Naval Ocean Systems Center
San Diego, CA 92152-5000

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Manufacturing Technology and Industrial Modernization Incentive Programs

Science Applications International Corporation

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NAVAL OCEAN SYSTEMS CENTER
San Diego, California 92152-5000

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ADMINISTRATIVE INFORMATION

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SB

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DEPARTMENT OF DEFENSE

Washington, D.C.

STATEMENT OF PRINCIPLES
FOR
DEPARTMENT OF DEFENSE
MANUFACTURING TECHNOLOGY PROGRAM

PROGRAM OBJECTIVES. *The productivity and responsiveness of our Defense industrial base is a key element of our national security and military posture. The Manufacturing Technology Program's objective is to significantly improve the productivity and responsiveness of the industrial base by engaging in initiatives which:*

- *Aid in insuring the economical production of qualitatively superior weapon systems on a timely basis*
- *Insure that advanced manufacturing processes, techniques, and equipment are used to reduce DoD materiel acquisition costs*
- *Continuously advance manufacturing technology to bridge the gap from R&D advances to full-scale production*
- *Foster greater use of computer technology in all elements of manufacturing*
- *Assure that more effective industrial innovation is stimulated by reducing the cost and risk of advancing and applying new and improved manufacturing technology*
- *Assure that manufacturing processes are consistent with safety and environment considerations and energy conservation objectives*

ROI CONSCIOUSNESS. *A deeper and more explicit consciousness of Return on Investment must be developed and used by all levels of management of the Manufacturing Technology Program. We must assure the high leverage Return on Investment potential of the DoD Manufacturing Technology Program is realized.*

PROGRAM PLANNING. *Industrial base needs must be identified and manufacturing technology projects programmed to meet these requirements. Program planning must constitute a fully integrated tri-Service activity. Individual manufacturing technology project planning must be well thought out, given wide spread visibility, and provide a mechanism for senior management personnel to impact the project content and priorities.*

IMPLEMENTATION AND TECHNOLOGY TRANSFER. *Full benefit from the program can only be achieved if its plans, progress, and results are readily available to DoD and the industrial base in a timely and convenient manner. Implementation and technology transfer of project results are critical elements of Manufacturing Technology Program management.*

EVALUATION. *The Manufacturing Technology Program must be routinely and continuously evaluated to measure its effectiveness. Program benefits must be documented by each Service in clear, simple and unequivocal terms.*

PROJECT SELECTIVITY. *We must assure maximum benefits from every manufacturing technology dollar invested. We must insure that:*

- *Technical feasibility has been previously demonstrated before procurement-funded manufacturing technology projects are initiated*
- *There is a well-defined DoD requirement for the technology and that it can be delivered in time to meet that requirement*
- *Private industry cannot or will not make the investment in the time frame required*
- *Anticipated project results are generic.*

ASSESSMENT OF NEEDS. *Manufacturing Technology Program investments should be determined by assessing both the generic production-related life-cycle-costs and the potential contribution of existing and emerging technologies to reduce those costs.*

PROGRAM MANAGEMENT. *Each Service will provide strong central program management to promote the requisite centralized fiscal planning and control necessary for direction and orientation of the program to the areas of greatest need and payoff. Multi-Service investments are encouraged. Program Managers will be encouraged to include new manufacturing technology in their acquisition strategies.*

Arden L. Bement, Jr.
Deputy Under Secretary of Defense
for Research and Engineering
(Research & Advanced Technology)

Dale W. Church
Deputy Under Secretary of Defense
for Research & Engineering
(Acquisition Policy)

Percy A. Pierre
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Joseph A. Doyle
Assistant Secretary of the Navy
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Robert J. Hermann
Assistant Secretary of the Air Force
(Research, Development & Logistics)

Signs of the Times

"Today's Navy faces a challenging world.
Uncertain economic growth, globalization, and
rapid, radical technological change
are coupled with increasingly
powerful, competitive,
and diversified naval threats."

— John C. Weaver, Rear Admiral, U.S. Navy,
May 1989

"The only way to bulletproof our country
is to design and make the best products in the world."
— Ross Perot, Fortune, March 26, 1990

"The U.S. defense industrial base is deteriorating. Long lead times to procure weapon systems, high costs, uncertain quality, and dependence on procurement of electronic components from other countries are symptoms of a decline in the capability of the U.S. defense industrial base.

A primary cause of this decline is the failure of the Department of Defense (DoD) and its contractors in the U.S. defense industry to invest sufficiently in manufacturing technology. The lack of investment reflects DoD's history of concentrating its resources and attention on product technology rather than process technology.

... existing procurement policies and regulations do not provide sufficient investment incentives to contractors."

—

Manufacturing Technology - Cornerstone of a Renewed Defense Industrial Base,
National Research Council, 1987

"During World War II, we were the "Arsenal of Democracy". Today our industrial base is dwindling, losing large numbers of manufacturers of defense critical goods. Some went out of business, some were absorbed in mergers, and others stopped doing business with the Deparment of Defense. In addition, many industry segments of concern to our national defense have moved offshore. This continued deterioration of the Defense Industrial Base is diminishing the credibility of our deterrent."

—

Manufacturing Technology - The Key to the Defense Industrial Base - The American
Defense Preparedness Association - October 1989.

PREFACE—DEPARTMENT OF DEFENSE MOTIVATIONS FOR INDUSTRIAL MODERNIZATION

The Manufacturing and Computer Integrated Engineering (CIE) Technology Branch, Code 936, of the Naval Ocean Systems Center (NOSC), supports the Space and Naval Warfare Systems Command (SPAWAR), Naval Air Systems Command (NAVAIR), Naval Sea Systems Command (NAVSEA), Department of Defense (DoD) Critical Technologies, the Director of Naval Laboratory mission areas, and NOSC mission areas. This report has been developed to highlight our ManTech and IMIP efforts. These efforts support the Navy's needs for advancing U.S. industrial modernization.

Neglect of the U.S. industrial base over the last several decades has left the nation's manufacturing capability ill-equipped to face the 21st century. America is slowly waking up. This report summarizes NOSC's role in U.S. industrial modernization. The initial part of this report describes the environment in which our Manufacturing Technology Program (ManTech) and Industrial Modernization Incentive Program (IMIP) functions. The later portion describes these programs specifically. The appendices provide detailed information about NOSC ManTech and IMIP activities. This report will provide a better understanding of the role these activities play in modernization of the DoD industrial base and the transition of NOSC technical developments to full production.

National emphasis has been placed on improving U.S. productivity, Total Quality Management (TQM), and enhancement and protection of the industrial base. With significant international changes underway, both politically and economically, the defense industrial base must prepare to meet a challenging and changing environment. The ability to deliver future high technology, deterrent-type weapon systems requires more emphasis be placed on manufacturing. With reductions in supply and stockpiling, the ability to provide surge capability and rapidly mobilize U.S. manufacturing becomes an issue of national importance. As military budgets are reduced, affordability issues become key criteria in determining which systems to support. Quality and reliability, key to operational performance, are jeopardized as funding is reduced.

The goals of industrial modernization programs are to (a) develop new or improved processes, methods, techniques, or equipment to enhance our industrial-base capability, (b) ensure quality and affordability of DoD systems, (c) enable the transition of Research and Development (R&D) from development to production, and (d) allow the implementation of advanced methods and technologies in defense production facilities. A full decade has passed since the DoD issued the Statement of Principles for DoD Manufacturing Technology Program. Significant progress has been made in this decade, and the near-future will emphasize the DoD Laboratories role in "Commercialization of Federal Sciences and Technology."

While Government funding is the stimulus for these efforts, repetitive benefits are derived through technology transfer. Numerous Federal Technology Transfer Initiatives are outlined in figure 1. These congressional and presidential initiatives have been enacted since the early 1980s to encourage the transfer of federally-sponsored development to applications in the U.S. private and public sectors. ManTech is an effective, funded program to ensure these types of transitions. Closer industry and Government research activities are expected. During 1990, industrial spending on R&D is expected to be $67.7B, surpassing federal spending at $64.9B. Trends will continue towards increased industry and Government research cooperative programs. The $100M per year of Government funding supporting SEMATECH, an industry and Government consortium researching microelectronics, provides the largest single example to date.

The Defense Department's Critical Technologies Plan identifies twenty areas, shown in figure 2, where research will provide three-fold improvement and affect the long-term strength of U.S. weapons systems. Nearly without exception, the DoD Critical Technologies benefit from manufacturing process developments to enable utility of the research and development.

- ***The Stevenson-Wydler Technology Innovation Act of 1980*** law established and funded Offices of Research and Technology Applications at major federal laboratories to identify and provide information on technologies to private industry, universities and state and local governments.

- ***The Bayh-Dole University and Small Business Patent Procedure Act of 1980*** allows small firms and universities to obtain title to inventions funded by the federal government.

- ***The National Cooperative Research Act of 1984*** permits consortia of companies that have proper registration with the Department of Commerce to engage in joint development ventures without violating antitrust laws. It does not, however, permit co-production.

- ***The Federal Technology Transfer Act of 1986*** grants government laboratory directors authority to enter into cooperative research and development agreements with for-profit corporations, to assign patent rights to firms participating in cooperative agreements and to license technologies.

- ***The National Defense Authorization Act, 1987*** encourages the Secretary of Defense to transfer Department of Defense (DoD) developed technology to other U.S. private and public sector organizations and individuals to the extent that it is consistent with national security objectives calls for the Secretary to examine and implement methods to enable DoD personnel to promote technology transfer.

- Executive Order 12591, ***"Facilitating Access to Science and Technology"*** promotes the commercialization of science and technology, calls on the Secretary of Defense to identify new technologies that potentially would be useful to U.S. industries and universities, and to accelerate efforts to make these technologies more accessible to users.

- Under the ***Technology Competitiveness section of The Omnibus Trade and Competitiveness Act of 1988***, the National Institute of Standards and Technology promotes the commercialization and transfer of federally developed technology to private industry and state and local government; initiated regional centers for transfer of manufacturing technology; makes provisions to assist state technology extension programs, and establishes a clearinghouse for state and local initiatives on productivity, technology and innovation.

- ***The Domenici National Competitiveness Technology Transfer Act of 1989*** grants contractor-operated federal laboratories the authority to enter into cooperative agreements and license technologies; establishes time frames to speed up government negotiations for entering into cooperative agreements; and exempts cooperative agreements from Freedom of Information stipulations for up to five years.

(Source: SIGNAL, March 1990)

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Figure 1 - Federal Technology Transfer Initiatives Enacted Since the Early 1980's

TECHNOLOGY	MANUFACTURING CHALLENGES	FY91 FUNDING ($M)
*1. Semiconductor Materials and Micro-electronic Circuits	High-volume, low cost GaAs raw material Uniform epitaxial growth Non-destructive test techniques Data-driven, integrated manufacturing for semiconductor industry	$ 450
2. Software Producibility	Framework for information integration	$ 130
3. Parallel Computer Architectures	None (Related: memory chip availability)	$ 120
*4. Machine Intelligence and Robotics	Machine tool control technology Knowledge-based image analysis & understanding Sensor fusion Advanced materials for actuation systems Improved man-machine interfaces Integration of vision and force feedback Integration of manipulators and dexterous end-effectors Interface standards	$ 120
5. Simulation and Modeling	Metalworking processes simulation & modeling Application of expert system and AI	$ 210
*6. Photonics	Compound semiconductor manufacturing Low-cost, high-power diode arrays	$ 100
*7. Sensitive Radars	Low-cost producible X-band transmit/receive modules	$ 110
8. Passive Sensors	Increased uniformity and detectivity Improved in-process and acceptance testing Superlattice technology transition from R&D to manufacturing	$ 460
9. Signal Processing	None (Related: Electronics & photonics)	$ 130
*10. Signature Control	New materials application and fabrication Precision three-dimensional machining Laser/robotic inspection systems	N/A
11. Weapon System Environment	None	$ 180
12. Data Fusion	Computer and communication technologies Automated decision making Information engineering tools Machine-to-machine interface standards	$ 50
13. Computational Fluid Dynamics	None (Related: Parallel processing, microelectronics)	$ 80
14. Air-Breathing Propulsion	Composite materials manufacturing Near-net-shape composites Rapidly solidified alloys Air-cooled, single-crystal parts Greater precision machining Transition from laboratory to production	$ 180
15. Pulsed Power	Solid-state and gas discharge switches Inductive storage devices Capacitors Batteries Homopolar generators Compensated alternators	$ 160
16. Hypervelocity Projectiles	Shape-stable nose tips High-density, high-strength alloys High compressive strength, low-density support structure	$ 120
17. High Energy Density Materials	Insensitive munitions Redefined environmental process requirements	$ 90
*18. Composite Materials	Substantial reduction in end item cost	$ 170
19. Superconductivity	Fabrication techniques using compressed powers and firing to final ceramic form	$ 95
20. Biotechnology Materials and Processes	Biosysthesis of systems-specific polymers, fibers, elastomers, and lubricants Low cost quantities of biological sensor materials	$ 100

* Currently or recently funded by ManTech at NOSC

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Figure 2 - Department of Defense Critical Technology Areas

THE ROLE OF NAVY LABORATORIES

Understanding NOSC ManTech and IMIP activities require an understanding of the environment in which our work is performed. NOSC is one of seven Navy R&D centers which provide the Navy with a variety of support. SPAWAR, through the Director of Navy Laboratories, manages seven Navy R&D centers and has contract oversight responsibility for four Navy university laboratories. Figure 3 lists these Centers and Laboratories and their specialties.

In the Strategic Plan of 1989, the Director of Navy Laboratories recognizes that Naval warfare will become more challenging in the future. The threat will be diverse and demanding. Of key concern to industrial modernization, affordability constraints will become increasingly more demanding. In addition, changes in international situations will require improved surge capability. Future technological superiority of the Navy is dependent upon the rapid development and application of the advanced technologies shown in figure 4. Fleet implementation of each of these technologies, without exception, benefit from continued developments in manufacturing technologies to produce the products.

The Navy Labs and Centers are in the responsible position of providing a bridge between DoD and industry for advanced R&D. Several programs have been initiated to strengthen this bridge and enhance DoD industry capability. A few of these programs are shown in figure 5.

As the Navy moves into the 21st century, the major areas of R&D center performance continue to support advancements in the high technologies. Trends point to continuing growth in systems engineering, software development and support, technical support to Systems Command program managers, and contracting functions. The R&D Centers will continue to be the principal Navy Research, Development, Test, and Evaluation (RDT&E) technological activity for platforms, combat systems, weapons, countermeasures, support systems, and resolution of fleet problems. This requires them to be premier technological organizations.

R&D CENTERS

- **David Taylor Research Center - Bethesda**
  - Naval vehicles and logistics
- **Naval Air Development Center - Warminster**
  - Aircraft systems and airborne ASW
- **Naval Coastal Systems Center - Panama City**
  - Undersea countermeasures, special warfare, amphibious warfare, land mine countermeasures, and diving
- **Naval Surface Warfare Center - Dahlgreen**
  - Surface ship warfare systems, ordnance, mines, and strategic systems
- **Naval Underwater Systems Center - Newport**
  - Submarine warfare and submarine weapons systems
- **Naval Weapons Center - China Lake**
  - Air warfare systems and tactical missiles
- **NAVAL OCEAN SYSTEMS CENTER - SAN DIEGO**
  - **Command control, communications, ocean surveillance, surface- and air-launched undersea weapons, and submarine arctic warfare**

UNIVERSITY LABORATORIES

- **Applied Physics Laboratory/Johns Hopkins University**
  - Surface weapons, weapons systems, combat systems, fleet ballistic missile systems, and space systems and sensors
- **Applied Physics Laboratory/University of Washington**
  - Ocean, polar, and environmental science; underwater acoustics
- **Applied Research Laboratory/Pennsylvania State University**
  - Undersea technology and digital simulation; hydrodynamics, hydroacoustic, and propulsor technology; manufacturing technology
- **Applied Research Laboratory/University of Texas**
  - Underwater acoustic technology, underwater weapons and sensor technology, environmental effects prediction

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Figure 3 - The Navy Research & Development Centers and University Laboratories

- • Advanced sensors
- • Autonomous systems
- • Computing power and modeling
- Cooperative engagement
- • Countermeasures
- Directed energy
- Energy storage and conversion
- • Engineered materials
- • Environmental sciences
- • Fiber optics and photonics
- • Information management and decision-making
- • Insensitive highly energetic materials
- Multistatic systems
- Range and test technologies
- • Signature reduction
- • Software engineering
- Superconductivity
- • Submarine detection
- • Simulation
- • Space-based systems

• **Currently or recently funded by ManTech at NOSC**

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Figure 4-Advanced Technologies for Navy Superiority

NAVY INDUSTRIAL BASE PROGRAMS

• **BMP**	The Best Manufacturing Practices (BMP) program is to review and document the best practices and potential industry-wide problems at defense manufacturers. The intent of the BMP program is to use this documentation as the initial step in a voluntary technology sharing process among the industry.
• **CENTERS OF EXCELLENCE**	Including the Automated Manufacturing Research Facility (AMRF) at NIST, the Electronics Manufacturing Productivity Facility (EMPF), the National Center of Excellence in Metalworking Technology (NCEMT) operated by Metalworking Technology, Inc., and the Center of Excellence for Composites Manufacturing Technology, the Centers of Excellence provide mechanisms for industry, academia, and government to work together to solve manufacturing problems.
• **CRDA**	The Cooperative Research and Development Agreements (CRDA) are agreements between Navy labs and one or more non-federal entities. These entities could be industry, university, or individuals. The Navy lab may furnish people, service, equipment, and facilities, but not funds. The Non-federal party may furnish everything including funds. Work must be related to the mission of the lab. While commercialization of federal science and technology will tend to be the goal of most CRDAs, there are no requirements of that goal. Small businesses and domestic business entities are given preference.
• **IMIP**	The Industrial Modernization Incentive Program (IMIP) encourages DoD weapon system contractors to modernize factories to increase productivity, improve product quality, and reduce acquisition costs by offering incentives such as Productivity Savings Rewards or Contractor Investment Protection.
• **IRAD**	Navy personnel provide industry with review and guidance on Independent Research and Development Projects.
• **ManTech**	The Manufacturing Technology (ManTech) Program is to reduce acquisition costs by applying advanced technology to manufacturing processes. ManTech promotes timely establishment of new manufacturing processes, techniques, or equipment to support present and future Navy system production requirements.
• **MTIAC (DoD)**	The Manufacturing Technology Information Analysis Center (MTIAC) distributes data on DoD Mantech projects to industry.
• **NPCP**	The Navy Potential Contractor Program (NPCP) provides a vehicle for industry to contract with the Navy Labs for research. Under NPCP, information is transferred to industry and academia. No technical goods or services are to be exchanged. The NPCP is intended to allow access to information which will help parties orient their IR&D efforts and to focus on problems DoD is having in the technical arena. NPCPs can evolve into CRDAs.
• **PECI/PIF**	The Productivity Enhancement Capital Investment (PECI)/Productivity Investment Fund (PIF) is a funded program administered by the Defense Productivity Program Office (DPPO). The program was established in 1979 to improve the capital stock of DoD activities. It is designed to enable managers to make timely investments in equipment and facilities which increase outputs of an organization in relationship to inputs.
• **SBIR**	The Small Business Innovation and Research (SBIR) activity is part of the Small Business Administration. The SBIR assists small companies in bidding on government contracts and issues research grants.

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THE NAVAL OCEAN SYSTEMS CENTER

The Naval Ocean Systems Center (NOSC) is a full-spectrum RDT&E center serving the needs of the Department of the Navy and the Department of Defense within assigned mission and leadership areas. We provide solutions to Naval and Joint Service problems through the generation and application of technology. We seek to supply innovative alternatives to tomorrow's decision makers, thus enabling them to pursue new or expanded missions.

NOSC is located on the Point Loma Peninsula in San Diego, California. The facilities are widely dispersed over the peninsula which stretches out into the ocean more than three miles. The Topside facilities permit clear line-of-site connections to both shore and afloat stations. The Command, Control, and Communications facility on the Seaside is protected from the extensive electromagnetic activity present from the City of San Diego. At the Bayside facility, the calm environment of the harbor is ideal for in-the-water experiments. We also have facilities in Hawaii and Alaska.

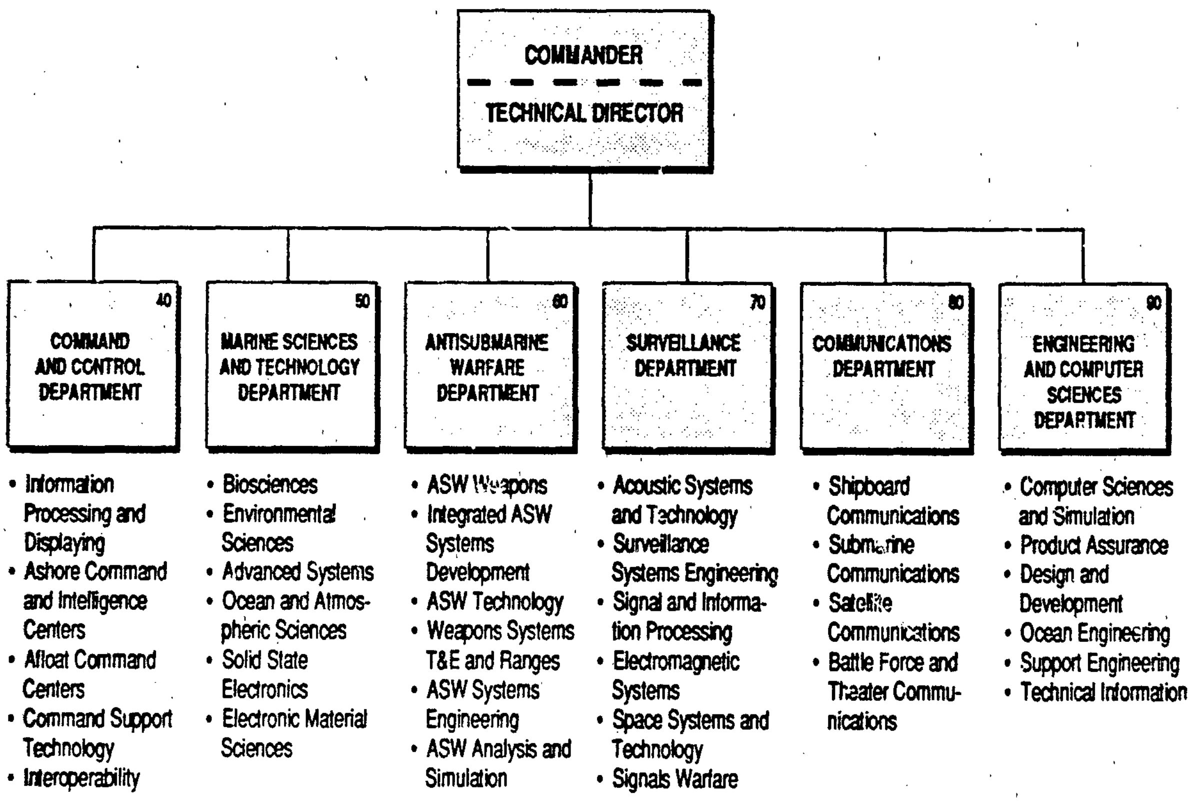

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Figure 6 - Top Level Naval Ocean Systems Center Organization

NOSC MISSION

Our strategic role, as defined by the Director of Navy Labs, is to continue to be the technical leader in command control, communications, ocean surveillance, surface- and air-launched undersea weapons, and submarine arctic warfare. The center creates, directs, and transitions technology; initiates programs; provides technical support to the systems commands; provides production, in-service engineering, test, and evaluation support when necessary; provides technical support to the fleet; and as appropriate, transitions system maintenance to other activities.

NOSC assumes technical leadership for developing systems and solutions. Our principal role is to provide the Navy team with "smart buyer" support in the systems acquisition process as a Technical Agent of the Systems Command. NOSC focuses on the Navy's future needs and is uniquely capable of serving the Fleet in times of national crisis. Specifically, we support systems for which we share a responsibility during introduction into the Fleet and provide technical expertise and facilities not readily available to operational commands. Our strong commitment to close liaison with the Fleet ensures that our efforts remain relevant.

NOSC ORGANIZATION

We are organized into a number of operations or "Codes." Figure 5 shows the top level NOSC organization. NOSC is structured into six Technical Departments. A sampling of our major programs includes ACDS, JTIDS, TFCC, and VHSIC. A new computing system of the supercomputer class is being procured to assist in high-speed modeling. The Engineering and Computer Sciences Department is responsible for Prototype Development and Transition-to-Production. Divisions of this department include Operational Test and Evaluation, Product Assurance, Technical Publications, and the Design and Development Division. The Design and Development Division is the home for the ManTech and IMIP Programs at NOSC.

MANUFACTURING TECHNOLOGY/INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM

Congress appropriates funds each year under the category of Industrial Preparedness (Program Element 78011) to ensure that the manufacturing capabilities of our nation are more than sufficient to support a major defense effort. These funds are administered by the DoD and distributed to the appropriate agencies. The Navy ManTech program supports the development of new manufacturing technology and industrial modernization.

The NOSC ManTech/IMIP activities concentrate on those technologies which directly support the Naval Fleet. A few examples of technologies we have transitioned through ManTech to the Fleet are shown in figure 7. In NOSC's strategic plan released in July of 1989, the Center's leaders noted, "We will emphasize product and software assurance, and we will strengthen our NOSC design review process to encourage quality, reliability, producibility, and affordability." As such, NOSC ManTech and IMIP thrust areas include microelectronics, microwave tubes and devices, opto-electronics, and related technologies.

MANTECH/IMIP ORGANIZATION

Our activity occurs in the Manufacturing and CIE Technology Branch, Code 936, and is a part of Code 90, Engineering and Computer Sciences Department. However, our ManTech/IMIP activity is also part of a larger DoD ManTech/IMIP organization. The DoD ManTech/IMIP organization is shown in figure 8. Projects identified by the Assistant Secretary of the Navy, Navy System Commands, NOSC Codes, and other DoD and Government agencies flow to Code 936. Our Project Managers prioritize the projects, then manage, perform, and coordinate activities to achieve timely results.

- Microelectronic Computer Integrated Manufacturing
- Electron Beam Imaging
- Focused Ion Beam Lithography
- Masked Ion Beam Lithography
- VHSIC (Many)
- Liquid Crystal Light Valve
- Fluid Prisms
- Materials (Ga As)
- Metal Core Boards
- Phalanx Composite Dome
- Microwave Tubes and Devices
- Phased Array Radar Test System
- AI Robotic Welding
- Robotic Inspection System
- Robotic Hybrid Assembly
- Fiber Optic Projects (Many)
- Composite Missile Fins (SM-2)
- Composite Torpedo Propellors

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Figure 7 - R&D NOSC Projects that Transitioned through ManTech to the Fleet

DoD MANTECH AND IMIP ORGANIZATION

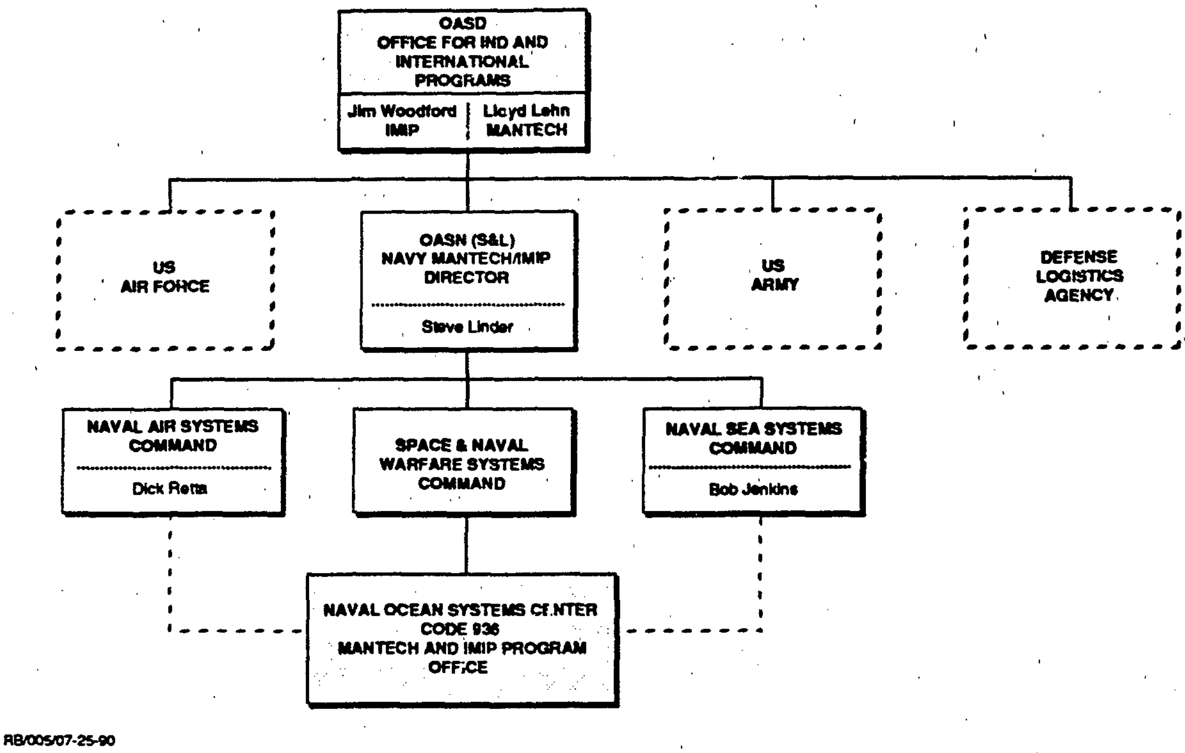

Figure 8 - Department of Defense ManTech and IMIP Organization

MANTECH

Established from a tri-service activity, the primary thrust of the Manufacturing Technology (ManTech) Program is to reduce acquisition costs by applying advanced technology to manufacturing processes. This activity becomes more critical as procurement budgets decrease. ManTech promotes timely establishment of new manufacturing processes, techniques, or equipment to support present and future Navy system production requirements. Figure 9 shows the process through which ManTech programs are derived. Figure 10 displays the characteristics of ManTech projects. ManTech developments generally have feasibility established through R&D. ManTech then provides the vehicle for transition of R&D advances to production. Figure 11 graphically represents what ManTech hopes to achieve.

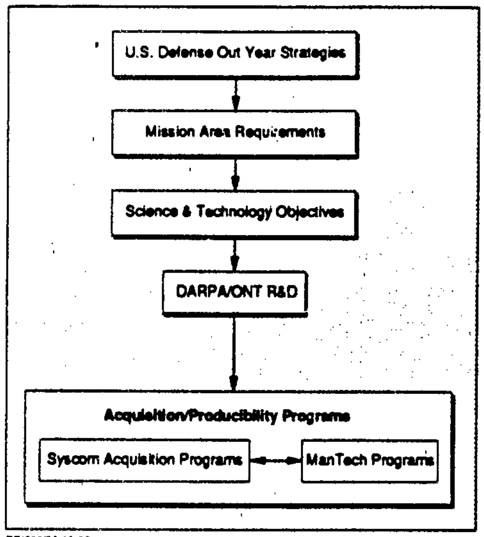

Figure 9 - ManTech Programs which Compliment System Acquisition Programs Assure Producibility and Affordability

To ensure that Navy requirements are being satisfied, NOSC ManTech analyzes the cost and technical drivers of emerging weapon systems in seeking cost reducing opportunities. In addition, we provide program management and technical support for Navy ManTech Headquarters, coordinate in-plant demonstrations, implementation of results, and support tri-service DoD Manufacturing Technology Advisory Group (MTAG) activities. We are also the principal naval laboratory for technical assessment and execution of the technologies shown in figure 12.

- Production-oriented manufacturing processes, materials, testing, and inspection improvements
- Proven feasibility from prior R&D or extrapolation of known technology
- Directly supports one known system, but can benefit other components/systems or demonstrate generic techniques
- Beyond normal risk of industry
- Provide a significant return on investment.

Figure 10 - The Character of ManTech Projects

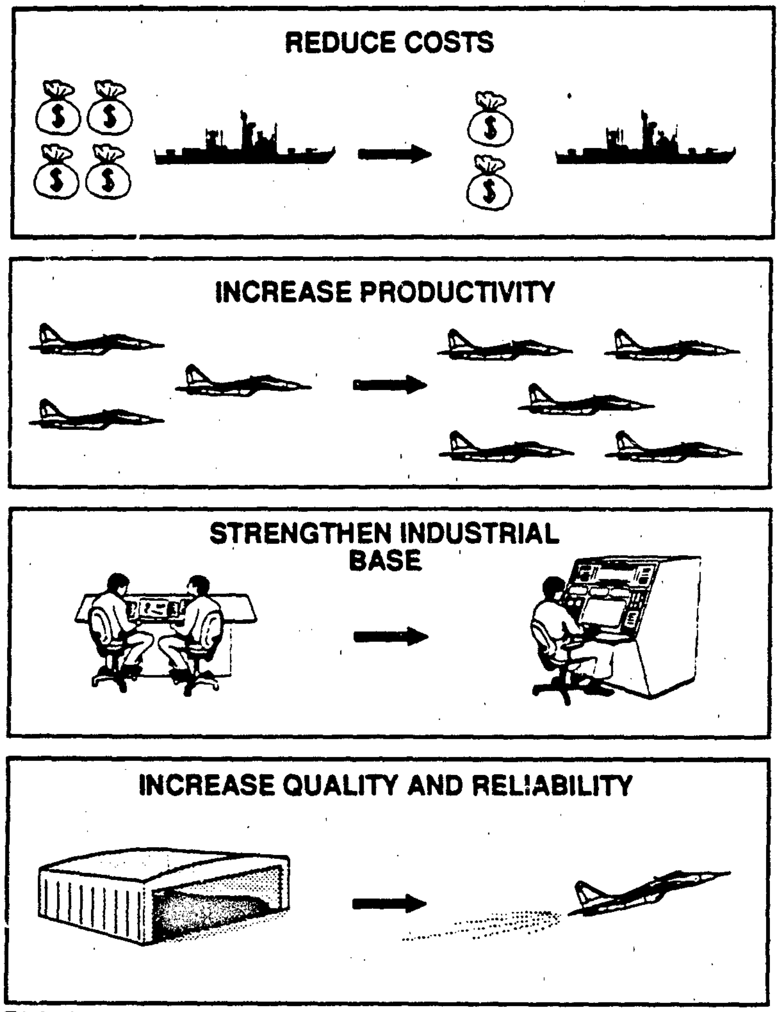

Figure 11 - The Objectives of ManTech Projects

- Microelectronics computer integrated manufacturing
- VHSIC technology
- Electronic materials
- Microwave tubes and devices
- Fiber optics/electro optics
- Display technology
- Robotics/artificial intelligence

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Figure 12 - NOSC ManTech Technologies

For NOSC ManTech Projects to realize their full potential in savings for the DoD, the results must be effectively disseminated. We use Government-Industry Data Exchange, end of contract demonstration, and the MTAG, including its subcommittees on Electronics, Non-metals, CIM, Quality, Metals, and Munitions, to provide information dissemination. NOSC currently has six representatives serving on MTAG's Electronics, Non-metals, CIM, and Quality subcommittees. Our representative serves as the chairman of the electronics subcommittee. In addition, NOSC provides Government and Industry access to key DoD ManTech databases.

NOSC MANTECH RESULTS

ManTech has been active in the Navy since 1977. During this period, NOSC ManTech has had many successful projects. A sample of some of the results of our efforts are shown in figure 13.

TITLE	APPLICATION	SPONSOR	EXPENDED ($K)	PRODUCTION BENEFITS PROJECTED ($K)
Ion Implantation System	MINI-HALO, Phoenix	NAVAIR	734	20,000
Fiber Optics for Military Aircraft	Aircraft	NAVAIR	1,622	33,555 **
Automated Test System for Phased Array	Aegis	NAVSEA	677	1,200 per year
Rigid Flex Printed Circuit Manufacturing	Standard Missile	NAVSEA	152	6,500 **
Foam Filled Fiberglass Radome	Phalanx	NAVSEA	116	4,684 by 1985
Low-Cost Torpedo Propeller Manufacturing	Torpedos: MK46 & MK48	NAVSEA	220	20,000
Batch Vapor Phase Soldering of Flexible Printed Circuit Connectors	Standard & Sparrow Missiles	NAVSEA	120	1,904 **
Metal Core Printed Circuit Boards	Standard Missile II	NAVSEA	180	1,139 **
Hermetic Tape Carrier (HTC) for Integrated Circuits	Generic to DoD electronics	NAVSEA	510	2,977 **
Automated Fusion Weld Inspection	Cruise Missile	NAVSEA	573	1,808
Crossed-Field Amplifier Tube	Aegis Radar System	SPAWAR	280	52,235
Robotic Microwave Hybrid Substrate Assembly	Combined Altitude Radar Altimeter	SPAWAR	764	7,700
Other NOSC ManTech Projects			55,053	115,299
TOTAL			61,000	269,000

** Additional savings available by generic application to DoD electronics production

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Figure 13 - Examples of Navy Manufacturing Technology Results

The NOSC Manufaeturing Technology Program functions as the lead laboratory for several technology thrusts within the Assistant Secretary of the Navy (ASN) sponsored program. Funding and related statistics for 1977 to 1990 are:

$61M Cumulative funding including:
$43M Industrial Base Funding
$18M NOSC In-house (18 MYr/Yr)
52 projects completed
$269M Audited Cost Savings (4.3 ROI).

Significant cost savings have been created in dual-use, defense and commercial, technologies. The dual use technologies developed by NOSC ManTech are shown in figure 14. Several development areas have unique military applications. The DoD unique technologies are shown in figure 15.

In supporting the ManTech/IMIP objectives of the Navy, we have been involved in several joint programs with other DoD agencies. Examples of some of these programs are listed in figure 16.

NOSC MANTECH FUTURE

Technology is constantly advancing at a rapid pace. ManTech must always have an eye toward the future. NOSC ManTech has a lead role in development of the Office of the Assistant Secretary of the Navy ManTech Strategic Plan. Areas to be fully developed in the plan include directions of Technical Thrusts, Core Technologies, and Centers of Excellence. ManTech Thrusts already identified as important future areas are shown in figure 17.

- Composite Material Torpedo and Missile Structures
- Microelectronics Sub-micron Processes and Computer Integrated Manufacturing Technologies
- Fiber optic Applications in Avionics and Undersea Systems
- Large-Screen Display Liquid Crystal Light Valves and Fluid Prisms
- Computer Integrated Manufacturing Applications in Microelectronics Manufacturing
- Robotics and Artificial Intelligence Applications in Welding
- Material Handling
- Process Control
- Automated Inspection and Material Resource Planning (MRP)

RB/022/06-18-90

Figure 14 - Dual-Use ManTech Technology Areas

• High Power Microwave ECM and Directed Energy Devices • Radiation Hardened Fiber Optics and Microelectronics • Composite Material Torpedo and Missile Structures and Radomes	• Infrared Detectors and Focal Plane Arrays • Phased Array Ship Defense and Aircraft Radar

RB/023/06-18-90

Figure 15 - ManTech Unique Military Applications

• USAF/Navy	Precision-Guided Munitions IMIP
• USAF/Navy	Automated Diagnostic System
• USAF/Navy	Enhanced Real-Time X-Ray
• Army/Navy	Automated Wirebond Pull Tester
• Army/Navy	Electronics Cost Driver Program
• DARPA/Navy/USAF	Sensor-Based Manufacturing Program
• DOC/Navy	Computer Integrated Manufacturing Communication Protocol
• USAF/USMC/Navy	Robotics, AI Database

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Figure 16 - Examples of Joint NOSC Activities

- Computer Integrated Manufacturing (CIM) - Microelectronics
- Sensor Based Manufacturing (SBM)
- Precision Guided Munitions IMIP
- Shipboard Fiber Optics
- EW Sensors and Materials Thrust

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Figure 17 - Future Thrusts at NOSC ManTech

IMIP

The Industrial Modernization Incentive Program (IMIP) was established from a tri-service committee in 1982. It is a DoD program encouraging DoD weapon system contractors to modernize factories to increase productivity, improve product quality, and reduce acquisition costs. IMIP was preceded by the TechMod and GetPrice programs. Once the 1982 test case proved successful, the DoD-wide guide was published in August of 1986.

IMIP relates directly to our NOSC strategic plan to "emphasize product and software assurance, and . . strengthen our NOSC design review process to encourage quality, reliability, producibility, and affordability." IMIP is a comprehensive approach to establishing a defense industrial base that is capable of providing high-quality, reliable weapons systems at reasonable costs.

IMIP incentives are based on savings resulting in improvements over projected costs. Figure 18 graphically represents the IMIP process. IMIP efforts are typically conducted in three phases. Phase I consists of a structured factory analysis of the existing and future production system, identification of resulting benefits, and identification of required technology. In Phase II, the contractor defines system requirements, identifies specific projects, and finalizes required planning, cost benefit analysis, and capital requirements. During Phase III, projects are implemented, capital equipment is acquired, and the new systems are validated.

DoD Directive 5000-44, IMIP, states contractors should conduct IMIP efforts without Government funding. However, when it is in the best interest of the Government, funding may be provided by the Government. The Navy is currently seeking a budget line to provide funding directly to contractors. ManTech or the benefiting weapon system program may also provide funding.

One incentive for undertaking an IMIP is the Productivity Savings Reward (PSR). The contractor's share of the savings is that share necessary to make the investment an attractive business opportunity. The contractor's share is usually paid after assuring that the savings are, in fact, achieved.

An additional incentive of a Contractor Investment Protection (CIP) may be available. The CIP provides for Government acquisition of certain identified pieces of severable plant equipment in the event of Government termination or failure to procure a specified number of systems. CIP is only applied in situations where the contractor is bearing unacceptable monetary risk and the Government will benefit from the use of the equipment.

IMIP projects can address a number of different technologies. They fall into the two categories of Modernization Investment Projects (MIPs) and Modernization Efficiency Projects (MEPs). Figure 19 shows examples of MIPs and MEPs.

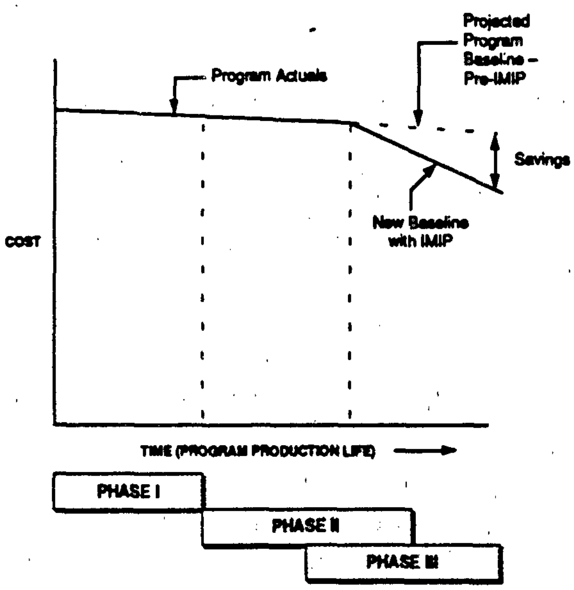

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Figure 18 - IMIP Process

Modernization Investment Projects (MIPs)
- Robotics/AI Applications - Automation (flexible/hard) for Assembly - Material Handling/Storage Systems - Plating/Coating Process Improvements - Automated Diagnostic Equipment - Automated Machining Centers - Computer Integrated Manufacturing - Paperless Factory
Modernization Efficiency Projects (MEPs)
- Plant Rearrangement - Overhead Cost Reductions - MIS Integration - Office Automation

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Figure 19 - Types of IMIP Projects

The Air Force has been very aggressive in using the IMIP to modernize their manufacturing contractor base. Figure 20 presents some comparison of the different services use of IMIP.

Service	Number	Sample of Benefiting Systems
• Navy - NAVAIRSYSCOM	8	F-14/F-18/E-2/C-2/A-6/APG-63/65/AWG-9 Harpoon Missile/Phoenix/ARBS/Maverick/ Rocket MTRS
- NAVSEASYSCOM	0	JTIDS/SM-2/Ship Propulsion/Sonar/ Rubber Domes/MEWS/UYQ-21/Harm/Patriot
• Air Force	148	JTIDS/AMRA AMF/F-16/Maverick/ARBS/ Phoenix/B-1B/B-52/Cruise Missile/Lantirn
• Army	0	(TOW)
• Total Programs	150	

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Figure 20 - Current IMIPs

MANTECH AND IMIP COMPARED

ManTech compliments IMIP with distinct and related activities. Figure 21 shows how ManTech and IMIP, along with state-of-the-art equipment and off-the-shelf technology, come together in a production implementation. ManTech is aimed at making first-case manufacturing process and equipment improvements in the production environment. Significant technical and fiscal risks are involved. Government funding participation (nominally at $200M a year) is essential. IMIP is aimed at improvements on a factory-wide basis. It involves both well-established and state-of-the-art technology. IMIP Factory Analysis often leads to the identification of needed Manufacturing Technologies. Development of those technologies allow them to be combined with existing technology into a cost-effective, successful production modernization.

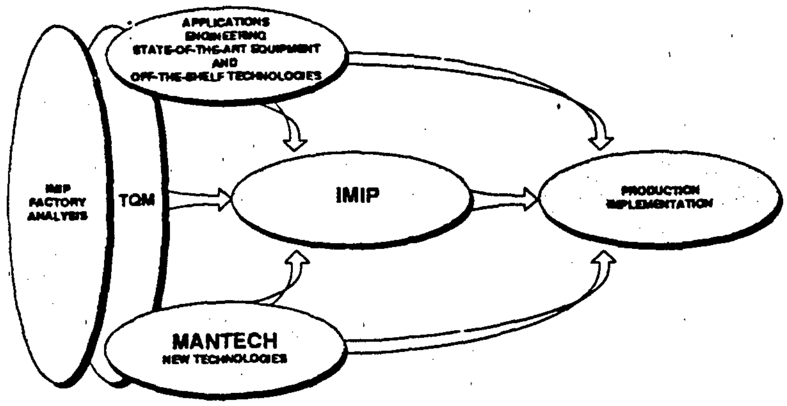


Figure 21 - Industrial Productivity Tools

APPENDICES OVERVIEW

The Appendices provide a detailed background of NOSC ManTech/IMIP activities. The major sections are divided into ongoing projects, new initiatives, completed projects, program planning, and technology databases. Project objectives, progress, benefits to be accomplished, industry involvement, and relationship to other projects and programs are included.

The **Ongoing Projects** (appendix A) section describes active projects currently underway at NOSC. These activities are providing exciting new advances to help manufacturers meet tomorrows Navy needs today. Key benefits of these programs include reducing costs of parts to the Navy, improving quality, reliability, and availability, and the development of manufacturing processes not currently available in the United States.

New Initiative Projects (appendix B) are being undertaken to continue to promote the NOSC mission into the future. Benefits of these projects include improvement in availability as in the Decoy Chaff project, advancements in quality and reliability as in the Homogeneous Flux Epitaxy project, improved weapon system performance as in the MK-50 projects, and significant cost savings to the Department of Defense as realized in the IMIP and other projects.

The **Completed Projects** (appendix C) section provides brief overviews of our finished NOSC ManTech projects. These advances have helped manufacturers meet Navy needs at reduced costs and have provided improved quality, reliability, and availability. It is difficult to quantify the value of advanced manufacturing technology because of secondary and tertiary effects. Not all NOSC ManTech projects achieved the total success envisioned at their outset. However, estimates places direct savings to DoD at over $260M as a result of the NOSC ManTech projects expenditures of $60M.

Technology is constantly advancing at a rapid pace. ManTech must always have an eye towards the future. Areas to be fully developed in the Navy ManTech Strategic Plan include directions of Technical Thrusts, Core Technologies, and Centers of Excellence. NOSC ManTech has also identified five technology areas for specific program planning. These areas include

- Microwave Tubes and Devices
- Data Driven Manufacturing for Electronics
- Sensor Based Manufacturing
- GaAs for EW Producibility
- Fiber Optics ManTech.

Each of these activities are discussed in the section called **Program Planning** (appendix D).

In performing its job, the NOSC ManTech/IMIP office has needed information regarding DoD sponsored ManTech & IMIP projects. Databases were developed which have now become national assets. Since its formation in the late 1970's, NOSC ManTech has been improving performance by the use of automated information handling. At this time, there exists a significant amount of historical data covering all of the DoD ManTech projects. The four systems described in the Technology Databases (appendix E) section were developed at NOSC. All of these systems are operating on a VAX 8650, running a UNIX operating system, and use the INGRES relational database manager.

The projects described in the appendices support U.S. industrial modernization. They develop new or improved processes, methods, techniques, or equipment to enhance our industrial base capability, ensure quality and affordability of DoD systems, enable the transition of R&D from development to production, and allow the implementation of advanced methods and technologies in defense production facilities.

APPENDIX A—ONGOING PROJECTS

MICROELECTRONIC COMPUTER INTEGRATED MANUFACTURING (MicroCIM)

OBJECTIVE

Working to help the DoD and Navy Systems Command's objective of having electronic systems in the fleet at reduced costs, the Microelectronics Computer Integrated Manufacturing (MicroCIM) program is applying the latest in computer technologies to make concrete advancements in reducing electronic parts costs. Specific manufacturing technologies being employed include factory modeling and simulation, computer-aided design (CAD), computer-aided manufacturing (CAM), and direct electronic transfer. Information is being gathered and analyzed to examine cost drivers.

Programs preceding MicroCIM have focused on improving labor performance on the factory floor. However, analysis has shown that factory floor labor accounts for less than 15% of parts cost. MicroCIM extends beyond the factory floor to examine cost drivers in other areas of the enterprise.

PROGRESS

The Phase I "as-is" factory analyses have been completed. Phase II implementation and demonstration projects have been awarded to two industrial contractors. Specific projects being developed in Phase II include a robotic pick and place system and an electronic testing system.

BENEFITS TO BE ACCOMPLISHED

The immediate benefit of the MicroCIM program is the reduction in costs of electronic parts at Raytheon and CTS. Transfer of the technology to other DoD suppliers will achieve cost reduction at their facilities.

The CTS electronic test system implements the uploading of data from the Electrical Test workstation to the host computer. This data will supply the information necessary to determine the control parameters at an upstream process station. The CTS system will also translate all workstation instructions to electronic media for display on factory floor monitors. Workstation instructions might include drawings, specifications, or work instructions.

The Raytheon activity will result in direct input of operation parameters from the CAD database to a pick and place robot. Raytheon will also achieve direct downloading of CAD data to the wire-bonding and wire-bond pull test station.

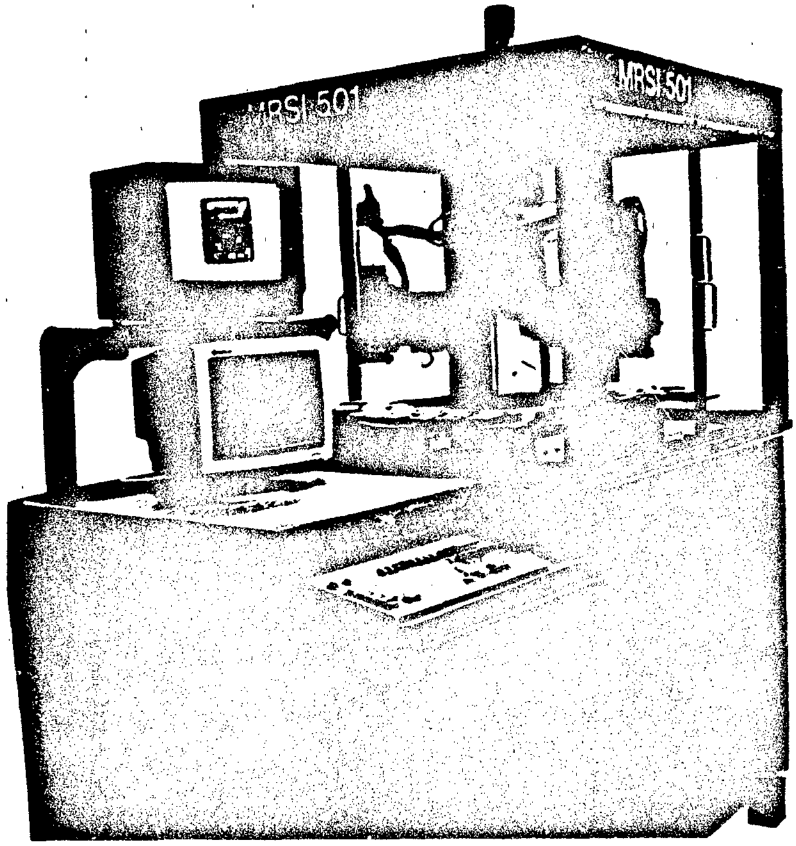
INDUSTRY INVOLVEMENT

Raytheon is representing large electronics manufacturers while CTS represents small companies which do not have the capital for large modernization projects. The methods of achieving the cost reductions will be documented for use by other DoD suppliers.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

MicroCIM is a follow-on to the Integrated Facility for Automated Hybrid

Microcircuit Manufacturing (IFAHMM) program. The IFAHMM program was conducted by Teledyne Microelectronics at their Los Angeles plant. Teledyne analyzed their factory floor operation using the Air Force-developed Integrated Computer-Aided Manufacturing (ICAM) Definition Language (IDEF) modeling method. They designed an upgraded facility focusing on the use of bar code readers to eliminate paper travelers, the transfer of design data from the Host system database to a die-attach machine, and the transfer of data from the electronic test station to the host system database.



Direct input of operational parameters from the CAD database to a pick-and-place robotic system is being developed by Raytheon.

CAD TO CAM FOR HYBRID ASSEMBLIES

OBJECTIVE

Hybrid Microelectronic Assembly (HMA) is a rapidly developing technology. Evolution occurs as fast as new materials and manufacturing methods become available. For the Computer-Aided Design (CAD) to Computer-Aided Manufacturing (CAM) for Hybrid Assemblies project. HMA is defined as a module or subcircuitry that is incorporated into a large electronic assembly. An HMA incorporates a mix of electronic device materials on a common substrate. The diversity of materials such as silicon, cermets, and various metallurgies, combined with various techniques for interconnecting these components together, give HMA devices a uniqueness and complexity not found in other electronic assemblies.

The Electrosystems Division of the National Institute of Standards and Technology (NIST) hopes to provide the initial development and verification of a specification for the format of HMA design and production data. It is expected the the HMA data specification would be based upon the Initial Graphics Exchange Specification (IGES) and follow on to the Product Data Exchange Specification (PDES). Other standards, such as the standard communications protocol for interconnection of electronic packaging and production equipment, may also be used.

The four phases of this program consist of:

1. The development of a definition of precisely what data are needed for the complete description of an HMA.

2. The development of the format representation of the product data in cooperation with a standards organization.

3. The demonstration and verification of the concept of the HMA data description design in an automated hybrid manufacturing testbed environment.

4. The incorporation of the knowledge gained from a testbed demonstration into the data description.

PROGRESS

A literature search has been completed. A preliminary hybrid microcircuitry design data description is being developed. The concept description will be presented at two user workshops for further discussion and expansion.

BENEFITS TO BE ACCOMPLISHED

The development of the data format is necessary to permit the interchange of data between CAD and CAM systems and to provide an archiving capability of the design such that HMAs may be produced in the future conforming to the original design specifications.

INDUSTRY INVOLVEMENT

A list of industry contacts has been generated. User workshops were conducted at the Product Data Exchange

Specification (PDES) Workshop in Albuquerque and the ISHM Workshop in Baltimore. Raytheon and CTS are involved.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project relates directly to the MicroCIM program.

COMMUNICATIONS PROTOCOL FOR MICROELECTRONICS COMPUTER INTEGRATED MANUFACTURING

OBJECTIVE

The goal of the Communications Protocol for Microelectronics Computer Integrated Manufacturing (MicroCIM) project, also known as "Meet-In-The-PC," is a standardized method of attaching process equipment to the factory computer hierarchy that is universally acceptable to hybrid manufacturers and their equipment suppliers. Meet-in-the-PC is a method of neutral protocol exchange of data. It uses the Personal Computer (PC) to bridge the gap between the factory computer system and the process equipment. Different types of factory computers and networks are accommodated. The myriad of choices related to the equipment are supported including different process types, interfaces, and diverse levels of intelligence. A separate PC is used for each piece of process equipment. This solves the physical interface problem by making the factory responsible for one side and the equipment vendor responsible for the other.

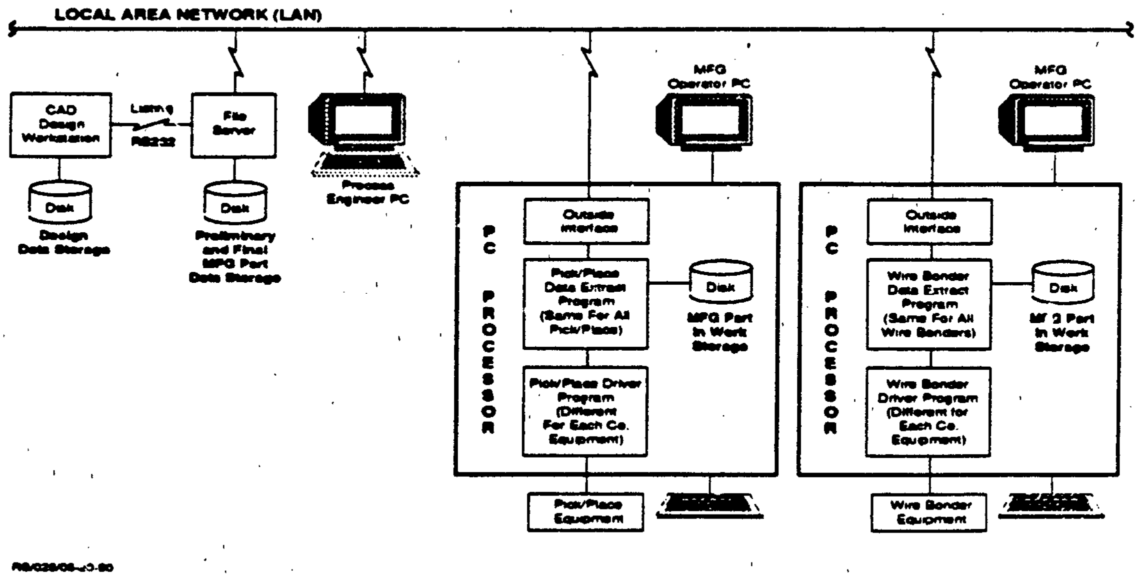
PROGRESS

Version 0.2 of the specification has been developed and mailed to the user groups for comments and revision. The IFAHMM program and early AHAP meetings included many discussions of how to solve the equipment connection problem. The middle ground Meet- in-the-PC solution was articulated to the AHAP members in April 1988.

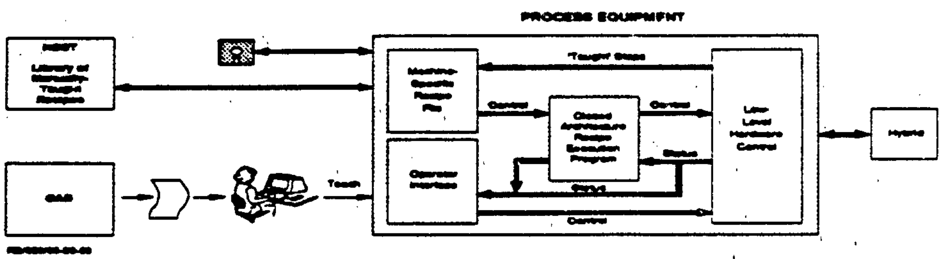
In December 1988, National Institute of Standards & Technology (NIST) was funded by the Navy to write a specification and provide a demonstration at a NIST Automated Manufacturing Research Facility (AMRF) open house in November 1989. Concurrently, a low-level effort at Computer Sciences Corporation (CSC) addressed the content of the data that would cross the interface.

A workshop was held in April 1989 with the goal of developing a prototype specification. The subject of process models was introduced late in the workshop and was deemed by the user participants as vitally important to the effort. Agreement was reached for the initial platform to be a PC using the DOS operating system and "C" as the programming language.

COMMUNICATIONS PROTOCOL FOR MICROELECTRONICS CIM
(MEET-IN-THE-PC)

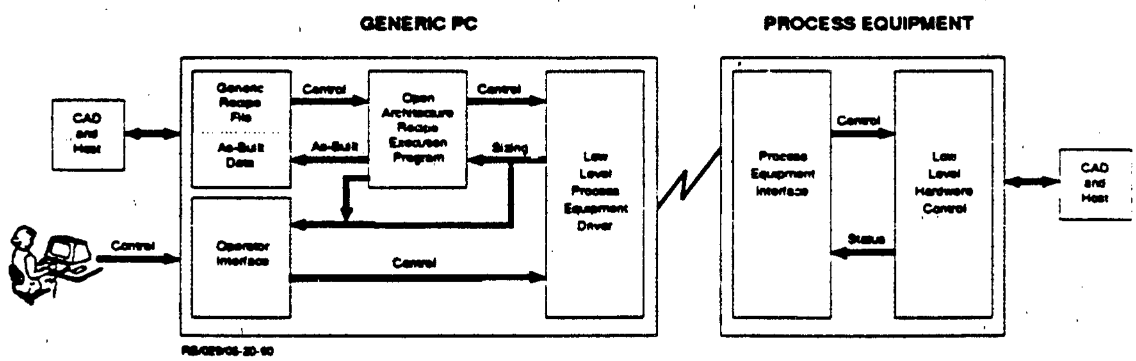


AS-IS FUNCTIONAL MODULES



CSC continued developing process models and has completed prototypes for laser trim, die attach, plasma clean, wire bonder, cover seal, fine leak bomb, fine leak test, gross leak bomb, and gross leak test. CSC has also participated in the related effort SECS wire bonder task force, which is trying to identify information transfer content requirements to control a wire bonder using the SECS protocol.

TO-BE FUNCTIONAL MODULES



BENEFITS TO BE ACCOMPLISHED

Direct factory computer control of process equipment and involvement of the factory computers in information gathering is essential to successful automation. Flexible, efficient, and cost-effective factory computer connection to, control of, and involvement with process equipment is the critical problem impeding automated hybrid manufacturing today. The Meet-in-the-PC project will establish a neutral base protocol between the factory computer and the process equipment.

INDUSTRY INVOLVEMENT

Workshops are scheduled to occur at Raytheon, and Naval Ocean Systems Center, CTS MicroCIM. Beta testing is to occur at the MicroCIM contractor sites. CSC is providing direct support to the project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The project follows from the IFAHMM project and is directly related to MicroCIM.

HEAT PIPES FOR PRINTED CIRCUIT BOARDS

OBJECTIVE

The goal of this project is the development of manufacturing technology for the production of high quality heat pipe substrates by automated methods. This would permit the cost of heat pipes to reduce to a point where they will become cost-competitive candidates for transferring heat away from electronic components mounted on printed wiring boards.

Heat pipes are very effective heat transfer devices for removing heat from board-mounted electronic components. Internally, heat pipes work by means of evaporation/condensation cycles. They typically consist of a wick and liquid enclosed in a round or flat, thin-walled, metallic tube. In operation, the liquid absorbs heat from an electronic component, vaporizes, and flows through the center cavity to the extreme, cooler ends of the pipe, where it condenses and gives up heat to the mass of the card cage. The liquid is then pumped through the wick by capillary action, back to the heat zone under the electronic component, and the cycle is repeated.

The most critical technical task of the project, from both the performance and the fabrication standpoint, is the development of precise, automated processes to evacuate, fill, purge, and seal the heat pipes. With technical success in these areas, the attainment of the original goal to reduce the cost of heat pipe substrates is highly probable.

PROGRESS

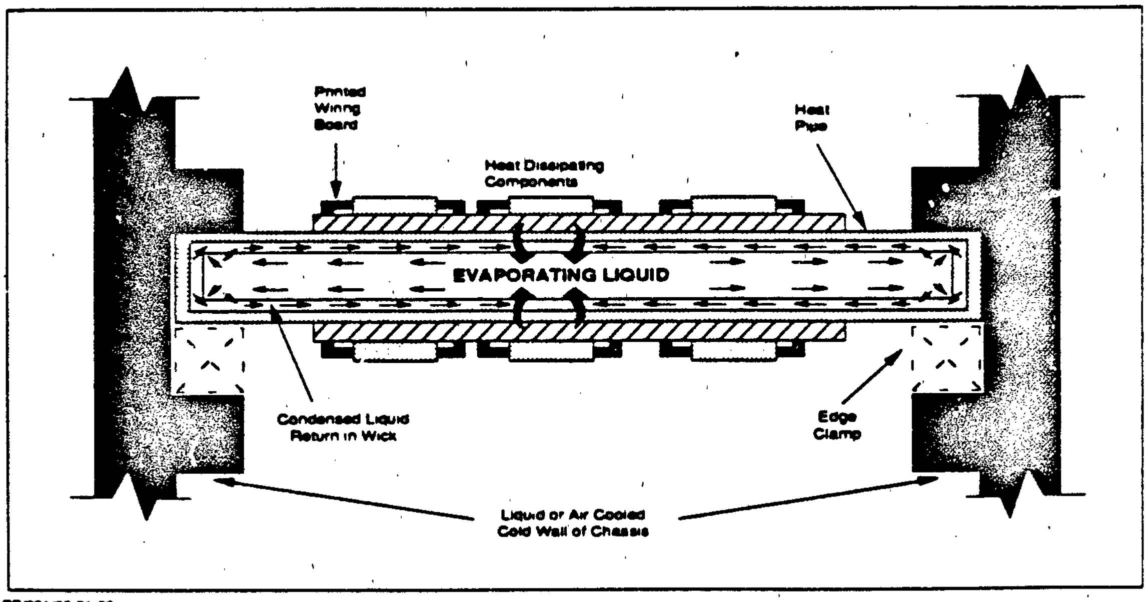
The acquisition and development of processes and equipment for producing the heat pipe frame is in the final stages. The required equipment includes the following:

- Processing Station
- Thermal Test Station
- Welding Process
- Drill Station
- Shear Station
- Wick Insertion Equipment
- Side Plate Adhesive Curing Station.

BENEFITS TO BE ACCOMPLISHED

Traditionally, heat pipes have been custom designed, expensive, and therefore limited in application. In years past, heat pipes have made their way into a few electronic systems on a very selected, design-driven basis. Unfortunately, due to the high cost of heat pipes, designers were reluctant to specify them; and due to low demand, suppliers were slow to invest in manufacturing automation that could have reduced the cost. This Manufacturing Technology (ManTech) project was conducted to develop the special processes and tooling required to produce large quantities of high-quality, low-cost heat pipe substrates.

HEAT PIPES PROVIDE EFFECTIVE COOLING FOR ELECTRONIC COMPONENTS



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INDUSTRY INVOLVEMENT

The ManTech project is being developed by Hughes Aircraft Company. Hughes elected to contract Automated Tooling Systems (ATS) for the design and fabrication of the process station. ATS was also selected to design and fabricate other minor production tooling for welding the heat pipe, trimming the pipe to length, and drilling the end of the heat pipe. The test station, along with other assembly equipment, is being built by Hughes.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The SHARP/SEM Program has recognized the merit of this technology and included provisions for heat pipe frames in their program specifications. In 1986, they expressed their desire to be associated with the program and were subsequently assigned as the prime implementation vehicle for the project. Interface requirements of the SHARP/SEM Program specifications were incorporated in the design of the prototype units and design documentation, and several substrates were furnished to the program for independent testing and evaluation.

VERY LARGE SCALE INTEGRATED CIRCUITS PACKAGING TECHNOLOGY

OBJECTIVE

The goal of the Very Large Scale Integrated Circuits (VLSIC) Packaging Technology project is to demonstrate manufacturing technology for fabricating multichip microcircuits using silicon as a substrate material and aluminum nitride as the package material. With new advances in integrated circuit technology and increased functional chip density, packaging and interconnections between devices have become limiting factors in achieving higher functional densities on the systems level.

PROGRESS

Hughes Microelectronics is continuing development of the polyimide dielectric substrate for the demonstration model and has produced the Computer-Aided Design report. W.R. Grace and Coors Ceramic Company have produced flat, 5- by 5-inch aluminum nitride substrates. They continue work on the top metalization, brazing, and plating process.

BENEFITS TO BE ACCOMPLISHED

VLSIC are required to produce the highly functional, small packaged, lightweight, low power consuming electronics needed to achieve the Navy's communication requirements. The demand for an order of magnitude increase in circuit density will be met by grouping devices into multichip modules thus eliminates the first level of packaging. Additional density will be achieved by reducing the geometries of interconnects between devices making them equivalent in size to chip geometries.

INDUSTRY INVOLVEMENT

Hughes Microelectronics is responsible for developing the silicon-based high density multichip interconnect substrates. W.R. Grace, and Coors Ceramic Company are developing and manufacturing packages capable of accepting the substrates.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

VLSIC components will be generic to many DoD electronics programs.

FOCUSED ION BEAM LITHOGRAPHY

OBJECTIVE

The goal of the Focused Ion Beam (FIB) manufacturing project is to produce a versatile, cost-effective microcircuit fabrication system. The system employs a machine based on submicrometer-sized focused ion beams.

PROGRESS

This long-term project is essentially complete with the formal, end of contract demonstration scheduled for February of 1990. The hardware is complete and functional. The software modules which provide menu-driven control, machine control software, and pattern transcription software are not complete.

This software minimizes the requirements for the operator to have in-depth knowledge of the FIB system operation. The software is being developed under internal funding at Hughes Research Laboratory.

BENEFITS TO BE ACCOMPLISHED

When complete, the FIB system will be used for direct implantation of circuits from CAD data.

INDUSTRY INVOLVEMENT

Hughes Research Laboratory has provided the bulk of the effort under this project. Microbeam, Inc., provides the license of the FIB technology.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The focused ion beam will facilitate production of numerous DoD electronic products.

MASKED ION BEAM LITHOGRAPHY

OBJECTIVE

Masked Ion Beam Lithography (MIBL) establishes a production ion beam replication system offering high resolution and fast exposure.

PROGRESS

Recent progress includes improving the throughput of the MIBL exposure system. The wafer-storage servo-control used in the MIBL exposure system is based on the same technology demonstrated in the Hughes electron beam lithography systems. Recent stage tests revealed that the servo-loop no longer provides acceptable stage positioning accuracy with the modifications for increasing the step-and-repeat speed. The stage positioning accuracy is now inadequate to evaluate the MIBL exposure system performance, or to demonstrate MIBL exposure technology. Further evaluation of options for meeting the objectives of this program are underway. These recent mechanical and servo-control problems in no way diminish the excellent ion beam lithography and mask development work that has been completed under this program.

BENEFITS TO BE ACCOMPLISHED

The ion beam lithographic technique will allow the economical replication of submicrometer patterns compatible with VHSIC processes and high yield.

INDUSTRY INVOLVEMENT

Hughes Aircraft Research Laboratory is the prime contractor for this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The project benefits from and provides technology to the Focused Ion Beam and DARPA X-Ray Lithography initiatives. This project has also been a topic of discussion in the Defense Advanced Research Projects Agency (DARPA)/Industry SEMATECH coalition.

FIBER OPTIC MICROCABLE

OBJECTIVE

The Fiber Optic Microcable project transitions ultraviolet-cured fiber optic microcable manufacturing technology from NOSC to industry. As a new manufacturing technology, scale-up to low production rates are being performed.

Current torpedoes and other remotely guided undersea systems must use an insulated metallic wire with a seawater return to provide communication between the system and its launch platform. This technique results in seawater return, large storage volume, high weight, low bandwidth, poor covertness, and marginal reliability. A lightweight fiber optic cable design offers substantial improvements in all of the above areas. Unfortunately, the current limited sources can provide less than 5-km lengths where 10-km and 20-km lengths are required. Poor manufacturing processes and extremely high costs result in further limits on the application of fiber optic microcable.

This project will result in a manufacturing process to produce fiber optic microcable suitable for torpedo and weapons control at a fraction of the current cost. Production rate increases of approximately 10 times are predicted.

PROGRESS

This project is new and, as such, no manufacturing technology progress has been completed. However, proceeding projects and related projects discussed below have been very successful.

BENEFITS TO BE ACCOMPLISHED

The primary financial benefit will be the reduction of cabling costs for fabricating microcable. This manufacturing technology will reduce the material and labor costs from $1.83 per meter to approximately $0.12 per meter.

A wide range of potential applications in sonobuoys, tactical wideband communication links, sea- and air-launched weapons, surveillance systems, and remotely operated vehicles exists.

INDUSTRY INVOLVEMENT

Solicitation for a contractor to take part in this project is currently underway.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Original accomplishments for this program occurred under Independent Exploratory Development (IED) funding. These accomplishments include the completion of prototyping and pilot production facilities to fabricate ultraviolet-cured microcables, fabrication of prototype fiber optic torpedo microcables, identification and evaluation of appropriate optical fiber buffer systems, development of suitable UV lamp designs, and evaluation of UV cured structural adhesive resins.

Naval Undersea Systems Center (NUSC) and NOSC performed a limited demonstration of fiber optic microcable from a MK 48 torpedo launched from an SSN 637 class submarine. Using microcable coiled by NOSC, reliable fiber optic payout from the torpedo and submarine was successfully demonstrated.

ENHANCED REAL-TIME X-RAY

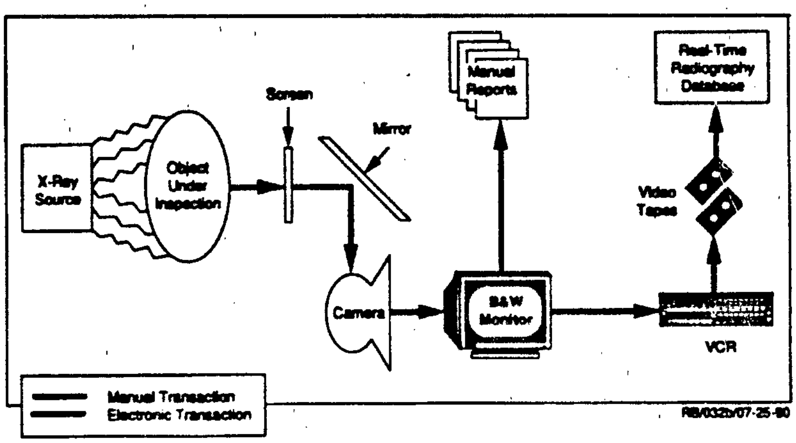
OBJECTIVE

The objective the Enhanced Real-Time X-Ray project is to develop the sensor-based technology of a large screen display, real-time radiographic inspection system. Associated technologies are being combined to overcome the shortcomings of small field-of-view and low resolution. The small field-of-view has required numerous set-ups and frequent refocusing. Low resolution has resulted in marginal fault identification and subjective interpretations of "gray scales." The heavily operator-dependent system is subject to errors resulting from the monotony of the tasks.

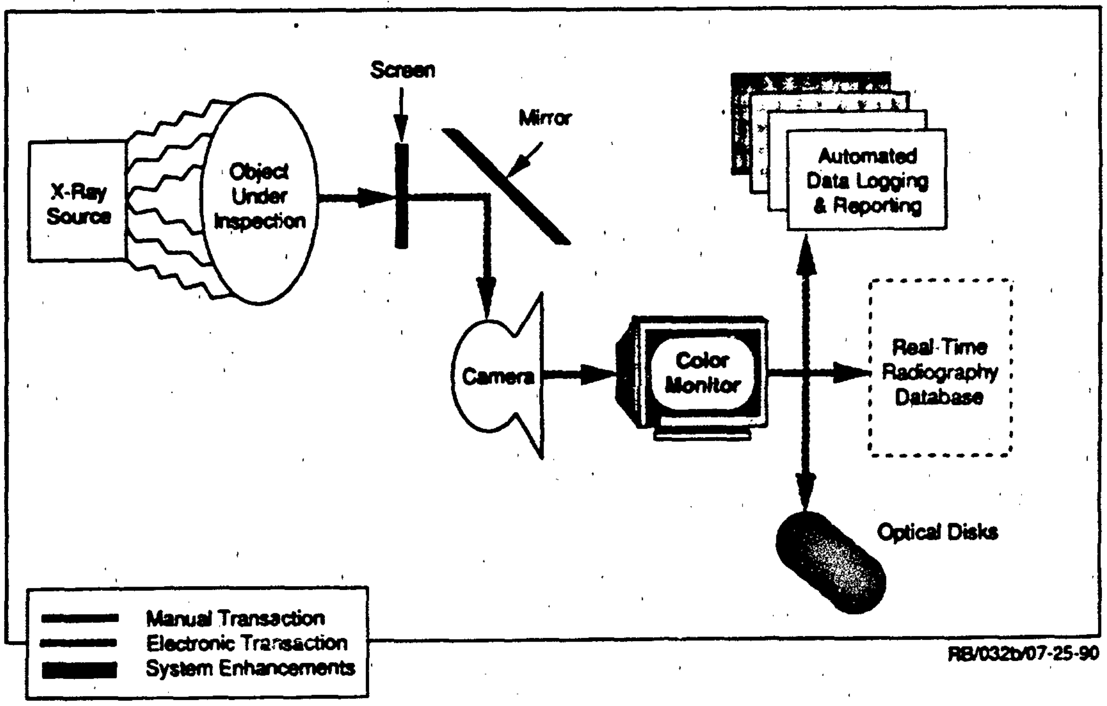
PROGRESS

Four major areas are being enhanced under this project. These include large field-of-view displays, scintillated fiber optic screens, cooled CCD camera receivers, and improved data acquisition. A large field-of-view is being developed by employing a 1024-pixel system, versus the current 512-pixel system. The factor of four improvement will decrease inspection time by decreasing the number of set-ups and refocus operations.

Scintillated fiber optic screen technology will increase the efficiency of light energy conversion of five to seven percent under the current phosphorus screen to 35 to 40% for the new screen. Color monitors will enhance the quality of the record and the interpretation capability. Cooled CCD Camera Receiver technology will improve the quality of the transmitted signal by reducing the noise level. A new processor capable of displaying 30 frames per second will greatly increase the data acquisition capability of the system.



"As-Is" radiographic inspection process.



"To-Be" radiographic inspection process.

BENEFITS TO BE ACCOMPLISHED

The combination of the associated technology will greatly enhance the quality of the inspection of solid rocket motors. In addition, the amount of labor required will be significantly reduced. Conservative estimates of the savings over a 5-year period is 21,516 man-hours. This relates to a cost saving of $1.5M from an investment of $0.5M. Industry Involvement Hughes Aircraft in Tucson is the prime contractor for this Air Force funded Industrial Modernization Incentive Program (IMIP) activity. Aerojet Solid Propulsion Company is performing the technical work. This project compliments other projects already in process or proposed by Aerojet.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project is a joint effort with the Air Force Armament System Division's Precision Guided Munitions (PGM) IMIP, out of Eglin Air Force Base in Florida. The Navy is funding one-third of this project. Inspection systems for rocket motors will support a number of DoD weapon systems including Standard Missile, Maverick, Skipper, Sea Lance, SRAM, AIWS, Minuteman, AMRAAM, Hawk, and others.

PRECISION GUIDED MUNITIONS (PGM) INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM (IMIP) ACTIVITY

OBJECTIVE

The objective of the Precision Guided Munitions (PGM) Industrial Modernization Incentives Program (IMIP) Activity is to provide technical and management support to the Tri-Service PGM IMIP program.

PROGRESS

NOSC has developed the PGM IMIP MIS (see appendix E) to assist in monitoring the technical and management activities of the program. The Management Information System (MIS) consists of various means of electronic communication and databases including contacts enabling technology and proposal tracking.

BENEFITS TO BE ACCOMPLISHED

Technical integrity of the PGM IMIP program is ensured through technical assessments. Phase I of an IMIP provides the structured factory analysis of existing and future production systems, identification of resulting benefits, and identification of required technology. In Phase II of an IMIP, the contractor defines system requirements, identifies specific projects, and finalizes required planning, cost-benefit analysis, and capital requirements. NOSC provides technical assessments and recommendations for all Phase I and Phase II PGM IMIP projects.

NOSC also provides technical monitoring for roughly half the PGM IMIP subcontractors. Performing in a role similar to that of a program manager, NOSC oversees subcontractor activity, monitors progress, and provides reports to the PGM IMIP office at Eglin Air Force Base, FL.

INDUSTRY INVOLVEMENT

Hughes Aircraft, Tucson, AZ, is the prime contractor for this Air Force funded Industrial Modernization Incentive Program (IMIP) activity. Approximately one dozen subcontractors are involved with the PGM IMIP activity.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project is a joint effort with the Air Force Armament System Division's Precision Guided Munitions (PGM) IMIP, Eglin Air Force Base, FL. The Navy is funding selected projects. The PGM IMIP activity supports a number of DoD missile systems including Maverick, AMRAAM, Phoenix, Army TOW, and USMC ARBS.

APPENDIX B—NEW INITIATIVES FY 91

DECOY CHAFF MANUFACTURING TECHNOLOGY

OBJECTIVE

The objective of the Decoy Chaff Manufacturing Technology program is to develop the processes to produce chaff dipoles which disperse in an omnipolarized manner. When dispersed in countermeasure operations, the dipoles used in current chaff decoy designs tend to descend predominantly in a horizontal orientation. Radars have been developed and deployed that can distinguish between a target-of-opportunity and a chaff dispersion of horizontal dipoles.

Currently, chaff dipoles can be modified to provide an omnipolarized dispersion by means of a special treatment process. Unfortunately, this chaff is produced by an undisclosed process that is the exclusive property of an off-shore, foreign-based supplier. The cost of the chaff is 5 to 10 times the cost of the present chaff.

This project will establish the material specifications as related to the new manufacturing process, develop large scale production processes to produce metalized glass fiber with controlled variations in diameter, develop assembly processes for the chaff-package to accommodate the new fiber material, and adapt new processes and equipment to existing manufacturing facilities.

PROGRESS

This is a new initiative. As such, no progress has been made specifically on this project. However, Lundy Technical Center of Pompano Beach, Florida, has demonstrated the feasibility of a new process that fabricates the metalized glass fiber with controlled variations in the fiber diameter.

BENEFITS TO BE ACCOMPLISHED

A chaff cartridge that will produce an omnipolarized dispersal of dipoles will provide countermeasures against a threat for which there is presently no defense. The development is totally dependent on the capability to manufacture fibers in large quantities. to a known design, and using a known, feasible process. This process is not currently available in the United States.

Current government orders indicate an average yearly procurement rate of over 10,000 decoys. Conservative estimates are that one-half of these decoys will include the omni-polarized chaff. Each round requires 25 pounds of chaff. The foreign processed chaff costs $37.50 per pound. U. S. process chaff costs $15.00 per pound. A cost comparison of the chaff as produced by the two sources shows a savings of $13.5M over 5 years for an investment of $0.6M, or a 20-to-1 return on investment. This analysis does not include either the rework of existing inventories or new decoy systems.

INDUSTRY INVOLVEMENT

Lundy Technical Center of Pompano Beach, Florida has demonstrated the feasibility of a new process that fabricates the metalized glass fiber with controlled variations in the fiber diameter.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Other decoy systems, e.g., Chaff Buoy and land-based chaff decoys, are still in the planning stages.

MK-50 COMPOSITE PROPELLER

OBJECTIVE

The objective of the MK-50 Composite Propeller project is to save the Government money by replacing the present machined rotor with an "as-molded" thermoplastic composite rotor. The present rotor for the Torpedo MK-50 propulsion system is made as a machined part because the required profile tolerance could not be obtained from a casting. The resultant cost of manufacture is higher than desirable. Statistical Process Control (SPC) is used on the machining of this part and the quality has been outstanding. Even though the process is under excellent control, there are twenty steps in the operation to fabricate the rotor. The objective of this project is to produce the rotor using an injection mold process where the desired profile tolerance may be achieved from an "as-molded" process without secondary machining.

PROGRESS

The thermoplastic manufacturing process has been evaluated in the light of the development of new materials within the past 5 years. It has been concluded that the thermoplastic materials have the necessary strength characteristics to meet the requirements of the MK-50 rotor. The evaluation phase to establish the thermoplastic manufacturing process is complete. It is now necessary to establish the process and demonstrate that this process will provide rotors that meet specification requirements at a lower cost.

BENEFITS TO BE ACCOMPLISHED

Multiple benefits in cost and performance will be achieved by this project. These include a simplified manufacturing process with good repeatability and surface finish. This will result in lower production costs The conversion from aluminum tc thermoplastic will result in a 25 to 35 percent weight reduction resulting in increased performance. In addition, composites are inherently noncorrosive which should result in lower operating costs.

INDUSTRY INVOLVEMENT

Allied-Signal Aerospace Company from Tempe, AZ, is proposing the technology development for this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

While this effort is specifically focused on the MK-50, the technology developed is applicable to all subsequent underseas propulsion systems.

MK-50 COMPOSITE OXIDANT TANK

OBJECTIVE

The objective of the MK-50 Composite Oxidant Tank project is to save the Government money by replacing the heavy, complex Inconel assembly with a fiber-wound composite tank. The current design requires 13 parts, 35 machining and welding operations, 8 hand-finish operations, 2 heat treatments, and 15 inspections. The three subassemblies require an additional 16 machining, 12 braze and weld, 2 plating, 3 furnace, 10 cleaning/degreasing, 16 hand-finish and abrading, and 18 inspection operations. For the composite tank, fibers will be wound on a thin aluminum shell and the fittings bonded inside using a patented vulcanized rubber process. Total setup and machining will be reduced by more than 50 percent.

PROGRESS

A detailed proposal for the composite oxidant tank has been prepared. Using IR&D funds, Allied-Signal has evaluated the feasibility of filament-winding the MK-50 Oxidant Tank. A preliminary design, an interface evaluation, and stress calculations have been made. The application was determined to be feasible. The details of the manufacturing process remain to be established.

BENEFITS TO BE ACCOMPLISHED

This project will result in an oxidant tank that is lighter in weight, lower in cost, and has improved corrosion resistance. Since the new process allows material to be applied in specific locations and directions to meet more stringent requirements, vessel designs can be optimized for strength, cycle life, static life, and other unique requirements while minimizing weight.

INDUSTRY INVOLVEMENT

Allied-Signal Aerospace Company from Tempe, AZ, is proposing the technology development for this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Fiber-wound composite tanks and pressure vessels are being used for a considerable number of applications such as the Phalanx launch system and the Lamps III sonobuoy launcher. This project will support subsequent SCEPS underseas propulsion systems.

MACHINE VISION IN HYBRID MANUFACTURING/LASER TECHNOLOGY IN HYBRID MANUFACTURING

OBJECTIVE

The objective of this project is to identify candidate projects which either show how machine vision and laser technology can currently be used by the hybrid industry, or lead to the development of new technology required by industry. Candidate projects will be identified as the result of surveying hybrid manufacturers, equipment vendors, academic researchers, and Government procurement agencies.

PROGRESS

Early results from the surveys show that reduced component size and circuit density are driving factors and that proper illumination is one the the technical barriers for machine vision. Early results suggest that cutting, marking, scribing, and trimming functions are the best candidates for ManTech developments in laser applications.

Seven specific follow-on projects have been identified as a result of the surveys. These include:

1. Laser Soldering & Positioning of Surface Mount Component
2. Microcircuit Process Control Using Laser Dimensional Measurement Techniques
3. Fine Line Circuit Patterns Using Laser Assisted Etching/Deposition Techniques
4. Color Vision For Die Topography Identification
5. Automatic Precision Die Attach System
6. Automated Thin Film Resistor Trim Kerf Inspection
7. Lighting and Optics Expert System for Machine Vision.

BENEFITS TO BE ACCOMPLISHED

Benefits to be realized by the projects listed above include:

65% reduction in throughput time per substrate using laser soldering & laser assisted placement for hybrids,

increased quality of wire bonding of all microelectronic assemblies required to meet MIL-STD-883 method 2017,

50% reduction in wire bond inspection time,

66% reduction in thin film resistor inspection time,

lower skill level requirements,

higher yields,

savings well over $10M per year.

INDUSTRY INVOLVEMENT

Treese & Associates conducted machine vision surveys. Simplex Technologies conducted the laser technology analysis.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Candidates identified under this project fall under the broader heading of Sensor Based Manufacturing (SBM). The Office of the Assistant Secretary of the Navy (OASN) has initiated a joint effort with DARPA to establish SBM programs. OASN will concentrate on development and near-term application of technology. DARPA will focus on long-term technology development.

JOINT AIR FORCE/NAVY PRECISION GUIDED MUNITIONS (PGM) IMIP-ADVANCED MEDIUM RANGE AIR-TO-AIR MISSILE (AMRAAM) TRAVELING WAVE TUBE (TWT)

OBJECTIVE

The objective of the Joint Air Force/Navy Precision Guided Missile (PGM) Industrial Modernization Incentive Program (IMIP)—Advanced Medium Range Air-to-Air Missile (AMRAAM) Traveling Wave Tube project is to develop low-cost production techniques to produce the complex structures of the traveling wave tube. The pulsed traveling wave tube utilizes periodic-permanent-magnet focusing and multiple-depressed collectors to achieve a small and lightweight package with high efficiency.

PROGRESS

This is a new initiative. As such, there is no progress to report on this specific project.

BENEFITS TO BE ACCOMPLISHED

The cost of each traveling wave tube will be reduced by approximately $3,000. The Navy requirement is for 1200 AMRAAM traveling wave tubes each year.

INDUSTRY INVOLVEMENT

AMRAAM tubes are being built by three tube companies. Litton Electron Devices has proposed to develop the manufacturing methods program.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

TWTs have application on numerous DoD air vehicles. Air Force and Navy Precision Guided Missiles will benefit directly from this project. Other DoD guided missile programs may also benefit.

HOMOGENEOUS FLUX EPITAXY

OBJECTIVE

There are numerous serious problems associated with the conventional Molecular Beam Epitaxial (MBE) growth that are a direct consequence of the basic design of that system. This project proposes to develop a Homogeneous Flux

Epitaxy (HFE) system as a highly modified MBE system. The HFE system would maintain lateral compositional homogeneity over the total substrate surface. All of the desirable features of MBE, such as controlled doping profiles, and abrupt or diffuse heterojunctions and delta-dopings, are incorporated in HFE.

PROGRESS

This new initiative for Navy ManTech is a follow-on implementation of a DARPA initiative.

BENEFITS TO BE ACCOMPLISHED

Among the many benefits of utilizing the HFE growth system are the ability to grow epitaxial thin films having lateral composition uniformity over the total surface of the substrate. Also, the ability to use much larger substrates and the ability to obtain much higher production rates. These achievements will result in a substantial reduction in production costs.

INDUSTRY INVOLVEMENT

A determination of industrial involvement is underway.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project falls under the much broader heading of Sensor Based Manufacturing. The Office of the Assistant Secretary of the Navy (OASN) has initiated a joint effort with DARPA to establish SBM programs. OASN will concentrate on development and near-term application of technology. DARPA will focus on long-term technology development.

LASER-ENERGIZED ELECTRON MICROSCOPY OF SEMICONDUCTORS

OBJECTIVE

The object of the Laser-Energized Electron Microscopy of Semiconductors project is to provide a new analytical method for defect and process control. A nondestructive, contact-less method for imaging electronically active regions in semiconductor materials will reduce rejects through in-process detection.

PROGRESS

Feasibility testing of the proposed method using nonpenetrating illumination from above the sample has previously been demonstrated at NOSC.

BENEFITS TO BE ACCOMPLISHED

This project will improve manufacturability for a variety of microelectronic components resulting from a new material and process qualification method. This ManTech pro- ject should result in millions of dollars of savings for current materials and devices as well as enable advanced component fabrication from higher-performance, compound materials that are not now economically producible.

Specific application of this technology will improve infrared focal plane manufacturability. Current long wavelength infrared detector focal plane arrays require growing and processing of mercury cadmium telluride (HgCdTe) on cadmium telluride (CdTe) wafers. The cost and availability of such components is limited by extremely low component yields. The new methods proposed by this project for early detection of material and process defects are urgently needed.

INDUSTRY INVOLVEMENT

Laboratory work at NOSC will be performed in collaboration with interested companies. Samples will be obtained from manufacturers of GaAs microelectronic components and from manufacturers of IR focal plane arrays. NOSC will share all internally developed with interested companies and will serve as a basis for the development of contract specifications for the adaptation of the process to production applications.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This is proposed for FY90 to DARPA for Navy ManTech follow-on. Although many problems could be addressed using such a capability, a specific problem of military significant is the qualification of CdTe substrates for IR focal plane production.

APPENDIX C—COMPLETED PROJECTS

NOSC HISTORICAL SUMMARY

Since 1977, NOSC ManTech has completed over 52 Manufacturing Technology projects. While not all projects were as successful as anticipated at their outset, on average, NOSC ManTech has generated an ROI in excess of 4.3 to 1. The following section describes each of the completed projects. The figure below highlights a few of those projects. ManTech projects required the involvement of industry. The companies which have worked with NOSC to improve the Navy's industrial base are shown in the exhibit below.

TITLE	APPLICATION	SPONSOR	EXPENDED ($K)	PRODUCTION BENEFITS PROJECTED ($K)
Ion Implantation System	MINI-HALO, Phoenix	NAVAIR	734	20,000
Fiber Optics for Military Aircraft	Aircraft	NAVAIR	1,622	33,555 **
Automated Test System for Phased Array	Aegis	NAVSEA	677	1,200 per year
Rigid Flex Printed Circuit Manufacturing	Standard Missile	NAVSEA	152	6,500 **
Foam Filled Fiberglass Radome	Phalanx	NAVSEA	116	4,684 by 1985
Low-Cost Torpedo Propeller Manufacturing	Torpedos: MK46 & MK48	NAVSEA	220	20,000
Batch Vapor Phase Soldering of Flexible Printed Circuit Connectors	Standard & Sparrow Missiles	NAVSEA	120	1,904 **
Metal Core Printed Circuit Boards	Standard Missile II	NAVSEA	180	1,139 **
Hermetic Tape Carrier (HTC) for Integrated Circuits	Generic to DoD electronics	NAVSEA	510	2,977 **
Automated Fusion Weld Inspection	Cruise Missile	NAVSEA	573	1,808
Crossed-Field Amplifier Tube	Aegis Radar System	SPAWAR	280	52,235
Robotic Microwave Hybrid Substrate Assembly	Combined Altitude Radar Altimeter	SPAWAR	764	7,700
Other NOSC ManTech Projects			55,053	115,299
TOTAL			61,000	269,000

** Additional savings available by generic application to DoD electronics production

RB/025/06-19-90

INDUSTRY WHICH HAS WORKED WITH NOSC MANTECH TO IMPROVE THE NAVY INDUSTRIAL BASE

Applicon Corp.	Kulicke & Soffa Industries
Boeing Electronics Company	Laser Diode Laboratories
Bunker Ramo Corporation	Litton Systems
Canadian Commercial Corporation	Lockheed Missile and Space Company
Cimflex Teknowledge	MA/COM
Computer Sciences Corporation	Material Research Corporation
Electron Beam Microfabrication Corporation	NASSCO
Freud Precision	National Semiconductor
Garrett Pneumatic	Raytheon
General Dynamics Corporation	RCA
Gould, Incorporated	SAIC
Haveg Industries, Inc.	Sperry Rand Corporation
Hughes	Teledyne Microelectronics
Hughes Aircraft Company	Varian Associates
IBM	Watkins-Johnson Company
International Telephone & Telegraph Corporation	Westinghouse

RB/027/06-19-90

AUTOMATIC DIAGNOSTIC SYSTEM (ADS)

OBJECTIVE

Automatic Diagnostic System (ADS) is intended as a semiautomatic test station to facilitate troubleshooting of hybrid circuits found defective during electrical testing. Data will be analyzed by a trained technician for fault isolation. The purpose of the ADS is to eliminate problems caused during troubleshooting by accurately placing probes and blocking other inadvertent signals without lifting leads. Since electrical testing occurs near the end of the production cycle, so much manufacturing expense has accrued that it is more cost-effective to repair a defective circuit than to scrap it. Currently, circuits which have failed electrical testing are given to technicians who must determine the nature of the failure, isolate the failure to the component level, and replace the component. The technician must activate the circuit and inject test signals. Sometimes the small circuit size and closeness of the components results in inadvertent contact with, and damage to, another part of the circuit. Often, leads must be unsoldered or cut to ensure that only selected portions of the circuit are tested and no misleading information results. The plan is to demonstrate that a multiprobe system can inject signals while grounding leads at other appropriate points to provide accurate test data without circuit damage.

PROGRESS

An ADS one-probe prototype was developed by Hughes Aircraft Corporation, Newport Beach, CA, and was successfully tested in July 1988. Hughes tasked the Micromanipulator Company, in February 1989, to develop a multiprobe unit. That unit was completed in January 1990. Hughes integrated the multiprobe unit with their CAD system and conducted performance demonstrations in April 1990.

The contractor will provide procurement specifications for the multiprobe system together with acceptance requirements and clearly defined generic interface specifications to enable integration with the diagnostic computer, in-circuit tests, CAD, and Shop Floor Control system. Also required are cost analyses, operator skill level requirements, and test or analysis results that validate the procurement package.

BENEFITS TO BE ACCOMPLISHED

The result of this effort will be a low-cost method of rapidly troubleshooting defective circuits, without causing other problems in the process. All test point locations and test parameters are to be downloaded from the CAD database directly to the system to eliminate errors associated with manual data entry. The system will automatically position probes, inject test signals, and collect response signals in order to eliminate accuracy problems and ensure test repeatability.

Instead of cutting leads, leads are blocked through the use of grounding probes, thereby promoting circuit integrity.

INDUSTRY INVOLVEMENT

ADS addresses the issue of non-destructive testing which is of concern throughout the electronics industry. In addition to the present effort, the Cimflex Teknowledge Company is negotiating with Hughes to incorporate an expert diagnostic program into ADS. The expert system would be based on the Electra system that Teknowledge designed for printed circuit board analysis. Electra starts testing at a high design level by checking input and output. After analysis of the collected data, Electra directs the tests to specific modules or circuit components to isolate faults.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The ADS program is derived from the requirements of the Integrated Hybrid Manufacturing Center program, which is part of the AMRAAM TECH MOD contract awarded by the Air Force to Hughes Aircraft Company, with supplemental funding by the Navy ManTech office.

LOW-COST ION IMPLANTATION SYSTEM

OBJECTIVE

Developed from 1977 to 1982, the Low-Cost Ion Implantation System objective was to develop a simple table-top, compact, dedicated ion implanter which would actively participate in the manufacture of high performance semiconductor devices and LSI circuits.

BENEFITS ACCOMPLISHED

At the start of the program, no commercial ion implantation machines existed that could produce high-beam currents from a simple, compact, moderate-cost machine. The high-current machines available were automated descendants of large, high-energy particle accelerators and occupied as much as 100 square feet of laboratory space. Cost savings over seven years were forecasted at \$20.0M due to (a) a projected \$60K/unit cost versus \$150K/unit for the large high-energy, single-purpose systems and (b) a 10:1 savings expected from space and overhead costs.

INDUSTRY INVOLVEMENT

Hughes Aircraft Industrial Electronics Group measured the technological and economic advantages of using ion-implantation in a dedicated machine mode.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The Low-Cost Ion Implant System was originally intended for implementation in the F-18, VAMX, LDI Radar, Phoenix Missile, and others. The F-18 device requirements were canceled but this ManTech technology was implemented in the DARPA MINI-HALO System. The DARPA MINI-HALO System was a multimillion dollar program which could not have successfully achieved performance goals without the Low-Cost Ion Implant technology.

ELECTRON BEAM IMAGING SYSTEM

OBJECTIVE

Developed between 1978 and 1983, the objective of this project was to develop a production model Electron Beam Projection System (EBPS). This unit was to provide low-cost, high-yield, and reliable capability for producing specified submicron dimensions for electronic devices.

BENEFITS TO BE ACCOMPLISHED

Unfortunately, while the machine concept was good, alignments on the order of 0.2 to 0.3 microns were achieved versus 0.1 microns required for the project to be successful. With feasibility not being demonstrated, the decision was made to discontinue the project.

INDUSTRY INVOLVEMENT

Electron Beam Microfabrication Corporation was the prime contractor on this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The Electron Beam Imaging System was intended to have supported numerous Navy electronic production activities.

FIBER OPTIC FOR MILITARY AIRCRAFT

OBJECTIVES

Between in 1978 and 1982, several ManTech projects were undertaken to create the production base to allow production of military aircraft using fiber optics. These projects included:

- F/O Bundle Cabling—to establish cost-effective manufacturing processes for the mass production of fiber optic cabling
- F/O Multipin Connectors—to develop cost-effective manufacturing processes for the production of Hybrid Multipin fiber optic bundle connectors
- F/O Terminal Polisher—to provide cost-effective manufacturing processes for the mass production of portable, air-driven, variable speed fiber optic terminal polishers for aircraft cabling.

- F/O Bundle Couplers—to establish cost-effective manufacturing processes for the mass production of fiber optic bundle couplers
- F/O Transmitter Module—to establish production manufacturing processes for a fiber optic transmitter module
- Radiation Resistant Optical Fibers—to establish manufacturing processes for a mass production of radiation-hard optical fibers
- F/O Digital Receiver—to develop cost-effective manufacturing process for mass production of fiber optical digital receiver modules

The application of fiber optics to airborne systems has a very high payoff potential. Due to its wideband, high data rate capability, fiber optics will play an important role in interconnecting systems which use advanced forms of integrated circuits such as VHSIC and VLSI. fiber optic applications are promoted because increasing use of composite materials in advanced high-performance aircraft demands superior interference resistance without the weight penalty of metal shielding. fiber optics have an inherent weight advantage over traditional metal systems.

BENEFITS TO BE ACCOMPLISHED

Without these ManTech projects, it was questionable whether designers of military systems would use fiber optics for production aircraft given the lack of a manufacturing base. Implementation of fiber optic technology has not yet taken place aboard production aircraft. Therefore, no cost savings have been realized. In an August 1980 cost analysis performed by NOSC, a cost savings of $14.8M was indicated from the implementation of these processes in the E-3A aircraft production alone.

While a multipin connector was developed, it was not used in military systems. However, a single fiber version of this connector is available for potential use in Navy systems. Although cost savings are difficult to determine, this connector was one of the very few multipin connectors available for military applications in 1985.

Cost savings projections remain valid pending the Navy's commitment to fiber optic technology aboard production aircraft. Based on a February 1978 cost savings analysis that assumed use of automated techniques for polishing fiber optic cable in the field for 100 aircraft per year, gross annual cost savings of $50,000 are anticipated.

Equipment to produce high-volume production of bundle couplers suitable for use in aircraft was developed, tested, and delivered to NOSC.

The Ground Launched Cruise Missile (GLCM) became one of the first internationally deployed weapon systems to be interconnected by fiber optics. The estimated cost savings accruing from the GLCM commitment for 2100 fiber optic transmitter modules was $280,000. For Radiation Hard Optical Fibers, the ManTech project reduced the life cycle costs from an estimated $50 per meter to an estimated $10 per meter.

In all cases, significant aircraft weight savings are expected from the replacement of systems utilizing copper wire, and discrete circuits and hand assembly with fiber optic systems utilizing monolithic and hybrid integrated circuit technology.

INDUSTRY INVOLVEMENT

Boeing Electronics Company developed the manufacturing technology for the fiber optic bundle cable. Bunker Ramo Corporation in Danbury, CT, provided the technology development for the multipin connector. International Telephone & Telegraph Corporation provided the contractor support for the Terminal Polisher and the Radiation Resistant Optical Fibers activities. McDonnell-Douglas indicated interest in utilizing the terminal polisher on the Advanced Harrier AV-8b. Sperry Rand Corporation produced the fiber optic transmitter modules. Canadian Commercial Corporation performed the fiber optical Digital Receiver Module project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

These projects supported the development of fiber optic technology for military aircraft. In addition, fiber optic technology is being implemented in Navy ships and systems such as AEGIS. A number of other military applications have been identified for use of these technologies including:

- Canadian shipboard multiplex system
- MIL-STD 1553 optical interface on airborne computer AN/AYK-15a
- MIL-STD 1553 optical interface on Standard Navy Airborne Computer AN/AYK-14
- Optical link interfaces for the next generation of advanced shipboard computers (AN/UYK-43 and AN/UYK-44)
- Distribution of data in the Integrated Inertial Sensor Assembly (IISA) to be used on all military aircraft
- TACAN antenna system

Cost savings have not been documented for the above applications due to the complexity of auditing planned applications and their quantifiable cost benefits.

HYBRID AUTOMATED LEAD TESTER

OBJECTIVE

Developed between 1978 and 1982, the objective of the Hybrid Automated Lead Tester (HALT) was to reduce the assembly and rework cost and improve the reliability of manufacturing hybrid and integrated circuits by establishing the production processes necessary for implementing and automating recently developed Nondestructive Pull Testing (NDPT) techniques.

BENEFITS TO BE ACCOMPLISHED

The project established a generic, automated wire bond pull tester which is now commercially available. It has the capability to automatically test all types of microcircuit wire bonds either non-destructively or destructively.

INDUSTRY INVOLVEMENT

Kulicke & Soffa Industries provided the equipment for manufacturing. The HALT system has been used on all military and commercial microcircuits requiring 100% pull test at the following facilities:

Hughes, Tucson, AZ
Martin Marietta, Orlando, FL
General Electric, Valley Forge, PA
RCA, Moorestown, NJ
Lockheed Electronics, Sunnyvale, CA

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supported production of the AMRAAM, LANTIRN, AEGIS ship-board defense system electronics and numerous other DoD electronic systems.

HIGH RADIANCE DIODES

OBJECTIVE

Developed between 1977 and 1981, the High Radiance Diodes project was to establish cost-effective manufacturing processes for the mass production of Gallium Aluminum Arsenide (GaAlAs) high radiance emitting diodes (LEDs). These devices support the use of fiber optic systems in military aircraft.

BENEFITS TO BE ACCOMPLISHED

Unique tooling was fabricated and production techniques were established to automate production, maintain critical tolerances, increase quality, and reduce costs. Cost savings on the GLCM program alone were estimated at $400k. The LED is now commercially marketed and it is used in the fiber optic transmitter module developed under fiber optic Transmitter Modules ManTech project.

INDUSTRY INVOLVEMENT

Laser Diode Laboratories provided the industry support to this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

High Radiance Diodes support numerous military fiber optic systems.

VERY HIGH SPEED INTEGRATED CIRCUIT TAPE INTERCONNECT

OBJECTIVE

Developed between 1985 and 1987, the Very High Speed Integrated Circuit (VHSIC) Tape Interconnect project was to establish materials and processes for high lead count decal interconnects of chip packages.

BENEFITS TO BE ACCOMPLISHED

No immediate or direct benefits were derived from this project since, for other reasons, IBM has designed tape (decal) out of their VHSIC devices. The materials work performed on this project was used on semiconductor devices and the measurements developed will be used in other applications.

INDUSTRY INVOLVEMENT

IBM performed the materials and measurements work completed on this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supported specific requirements of the VHSIC program.

AUTOMATED TEST SYSTEM FOR PHASED ARRAY

OBJECTIVE

Developed in 1977, the Automated Test System for Phased Array Antenna was to improve production of the AEGIS Near Field Antenna Test Systems.

BENEFITS TO BE ACCOMPLISHED

The net savings per ship has been estimated at $400K. With 3 ships per year, savings could be $1.2M per year for the life of the AEGIS system.

INDUSTRY INVOLVEMENT

RCA was the prime contractor who developed the automated test system.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supports the Navy's AEGIS system.

COMPOSITE MATERIAL SUBMARINE MAST

OBJECTIVE

Developed between 1977 and 1981, the object of the Composite Material Submarine Mast project was to replace manually-machined, complex, ellipsoid-shaped titanium billets with a low-cost, machine-wound, graphite-epoxy material system.

BENEFITS TO BE ACCOMPLISHED

The project was of limited success in that lower cost materials and processes were developed. However, the applicable program, "Dark Eyes" stopped short of planned procurement as it underwent lengthy design and management changes. The Navy has not yet chosen to adopt the low-cost ManTech mast.

INDUSTRY INVOLVEMENT

Lockheed Missile and Space Company provided the technical success realized by this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project was developed in direct relation to the Navy's "Dark Eyes" program.

RIGID FLEX PRINTED CIRCUIT MANUFACTURING

OBJECTIVE

Performed between 1977 and 1979, the Rigid Flex Printed Circuit Manufacturing project recommended specifications for rigid flex assembly and processing.

BENEFITS TO BE ACCOMPLISHED

Since this project was the only known manufacturing project on rigid flex, it is postulated that the results of this project served as the foundation for the current military specification on rigid flex assemblies. Cost savings resulting from this project are estimated to exceed $6.5M.

INDUSTRY INVOLVEMENT

General Dynamics Corporation performed the ManTech development work.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project specifically supported the Standard Missile, SM-1, and SM-2. In addition, the specifications are generic to all defense electronics requiring MIL-STD-2118.

FOAM FILLED RADOME

OBJECTIVE

Developed in 1977 and 1978, the Foam Filled Radome project provided the manufacturing technologies to produce the radomes for the Phalanx systems.

BENEFITS TO BE ACCOMPLISHED

The technology developed under this project resulted in a savings of $4750 per radome. The Phalanx has a Track Radome and a Search Radome. Although the quantity of Phalanx systems is classified, savings realized prior to 1985 were in excess of $4.6M.

INDUSTRY INVOLVEMENT

General Dynamics developed and implemented the technology developed under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project directly supported the Phalanx ship defense system.

MICROCIRCUIT BUMPED TAPE AUTOMATED BONDING (BTAB)

OBJECTIVE

Developed between 1977 and 1981, Bumped Tape Automated Bonding was to maintain the advantages of conventional Tape Automated Bonding, offer some features of its own, and be compatible with conventional aluminum-metalized integrated circuit chips.

BENEFITS TO BE ACCOMPLISHED

BTAB technology served as the basis for tape interconnection on the VHSIC Program. Actual cost savings have not been developed due to the complexity of auditing planned applications.

INDUSTRY INVOLVEMENT

General Dynamics committed to implement this technology on the USN Standard Missile line and the Army Post-Stinger Missile line. Westinghouse Defense Group implemented this technology at their facility in Baltimore.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This technology supports Defense missile programs and VHSIC electronic programs.

COMPUTER-CONTROLLED SHIP FRAME BENDER

OBJECTIVE

Developed between 1977 and 1982, the Computer Controlled Ship Frame Bender replaced the current manual method of preparing I-beams for construction of ships with a full-scale production system.

BENEFITS TO BE ACCOMPLISHED

Benefits originally expected have not been realized since the prime contractor did not implement the system. The Frame Bender was expected to reduce the cost of beam shaping for ship beams and piping, ship hull ribs, and aircraft spars.

INDUSTRY INVOLVEMENT

NASSCO developed the full-scale computer-controlled frame bender. However, after failing to perform adequately on the production-ready requirements of the contract and the cancellation of Navy ship construction contracts at NASSCO, implementation of the system was not undertaken.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The Frame Bender could be used to support future ship or aircraft building.

AUTOMATIC LAYOUT OF INTEGRATED CIRCUITS

OBJECTIVE

Developed between 1977 and 1981, the technical objective of this project was to provide interactive CAD graphics for layout of Large Scale Integrated (LSI) Systems in order to effect a reduction of total costs of LSI systems, to improve the performance of LSI electronics, and upgrade the reliability of LSI chips.

BENEFITS TO BE ACCOMPLISHED

Planned cost savings were calculated and successfully demonstrated to be equal to a 43% reduction in engineering design time per circuit. The annual DoD design budget is approximately $100M/year.

INDUSTRY INVOLVEMENT

Applicon Corp., CSC, and the University of Minnesota provided support to the development of the Automatic Layout of Integrated Circuits project. Applicon Corp. adopted the techniques into its software package which was sold commercially throughout the U.S.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The project offers support to all DoD electronic systems activities. The NOSC Microelectronics Lab used the design software for prototype-custom military IC design development.

LOW COST TORPEDO PROPELLERS

OBJECTIVE

Developed between 1977 and 1981 and fully implemented in 1983, the objective of the Low Cost Torpedo Propeller project was to reduce production costs by a factor of four by use of new materials.

BENEFITS TO BE ACCOMPLISHED

Plastic propellers costing $449 per set replaced aluminum propellers at $2214 per set. Savings of over $20.7M are projected from the use of this technology.

INDUSTRY INVOLVEMENT

Haveg Industries, Inc., and Freud Precision performed the work under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Other Navy systems requiring propellers, such as MK48 and the Advanced Heavyweight Torpedo, may have benefited from this program.

LOW COST COMPOSITE MISSILE FINS

OBJECTIVE

Developed between 1977 and 1982, the Low Cost Composite Missile Fins project was to develop and implement low cost production techniques for fabricating missile wings from composite materials as a replacement for magnesium.

BENEFITS TO BE ACCOMPLISHED

Estimated cost savings from a production of 1200 missiles per year over a five year period is $13M. Estimate of the composite dorsal fin production cost indicates this fin will cost approximately $350 more than the original coated aluminum fin. However, weight savings of 14 pounds per missile has resulted in performance improvement and cost-avoidance savings which the Standard II Program Office judges more than offsets the cost differential.

INDUSTRY INVOLVEMENT

General Dynamics provided the development work under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

While specifically developed for the Standard II Missiles, the technology developed under this program is generic to all missiles in DoD.

ADVANCED LIGHT WEIGHT TORPEDO (ALWT) BOILER COMPUTED TOMOGRAPHY EVALUATION

OBJECTIVE

Developed between 1984 and 1985, the ALWT Boiler Computed Tomography Evaluation project was to develop an inspection and evaluation of tow boilers produced for MK-50 Advanced Light Weight Torpedo. Computed Tomography, an advanced X-ray inspection technique, was used. Results included determination of cracks, voids, and contaminants present in the the lithium boiler fill.

BENEFITS TO BE ACCOMPLISHED

Computer-aided tomography was demonstrated to be an effective tool in determining the quality of the fill process. Definite problems with the existing fill process were identified. Garrett Corporation is now motivated to utilize tomography for troubleshooting when anomalies are suspected in specific boilers during fill.

INDUSTRY INVOLVEMENT

Garrett Pneumatic provided the work under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project was specific to the MK-50 program.

PLASTIC MOLDED MICROWAVE COMPONENTS

OBJECTIVE

Developed between 1978 and 1980, the Plastic Molded Microwave Components project was to replace existing metal-designed components on the Phalanx weapon system with plastic molded components.

BENEFITS TO BE ACCOMPLISHED

Considerable savings were anticipated from producing the plastic components. Inspired in part by the competition of the plastic parts, a considerable reduction in the cost-to-produce metal components was undertaken. The cost reduction was successful enough that the expenditure of funds for high-rate production tooling was no longer justified.

INDUSTRY INVOLVEMENT

General Dynamics developed both the plastic molded approach and the cost reduction in producing metal components.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supported the Phalanx weapon system.

BATCH VAPOR PHASE SOLDERING OF FLEXIBLE PRINTED CIRCUIT CONNECTORS

OBJECTIVE

Developed between 1979 and 1981, the Batch Vapor Phase Soldering (VPS) of Flexible Printed Circuit Connectors was to develop new soldering processes and techniques. These techniques were to reduce the cost of interconnecting connectors to flexible printed circuit board assemblies via vapor soldering techniques.

BENEFITS TO BE ACCOMPLISHED

The batch vapor phase soldering ManTech project was a major driving force in establishing techniques for applying VPS to military systems. The lessons learned from this project pioneered the way for cost-effective and reliable methods of assembling surface mounted devices. Beyond providing new capabilities, cost savings from the use of this specific technology were estimated in excess of $5M in the production of circuit cards for missiles.

INDUSTRY INVOLVEMENT

General Dynamics developed the batch vapor soldering manufacturing technology.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This technology supported the Standard Missile, the Sparrow Missile, and numerous other DoD electronics applications.

NEAR NET ISOTHERMAL FORGING

OBJECTIVE

Developed in 1979, the Near Net Isothermal Forge/Spin Transage TI Alloy project was to implement a low cost, single piece, forced gas generator case production technology.

BENEFITS TO BE ACCOMPLISHED

Cost trade analysis indicated that the Transage 175 gas generator case would save the D-5 program approximately $25M over the lifetime of the program. However, D-5 production was in the final phases of development. A concurrent production development program for the Transage 175 case was estimated at $4.8M. Since this amount was unbudgeted, the D-5 Program Office would not commit the funds and the Transage 175 gas generator was not implemented on the D-5 missile program.

INDUSTRY INVOLVEMENT

Lockheed Missiles provided the technical development for this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supported the Trident, D-4, and D-5 Missile development. The technology is generic to many DoD systems.

METAL CORE PRINTED CIRCUIT BOARDS

OBJECTIVE

Developed in 1980 and 1981, the Metal Core Printed Circuit Boards project was to replace epoxy powder materials with metal in the core of electronic printed circuit boards.

BENEFITS TO BE ACCOMPLISHED

Labor and material estimates plus facility charges to accommodate configuration were considered in the cost comparison. The average cost savings for 1100 units over three years was projected at $118 per board. Ten year savings were estimated at over $1.1M.

INDUSTRY INVOLVEMENT

General Dynamics was the prime contractor on this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supports the Standard II Missiles specifically and is generic to all defense electronics requiring high power thermal management.

HERMETIC TAPE CARRIER (HTC) FOR INTEGRATED CIRCUITS

OBJECTIVE

Developed between 1980 and 1983, the Hermetic Tape Carrier (HTC) for Integrated Circuits project was to reduce both integrated circuit assembly costs and physical size of hermetically sealed devices via tape automated bonding techniques.

BENEFITS TO BE ACCOMPLISHED

Automated packaging using the HTC concept was forecasted to provide a 20% cost savings over side-brazed hermetic DIPs with 100 mil lead centers and a 30% cost savings over multileaded chip carriers with 50 mil lead centers. For National Semiconductor Military devices only, this represents a projected savings of nearly $3M.

INDUSTRY INVOLVEMENT

National Semiconductor provided support to this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project has generic application to DoD electronics, VHSIC, and complex high-lead count integrated circuits.

AUTOMATED FUSION WELD INSPECTION SYSTEM

OBJECTIVE

Developed between 1981 and 1983, the Automated Fusion Weld Inspection project was to develop the technology, including software and robots, to automate the inspection process for fusion welds for the Cruise Missile fuselage sections.

BENEFITS TO BE ACCOMPLISHED

Cost savings on the Cruise Missile fuselage alone was estimated at $1.8M. Other applications of this technology are expected to result in additional savings. The process was immediately extended to eleven other Cruise Missile related parts.

INDUSTRY INVOLVEMENT

General Dynamics provided the technical support to this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project directly supported the Cruise Missile program. However, the technology has generic application to weld inspections.

CROSSED-FIELD AMPLIFIER TUBE

OBJECTIVE

Developed between 1977 and 1979, the Crossed-Field Amplifier Tube project set out to make significant reductions in the cost of manufacturing the high-power, crossed-field amplifier used in the Aegis radar system.

BENEFITS TO BE ACCOMPLISHED

The original design required extensive use of highly skilled fabrication and assembly labor. As a result, these crossed-field amplifiers cost in excess of $21,000 each. During this project, nine brazing and twelve machining operations were eliminated, and the number of piece parts was reduced by 95. In addition, these and other techniques permitted utilization of lower skilled labor in the tube assembly operations. Total costs savings have been estimated at over $52M.

INDUSTRY INVOLVEMENT

Varian Associates developed and implemented the manufacturing technology under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The project specifically supports the Aegis radar system. However, the technology has application in other DoD radar systems.

CAD/CAM OF MICROWAVE INTEGRATED CIRCUITS

OBJECTIVE

Developed between 1978 and 1980, the CAD/CAM of Microwave Integrated Circuits project was undertaken for the purpose of establishing low-cost production techniques for microwave integrated circuits. It was specifically applied to lower the production costs of an X-band GaAs FET multistage low noise amplifier.

BENEFITS TO BE ACCOMPLISHED

The final report by the Watkins-Johnson Company describing the new manufacturing techniques praised the effort and stated that up to half of the labor cost for amplifier assembly could be saved by implementation. However, it was also stated that unless an order of about $2M was received, the implementation would not take place. The current management of the amplifier production facility does not believe that implementation would give a cost savings at smaller quantities. Peripheral benefits were realized. The CAD system was made more accurate and faster. An automated bonding machine was also implemented and some semiautomated testing processes were sped up.

INDUSTRY INVOLVEMENT

Watkins-Johnson Company developed the technology under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

While this project focused specifically on the X-band GaAs FET multistage low noise amplifier, the techniques are applicable to a very broad range of circuits and generic production techniques.

POSITIVE ANODE MAGNETRON

OBJECTIVE

Initiated in 1977, the goal of the Positive Anode Magnetron project was to establish low-cost techniques for fabricating magnetrons for the Phoenix missile system.

BENEFITS TO BE ACCOMPLISHED

The program was jeopardized by Iranian compromise. As such, the tubes were removed from the missile and the MT program was not completed as planned. However, some indirect savings are expected to result from the generic technology developed. For example, MA/COM has provided ten of the small, lightweight, low-cost magnetrons to Motorola for use in a developmental missile system. If these tubes are accepted for system use, large numbers will be purchased and considerable cost savings will result.

INDUSTRY INVOLVEMENT

MA/COM provided the limited technology development under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Originally planned to support the Phoenix missile system, the technology developed may be used on a number of future missile systems.

HARPOON MAGNETRON

OBJECTIVE

Developed between 1978 and 1980, the goal of the Harpoon Magnetron project was to develop major cost reduction improvements.

BENEFITS TO BE ACCOMPLISHED

Three cost reduction improvements were developed under this ManTech program. These included a demountable tuner mechanism, improvements in labor utilization, and the use of semiautomatic processing equipment. Cost savings in excess of $345k have been realized.

INDUSTRY INVOLVEMENT

Raytheon Microwave/Power Tube Division developed and implemented the technology created under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The techniques developed under this ManTech project were specifically focused on the Harpoon missile program.

HIGH AVERAGE POWER CROSSED-FIELD AMPLIFIERS

OBJECTIVE

Developed between 1980 and 1985, the goal of the High Average Power Crossed-Field Amplifiers (CFA) project was to reduce the manufacturing cost of directly cooled, high average power cold cathode crossed field amplifiers by applying advanced manufacturing technology to this newly developed class of CFA.

BENEFITS TO BE ACCOMPLISHED

The noise immunity technology implemented in the processing unit has been applied to other test systems at Raytheon. It has helped to reduce emissions from a 160-kW Traveling Wave Tube (TWT) and has been used to improve signal-to-noise ratios for other lower power automatic test sets.

INDUSTRY INVOLVEMENT

Raytheon performed the technology development work under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The techniques developed here are being used for AN/SPS-48 type radars.

TRAVELING WAVE TUBES (TWT) BARREL SIZING

OBJECTIVE

Developed between 1980 and 1982, the goal of the TWT Barrel Sizing project was to establish new and improved fabrication, stacking, and assembly techniques to fabricate low-cost body/circuit assemblies.

BENEFITS TO BE ACCOMPLISHED

All high-power ECM traveling wave tubes use an integral magnetic pole piece design which requires very accurate machining, assembly, and final dimensioning of the inner diameter of the body. Gun drilling, waferless body brazing, and cold stuffing were utilized to achieve cost reductions under this project. Projected savings over the first five years after project completion were $1.4M.

INDUSTRY INVOLVEMENT

Development and implementation of the technology under this project was performed by Varian Associates.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supports the development of affordable TWTs for DoD.

HIGH POWER KLYSTRON

OBJECTIVE

Developed between 1979 and 1982, the goal of the High Power Klystron project was an effort to significantly reduce the overall klystron cost.

BENEFITS TO BE ACCOMPLISHED

Costs reductions were accomplished by minimizing the number of machining and brazing operations, reducing the piece part population, and decreasing the skill levels required for manufacture and processing. As such, cost savings in excess of $6.68M were expected as a result of this project.

INDUSTRY INVOLVEMENT

Varian Associates develop and implemented the technology created under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The high power klystrons improved under this project were used on the Phalanx program.

MILLIMETER-WAVE COUPLED CAVITY TRAVELING WAVE TUBE

OBJECTIVE

Developed between 1980 and 1982, the objective of the Low Cost Processing of mm-Wave Coupled Cavity TWT Parts was to establish the capability to produce low-cost parts for the Navy EHF Satellite Program (NESP).

BENEFITS TO BE ACCOMPLISHED

Precision computer and laser-controlled diamond turning machines and methods were adapted for use in producing small circuit parts to the tight dimensional tolerances required. Cost savings are expected to be in excess of $1.602M.

INDUSTRY INVOLVEMENT

Hughes Aircraft Company, Electron Dynamics Division, was the contractor for this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supports the production of the NESP.

WAVEGUIDE DIP SOLDERING

OBJECTIVE

Developed between 1981 and 1983, the Waveguide Dip Soldering project was to develop methods for hot oil dip soldering of aluminum and plated plastic microwave and electronic assemblies.

BENEFITS TO BE ACCOMPLISHED

Savings of over $900k were expected from the use of metalized plastic shielding enclosures where die cast aluminum housings were previously utilized. Additional savings is expected from other programs. In addition, a 50% weight reduction can be achieved.

INDUSTRY INVOLVEMENT

Hughes Aircraft Company, Ground Systems Group, was the contractor on this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

While specifically focusing on production of affordable microwave systems, this project also supports a wide array of other applications.

X-BAND HI-GAIN CROSSED-FIELD AMPLIFIERS

OBJECTIVE

Developed between 1982 and 1987, the objective of the X-Band Hi-Gain Crossed-Field Amplifiers (CFA) project was to reduce the acquisition cost of lightweight, high-gain, X-Band, cathode-driven, CFAs by applying low cost manufacturing techniques and processes for production fabrication, assembly, and test.

BENEFITS TO BE ACCOMPLISHED

Estimated savings per tube were $23,451. Five year savings were forecasted at nearly $3M.

INDUSTRY INVOLVEMENT

Raytheon Microwave/Power Tube Division provided the technical support to this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project supports generic development of affordable CFA's for DoD.

AN/SPS-40 MODULES

OBJECTIVE

Developed between 1981 and 1983, the objective of this project was to reduce the cost to produce the AN/SPS-40 radar system. The AN/SPS-40 radar system had been modified under an earlier Research & Development (R&D) program to increase its reliability and maintainability. This was accomplished by replacing UHF tetrode vacuum tubes with solid state modules.

BENEFITS TO BE ACCOMPLISHED

Solid state module costs were $6,880 prior to this ManTech program. Costs were reduced to $4,139 per module. Three years savings were forecasted to be greater than $12M.

INDUSTRY INVOLVEMENT

Westinghouse developed and implemented the technology created under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Although this project focused on the AN/SPS-40, the improved production methods for fabrication, testing, and inspection are generic to solid state module production.

FLUID POLARIZING PRISM FOR LARGE SCREEN DISPLAYS

OBJECTIVE

Developed between 1983 and 1985, the Fluid Polarizing Prism project was to cost-effectively implement production facilities which satisfy the Navy's requirement for high-quality polarizing prisms for command/control large screen displays.

BENEFITS TO BE ACCOMPLISHED

Cost savings in excess of $985k over a five year period was forecasted.

INDUSTRY INVOLVEMENT

Hughes Aircraft Company developed the technology for this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Large screen displays are used in a number of military control centers and briefing rooms. The technology developed here was applied to the Navy's military PT 525 large screen display.

EXTRA-HIGH FREQUENCY (EHF) TRAVELING WAVE TUBE (TWT) FOR SATELLITE COMMUNICATIONS

OBJECTIVE

Initiated in 1985, the EHF TWT for Satellite Communications project was to reduce the cost of medium power Q-band traveling wave tubes to be used in the Navy EHF Satellite Program (NESP) through improved manufacturing processes and techniques.

BENEFITS TO BE ACCOMPLISHED

Disappointingly, tube #9 failed in testing and none of the Raytheon tubes met the contract specifications. With all funds expended, no economic benefits are anticipated from this project.

INDUSTRY INVOLVEMENT

Raytheon provided the technology development under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project was to support the Navy's EHF Satellite Program (NESP).

AUTOMATIC SELF-PROTECTING JAMMER (ASPJ) TRAVELING WAVE TUBES (TWT)

OBJECTIVE

Developed between 1984 and 1986, the goal of the Automatic Self-Protecting Jammer (ASPJ) Traveling Wave Tubes project was to develop techniques to achieve a significant cost reduction for high-power ECM traveling wave tubes.

BENEFITS TO BE ACCOMPLISHED

Complete cost reduction benefits from this project are still under evaluation.

INDUSTRY INVOLVEMENT

Teledyne Microelectronics, Raytheon, Varian Associates, and Litton Systems were involved in developing the technology for this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

ManTech concepts have been adapted to tubes for these systems: ALQ-135 (band 1-1/2), ALQ-16 (band 8), and SSQ-95(AEB). Some technologies are planned for use in the ALQ-172, ALQ-189, and the ALQ-135.

ROBOTIC MICROWAVE HYBRID SUBSTRATE ASSEMBLY

OBJECTIVE

Developed between 1984 and 1986, the goal of the Robotic Microwave Hybrid Substrate Assembly project was to reduce costs by eliminating the high labor content, quality degradation, and low production by utilizing a robotic system capable of soldering the microwave hybrid substrate to the metal carrier ground plane.

BENEFITS TO BE ACCOMPLISHED

The average cost of a Combined Altitude Radar Altimeter (CARA) was reduced by $21.80 for a projected savings of $7.77M. In addition, this project stimulated interest in upgrading through Computer Integrated Manufacturing. The project also provides a model for others to follow who have not had hands-on robotic experience. The final report is, in effect, an introductory manual to robotics manufacturing applications.

INDUSTRY INVOLVEMENT

Gould, Incorporated provided and implemented the technology developed under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The technology developed on the ManTech project is being applied to the CARA at Gould, NavCom. This technology is applicable to any application requiring attachment of a ceramic substrate to an assembly.

SILICON LIQUID CRYSTAL LIGHT VALVE

OBJECTIVE

Developed in 1984 and 1985, the goal of the Silicon Liquid Crystal Light Valve (SiLCLV) project was to cost-effectively develop and implement a "Silicon Photosensor Liquid Crystal Light Valve" production facility for manufacture of modules capable of retro-fitting combat direction systems and providing multicolor and video-rate displays for command control, training simulation, and radar signal processing applications.

BENEFITS TO BE ACCOMPLISHED

Work was initiated. However, when the contract determined that they could not use IR&D dollars to cost share the program as originally planned, work was stopped and no benefit was realized.

INDUSTRY INVOLVEMENT

Hughes Aircraft Company has anticipated performing the work under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This activity would have supported Navy command and control systems, training simulation systems, and radar signal processing applications.

VERY HIGH SPEED INTEGRATED CIRCUIT DRY PLASMA ETCHING

OBJECTIVE

Developed between 1984 and 1988, the goal of the Very High Speed Integrated Circuit (VHSIC) Dry Plasma Etching project was to develop dry (plasma) etching machines and processes for multilevel metalization systems to reduce the manufacturing costs and increase the reliability of VHSIC components.

BENEFITS TO BE ACCOMPLISHED

A single machine polysilicon etch process was developed. Radiation test results show improvement in radiation hardness for the enhanced process. Yield improvements ranging between a factor of two and ten, depending on test criteria, have been demonstrated. These effects result in a savings forecast of over $21M.

INDUSTRY INVOLVEMENT

Material Research Corporation and Westinghouse Advanced Technology developed and implemented the technology created under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The technology developed here is implemented in the production of VHSIC SRAM. It will also be used to enhance other DoD electronic chip production.

VERY HIGH SPEED INTEGRATED CIRCUIT THIRD LEVEL INTERCONNECT

OBJECTIVE

Developed between 1984 and 1988, the goal of the Very High Speed Integrated Circuit (VHSIC) Third Level Interconnects project was to develop cost-effective methods of accommodating the large number of inputs and outputs between printed wiring boards and the unit interconnect system.

BENEFITS TO BE ACCOMPLISHED

Several of the objectives of this project were satisfied. A surface mount backplane connector was developed which is capable of accommodating fiber optic or radio frequency contacts. Thermal management techniques were developed and employed to reduce the junction temperature and, therefore, the failure rate of the VHSIC systems. However, two problems remained. The first is the fiber optic terminals which have shown borderline insertion loss results. The second is failure of the printed wiring boards in temperature cycling. While the technologies developed will accommodate the greater signal density of VHSIC devices, reduce the cost of building backplanes, and thermal improvements should make VHSIC devices much easier to use, a forecast of the total economic benefit is not currently available.

INDUSTRY INVOLVEMENT

Sperry Rand Corporation has developed the technology under this project.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The project supports the development and use of VHSIC systems.

VERY HIGH SPEED INTEGRATED CIRCUIT MULTI-LAYER RESIST LITHOGRAPHY

OBJECTIVE

Developed between 1984 and 1987, the goal of the Very High Speed Integrated Circuit (VHSIC) Multilayer Resist Lithography project was to improve the quality of resist technology and related equipment used in the production of VHSIC class integrated circuits to maintain the n critical dimensions, reduce line width variations, and reduce defects.

BENEFITS TO BE ACCOMPLISHED

Cost analysis showed the savings from reduced costs of chip production would provide an annual return on investment of 646%.

INDUSTRY INVOLVEMENT

Westinghouse Electric Corporation developed and implemented the technology created under this project. In addition, Bell Labs, Texas Instruments, International Business Machines, Ford Aerospace, and others attended the final project demonstration.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

VHSIC supports a number of DoD electronic systems. Cost reduction because of this project will eventually lead to faster incorporation of VHSIC technologies into military systems.

APPENDIX D—PROGRAM PLANNING

OFFICE OF THE ASSISTANT SECRETARY OF THE NAVY (OASN) STRATEGIC MANUFACTURING TECHNOLOGY (MANTECH) PLAN

OBJECTIVE

The objective of the Office of the Assistant Secretary of the Navy (OASN) Strategic ManTech Plan project is to develop short-term (1--3 years) and long-term (3-5 years) technology thrust roadmaps for Navy ManTech.

End products of this activity will include the identification of Technology Programs, definition of Centers of Excellence, Executive Summary Matrixes, On-line Management Information System, discrete Project RD-6s, and IMIP candidate programs. Support under the plan would include joint Navy, DARPA, NIST, and DLA activities, Tri-service ManTech Advisory Group (MTAG), and Best Manufacturing Practices (BMP) support.

Progress Working groups have convened and methodologies for achieving the objective developed.

BENEFITS TO BE ACCOMPLISHED

The principal goal of the OASN Strategic ManTech Plan is to achieve a meaningful ManTech implementation that is fully coordinated across the Navy, including the System Commands and the Laboratories, and other DoD agencies, including DARPA and NIST. The plan is to fully support the needs of the System Commands in achieving their mission.

INDUSTRY INVOLVEMENT

Metalworking Technology, Inc., a non-profit subsidiary of the University of Pittsburgh Trust, is providing assistance with this activity. Metalworking Technology operates the National Center for Excellence in Metalworking Technology. Similarly, a 1990 contract will be awarded for an industry/university coalition for a center of excellence in composite materials.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The OASN Strategic ManTech Plan links directly to DARPA Exploratory Development (6.2) activity. The activity supports the DoD Critical Technologies Plan. The plan directly supports Navy SYSCOM thrusts such as SSN-21 Seawolf, Modular Shipbuilding, Avionics, Composite Aircraft Structures, ASW, and others. ManTech and IMIP are distinct and related activities. ManTech is aimed at making first-case manufacturing process and equipment improvements in the production environment. IMIP is aimed at improvements on a factory-wide basis.

INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM (IMIP) PROGRAM PLANNING

OBJECTIVE

The objective of the Industrial Modernization Incentives Program (IMIP)

Program Planning activity is to support Navy IMIP at the Assistant Secretary of the Navy level. This support will include setting policy and defining direction for the program and developing the Secretary of the Navy Instruction. The plan will also include an approach to assisting the System Commands with individual IMIP projects. NOSC will also evaluate Navy IMIPs. At the DoD level, the objective is to assist in the development of the DoD directives, instructions, and guides produced by OASD. At NOSC, planning is underway to review selected contracts with the center to identify possible IMIP opportunities.

PROGRESS WORKING

Sessions with the OASN have been conducted and implementation is continuing. Material for presentation within NOSC is being prepared to describe the IMIP Program, why IMIP helps productivity, and how the laboratory implements an IMIP.

BENEFITS TO BE ACCOMPLISHED

The principal goal is to achieve a meaningful IMIP implementation that is fully coordinated across the Navy, including the System Commands and the Laboratories, and other DoD agencies. The plan is to fully support the needs of the System Commands in achieving their mission.

INDUSTRY INVOLVEMENT

Just as with most IMIPs, planing heavily involves the DoD industry. Views and opinions of various DoD contractors are being evaluated to insure a coordinated, achievable program.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This activity supports the DoD Critical Technologies Plan. ManTech compliments IMIP with distinct and related activities. ManTech is aimed at making first-case manufacturing process and equipment improvements in the production environment. IMIP is aimed at improvements on a factory-wide basis which can include ManTech for new or improved technologies and/or off-the-shelf technologies.

MICROWAVE TUBES AND DEVICES

OBJECTIVE

Microwave tubes are essential components for a wide variety of Navy systems that use high-power transmitters. These systems include almost all Navy radars, and many long-range communications systems. The high cost, complex technologies, and importance to the Navy, make microwave tubes promising candidates for Navy Manufacturing Technology efforts.

The Microwave Tube and Devices Project is to identify programs which require improved manufacturing technology, structure Manufacturing Technology programs to bring about a reduction in Navy procurement costs for these devices, and to analyze Manufacturing

Technology projects to insure the effective application of successful technologies.

PROGRESS

Six Manufacturing Technology projects have been selected as candidates for Navy funding. All projects are scheduled to start in Fiscal Year 1991.

BENEFITS TO BE ACCOMPLISHED

The Defense Department purchases large quantities of microwave tubes. Each year approximately 30,000 microwave tubes costing $250M are purchased for use in original equipment, replacements, or spares. Approximately 20% of these tubes are for Navy applications.

The Manufacturing Technology project envisioned will provide numerous benefits to the Navy. Some of these benefits include increasing the frequency coverage for Navy airborne EW systems and reducing costs for essential parts of the missile and gun control system of the Navy F-14, the Aegis radar system, and AAED minitubes. Expendable Buoy and EW Payload Decoy systems will enjoy longer shelf life, higher reliability, and lower cost. Low cost is necessary in order for these expendable decoy systems to be economically feasible. The AMRAAM Traveling Wave Tube project will provide significant savings over the life of the program.

INDUSTRY INVOLVEMENT

Almost all major tube companies have been involved in this project. These companies include Litton Industries, Varian Associates, Teledyne MEC, Raytheon, and Hughes. Efforts were made to select projects involving tubes now in production, or about to go into production.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The AMRAAM Traveling Wave Tube Project is a joint Navy/Air Force activity described in more detail in the section on New Initiatives.

DATA DRIVEN ELECTRONICS MANUFACTURING PLANNING

OBJECTIVE

NIST has acquired a great deal of experience and expertise in building the Automated Manufacturing Research Facility (AMRF). The cornerstone of the AMRF was to develop the concept of "data-driven manufacturing." NIST is now ready to use its experience and expertise to expand into other manufacturing areas. NIST is particularly interested in developing a data-driven approach for electronics manufacturing. NIST has asked NOSC to join with them in pursuit of this objective.

PROGRESS

Previous work has established many of the data elements for manufacturing.

A plan has been developed for studying various standards, measurements, and technological problems associated with hybrid design, manufacture and testing.

BENEFITS TO BE ACCOMPLISHED

The Data Driven Electronics Manufacturing activity will apply the DARPA Initiative in Concurrent Engineering (DICE) technology to specific Navy requirements.

INDUSTRY INVOLVEMENT

While there is no current industrial involvement, a major goal of this project is to act as the hub that will integrate several existing enterprises already involved in the design, manufacture, and testing of hybrid circuits.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

This project is directly linked to the NOSC MicroCIM and NIST AMRF. Other related projects include the Navy's printed-circuit board production at RAMP, the circuit board assembly and processing system (CCAPS), the Electronics Manufacturing Productivity Facility (EMPF), the Micro-Miniature Repair Program (2M), and the monolithic circuits activity. In addition, the Navy's Soldering Science Center at Crane and the Naval Avionics Center at Indianapolis are involved in related projects. This project will eventually incorporate all of the work performed under IFAHMM and MicroCIM.

SENSOR BASED MANUFACTURING

OBJECTIVE

The Sensor Based Manufacturing (SBM) project is the outgrowth of a NOSC Manufacturing Technology Office thrust program for the automation of inspection and test processes. In the use of sensor output to control a process, the output is fed to a control system through decision algorithms and feedback loops to take appropriate action to control a fabrication process. The long-term objective of DoD is to improve product quality to where inspection is no longer required.

Computer integrated manufacturing and concurrent engineering are being employed to meet the need in design and manufacturing to increase yield, reduce rework, and improve quality. However, these methods are highly dependent upon the timeliness and accuracy of shop floor status information. An increasing number of defense contractor proposals under the ManTech and IMIP Programs are related to problems both in sensing workpiece condition and the processing of that information. There is an urgent need to identify advances in sensor technology which have a demonstrated feasibility and to implement that technology on the production line.

PROGRESS

The critical, initial steps have been taken to promote the SBM Thrust Program. Considerable effort has been expended by NOSC to obtain support and coordinate with other DoD agencies. Highest priority should now be given to the immediate development of SBM Manufacturing Technology and Industrial Modernization Incentives Program project proposals for submittal to the appropriate sponsoring activities.

BENEFITS TO BE ACCOMPLISHED

The ideal, long-term objective of DoD is that product quality will improve to where inspection will no longer be required.

INDUSTRY INVOLVEMENT

Industry is involved on specific case-by-case projects. Most projects are still in the proposal stage.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Several projects have been identified which fall into the category of Sensor Based Manufacturing. These include projects like the Sensor Controlled Homogeneous Flux Epitaxy (HFE) Growth System.

GALLIUM-ARSENIDE (GaAs) FOR ELECTRONIC WARFARE (EW) PRODUCIBILITY

OBJECTIVE

This objective of the Gallium Arsenide for Electronic Warfare Producibility program is to develop the manufacturing technology to produce high volumes of GaAs based devices. DoD will require approximately 500,000 of these type devices each year by the year 2000. GaAs devices are key components in active aperture radars. Applications include spaced based radar, surface ship radar, aircraft radar, and secure communication systems.

This ManTech program will address both multichip packaging technology and processes, as well as whole wafer devices currently under development by the DARPA MIMIC program.

PROGRESS

The planning is currently in a fact-finding mode. Formal endorsement by various acquisition offices in the Navy's three systems commands is being sought.

BENEFITS TO BE ACCOMPLISHED

The focus of this program covers the entire manufacturing process of GaAs devices. This includes material growth, wafer fabrication process controls, and assembly and packaging automation. Major emphasis will be placed on tuning and testing technology.

INDUSTRY INVOLVEMENT

Contractor support for this program will be competed. At least six of the current GaAs suppliers are expected to take part in the competition.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The program will be informally linked to the DARPA MIMIC program. The

MIMIC program concentrates on only the whole wafer GaAs based device technology. In addition, this results of this ManTech program will support the transition of DARPA's space based radar and IRFPA efforts.

FIBEROPTICS MANUFACTURING TECHNOLOGY

OBJECTIVE

Fiberoptics have numerous technical characteristics making them desirable to Navy applications. However, much work needs to be done with the manufacturing process to get fiberoptics into applications. This planning activity expects to identify applications of fiberoptics which will provide the highest pay-off to the Navy. Current areas of focus include shipboard communications and fiber-guided systems.

PROGRESS

Activity was initiated on October 31, 1989. Since that time, several potential candidate applications have been identified. These include FO Couplers, FO Gyros, FO Delay Line, FO Phased Array, and FO Guided Systems (FOGS).

One proposal is expected to be funded in fiscal year 1990.

BENEFITS TO BE ACCOMPLISHED

Fiberoptics provide unique, desirable characteristics.

INDUSTRY INVOLVEMENT

At this time, NOSC is seeking appropriate industry involvement.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The Air Force has asked NOSC to help them define and fund a joint program for FO Gyros. NOSC is currently managing a new thrust funded by DARPA for FO Gyros.

APPENDIX E—TECHNOLOGY DATABASES

ROBOTICS & ARTIFICIAL INTELLIGENCE DATABASE (RAID)

OBJECTIVE

Sponsored by the Tri-Services, RAID is to provide the authoritative source for all Defense-sponsored efforts in Robotics and Artificial Intelligence technology. Database access is limited to Government and written requests from approved contractors. During 1990, management of the RAID database is expected to move to the Defense Technical Information Center (DTIC).

PROGRESS

The RAID database is fully operational. In addition, this activity supports the Joint Technology Panel for Robotics. RAID resides solely at NOSC. It also provides a calendar of robotic and AI events. On-line access is provided to government personnel. There are nearly 2,200 projects described and 3,000 points of contacts listed in RAID. Advanced relational database search capabilities provide easy methods for finding meaningful information.

BENEFITS TO BE ACCOMPLISHED

RAID's clients are Industry and Government. Use of the RAID database improves technology transfer by providing points of contacts for information about specific robotic and artificial intelligence areas. It also minimizes the duplication of efforts. Finally, RAID provides a mechanism for members of the robotics and artificial intelligence community to communicate via the electronic mail system. A calendar of events keeps members of the RAID community current on conferences and symposiums and other robotics and artificial intelligence events.

INDUSTRY INVOLVEMENT

Industry, which is authorized by NOSC, can access the RAID database. Requirements are for the company to have a DD2345 Military Critical Technology clearance and a government sponsor letter.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

RAID is jointly sponsored by all three services.

Sample of Project Record

UNIQUE ID: 4743 QA LEVEL: verified

PROJ. TITLE: Motion Analysis and Object Recognition for Autonomous Navigation

GOVERNMENT AGENCY: DARPA PROJECT STATUS: on-going

DTIC ACCESSION NO: START: 12-sep-1989

CONTRACT NO. DACA76-89-C-0017 EST. COMPLETION: continuing

RESPONSIBLE DOD ORG: Defense Advanced Research Projects Agency
ACRONYM: DARPA

NAME: Simpson, Robert
PHONE: (202) 694-5017

PERFORMING ORG: University of Massachusetts
ACRONYM:

NAME: Riseman, Edward
PHONE: (413) 545-2746

APPLICATIONS	TECHNOLOGY KEYWORDS
Research	Algorithms
Robots	Dynamics
	Obstacle avoidance

RELATED EFFORT: Joint effort, ALV Project.

PROGRAM ELEMENT NO: FUNDING TYPE:

FY	ANNUAL FUNDS(K$)	IN HOUSE FUNDS(K$)	CONTRACT AMOUNT(K$)
90	530	0	530
89	300	0	300
TOTAL	830	0	830

UPDATE DATE: 21-nov-1989 DISTRIBUTION CODE:

ORIGINAL SOURCE: mail/riseman

UPDATE SOURCE: mail/riseman

This information comes from the Robotics/Artificial Intelligence Database (RAID) and is classified NCT, Distribution C.

Sample of Project Record (Cont.)

OBJECTIVE: Investigate capabilities for real-time dynamic perception and control of a mobile vehicle that autonomously navigates through known and partially known environments

APPROACH: This contract continues the research directions of contract DACA76-85-C-0008. A variety of algorithms for navigation by landmarks in a known environment were developed. The problem of matching 2D geometric models of landmarks was separated from the problem of recovering the 3D location and orientation of the camera from model-to-data correspondences. Initial experiments have demonstrated the feasibility of these algorithms and show some promise of robustness. This pair of algorithms will be used to update the robot's movement through the environment. In addition landmarks will be tracked in a low-level servo-control loop to keep correcting robot movement via perception. Stereo and motion algorithms are being used to recover environmental depth to aid in obstacle avoidance, model matching, and construction of surface models.

PROGRESS: Experiments are continuing for both indoor hallways and outdoor sidewalk and building scenes. Sucessful experiments of matching landmark models to lines extracted from real images have been achieved when the approximate starting location of the robot is known. Experiments on recovering depth to aid in obstacle avoidance, model matching, and construction of surface models.

This information comes from the Robotics/Artificial Intelligence Database (RAID) and is classified NCT, Distribution C.

SIMON

OBJECTIVE

Simon is to provide the authoritative source for all Defense-sponsored Manufacturing Technology (ManTech) projects. Each record of the database contains the DoD Instruction for the specific Manufacturing Technology Project.

PROGRESS

Simon has been operational since 1987. The database currently contains over 600 projects. Three versions of the database are in use. The developmental version is located at NOSC. This version is the "working" version where new information is added quarterly as it is received from the services. A production version is located with the Defense Gateway Information System (DGIS). This version is accessed by Government personnel. A third, limited version is located with the Manufacturing Technology Information Analysis Center (MTIAC). While complete historical project information and points of contacts data is provided, this limited version does not contain future planning data. This version of Simon is available for access by industry.

BENEFITS TO BE ACCOMPLISHED

Simon was developed to provide accurate and timely information about DoD ManTech projects. The availability of this information helps to improve technology transfer by providing points of contact. Simon also helps to eliminate redundant activities by providing users with information about other project objectives.

INDUSTRY INVOLVEMENT

Industry may access Simon through MTIAC.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

IMIP users search Simon to ensure project coordination, to eliminate redundant efforts, and to provide information on areas for potential modernization.

MANUFACTURING TECHNOLOGY DATABASE/MANAGEMENT INFORMATION SYSTEM (MTDB/MIS)

OBJECTIVE

The Manufacturing Technology Database/Management Information System (MTDB/MIS) is the original NOSC ManTech database. This is a private database for use by NOSC Code 936 only. This database provides current project data and historical data on all NOSC ManTech projects in all services since ManTech began in 1977. In addition, the database information feeds a management information system.

PROGRESS

The database includes projects descriptions, funding levels, savings generated, and additional information on all NOSC ManTech projects. As a Management Information System, the MTDB/MIS tracks quarterly progress and cost savings for NOSC ManTech projects. The MTDB/MIS contains data on over 300 projects and 1400 points of contacts.

BENEFITS TO BE ACCOMPLISHED

The MTDB/MIS provides important management and control information to NOSC Code 936 for use with active projects. Being the initial ManTech database, the MTDB provided important lessons-learned which have been used to enhance the user-friendliness and information quality of subsequent ManTech and IMIP database.

INDUSTRY INVOLVEMENT

Industry has no access to this database. However, the MTDB provides information on areas of interest and mailing information used to prepare invitations to End of Contract Demonstrations.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

The MTDB/MIS provides a history of all NOSC ManTech projects.

PRECISION GUIDED MUNITIONS INDUSTRIAL MODERNIZATION INCENTIVES PROGRAM MANAGEMENT INFORMATION SYSTEM (PGM IMIP MIS)

OBJECTIVE

The objective of the PGM IMIP MIS is to provide an effective management information tool including enabling technologies for technology transfer of information. This system incorporates electronic communications. Proposal Tracker and Contracts Databases also form part of this system.

PROGRESS

The system was initiated and developed in 1985. In 1986 it became a fully operational system. The database contains over 680 project descriptions and 540 points of contacts. New projects relevant to the PGM IMIP are continuously included in the database. The IMIP MIS was developed to provide support an Air Force sponsor. As such, it had requirements that were significantly different than the other ManTech databases. The querying functions have been specifically developed to support the IMIP community.

BENEFITS TO BE ACCOMPLISHED

The system provides on-line access to project and management information for PGM IMIP. Benefits desired from the IMIP MIS are similar to those desired from the ManTech databases. Those benefits includes improving technology transfer by providing points of contacts for information and minimizing the duplication of efforts.

INDUSTRY INVOLVEMENT

The PGM IMIP MIS is available to all PGM IMIP contractors. In addition, other DoD contractors, on request, have been provided access or have had searches conducted.

RELATIONSHIP TO OTHER PROJECTS AND PROGRAMS

Information in the database was derived from numerous other databases including PGM IMIP projects.

APPENDIX F—ACRONYM LIST

ADS	Automatic Diagnostic System
AHAP	Ad Hoc Advisory Panel
ALWT	Advanced Light Weight Torpedo
AMRAAM	Advanced Medium Range Air-to-Air Missile
AMRF	Automated Manufacturing Research Facility
ARBS	Angle Rate Bombing Site
ASPJ	Automated Self-Protecting Jammer
ASW	Anti-Submarine Warfare
BMP	Best Manufacturing Practices
BTAB	Bumped Tape Automated Bonding
CAD	Computer-Aided Design
CAM	Computer-Aided Manufacturing
CARA	Combined Altitude Radar Altimeter
CCAPS	Circuit Board Assembly and Processing System
CCD	Charge-Coupled Device
CFA	Crossed-Field Amplifiers
CIE	Computer Integrated Engineering
CIM	Computer Integrated Manufacturing
CIP	Capital Investment Plan
CSC	Computer Sciences Corporation
DARPA	Defense Advanced Research Projects Office
DGIS	Defense Gateway Information System
DICE	DARPA Initiative in Concurrent Engineering
DIPS	Dual In-Plane Switch
DoD	Department of Defense
EBPS	Electron Beam Projection System
ECM	Electronic Counter Measures
EHF	Extra-High Frequency
EMPF	Electronics Manufacturing Productivity Facility
FET	Fleet Evaluation Trial
FIB	Focused Ion Beam (Lithography)
FO	Fiberoptics
FOGS	FO Guided Systems
GaAlAs	Gallium Aluminum Arsenide
GLCM	Ground Launched Cruise Missile

HALT	Hybrid Automated Lead Tester
HFE	Homogeneous Flux Epitaxy
HMA	Hybrid Microcircuit Assembly
HTC	Hermetic Tape Carrier
ICAM	Integrated Computer-Aided Manufacturing
IDEF	ICAM Definition Language
IED	Independent Exploratory Development
IFAHMM	Integrated Facility for automated Hybrid Microcircuit Manufacturing
IGES	Initial Graphics Exchange Specifications
IMIP	Industrial Modernization Incentive Program
ISHM	International Society for Hybrid Manufacturing
ITSA	Integrated Inertial Sensor Assembly
JTIDS	Joint Tactical Integrated Display System
LANTIRN	Low Altitude Navigation & Targeting Infrared System
LED	Light Emitting Diodes
LSI	Large Scale Integration
ManTech	Manufacturing Technology
MBE	Molecular Beam Epitaxial
MIBL	Masked Ion Beam Lithography
MicroCIM	Microelectronics Computer Integrated Manufacturing
MIS	Management Information System
MTAG	Manufacturing Technology Advisory Group, Tri-Service
MTDB/MIS	Manufacturing Technology Database/Management Information System
MTIAC	Manufacturing Technology Information Analysis Center
NAVAIR	Naval Air Systems Command
NAVCOM	Navy Communication
NAVSEA	Naval Sea Systems Command
NAVSUP	Naval Supply Systems Command
NDPT	Nondestructive Pull Testing
NESP	Navy EHF Satellite Program
NIST	National Institute of Standards and Technology
NOSC	Naval Ocean Systems Center
NUSC	Naval Undersea Systems Center
OASN	Office of the Assistant Secretary of the Navy
PCB	Printed Circuit Boards
PDES	Product Data Exchange Specification

PGM	Precision Guided Munitions
PSR	Producitivity Savings Reward
PWA	Printed Wiring Assembly
R&D	Research and Development
RAMP	Rapid Acquisition of Manufactured Parts
RDT&E	Research, Development, Test, and Evaluation
ROI	Return on Investment
SBM	Sensor Based Manufacturing
SCEPS	Stored Chemical Energy Propulsion System
SEM	Standard Electronic Module
SHARP	Standard Hardware Acquisition and Reliability Program
SiLCLV	Silicon Liquid Crystal Light Valve
SPAWAR	Space and Naval Warfare Systems Command
SPC	Statistical Process Control
TQM	Total Quality Management
TWT	Traveling Wave Tube
USN	United States Navy
UV	Ultraviolet
VHSIC	Very High Speed Integrated Circuit
VLSI	Very Large Scale Integrated Circuit
VPS	Vapor Phase Soldering
2M	Micro-Miniature Repair Program

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As a result of the Navy's need to advance the U. S. industrial modernization and technology base, this document was developed to accentuate the Naval Ocean Systems Center (NOSC) Manufacturing Technology (ManTech) and Industrial Modernization Incentives Program (IMIP). Goals of the NOSC ManTech and IMIP programs are to develop new and improved processes, methods, techniques, and equipments to enhance our industrial-base capability, ensure quality and affordability of command, control, communications and ocean surveillance systems, enable the transition of Research and Development (R&D) from development to production, and expedite the implementation of advanced methods and technologies in defense production facilities. The Manufacturing and Computer Engineering Technology Branch personnel directly contributed to the concept and development of this report.

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