complete design of step and scan system for projection x-ray. (\$1.0M)
- (U) Demonstrate subsystems for 0.18 micron tools in ion-beam and electron-beam exposure systems. (\$5.0M)

(U) FY 1996 Planned Program:

- (U) Deliver 0.25 micron feature size x-ray masks from mask shop. (\$7.0M)
- (U) Demonstrate prototype projection electron-beam and ion-beam lithography lens. (\$8.0M)
- (U) Demonstrate repair tool for repair of masks with 0.15 micron features. (\$5.0M)
- (U) Develop alignment sub-assemblies and sources for 0.12 micron lithography system. (\$5.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-10 Date: June 1994
PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

- (U) FY 1997 Planned Program:
 - (U) Demonstrate stage control for lithography tools with 0.12 micron capability. (\$4.0M)
 - (U) Fabricate devices using soft x-ray reduction techniques. (\$3.0M)
 - (U) Demonstrate breadboard (alpha) version of electron-beam or ion-beam projection lithography system. (\$9.0M)
 - (U) Fabricate masks and devices with .18 micron design rules. (\$14.0M)

- (U) Program To Completion: This is a continuing program.

- D. (U) WORK PERFORMED BY: IBM, Essex Junction, VT; ETEC, Hayward, CA; University of Wisconsin, Madison, WI; ALG, Rockville, MD; Lockheed-Sanders, Nashua, NH; AT&T, Murray Hill, NJ; SVGL, Wilton, CT; and Lawrence Livermore National Lab, Livermore, CA.

- E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: No Change.

- F. (U) PROGRAM DOCUMENTATION: Not applicable.

- G. (U) RELATED ACTIVITIES: Not applicable.

- H. (U) OTHER APPROPRIATION FUNDS: None.

- I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

- J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Jun 95	Demonstrate mask repair tool for masks with 0.15 micron features.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-10 Date: June 1994

PE Title: Electronics Manufacturing
Technology

Budget Activity: 3. Advanced Development

- Dec 95 Demonstrate a "nanowriter" electron-beam tool for writing features at 50 nanometers.
- Jul 96 Demonstrate source for Extreme Ultra Violet (EUV) (13.5 nm) lithography.
- Sep 96 Fabricate devices with 0.18 micron features.
- Apr 97 Demonstrate breadboard (alpha) version of electron-beam lithography system.
- Apr 98 Deliver mask with 0.18 micron design rules.
- Jul 98 Demonstrate integrated x-ray point source stepper for 0.18 microns.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E Project Number: MT-11 Date: June 1994
 PE Title: Electronics Manufacturing Technology Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> CALS Shared Resource Centers								<u>Total</u>		
<u>Popular Name</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>FY 1996</u>	<u>FY 1997</u>	<u>FY 1998</u>	<u>FY 1999</u>	<u>FY 2000</u>	<u>FY 2001</u>	<u>To Complete</u>	<u>Program</u>
	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Program</u>
MT-11	43,000	40,000	20,000	15,000	15,000	0	0	0	0	133,000
	Continuous Acquisition and Life-Cycle Support (CALS) Shared Resource Centers									

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: CALS Shared Resource Centers (CSRC) deploy information technology and tools to facilitate enterprise integration and enhance electronic commerce for business and government in order to improve the competitiveness of the U.S. civil-military industrial base and enhance military preparedness. CSRCs will concentrate on: (1) delivery of information, training and consulting services with special emphasis on small to medium sized enterprises in regional areas throughout the country; (2) delivery of information and expert services to other providers in the nationwide manufacturing extension network; and (3) development of critical technologies.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
- (U) Cognizance for the CSRC program transferred from Air Force to ARPA.
 - (U) Established a new contract and other agreements for continuation of the original CSRC activity as the Department's tri-service CALS standards and technologies development, deployment, training and education hub; and established three new CSRC Regional Satellites as directed by the Congress. (\$23.0M)
 - (U) Continued operation of the six original CSRC Regional Satellites as directed by the Congress, and establish links to related technology deployment activities. (\$20.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-11 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

(U) FY 1995 Planned Program:

- (U) Continue CALS Shared Resource Center (CSRC) hub activities; develop additional training courses and train instructors for the CSRC Regional Satellites and other manufacturing extension service providers in the nationwide network; enable network access to the online CALS library and to expert consulting services; conduct development, demonstrations and tests of CALS technology, standards and software focused on manufacturing and logistics applications; support DoD and industry groups in CALS outreach forums; demonstrate feasibility of mechanisms to increase the proportion of non-federal funding for the CSRC program. (\$20.0M)
- (U) Continue CSRC Regional Satellite activities; expand the depth of specialized expertise unique to each node through technology demonstration projects; increase the number of small and mid-size enterprises in each region reached through CSRC outreach activities; provide training and technical assistance for regional clients in implementing CALS and electronic commerce; demonstrate an initial range of services and information available to other extension service providers in the nationwide network; demonstrate the feasibility of mechanisms to increase the proportion of non-federal funding for operating the regional satellites. (\$20.0M)

(U) FY 1996 Planned Program:

- (U) Continue the CSRC hub activities; demonstrate insertion of advanced information technology from other ARPA programs in CALS applications; conduct development, demonstrations and tests of CALS technology, standards and software focused on manufacturing and logistics applications; support DoD and industry groups in CALS outreach forums; implement mechanisms to increase the non-Federal funding share for the CSRC program. (\$15.0M)
- (U) Continue CSRC Regional Satellite activities; spin off commercially viable technology and services resulting from specialized expertise unique to each node; further increase the number of small and mid-size enterprises in each region reached through CSRC outreach activities; provide training and technical assistance for regional clients in implementing CALS and electronic commerce;

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

Project Number: MT-11 Date: June 1994

PE Title: Electronics Manufacturing Technology

Budget Activity: 3. Advanced Development

expand the range of services and information available to other extension service providers in the nationwide network; implement mechanisms to increase the share of non-Federal funding for operating the regional satellites. (\$5.0M)

(U) FY 1997 Planned Program:

- (U) Continue the CSRC hub activities; demonstrate insertion of advanced information technology from other ARPA programs in CALS applications; conduct development, demonstrations and tests of CALS technology, standards and software focused on manufacturing and logistics applications; support DoD and industry groups in CALS outreach forums; refine mechanisms that increase the non-Federal funding for the CSRC program. (\$10.0M)
- (U) Continue CSRC Regional Satellite activities; spin off commercially viable technology and services resulting from specialized expertise unique to each node; transfer retail technology deployment activities to the NIST Manufacturing Extension Partnership. (\$5.0M)

(U) Program to Completion:

- (U) Complete initial demonstrations and pilot programs for implementation of CALS and electronic commerce; update technology plans, standards, training courses and assistance services to reflect lessons learned; transition CSRC extension services to become largely self sustaining elements of a continuing manufacturing extension program beyond RDT&E.

D. (U) WORK PERFORMED BY: The CSRC hub activity is the Concurrent Technologies Corporation, a nonprofit institution in Johnstown, PA. The existing CSRC Regional Satellites are contracts with teams involving educational or nonprofit institutions and/or small businesses. They are located in regions directed by Congress, including Scranton PA, Palestine TX, Orange TX, San Antonio TX, Dayton OH, Cleveland OH, and Fairfax VA. In FY 1994 new CSRC Regional Satellites will be established in Oakland CA, Atlanta GA, and Bremerton WA.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603739E

PE Title: Electronics Manufacturing Technology

Project Number: MT-11

Date: June 1994

Budget Activity: 3. Advanced Development

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: Not applicable.

F. (U) PROGRAM DOCUMENTATION: None.

G. (U) RELATED ACTIVITIES: This program is related to the DoD CALS Program (PE 0603736D), and will be closely coordinated with the OSD CALS Office. This program is also being closely coordinated with the Manufacturing Extension Program at the National Institute of Standards and Technology.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: None.

J. (U) MILESTONE SCHEDULE:

Plan	Milestones
Feb 94	Transfer CSRC program from Air Force to ARPA.
Jun 94	Establish agreements for continuation of existing centers.
Sep 94	Establish three new CSRC Regional Satellites.
Sep 95	Complete initial demonstrations, show feasibility of non-Federal cost share.
Sep 96	Demonstrate value of networked access to CSRC services; implement mechanisms for non-Federal cost sharing.
Sep 97	Transition CSRC retail deployment activities to manufacturing extension program beyond RDT&E.
Sep 98	Transition CSRC activities to manufacturing extension program beyond RDT&E.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603744E

PE Title: Advanced Simulation

Project Number: SM-01

Date: June 1994

Budget Activity: 3. Advanced Development

A. (U) RESOURCES: (\$ In Thousands)

Project Title: Advanced Simulation (National Guard)

<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>FY 1994</u>	<u>Estimate</u>	<u>FY 1995</u>	<u>Estimate</u>	<u>FY 1996</u>	<u>Estimate</u>	<u>FY 1997</u>	<u>Estimate</u>	<u>FY 1998</u>	<u>Estimate</u>	<u>FY 1999</u>	<u>Estimate</u>	<u>FY 2000</u>	<u>Estimate</u>	<u>FY 2001</u>	<u>To</u>	<u>Total</u>	
SM-01			Advanced Simulation (National Guard)																	
	27,107	20,937	20,899	14,700	20,000	15,000	15,000	18,000	0	180,149										

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: In FY 1992, Congress appropriated funds to initiate a program to apply advanced technology to the training of National Guard Roundout Brigades. This program was initiated to respond to issues that developed in the 1991 Desert Shield/Desert Storm mobilization and is now being considered as part of an Advanced Concept Technology Demonstration.

(U) This program element is budgeted in the Advanced Development Budget Activity because its goal is to achieve a significant improvement in training effectiveness required for reserve component maneuver force mobilization through the use of advanced distributed information technologies and innovative training strategies at a lower cost than current active component methods for conducting the same training. The intent is to develop and integrate technologies that enable National Guard soldiers to conduct sophisticated training either at the local community armory, or at the soldier's home. The program will capitalize on existing commercial technologies where feasible, and develop technologies where needed with dual-use potential.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Connected two test brigades to the Defense Simulation Internet (DSI). (\$1.2M)
- (U) Continued development of reconfigurable ground simulator. (\$4.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603744E

Date: June 1994

Project Number: SM-01

PE Title: Advanced Simulation

Budget Activity: 3. Advanced Development

- (U) Conducted field trials of brassboard location instrumentation and intervehicular communications technology. Execute partial Phase II effort to develop and test prototypes in unit testbeds. (\$4.3M)
- (U) Continued development of desktop equipment simulators and advanced technology distributed training capabilities. Priorities will be on the maneuver battalion staff, forward support battalion staff, critical vocational skills of support personnel, brigade staff and small unit leaders. (\$4.6M)
- (U) Initiated connection of armories in the State of Iowa to the statewide fiberoptic network. (\$10.0M)
- (U) Intensified development of measures of performance and program evaluation research. (\$3.0M)

(U) FY 1995 Planned Program:

- (U) Operate two test brigades on the Defense Simulation Internet (DSI). (\$1.5M)
- (U) Conduct initial functionality test of reconfigurable ground simulator. (\$1.0M)
- (U) Complete development and assessment of location instrumentation and intervehicular communications technology. (\$6.0M)
- (U) Continue development of desktop simulators and advanced technology distributed training capabilities and delivery technologies. (\$9.0M)
- (U) Continue development of measures of performance and conduct of program evaluation research. (\$3.4M)

(U) FY 1996 Planned Program:

- (U) Operate two test brigades on the Defense Simulation Internet (DSI). (\$1.5M)
- (U) Develop innovative training programs and delivery assessment technologies. (\$6.0M)
- (U) Continue development of desktop simulators and advanced technology distributed training capabilities and delivery technologies. (\$9.1M)
- (U) Continue development of measures of performance and conduct of program evaluation research. (\$4.3M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603744E

PE Title: Advanced Simulation

Project Number: SM-01

Date: June 1994

Budget Activity: 3. Advanced Development

(U) FY 1997 Planned Program:

- (U) Complete evaluation of two test brigades on the Defense Simulation Internet (DSI). (\$1.5M)
- (U) Continue development of innovative training programs and delivery assessment technologies. (\$4.1M)
- (U) Complete development of desktop simulators and advanced technology distributed training capabilities. (\$5.5M)
- (U) Continue development of measures and conduct of program evaluation research. (\$3.6M)

(U) Program To Completion:

- (U) Develop pen-based shared graphics systems for platoon/teams.
- (U) Complete development of innovative training programs and delivery assessment technologies.
- (U) Network existing stand-alone GUARDFIST I simulators.
- (U) Develop voice actuated database reconfiguration system for rapid battlefield synchronization scenario generation.
- (U) Complete development of desktop simulators and advanced technology distributed training capabilities.
- (U) Develop cellular digital Combat Support/Combat Service Support (CS/CSS) interfaces to the Personal Status Monitor system.
- (U) Adapt reconfigurable simulators to high resolution Computer Image Generator (CIG) systems.
- (U) Develop JANUS - EAGLE interface.
- (U) Develop Battalion (BN) and Brigade (Bde) scenarios for Operations Other Than War (OOTW) and contingency operations.
- (U) Develop voice interactive courseware machines.
- (U) Continue development of measures and conduct of program evaluation research.
- (U) Complete program assessment and write final report.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603744E

Project Number: SM-01

Date: June 1994

PE Title: Advanced Simulation

Budget Activity: 3. Advanced Development

D. (U) WORK PERFORMED BY: Texas Instruments, Dallas, TX; Loral Corporation, Fort Knox, KY; Orlando, FL, Macon, GA, Seattle, WA; Silicon Graphics Inc., San Jose, CA; Sun Microsystems Inc., San Jose, CA; Houston Associates Inc., Arlington, VA, Boise, ID, Fort Leavenworth, KS, Ft. Stewart, GA; BDM Corporation, Monterey, CA, Fort Knox, KY, Fort Benning, GA, Camp Dodge, IA; SESCO Corporation, Arlington, VA; the Institute for Defense Analyses, Alexandria, VA; SRI, Menlo Park, CA; Illusion Engineering, Inc., Los Angeles, CA; Research Triangle Institute, Raleigh-Durham, NC; and Cubic Corp., San Diego, CA.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY:

1. TECHNICAL CHANGES: Networking existing and legacy training and simulation systems; expanding GUARDFIST technology to Mechanized Battalions; incorporate voice recognition and response technologies in simulation and training systems; expand pen-based shared graphics systems to interface personal status monitoring systems.

2. SCHEDULE CHANGES: New technology developments will continue program through transition period from 1998 through 2001.

3. COST CHANGES: \$68 million through the transition period.

F. (U) PROGRAM DOCUMENTATION:

- (U) MOA (ARPA/STRICOM) 10/93
- (U) MOA (ARPA/Fort Knox/ARI/NGB) 2/94

G. (U) RELATED ACTIVITIES: Work in this area is coordinated with the Defense Modeling and Simulation Office (DMSO) which guides DoD policy and ensures that unnecessary duplication does not occur. Direct interaction exists between this program and the Army's TRADOC, FORSCOM, National Guard Bureau and DCSOPS. A Senior Advisory Group (SAG) monitors project performance,

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603744E
PE Title: Advanced Simulation

Project Number: SM-01 Date: June 1994
Budget Activity: 3. Advanced Development

interested services send representatives to in-progress reviews and frequent briefings and Memoranda of Agreement coordinate actions. There is no unnecessary duplication of effort within the Army, ARPA or the Department of Defense.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: None currently exist, but preliminary discussions regarding a joint project with the French and British are underway.

J. (U) MILESTONE SCHEDULE:

<u>Plan</u>	<u>Milestones</u>
Jun 94	Conducted brassboard evaluation Phase II Force-on-Force.
Jul 94	Awarded contract for Force-on-Force prototype development.
Jul 94	Delivered proof-of-concept reconfigurable simulator.
Aug 94	Delivered prototype virtual reality equipment simulator.
Aug 94	Delivered first prototype advanced technology training programs.
Sep 94	Established DSI nodes for two test brigades.
Feb 95	Deliver prototype digital library.
Feb 95	Continue delivery of prototype training programs and assessment tools.
Feb 95	Initiate delivery of prototype equipment simulators.
Feb 95	Field trials of assessment tools.
May 95	Deliver draft assessment measures and plan.
Nov 95	Implement program evaluation program.
Nov 95	Begin delivery of prototype digital libraries and programs.
May 96	Implement assessment tools.
Aug 96	Send first experimental brigade to National Training Center (NTC).
Nov 96	Deliver modified training programs from FY 1996 NTC.
Feb 97	Deliver last equipment simulators.
Aug 97	Send second experimental brigade to NTC.
Oct 97	Develop voice actuated database reconfiguration system.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603744E

PE Title: Advanced Simulation

Project Number: SM-01

Date: June 1994

Budget Activity: 3. Advanced Development

Feb 98	Complete desktop simulators and advanced technology distributed training.
Jul 98	Prototype voice actuated database reconfiguration system.
Jul 98	Deliver prototype platoon network for GUARDFIST I.
Nov 98	Deliver networked GUARDFIST I.
Jan 99	Deliver voice actuated database reconfiguration system.
Sep 99	Deliver networked Bradley GUARDFIST platoon.
Jun 00	Deliver cellular digital CS/CSS interfaces to Personal Status Monitor system.
Jul 00	Deliver initial BN OOTW/Contingency scenarios.
Nov 00	Install final BN OOTW/Contingency scenarios.
Nov 00	JANUS - EAGLE prototype.
Feb 01	Install final Bde OOTW/Contingency scenarios.
May 01	Deliver high resolution ARPA Reconfigurable Simulator Initiative (ARSI) Computer Image Generator (CIG).
Jul 01	Deliver voice interactive courseware machines.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603745E Project Number: EM-01 Date: June 1994
 PE Title: Semiconductor
 Manufacturing Technology
 Development

A. (U) RESOURCES: (\$ In Thousands)

<u>Project Title:</u> Semiconductor Manufacturing Technology		FY 1996		FY 1997		FY 1998		FY 1999		FY 2000		FY 2001		Total	
<u>Popular</u>	<u>FY 1994</u>	<u>FY 1995</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
<u>Name</u>	<u>Actual</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Estimate</u>	<u>Complete</u>	<u>Program</u>
SEMATECH	89,500	90,000	90,000	70,000	50,000	30,000	0	0	0	0	0	0	0	0	513,966

B. (U) BRIEF DESCRIPTION OF MISSION REQUIREMENT AND SYSTEM CAPABILITIES: This project supports SEMATECH, a pre-competitive industrial consortium that addresses the long-term semiconductor manufacturing requirements for both military and civilian applications. The goal of SEMATECH is to continue reducing costs while maintaining the state-of-the-art in complexity and performance for silicon technologies. It will concentrate on future factory design and process definition and control efforts for flexible manufacturing of both low- and high-volume devices in the same factory. Environmentally conscious manufacturing, and safety and health of manufacturing personnel are also part of this effort. This project will combine advances in physical equipment with software advances, i.e., fully integrated computer-integrated manufacturing (CIM) systems, and modeling and simulation tools for designing processes, tools, and factories.

(U) SEMATECH comprises the companies that supply the majority of the integrated circuits used in defense systems, and it has a proven track record of working with equipment suppliers effectively. Therefore, SEMATECH will be the primary performer, with continued cost sharing from its member companies. In addition, a small portion of the funds in this project will support related longer-term efforts outside of SEMATECH that enhance the overall goal of achieving cost effective semiconductor manufacturing.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603745E

PE Title: Semiconductor

Manufacturing Technology

Project Number: EM-01

Date: June 1994

Budget Activity: 3. Advanced Development

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

(U) FY 1994 Accomplishments:

- (U) Completed 0.25 micron semiconductor manufacturing technology process definition. (\$64.0M)
- (U) Initiated projects for 0.18 micron semiconductor manufacturing technology process definition. (\$3.5M)
- (U) Established integrated environmental, safety, and health (ESH) objectives in all technical programs. (\$19.0M)
- (U) Executed a critical materials program investigating next generation substrate technologies. (\$1.0M)
- (U) Developed a productivity goal methodology, completing the analysis of three process flows from silicon-start through final packaging, ensuring continued improvement in overall capital productivity. (\$0.5M)
- (U) Initiated projects to place greater emphasis on back-end processes, such as packaging and test. (\$1.5M)

(U) FY 1995 Planned Program:

- (U) Demonstrate full flow 0.25 micron pilot line-capable manufacturing technology. (\$15.0M)
- (U) Complete development of key equipments and unit processes to enable 0.25 micron semiconductor manufacturing. (\$50.0M)
- (U) Develop software tools and models that assist in the design of processes and equipment based on first-principles of physics. (\$8.0M)
- (U) Plan and begin technology development projects for 0.18 micron feature size generations. (\$5.0M)
- (U) Optimize materials, processes, and equipment for low contaminant, robust manufacturing. (\$1.0M)
- (U) Initiate projects to reduce the sensitivity of manufacturing cost to production volume. (\$1.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603745E

Project Number: EM-01 Date: June 1994

PE Title: Semiconductor
Manufacturing Technology

Budget Activity: 3. Advanced Development

- (U) Initiate projects in generic design tools that support advanced capabilities. (\$1.0M)
- (U) Demonstrate improved manufacturing tools and methods with enhanced Environmentally Safety Health (ESH) performance. (\$9.0M)
- (U) FY 1996 Planned Program:
 - (U) Investigate mainstream process flows for 0.18 micron technology. (\$20.0M)
 - (U) Initiate key improvement projects for critical manufacturing tools needed for 0.18 micron capabilities. (\$50.0M)
 - (U) Complete integration of a software tool suite that supports rapid prototyping of advanced designs. (\$5.0M)
 - (U) Optimize micro- and mini-environments for contamination-free manufacturing. (\$6.0M)
 - (U) Demonstrate improved manufacturing tools and methods with enhanced ESH performance. (\$9.0M)

- (U) FY 1997 Planned Program:
 - (U) Complete the material optimization for low contaminant, robust manufacturing process chambers. (\$10.0M)
 - (U) Develop critical unit processes and capabilities for 0.18 micron technology. (\$50.0M)
 - (U) Plan and begin technology development projects for 0.12 micron feature size generations. (\$3.0M)
 - (U) Demonstrate improved manufacturing tools and methods with enhanced ESH performance. (\$7.0M)

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603745E

Project Number: EM-01 Date: June 1994

PE Title: Semiconductor
Manufacturing Technology

Budget Activity: 3. Advanced Development

(U) Program to Completion:

- (U) Initiate projects for key process modules for 0.12 micron technology.
- (U) Complete back-end process programs.
- (U) Complete internal equipment programs for 0.12 micron capabilities.
- (U) Demonstrate improved manufacturing tools and methods with enhanced ESH performance.

D. (U) WORK PERFORMED BY: The primary performer is the SEMATECH consortium in Austin, TX.

E. (U) COMPARISON WITH FY 1995 DESCRIPTIVE SUMMARY: Consistent with the FY 1995 Descriptive Summaries except that the semiconductor equipment portion has been moved to MT-01.

F. (U) PROGRAM DOCUMENTATION: Not applicable.

G. (U) RELATED ACTIVITIES: Not applicable.

H. (U) OTHER APPROPRIATION FUNDS: None.

I. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

J. (U) MILESTONE SCHEDULE:

Plan Milestones

Dec 94	Transfer key unit processes and generic manufacturing methods for integration into production facilities for 0.35 micron manufacturing.
Nov 95	Demonstrate generic design tools that support first-pass success and reduced design cycle times.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0603745E

Project Number: EM-01 Date: June 1994

PE Title: Semiconductor

Budget Activity: 3. Advanced Development

Manufacturing Technology

Dec 95	Complete full-flow 0.25 micron process technology development projects and transfer technology to member companies.
Mar 96	Transfer software tool suites that support reduced development cycle times.
Jun 96	Demonstrate operation of key elements of a fully integrated advanced manufacturing system enabling maximum flexibility and rapid response to process modifications.
Jul 97	Demonstrate process chamber technologies that contribute negligible contamination to wafers during fabrication.
Sep 97	Demonstrate critical unit processes for 0.18 micron technology.
Sep 98	Transfer back-end processes to member companies.
Sep 99	Transfer 0.12 micron technology equipment developments to member companies.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0605898E Project Number: MH-01 Date: June 1994
 PE Title: Management Headquarters (R&D) Budget Activity: 6. RDT&E Management Support

A. (U) RESOURCES: (\$ In Thousands)

Project Number & Title	FY 1994 Actual	FY 1995 Estimate	FY 1996 Estimate	FY 1997 Estimate	FY 1998 Estimate	FY 1999 Estimate	FY 2000 Estimate	FY 2001 Estimate	To Complete	Total Program
MH-01 Management Headquarters (R&D)	26,266	28,718	31,118	32,769	34,123	35,400	37,850	39,400	Continuing	Continuing

B. (U) BRIEF DESCRIPTION OF ELEMENT: This program element is budgeted in the Management Support Budget Activity because it provides funding for the administrative support costs of the Advanced Research Projects Agency. This funding provides for the personnel compensation and benefits for civilians as well as costs for building rent, physical and information security, travel, supplies and equipment, communications, printing and reproduction. In addition, funds are included for reimbursing the Military Services for administrative support costs associated with contracts undertaken on the Agency's behalf.

C. (U) PROGRAM ACCOMPLISHMENTS AND PLANS:

- (U) FY 1994 Accomplishments:
 - (U) Funding under this program element in FY 1994 supported management and administration for the RDT&E program assigned to ARPA. The majority of the funds were required for the pay of personnel who operate the Agency. The funding level reflects the rental costs associated with the expansion of office space, additional personnel provided by the FY 1994 Appropriation Act, and the related support requirements necessary to adequately execute the increased responsibilities assigned to the Agency. It also finances the ramp up to the additional end strength provided in FY 1995.

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FY 1996-2001 RDT&E POM DESCRIPTIVE SUMMARY

Program Element: #0605898E

Project Number: MH-01 Date: June 1994

PE Title: Management Headquarters (R&D)

Budget Activity: 6. RDT&E Management Support

- (U) FY 1995 Planned Program:
 - (U) ARPA will continue the management and administrative support efforts for headquarters at an increased level over FY 1994. An additional 28 billets have been added to ARPA in FY 1995.
- (U) FY 1996 Planned Program:
 - (U) ARPA will continue the management and administrative support efforts for headquarters at approximately the same level as FY 1995.
- (U) FY 1997 Planned Program:
 - (U) ARPA will continue the management and administrative support efforts for headquarters at approximately the same level as FY 1996.
- (U) Program to Completion:
 - (U) The management and administration of ARPA headquarters will continue.
- D. (U) WORK PERFORMED BY: Civilian and military personnel assigned to ARPA and by ARPA agent personnel operating within the Military Services.
- E. (U) RELATED ACTIVITIES: Not applicable.
- F. (U) OTHER APPROPRIATION FUNDS: None.
- G. (U) INTERNATIONAL COOPERATIVE AGREEMENTS: Not applicable.

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FORMAT C-4: Industrial Base Program Funding

Prepared by: ARPA Comptroller, 696-2390

**Funding Profile
(\$ in Thousands)**

Program Element	Project	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01
1. Manufacturing Technology									
62712E	MPT-01/Materials Processing Tech	110,604	95,824	99,230	106,240	140,570	136,139	145,640	182,240
63570E	PT-xx/Defense Reinvestment	474,000	625,000	650,000	675,000	700,000	725,000	500,000	250,000
63739E	MT-07/Centers of Excellence	23,837	15,000	15,000	10,000	0	0	0	0
63739E	MT-08/Manufacturing Tech Initiatives	6,741	14,342	27,800	29,112	35,920	25,000	25,000	25,000
63739E	MT-09/Dual Use Design & Mfg Tech	0	25,180	39,742	41,751	34,235	15,000	20,000	23,000
63739E	MT-11/CALS	43,000	40,000	20,000	15,000	15,000	0	0	0
63746E	MR-01/Maritime Technology	38,750	0	0	0	0	0	0	0
63747E	EV-01/Electric Vehicles	46,250	0	0	0	0	0	0	0
63748E	GV-01/Natural Gas Vehicles	15,000	0	0	0	0	0	0	0
Manufacturing Technology Total		758,182	815,346	851,772	877,103	925,725	901,139	690,640	480,240
2. Industrial Modernization Imp Pgm									
		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
3. Industrial Facilities									
		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
4. Industrial Preparedness Planning									
		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
5. Industrial Preparedness Measures									
		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
6. Title III (DPA)									
		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a
7. National Defense Stockpile									
		n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA SUMMARY

Basic Research

Computer Sciences	33,677	24,322	26,030	31,628	32,623	32,300	34,500	35,700
Electronics	28,853	41,934	42,126	40,835	40,560	42,333	43,778	47,533
Material Science	13,578	20,725	21,981	20,301	22,261	24,753	25,253	27,053
Environmental Sciences - Basic Res	10,349	725	0	0	0	0	0	0
Subtotal	86,457	87,706	90,137	92,764	95,444	99,386	103,531	110,286

Technology Areas

Aerospace Vehicles	54,374	25,939	30,954	83,148	83,922	19,000	16,000	10,000
Command, Control, Communications	46,908	83,097	83,576	83,602	84,602	58,042	75,542	92,156
Computers	192,157	243,700	233,075	253,800	265,260	266,462	289,034	303,484
Conventional Weapons	14,900	57,951	74,404	57,200	64,986	89,423	96,373	112,720
Elec Warfare/Directed Energy Weapons	26,285	38,873	25,114	29,224	29,408	30,527	48,527	62,527
Electronic Technology	551,434	495,898	533,230	502,565	530,555	543,510	640,442	710,387
Manufacturing Science and Technology	758,182	815,346	851,772	877,103	925,725	901,139	690,640	480,240
Materials, Processes and Structures	50,493	14,238	4,000	0	0	0	0	0
Manpower, Personnel and Training	26,266	28,718	31,118	32,769	34,123	35,400	37,850	39,400
Medical	0	15,295	28,000	28,002	33,498	38,500	43,500	47,500
Sensors	189,669	234,095	243,453	237,641	258,003	270,022	299,522	334,522
Simulation and Modeling Technology	117,940	116,072	123,996	106,375	71,000	74,653	98,253	103,353
Software	75,743	133,879	122,289	125,489	153,672	156,157	161,657	183,543
Special Access Programs	207,183	203,779	206,954	198,766	193,812	202,134	252,184	328,337
Surface/Undersurface Vehicles	68,044	43,100	37,373	41,881	45,844	54,345	64,345	80,645
Environmental Sciences - Tech Areas	63,000	24,000	27,855	26,900	20,936	19,000	12,000	12,000
Subtotal	2,442,578	2,573,980	2,657,163	2,684,465	2,795,346	2,758,314	2,825,869	2,900,814

Total	2,529,035	2,661,686	2,747,300	2,777,229	2,890,790	2,857,700	2,929,400	3,011,100
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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

BASIC RESEARCH AREA: Computer Sciences

**FUNDING PROFILE
(\$ in thousands)**

<u>Program Element</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
61101E CCS-02/Information Sciences	33,677	24,322	26,030	31,628	32,623	32,300	34,500	35,700

The Information Sciences Project supports scientific study and experimentation to advance the technological state-of-the-art in software, intelligent systems, human computer interaction, and high performance computing. Virtually all Defense and commercial sector information systems will be enhanced by this project.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

BASIC RESEARCH AREA: Electronics

FUNDING PROFILE
(\$ in Thousands)

<u>Program</u> <u>Element</u> <u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
61101E ES-01/Electronic Sciences	28,853	41,934	42,126	40,835	40,560	42,333	43,778	47,533

The Electronic Sciences Project is exploring and demonstrating electronic and optoelectronic device, circuit, and processing concepts that will enhance information transmission, gathering and processing. These technological advances will substantially increase the performance of electronic and optoelectronic devices while reducing their attendant the cost. This research will have far-reaching applications in both the military and civilian marketplaces.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

BASIC RESEARCH AREA: Material Science

**FUNDING PROFILE
(\$ in Thousands)**

<u>Program Element</u>	<u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
61101E	MS-01/Material Sciences	13,578	20,725	21,981	20,301	22,261	24,753	25,253	27,053

The focus of Material Science is on the development and exploitation of specialized-application materials and components such as high power/high density batteries and fuel cells and biomedical components. The high power/high density power source program will address Defense and Commercial sector power requirements for such diverse areas as transportation and microelectronics. Similarly, the biomedical program is exploring next generation sensory and component technology that will have application for both battlefield care and civilian trauma response.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

BASIC RESEARCH AREA: Environmental Sciences

FUNDING PROFILE
(\$ in Thousands)

Program <u>Element</u> <u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
61101E MS-01/Material Sciences	10,349	725	0	0	0	0	0	0

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Aerospace Vehicles

FUNDING PROFILE

Program Element Project	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
63226E EE-24/ASTOVL-Com Afford Lightweight Fighter	25,712	20,014	30,954	83,148	83,922	19,000	16,000	10,000
63226E EE-27/Advanced Space Technology Program	28,662	5,925	0	0	0	0	0	0
Total	54,374	25,939	30,954	83,148	83,922	19,000	16,000	10,000

The Advanced Short Takeoff and Land (ASTOVL) - Common Affordable Lightweight Fighter program is developing propulsive lift and modular advanced components to enable production of next-generation, lightweight fighter variants that will be tailored to the specific requirements of the Navy, Marine Corps, and Air Force. All variants will share a common engine, airframe and avionics; however, the Marine Corps variant will be ASTOVL capable while the Air Force version will substitute additional fuel capacity in lieu of the ASTOVL propulsion package. The program will enter Phase III, design and fabrication of a full scale demonstrator aircraft, in FY 1996.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Command, Control, Communications

**FUNDING PROFILE
(\$ in thousands)**

<u>Program Element</u> <u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62301E ST-01/JASONS	1,240	1,227	1,218	1,203	1,190	1,200	1,200	1,200
62702E TT-03/Naval Warfare Technology	26,459	33,383	36,687	37,728	39,830	41,407	51,407	66,407
63226E EE-45/Global Grid Communications	19,209	48,487	45,671	44,671	43,582	15,435	22,935	24,549
Total	46,908	83,097	83,576	83,602	84,602	58,042	75,542	92,156

The Command, Control and Communications Project will demonstrate the viability of integrating commercial communication resources and technologies with advanced optical components to satisfy defense and intelligence community advanced communications requirements. Prototype development and testing of several Naval warfare Programs such as ship systems automation and Simulation Based Design are also funded.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Computers

FUNDING PROFILE
(\$ in thousands)

<u>Program</u> <u>Element</u> <u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62301E ST-19/High Performance Computing	192,157	243,700	233,075	253,800	265,260	266,462	289,034	303,484

This project develops the computing networking and associated software technology base underlying the solutions to computational and information-intensive applications for future Defense and Federal needs. The program is an integral part of the National Information Infrastructure, and as such, is inherently dual use in orientation.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Conventional Weapons

FUNDING PROFILE
(\$ in thousands)

Program Element	Project	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01
62702E	TT-04/Advanced Land Systems Technology	14,900	33,239	34,654	31,500	34,986	50,186	54,686	66,686
63226E	EE-21/Advanced Land Systems	0	24,712	39,750	25,700	30,000	39,237	41,687	46,034
	Total	14,900	57,951	74,404	57,200	64,986	89,423	96,373	112,720

The Conventional Weapons Program supports development of lighter, more deployable equipment required for conventional combat, operations other-than-war, and de-mining activities. Battle Command Initiative requirements are also funded. The Operations Other-Than-War program will benefit law enforcement agencies as well as satisfying DoD requirements.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Electronic Warfare/Directed Energy Weapons

FUNDING PROFILE
(\$ in thousands)

<u>Program Element</u> <u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62702E TT-06/Advanced Tactical Technology	26,285	38,873	25,114	29,224	29,408	30,527	48,527	62,527

The Advanced Tactical technology program funds the development and application of lasers, microwave generators, and mathematical algorithms for signal processing to improve the performance of critical electronic warfare, radar, electronic display, sensor, and communications systems.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Electronic Technology

**FUNDING PROFILE
(\$ in thousands)**

Program Element	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01
62708E IC-03/High Definition Systems	84,800	67,950	68,000	68,000	68,000	68,000	68,000	68,000
62712E MPT-02/Electronic Processing Tech	94,332	88,471	93,931	104,928	104,252	116,453	151,453	183,453
63226E EE-34/Guidance Technology	10,144	10,870	18,937	18,000	17,000	17,000	17,000	17,000
63739E MT-01/Microelectronic Manufacturing	0	0	0	14,946	29,500	45,250	70,550	73,900
63739E MT-02/MIMIC	79,881	25,183	0	0	0	0	0	0
63739E MT-03/Infrared Focal Plane Array	41,429	44,809	38,200	19,400	0	0	0	0
63739E MT-04/Electronic Module Technology	97,580	130,930	136,512	112,826	151,087	160,106	200,472	222,522
63739E MT-05/Tactical Display Systems	9,382	16,210	21,161	20,169	29,735	18,500	25,500	32,500
63739E MT-06/Microwave and Analog Front End	0	24,475	54,489	55,296	54,981	55,201	62,467	68,012
63739E MT-10/Advanced Lithography	58,386	10,000	25,000	30,000	35,000	40,000	45,000	45,000
63745E EM-01/Microelectronics Manufacturing	75,500	77,000	77,000	59,000	41,000	23,000	0	0
Total	551,434	495,898	533,230	502,565	530,555	543,510	640,442	710,387

ARPA funds a large number of electronic technology-related projects that are advancing the state-of-the-art in such areas as flat panel displays, advanced lithography, optoelectronics, infrared focal plane array technology, microwave and millimeter wave circuit packaging, and multi-chip module design and manufacturing. Some of the applications of these technologies funded within this area include head-mounted displays, the Tactical Information Assistant, and the Rapid Prototyping of Application Specific Signal Processors program. Funding for the SEMATECH consortium is also included. The products of the electronic technology activities have wide ranging utility for the Services, other Federal agencies and the commercial sector.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Manufacturing Science and Technology

FUNDING PROFILE
(\$ in thousands)

Program Element	Project	FY 94	FY 95	FY 96	FY 97	FY 98	FY 99	FY 00	FY 01
62712E	MPT-01/Materials Processing Tech	110,604	95,824	99,230	106,240	140,570	136,139	145,640	182,240
63570E	PT-xx/Defense Reinvestment	474,000	625,000	650,000	675,000	700,000	725,000	500,000	250,000
63739E	MT-07/Centers of Excellence	23,837	15,000	15,000	10,000	0	0	0	0
63739E	MT-08/Manufacturing Tech Initiatives	6,741	14,342	27,800	29,112	35,920	25,000	25,000	25,000
63739E	MT-09/Dual Use Design & Mfg Tech	0	25,180	39,742	41,751	34,235	15,000	20,000	23,000
63739E	MT-11/CALS	43,000	40,000	20,000	15,000	15,000	0	0	0
63746E	MR-01/Maritime Technology	38,750	0	0	0	0	0	0	0
63747E	EV-01/Electric Vehicles	46,250	0	0	0	0	0	0	0
63748E	GV-01/Natural Gas Vehicles	15,000	0	0	0	0	0	0	0
Total		758,182	815,346	851,772	877,103	925,725	901,139	690,640	480,240

As its name implies, the Manufacturing Science and Technology program funds the development and demonstration of a wide array of advanced manufacturing concepts ranging from materials processing to the flexible factory. In addition, the Technology Reinvestment Program, Computer Aided Logistics System, and various centers of manufacturing excellence are funded within this global program. Dual use applications are stressed to the greatest extent possible.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Manpower, Personnel and Training

FUNDING PROFILE
(\$ in thousands)

<u>Program</u> <u>Element</u> <u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
65898E MH-01/Management Headquarters (R&D)	26,266	28,718	31,118	32,769	34,123	35,400	37,850	39,400

This program funds ARPA Management Headquarters administrative costs including personnel salaries, building leases, physical security and travel.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA SUMMARY

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Materials, Processes and Structures

FUNDING PROFILE
(\$ in thousands)

<u>Program</u> <u>Element Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62702E TT-07/Aeronautics Technology	12,705	0	0	0	0	0	0	0
62712E MPT-06/High Temperature Superconducting	37,788	14,238	4,000	0	0	0	0	0
Total	50,493	14,238	4,000	0	0	0	0	0

This Technology Area funds the final year of the High Temperature Superconducting Materials program.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Medical

FUNDING PROFILE
(\$ in thousands)

Program Element Project	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62712E MPT-07/Military Medical-Trauma Care Tech	0	15,295	28,000	28,002	33,498	38,500	43,500	47,500

The Military Medical/Trauma Care Technology project will exploit advances in electronics and information sciences to project advanced medical and surgical care into far-forward battlefield areas to permit early and successful clinical intervention. Telemedicine and simulation-based physician and medic training is also being developed. It is anticipated that the results of this project will also directly benefit civilian trauma care.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Sensors

FUNDING PROFILE
(\$ in thousands)

<u>Program Element</u>	<u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62301E	ST-23/Counter Proliferation Tech	22,276	40,802	46,217	50,738	58,402	59,112	64,112	65,112
62702E	TT-05/Advanced Targeting Tech	8,303	5,848	0	0	0	0	0	0
63226E	EE-36/Advanced ASW Technology	17,180	15,885	16,533	16,903	22,614	22,550	33,050	39,050
63226E	EE-40/Critical Mobile Targets	117,268	132,960	135,103	125,000	121,987	132,360	135,360	141,360
63226E	EE-41/Air Defense Initiative	24,642	38,600	45,600	45,000	55,000	56,000	67,000	89,000
	Total	189,669	234,095	243,453	237,641	258,003	270,022	299,522	334,522

The various ARPA sensor projects seek to harness emerging sensor technologies to facilitate the identification and classification of time-sensitive critical mobile targets; enhance detection of, and defense against cruise missiles, manned aircraft, and submarines; improve surveillance capabilities in support of the Comprehensive Test Ban Treaty verification requirements; and enhance detection and interdiction of chemical, biological and advanced conventional weapons.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Simulation and Modeling Technology

FUNDING PROFILE
(\$ in thousands)

<u>Program</u> <u>Element Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
63226E EE-37/Advanced Simulation	59,216	79,280	76,897	54,675	51,000	59,653	83,253	85,353
63226E EE-46/Defense Simulation Internet	31,617	15,855	26,200	37,000	0	0	0	0
63744E SM-01/Advanced Simulation - Natl Guard	27,107	20,937	20,899	14,700	20,000	15,000	15,000	18,000
Total	117,940	116,072	123,996	106,375	71,000	74,653	98,253	103,353

Funding for the Advanced Simulation program supports the development of a seamless, interoperable warfighting simulation environment to create, on demand, a synthetic theater of war that will enhance readiness training, doctrine development, requirements analysis, and battle management. The Defense Simulation Internet facilitates and expands upon the concept by establishing a world-wide network infrastructure to allow distributed, real time, multi-media simulation and modeling. Finally, the National Guard simulation program is developing simulation upgrades to permit more effective local training that will improve National Guard readiness.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Software

FUNDING PROFILE
(\$ in thousands)

<u>Program Element</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62301E ST-11/Intelligent Systems & Software	38,193	93,656	102,727	106,284	134,994	135,907	138,407	158,407
62301E ST-22/Software Engineering Tech	37,550	40,223	19,562	19,205	18,678	20,250	23,250	25,136
Total	75,743	133,879	122,289	125,489	153,672	156,157	161,657	183,543

The ARPA software programs fund the development of new information processing technology concepts that will enable advanced information systems to more efficiently accomplish decision making tasks in stressful, time-sensitive situations. The primary focus is on intelligent systems, software development and prototyping, and manufacturing-related software. Funding for the Software Engineering Institute, a Federally Funded Research and Development Center, is also included in this program. Given the ubiquitous nature of software today, the research undertaken in this program has application throughout the DoD and the civilian environments.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Special Access Programs

FUNDING PROFILE
(\$ in thousands)

<u>Program Element</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
63226E EE-CLS/Classified	202,308	198,904	202,176	194,036	189,129	197,134	247,184	323,337
65114E BL-01/Blacklite	4,875	4,875	4,778	4,730	4,683	5,000	5,000	5,000
Total	207,183	203,779	206,954	198,766	193,812	202,134	252,184	328,337

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Surface/Undersurface Vehicles

FUNDING PROFILE
(\$ in thousands)

<u>Program Element</u>	<u>Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
63226E	EE-39/Unmanned Undersea Vehicle System	23,850	17,839	17,900	17,570	17,395	18,115	21,115	26,115
63569E	AS-01/Advanced Submarine Technology	44,194	25,261	19,473	24,311	28,449	36,230	43,230	54,530
	Total	68,044	43,100	37,373	41,881	45,844	54,345	64,345	80,645

The Surface/Undersurface Vehicle programs provide for the incorporation of advanced technologies into maritime vehicles. Although the primary thrust of the program is focused on Naval ship applications, several of the techniques under development have spin-off potential in such areas as high precision machining.

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FORMAT C-5: BASIC RESEARCH AND TECHNOLOGY AREA

Prepared by: ARPA Comptroller, 696-2390

TECHNOLOGY AREA: Environmental Sciences

**FUNDING PROFILE
(\$ in thousands)**

<u>Program Element Project</u>	<u>FY 94</u>	<u>FY 95</u>	<u>FY 96</u>	<u>FY 97</u>	<u>FY 98</u>	<u>FY 99</u>	<u>FY 00</u>	<u>FY 01</u>
62712E MPT-01/Joint Casting Emissions	13,500	11,000	14,855	15,900	11,936	12,000	12,000	12,000
62712E MPT-01/Coal Utilization Center	5,000	0	0	0	0	0	0	0
63226E EE-21/Nuclear Waste Monitoring	250	0	0	0	0	0	0	0
63226E EE-21/Fire Protection	250	0	0	0	0	0	0	0
63739E MT-04/Environmental Conscious Mfg	20,000	0	0	0	0	0	0	0
63745E EM-01/CFC Free Manufacturing	9,000	9,000	9,000	7,000	5,000	3,000	0	0
63745E EM-01/Environmental Health & Safety	5,000	4,000	4,000	4,000	4,000	4,000	0	0
63749E EC-01/Earth Conservancy	10,000	0	0	0	0	0	0	0
Total	63,000	24,000	27,855	26,900	20,936	19,000	12,000	12,000

The Environmental Sciences program is developing novel approaches to control effluent emission and reduce the reliance on hazardous substances during the manufacturing process. Virtually all environmental programs have dual use applications.

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Format C-9: Counterproliferation
 (\$ in millions)

Activity: Non-Proliferation	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
Appropriation: RDT&E, Defensewide									
Intelligence	11.3	10.3	16.5	19.5	19.5	20.9	22.2	22.5	22.5
Battlefield surveillance	4.3	3.3	6.6	7.1	8.8	10.7	10.1	11.3	11.3
Passive defense	2.0	1.5	2.3	2.5	3.0	4.1	4.1	4.6	6.6
Active defense	1.2	1.0	2.3	2.5	4.0	5.0	5.0	6.0	6.2
Counterforce	1.2	1.0	4.5	5.0	6.0	7.0	7.0	8.0	5.0
Inspection support	1.5	0.9	2.5	3.0	3.0	4.0	4.0	5.0	4.8
Support to export control programs	1.0	1.0	1.1	1.1	0.5	0.5	0.5	0.0	0.0
Studies and analysis	4.0	3.3	5.0	5.5	5.9	6.2	6.2	6.7	8.7
Terrorism, theft, and accident response	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total ARPA Funding	26.5	22.3	40.8	46.2	50.7	58.4	59.1	64.1	65.1

SECTION III

**INSTALLATION CONSTRUCTION,
MAINTENANCE, AND ENVIRONMENT**

Format E-11: Environmental Priority Technology
 Advanced Research Projects Agency
 (Dollars in Millions)

Program Elements and Projects

	EY 1993	EY 1994	EY 1995	EY 1996	EY 1997	EY 1998	EY 1999	EY 2000	EY 2001
I. Cleanup									
Not Applicable									
II. Compliance									
Not Applicable									
III. Conservation									
A. RDT&E									
6.1 not applicable									
6.2 0602712E									
Materials & Electronics Processing Technology									
MPT-01 Coal Utilization							5.000		
6.3 0603226E									
Experimental Evaluation of Major Innovative Technology									
EE-21 Nuclear Waste Monitoring							0.250		
EE-43 Earth Conservancy									
Defense Reinvestment							20.000		
0603570E									
PT-01 Miniaturized Environmental Monitoring							1.455		
PT-04 Air Quality Monitoring w/Neural Net Based							1.241		
0603739E									
Electronics Manufacturing Technology									
MT-07 Coal Utilization							4.770		
0603749E									
Earth Conservancy							10.000		
EC-01 Earth Conservancy									
6.4 not applicable									
6.5 not applicable									
6.6 not applicable									
6.7 not applicable									
B. Milcon									
C. O&M									
D. Procurement									
E. Other									
F. Subtotal									
	27.466	15.250	0.000	0.000	0.000	0.000	0.000	0.000	0.000

**Format E-11: Environmental Priority Technology
Advanced Research Projects Agency
(Dollars in Millions)**

Program Elements and Projects

FY_1993 FY_1994 FY_1995 FY_1996 FY_1997 FY_1998 FY_1999 FY_2000 FY_2001

IV Pollution Prevention									
A. RDT&E									
6.1 0601101E	Defense Research Sciences								
	MS-01 Supercritical Fluid Technology	2.058	2.349	0.725					
	MS-01 Hazardous Waste Management		8.000						
6.2 0602712E	Materials & Electronics Processing Technology								
	MPT-01 Environmental Super Critical Water Oxidation			7.000	7.934				
	MPT-01 Joint Casting Emissions Reduction								
	MPT-01 Environmental Green			4.000	7.966	11.936	12.000	12.000	12.000
6.3 0603226E	Experimental Evaluation of Major Innovative Technology								
	EE-21 Fire Protection Technology		0.250						
0603570E	Defense Reinvestment								
	PT-01 Rapid Optical Screening Tool		1.590						
	PT-01 Tunable IR Laser Remote Sensing Sys.		1.700						
	PT-01 Gamma Ray Imaging		0.852						
	PT-03 Advanced Zero Emissions		0.300						
0603739E	Electronics Manufacturing Technology								
	MT-04 Environmentally Conscious Elec Sys Mig.		20.000						
0603745E	Semiconductor Manufacturing Technology (SEMATECH)								
	EM-01 CFC Free Manufacturing (Sematech)	10.000	14.000	13.000	11.000	9.000	7.000	0.000	0.000
6.4 not applicable									
6.5 not applicable									
6.6 not applicable									
6.7 not applicable									
B. Milcon		16.500	58.099	24.725	27.855	20.936	19.000	12.000	12.000
C. O&M									
D. Procurement									
E. Other									
F. Subtotal									
V Installations									
Not Applicable									
VI Grand Total		43.966	73.349	24.725	27.855	20.936	19.000	12.000	12.000

Prepared by: L. Golobic
Date: 6/10/94

SECTION IV

MANPOWER

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(\$ In Thousands)

(U) Format F-10: Civilian Employment Levels and Associated Payroll Costs

	<u>FY_93</u>	<u>FY_94</u>	<u>FY_95</u>	<u>FY_96</u>	<u>FY_97</u>	<u>FY_98</u>	<u>FY_99</u>	<u>FY_00</u>	<u>FY_01</u>
1. Direct Hire (Civilian workyears)									
a. US Citizens									
(1) Workyear	132.7	148	168	168	168	168	168	163	159
(2) Cost	10,082	11,661	13,732	14,162	14,554	14,949	15,455	15,653	15,694
b. Direct Hire Totals									
(1) Workyear	132.7	148	168	168	168	168	168	163	159
(2) Cost	10,082	11,661	13,732	14,162	14,554	14,949	15,455	15,653	15,694
2. Intergovernmental Personnel Act									
(1) Workyear	17	30	35	35	35	35	35	35	35
(2) Cost	2,171	4,080	4,856	5,099	5,354	5,622	5,903	6,200	6,510
3. Total (Civilian Workyears)									
a. Workyear	149.7	178	203	203	203	203	203	198	194
b. Cost	12,253	15,741	18,588	19,261	19,908	20,571	21,358	21,853	22,204
4. End Strength	137	157	182	182	182	182	182	177	173
5. Total E/S									
a. Numbers	137	157	182	182	182	182	182	177	173
b. Cost	12,253	15,741	18,588	19,261	19,908	20,571	21,358	21,853	22,204

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SECTION V

INFORMATION MANAGEMENT

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Format G-2B: All Other IT Costs by CIM Area
 Advanced Research Projects Agency
 Science and Technology
 Summary
 (Current \$ Millions)

Category 5
 CIM Functional Area: Science and Technology
 Central Design Activity: NONE

	FY 1993	FY 1994	FY 1995	FY 1996	FY 1997	FY 1998	FY 1999	FY 2000	FY 2001
2.874	2.654	2.732	2.732	2.732	2.732	2.732	2.732	2.732	2.732
2.874	2.654	2.732	2.732	2.732	2.732	2.732	2.732	2.732	2.732
TOTAL-Dev./Mod.									
2.632	2.805	2.882	2.882	2.882	2.882	2.882	2.882	2.882	2.882
2.632	2.805	2.882	2.882	2.882	2.882	2.882	2.882	2.882	2.882
TOTAL-Ops.									
5.506	5.459	5.614	5.614	5.614	5.614	5.614	5.614	5.614	5.614
4	5	6	6	6	6	6	6	6	6

Part 1 - Resource Baseline
A. Development and Modernization
 Appropriation for all entries is RDT&E
 Funding Source Breakout (PE's)

B. Operations
 Funding Source Breakout (PE's)

C. TOTAL Resources
 Summary Dollars
 Summary Manpower

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Format G-2B: All Other IT Costs by CIM Area

Advanced Research Projects Agency
Science and Technology

Part 2 - Narrative

All Agency IT resources support the Science and Technology CIM Functional Area. These resources are used to support the mission need of decision support for the identification and funding of high-risk, breakthrough, advanced technologies. The capabilities required to meet this need are achieved through the programmed resources. As goals of system users change in this highly dynamic environment, resource levels are adjusted. All resource programming and adjustments are approved by the Agency Senior Information Resources Management Representative (SIRMR).

Funds for each Agency IT system fall beneath the threshold of \$2 million per year. All other Agency IT is considered not a part of any definable system. Funds associated with both categories of IT are aggregated for this format.

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