RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)								DATE February 2000	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development					R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, R-1 #40				
COST *(In Millions)*	FY 1999	FY2000	FY2001	FY2002	FY2003	FY2004	FY2005	Cost To Complete	Total Cost
Total Program Element (PE) Cost	260.296	252.388	191.800	188.264	173.867	163.354	149.954	Continuing	Continuing
Uncooled Integrated Sensors MT-03	12.803	10.732	11.916	6.930	0.000	0.000	0.000	0.000	N/A
Electronic Module Technology MT-04	61.437	55.153	43.684	45.772	48.067	38.029	36.829	Continuing	Continuing
Tactical Information Systems MT-05	31.519	20.668	0.000	0.000	0.000	0.000	0.000	0.000	N/A
Microwave and Analog Front End Technology MT-06	3.809	0.000	0.000	0.000	0.000	0.000	0.000	0.000	N/A
Centers of Excellence MT-07	6.062	5.478	4.000	0.000	0.000	0.000	0.000	0.000	N/A
Manufacturing Technology Applications MT-08	20.685	18.564	0.000	0.000	0.000	0.000	0.000	0.000	N/A
Advanced Lithography MT-10	48.026	44.791	45.012	45.013	45.000	44.000	45.000	Continuing	Continuing
MEMS and Integrated Micro-systems Technology MT-12	75.955	74.711	37.712	37.590	24.000	24.025	10.825	Continuing	Continuing
Mixed Technology Integration MT-15	0.000	22.291	49.476	52.959	56.800	57.300	57.300	Continuing	Continuing

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE February 2000
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, R-1 #40

(U) Mission Description:

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

(U) The Uncooled Integrated Sensors project addresses a long-standing Defense requirement for uncooled infrared sensor arrays for major weapons systems that cannot accommodate costly cryogenic cooling packages.

(U) The Electronic Module Technology project is a broad initiative to decrease the cost and increase the performance of weapon systems through the insertion of electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components.

(U) Advanced Lithography technology has enabled the dramatic growth of integrated circuit capability. Advances have led to improvements in electronic and computing systems performance in terms of speed, power, weight and reliability. Further improvements require microcircuits with smaller features to meet the operational seed, power, weight and volume constraints.

(U) The Microelectromechanical Systems (MEMS) project is a broad and cross-disciplinary initiative to develop an enabling technology that merges computation with sensing and actuation to realize new systems for both perceiving and controlling weapons systems, processes and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS conveys the advantages of miniaturization, multiple components and integrated microelectronics to the design and construction of integrated electromechanical systems. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, opto-electronics and chip-based reaction and detection modules to perform tailored analysis sequences for monitoring of environmental conditions, health hazards and physiological states.

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(U) The goal of the Mixed Technology Integration project is to revolutionize the integration of mixed technologies at the micrometer/nanometer scale. This will produce low-cost, lightweight, low-power 3-D microsystems that improve battlefield awareness and the operational performance of military platforms. This project will leverage industrial manufacturing infrastructure to produce mixed-technology microsystems that will revolutionize the way warfighters see, hear, taste, smell, touch and control environments.

(U) Three on-going DARPA projects are nearing completion. Both the Tactical Information Systems (MT-05) and the Manufacturing Technology Applications (MT-08) projects end in FY 2000. The Tactical Information Systems project is designing and developing prototype modules, using core technologies that sense, think and communicate, and integrating them into selected personal information products. The project is also demonstrating the feasibility of combining real-time visual images of the environment with geospatially registered computer generated information for use by individual mounted and dismounted warfighters. The Manufacturing Technology Applications project goal is to reduce the cost and acquisition lead-time of future military systems by integrating manufacturing process considerations during the product design phase and by demonstrating high efficiency multi-product prototype factories. This project enables manufacturers to economically produce military variants of their commercial products in limited quantities through the introduction of flexible process technologies. The Centers of Excellence (MT-07) project finances demonstration, training and deployment of advanced manufacturing technology. This effort will transition to state/private support during FY 2001.

(U) **Program Change Summary:** (*In Millions*)	**FY 1999**	**FY 2000**	**FY 2001**
Previous President's Budget	265.442	246.023	233.198
Current Budget	260.296	252.388	191.800

(U) Change Summary Explanation:

FY 1999 Decrease reflects a reduction due to the Omnibus and SBIR reprogrammings.

FY 2000 Increase reflects the Congressional adds to Change Detection Technology, Defense TechLink Center, Laser Plasma X-ray Source Technology, Point Source Lithography Technology and CAMD programs. Funding for the Tactical Information Systems project was moderately increased to accelerate completion of the effort. Offsetting these increases was a Congressional reduction to the Robotics program and a government-wide rescission.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, R-1 #40

FY 2001 Decrease reflects the transition of the MEMS insertion efforts from the component-oriented Devices and Processes/Reliability program to specific programmatic applications and the completion of the Tactical Information Systems and Manufacturing Technology Applications projects.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)	DATE: February 2000
APPROPRIATION/BUDGET ACTIVITY: RDT&E, Defense-wide; BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE: Advanced Electronics Technology; PE 0603739E, Project MT-03

COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Uncooled Integrated Sensors MT-03	12.803	10.732	11.916	6.930	0.000	0.000	0.000	0.000	N/A

(U) Mission Description:

(U) The Uncooled Integrated Sensors project addresses the technology necessary to produce affordable, infrared sensor arrays essential to major weapon systems. The focal plane array consists of a two-dimensional detector array sensitive in a broad spectral range, integrated with unique signal processing to enhance performance and provide more efficient utilization of the information. The critical elements of the technology addressed in this program include the infrared material, detector array fabrication, read-out electronics, cryogenic packaging and testing, and module assembly. Processing and fabrication techniques focus on the production of affordable arrays, at low volume, in the configurations required by weapon systems. Performance enhancements in uncooled infrared and near-infrared sensors are also being addressed to provide an integrated, broadband two dimensional sensor array without the cryogenic package usually associated with infrared sensors. Thermal Imaging Devices will develop new imaging at the theoretical limit, (five to fifty times increase over current uncooled devices), achieving high performance in extremely small, low power configurations and demonstrating technology to open new applications for imaging devices.

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Uncooled Imaging Sensors. ($ 10.150 Million)
  - Demonstrated uncooled infrared array with thermal sensitivity of 0.05^{o} C.
  - Demonstrated low power micro-bolometer sensor for unattended ground sensors.
  - Fabricated and tested uncooled infrared arrays and low power solid state low light level arrays.

- Thermal Imaging Devices. ($ 2.653 Million)
  - Fabricated and evaluated microstructures with thermal isolation properties five to ten times less than current thermal devices.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-03

(U) FY 2000 Plans:

- Uncooled Imaging Sensors. ($ 2.732 Million)
  - Demonstrate 480x640 uncooled arrays with < .05 milli-kelvin, 1 mil pixel.
  - Transfer 480x640 uncooled infrared sensor to Army missile seeker program.
  - Conduct field evaluation of high sensitivity uncooled infrared sensor with low light sensor for ground operations.

- Thermal Imaging Devices. ($ 8.000 Million)
  - Demonstrate non-contact read-out devices and characterize sensitivity/noise sources.
  - Demonstrate non-contact imaging array with thermal sensitivity of 100 milli-kelvin.

(U) FY 2001 Plans:

- Thermal Imaging Devices. ($ 11.916 Million)
  - Demonstrate 100 gram imaging sensor with performance acceptable for micro-air-vehicles.
  - Optimize read-out structure to read signals with short (approx. 1 msec.) integration time.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-03

(U) Schedule Profile:

Plan	Milestones
Mar 00	Demonstrate non-contact read-out devices and characterize sensitivity/noise sources.
Sept 00	Field evaluation of high sensitivity uncooled sensor with low light level sensor for ground operations.
Nov 00	Demonstrate 100 gram imaging sensor with performance acceptable for micro-air-vehicles.
Sept 01	Demonstrate 50-gram sensor with sensitivity of 20 milli-kelvin.
Jan 02	Incorporate high responsitivity materials into detector structure.
Mar 02	Integrate materials and microstructure into imaging device.
Sept 02	Demonstrate five-gram sensor with sensitivity <5milli-kelvin, ideal thermal imaging device.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)								DATE February 2000	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-04					
COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Electronic Module Technology MT-04	61.437	55.153	43.684	45.772	48.067	38.029	36.829	Continuing	Continuing

(U) Mission Description:

(U) The Electronic Module Technology Project is a broad initiative to substantially decrease the cost and increase the performance of weapon systems through the timely insertion of state-of-the-art electronic modules. Electronic module technology addresses the design and fabrication of various types of digital, analog and mixed signal modules consisting of electronic, electro-optical and micro-mechanical components. It includes traditional approaches such as printed circuit boards, and emerging technologies such as high density Multichip Modules.

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

(U) The project has the following major elements: Photonic Analog/Digital (A/D) Conversion; Distributed Robotics; Design Support for Mixed Technology Integration (Composite CAD) and the Molecular-level Large-area Printing (MLP) program. Photonic Analog/Digital (A/D) conversion will utilize breakthrough photonic developments to substantially increase the speed by which analog signals are converted into digital data streams for data reduction and processing. Distributed Robotics is an effort to integrate developments in Microelectromechanical Systems (MEMS), power sources, communications and advanced microelectronics to design, construct and field multiple, high-performance, mobile, autonomous systems. Composite CAD seeks to develop the design tools (concept exploration, analysis, optimization and verification) to allow thousands of analog, digital, optical, MEMS and microfluidic devices to be integrated into “systems-on-a-chip” and other highly integrated mixed technology systems. The MLP program is exploring approaches to ‘print’ MEMS devices on large surfaces.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-04

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- OMNET. ($ 11.682 Million)
  - Demonstrated integrated optoelectronic transceivers and optical switches for reconfigurable interconnections of sensors to processors.
  - Demonstrated the ability to distribute computation across military platforms 1-100 meters in length for future Electronic Warfare/digital radar and image processors.

- Distributed Robotics. ($ 13.000 Million)
  - Constructed the unit platforms, integrated commercial or demonstrated technology elements (e.g., imagers, MEMS, wireless systems), and defined multiple, cooperative functions for selected military applications.

- Composite CAD. ($ 15.763 Million)
  - Continued to develop the mixed domain software (kinematic, electric, electrostatic and fluidic) analysis of micro-machined devices, systems of devices and corresponding electronic circuits to support the design of composite electronic sensors and systems.

- Photonic A/D. ($ 9.000 Million)
  - Initiated photonic A/D converter development to achieve breakthrough in high speed A/D conversion.

- Molecular-level Large-area Printing (MLP). ($ 11.992 Million)
  - Completed experimental characterization of first generation printing processes.
  - Selected second generation printing process.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-04

(U) FY 2000 Plans:

- Photonic A/D. ($ 15.100 Million)
  - Evaluate alternative photonic clock, optical sampler and quantizer module designs for photonic A/D converters operating in the 10-100 Giga-sample-per-second range.
  - Identify high impact applications for this technology.
- Distributed Robotics. ($ 13.467 Million)
  - Demonstrate feasibility of a variety of multiple robots (<5cm) to operate in specific military environments and their ability to adapt to varying environments and missions.
  - Demonstrate probability of mission success improved by distributed functionality.
- Composite CAD. ($ 10.544 Million)
  - Complete the development of systems software design and simulation capabilities for mixed technology micro-systems, including MEMS-enabled designs and microfluidic (Micro-Flumes) designs. The ultimate goal of the complete systems design capability is to enable mixed technology systems-on-a-chip.
  - Provide mixed technology design libraries, models and test structure data to improve design quality, development time and ability to reuse designs.
- Molecular-level Large-area Printing (MLP). ($ 16.042 Million)
  - Concentrate on the development and choice of non-conventional large-area, MLP techniques for a demonstration system.
  - Establish overlay capabilities for MLP.

(U) FY 2001 Plans:

- Photonic A/D. ($ 16.178 Million)
  - Complete initial photonic A/D converter evaluation and finalize design for demonstration module.
  - Demonstrate key photonic technologies.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-04

- Distributed Robotics. ($ 14.678 Million)
  - Demonstrate multiple robots with overall functionality and probability of mission success improved by integration of optimized control strategies.

- Molecular-level, Large-area Printing (MLP). ($ 12.828 Million)
  - Demonstrate and characterize 10,000 x 100 pixel density array on a spherical surface.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile :

Plan	Milestones
Mar 00	Evaluate initial PACT test and measurement methodology.
Apr 00	Characterize single crystal semiconductors on amorphous surfaces.
Jun 00	Establish overlay capabilities for MLP.
Jul 01	Demonstrate and characterize 10,000 x 100-pixel density array on spherical surface.
Aug 01	Demonstrate multiple robots with overall functionality and probability of mission success improved by integration of optimized control strategies.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-05					
COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Tactical Information Systems MT-05	31.519	20.668	0.000	0.000	0.000	0.000	0.000	0.000	N/A

(U) Mission Description:

(U) This project will develop the technology for transmitting and displaying critical situational awareness and surveillance information to the warfighter. This project consists of Smart Modules, Warfighter Visualization and Ultra-Wideband Communications. Smart Modules will design, develop and integrate prototype modules using core technologies that communicate into personal information products. Warfighter Visualization efforts demonstrate the feasibility of combining real-time visual images of the environment with geospatially registered computer-generated information. Together these systems will provide the mounted and dismounted warfighter with an unprecedented awareness in the most hostile environments.

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Smart Modules. ($ 16.562 Million)
  - Demonstrated a novel capture device that incorporates signal and data processing in a 3-D package for use by individual soldiers. This miniature device, weighing only a few ounces, is able to capture an image and rapidly analyze movement or correlate images with all processing done on the focal plane. The camera is compact enough to be worn by individual soldiers and communicate via a radio to and from geographic information system databases.
  - Demonstrated a wearable computer incorporating wireless communication in a one pound, one-watt configuration. This represents a three-fold improvement in weight and a ten-fold improvement in power over current technology. The wearable computer will be used in a wide variety of space applications by the small unit operations soldier.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-05

- Warfighter Visualization. ($ 14.957 Million)
  - Demonstrated ability to do precision, real-time georegistration using video from the Predator unmanned aerial vehicle. This capability enables vastly enhanced situational awareness by obviating the "soda straw" effect of narrow field of view video. This technology development was rapidly accelerated and used to provide coordinates on mobile targets at the Combined Allied Operation Center in support of Operation Allied Force.
  - Demonstrated prototype capability for dismounted soldiers to view the real world with tactical symbology in a battlefield environment. This technology makes use of a novel optical tracking technology that uses novel compact image processing hardware to back compute the location of camera from points in the scene. This capability provides location information in urban environment where GPS is jammed or blocked.

(U) FY 2000 Plans:

- Warfighter Visualization. ($ 20.668 Million) [Future Combat Systems – related = $3.000 Million]
  - Demonstrate a high performance special purpose processor that will take the capabilities of real-time georegistration and precision targeting demonstrated in Vicenza, Italy and shrink them onto a single chip. This will shrink the system for vehicle mounting or ultimate portability by a dismounted soldier or in handheld units such as night vision goggles.
  - Demonstrate a prototype advanced human interface capability for use in conjunction with other bodyworn processing units. This system will combine "supernormal" listening with tactile inputs and displays for a dismounted soldier.
  - Demonstrate full-surround foveal vision system for glass turret. This system matches the human visual system by providing high resolution only where it is needed in the visual field, but provides a seamless image using advanced video processing system.
  - Develop change-detection technology to interpret reconnaissance imagery and enhance intelligence community capabilities.

(U) FY 2001 Plans:

- Not Applicable.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-05

(U) Schedule Profile:

Plan	Milestones
Warfighter Visualization:	
Jul 00	Develop real-time visual data correlation system in dismounted and mounted warrior applications.
Dec 00	Demonstrate dynamic multi-sensor I/O in both dismounted and mounted military applications.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-07					
COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Centers of Excellence MT-07	6.062	5.478	4.000	0.000	0.000	0.000	0.000	0.000	N/A

(U) Mission Description:

(U) This project provides funding for the Robert C. Byrd Institute for Advanced Flexible Manufacturing at Marshall University. The Byrd Institute provides both a teaching factory and initiatives to local area industries to utilize computer-integrated manufacturing technologies and managerial techniques to improve manufacturing productivity and competitiveness. Training includes technologies to significantly reduce unit production and life cycle costs, and to improve product quality. This project also includes funding for the U.S.-Japan Management Training Program, whose purpose is to build a growing infrastructure of American scientists and engineers with knowledge about the Japanese R&D enterprise and provide training in the Japanese language, and has funded the Defense Techlink Rural Technology Transfer Project.

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Advanced Flexible Manufacturing. ($ 3.618 Million)
  - Completed expansion of the Institute for Advanced Flexible Manufacturing's satellite facilities.

- U.S.-Japan Management Training. ($ 1.444 Million)
  - Completed efforts with centers of excellence to support the understanding of Japan's manufacturing infrastructure, culture and language by students, researchers and executives.

- Defense Techlink Rural Technology Transfer Project. ($ 1.000 Million)
  - Provided funding for the Defense Techlink Rural Technology Transfer Project.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-07

(U) FY 2000 Plans:

- Advanced Flexible Manufacturing. ($ 3.978 Million)
  - Expand the Institute for Advanced Flexible Manufacturing's web-based electronics supply chain support to include 150 small manufacturers who now have access to Defense on-line procurement activities.

- Defense Techlink Rural Technology Transfer Project. ($ 1.500 Million)
  - Provide funding for the Defense Techlink Rural Technology Transfer Project.

(U) FY 2001 Plans:

- Advanced Flexible Manufacturing. ($ 4.000 Million)
  - Complete assessment of the Institute for Advanced Flexible Manufacturing's performance and transition from DoD to state/private support.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Oct 01	Complete assessment and transition of the Institute from DoD to state/private support.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-08					
COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Manufacturing Technology Applications MT-08	20.685	18.564	0.000	0.000	0.000	0.000	0.000	0.000	N/A

(U) Mission Description:

(U) Future military systems will be affordable only if the manufacturing process is considered as an integral part of product design, production takes place in flexible multi-product factories, and if advanced manufacturing technology is combined effectively with advanced business practices. This program focuses on demonstrations of process technology combined with innovative industrial practices and will measure the improvements in cost, schedule and quality achievable in key defense product areas.

(U) The Affordable Multi-Missile Manufacturing (AM3) program is an Advanced Technology Demonstration initiated in FY 1995. The objective of AM3 is to demonstrate the feasibility of 25-50 percent reductions in the unit cost of tactical missiles, in ongoing missile production programs, in new missiles and major modifications. This will be accomplished by teams of missile prime contractors, component suppliers and manufacturing equipment and software vendors who develop and demonstrate the combined effects of advanced design, manufacturing, assembly systems and processes, missile value engineering changes, and acquisition reform and business practice innovations. A major technical theme is to achieve economies across a mix of missiles to compensate for the decline in individual missile quantities. Demonstrations will be conducted in the design and manufacture of components and guidance and control/seeker assemblies for multiple missiles, including R&D and production programs.

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Affordable Multi-Missile Manufacturing (AM3). ($ 20.685 Million)
  - Established Technology Product Centers in key design product areas that use modular reusable design and standard parts concepts.
  - Established multi-product factory and multi-missile factory utilizing multi-missile factory concepts.
  - Continued progress with key suppliers on sourcing strategies, working toward completion of a supplier affordability process.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-08

- Completed design phases of reusable hardware demonstration projects – involving Inertial Measurement Unit (IMU), common processor and common infrared test station – and began validation and insertion.
- Continued rapid product development and producibility demonstrations on brilliant anit-tank, joint standoff weapon, standard missle-2, extended range guided munitions, and experimental munition-982 toward eventual completion and deployment in FY 2000.
- Successfully completed Activity Based Management demonstration at Ocala facility.
- Completed training for missile suppliers AM3 programs and awarded contracts for affordability initiative demonstrations.
- Completed planning and simulation for multi-missile factory demonstration, gaining approval to proceed with implementation.
- Continued progress with common family of parts demonstrations, awarding contracts for common IMU and progressing in other MEMS and IFOG/RLG efforts.
- Completed installation of Integrated Enterprise Resource Planning software, now operational.
- Continued progress in rapid product design environment – new design tools, now operational.
- Completed validation and definition for use of commercial electronic parts in missile applications.

(U) FY 2000 Plans:

- Affordable Multi-Missile Manufacturing (AM3). ($ 18.564 Million)
  - Complete integration of flexible factory assembly areas.
  - Deploy System Integration Design Environment.
  - Complete design and prototype fabrication of low cost IMU.
  - Complete common processor design verification test and integration.
  - Validate electronic collaborative tools and complete supplier affordability demonstration.
  - Complete integration of guided flight unit, gyro optics assembly fabrication and mid-body casting demonstration.
  - Complete common seeker commercial parts test evaluation, producibility analysis and flight test.
  - Complete common IMU design verification test, prototype demonstration unit and technology insertion review.
  - Complete process design for flexible multi-product assembly cells, validate on production parts and demonstrate on production line.
  - Complete electronic procurement and supplier integration demonstrations.
  - Design, build, and test laboratory and ground vehicle-mounted prototypes of a GPS Missile Retargeting Pseudolite.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development	R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-08

(U) FY 2001 Plans:

- Not Applicable.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Mar 00	Complete common processor design verification test and integration.
Mar 00	Complete process design for flexible multi-product assembly cells, validate on production parts and demonstrate on production line.
Jun 00	Complete flight tests of AM3 missile seeker prototypes.
Jul 00	Demonstrate a Laboratory Prototype of a GPS Missile Retargeting Pseudolite.
Jul 00	Complete integration of guided flight unit, gyro optics assembly fabrication and mid-body casting demonstrations.
Jul 00	Complete electronic procurement and supplier integration demonstrations.

RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)							DATE February 2000		
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development				R-1 ITEM NOMENCLATURE Advanced Electronics Technology PE 0603739E, Project MT-10					
COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Advanced Lithography MT-10	48.026	44.791	45.012	45.013	45.000	44.000	45.000	Continuing	Continuing

(U) Mission Description:

(U) Microelectronics is a key to improved weapon system performance. Lithography technology has enabled the dramatic growth in microelectronics capability over the past three decades. The improved capabilities in semiconductor technology contribute to significant system gains in speed, reliability, cost, power consumption and weight. Advanced microelectronics technology is essential for computing and signal processing in virtually all military systems including command, control, communications and intelligence; electronic warfare; and beam forming for radar and sonar. Further improvements in areas such as target recognition, autonomous guided missiles and digital battlefield applications require microcircuits with smaller features to meet the operational speed, power, weight and volume constraints of these systems.

(U) Current microelectronics fabrication utilizes feature sizes of 0.35 microns. The Advanced Lithography Program emphasizes longer-term research with expected high payoff in the fabrication of semiconductor devices with 0.1 or less micron feature sizes. These programs will develop technology for sub 0.1-micron features.

(U) The goal of the lithography program is to reduce technical barriers in the development of advanced lithographic technologies for the fabrication of a broad range of microelectronic devices and structures. Innovative research in pattern generation and transfer, imaging materials, new process and metrology will provide alternatives beyond current evolutionary trends. The program will investigate technologies for the creation of highly-complex patterns at sub 0.10μm resolution over field areas in excess of 1000 mm^2. Applications with larger geometries will be explored for innovative devices and structures beyond microelectronics.

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(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Sub 0.1 Micron Technology. ($ 24.887 Million)
  - Continued efforts in maskless lithography, including arrays of miniature e-beam columns, novel imaging materials and pattern transfer processes.
  - Continued network of university efforts in novel patterning.
  - Completed column test stand for maskless e-beam writer.
- Laser Plasma X-ray Source. ($ 5.951 Million)
  - Continued laser plasma x-ray source technology.
- X-ray Masks. ($ 13.888 Million)
  - Continued x-ray mask writer development.
  - Developed x-ray masks for the F-22, Apache Longbow and other defense programs.
- Nanotechnology and Crystalline Arrays. ($ 3.300 Million)
  - Initiated research in nanotechnology and crystalline control arrays.

(U) FY 2000 Plans:

- Sub 0.1 Micron Lithographies. ($ 22.791 Million)
  - Develop key tool components, materials and processing to accelerate the availability of emerging lithography technologies beyond 193 nm. Efforts will include maskless (electron beam, ion beam) approaches and the projection technologies, using optical, electron, x-rays and extreme ultraviolet.

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- Support Technologies. ($ 16.000 Million)
  - Develop support technologies, to include mask technology, resists and metrology.
  - Develop innovative optics designs and architectures and new materials and processing beyond the evolutionary trends in the industry.

- Laser Plasma X-ray Source. ($ 5.000 Million)
  - Continue laser plasma x-ray source technology.

- Point Source Lithography ($ 1.000 Million)
  - Continue point source lithography development.

(U) FY 2001 Plans:

- Sub 0.1 Micron Lithographies. ($ 25.900 Million)
  - Demonstrate key components of maskless wafer writer and key components for lithography of 0.07 micron features.

- Support Technologies. ($ 19.112 Million)
  - Accelerate technology developments in the lithography exposure sources and supporting (cross-cutting) technologies needed for microelectronics fabrication.
  - Develop reduced risks in key areas of components, materials and processing allowing industry to fabricate prototype tools and new high-performance devices for use in advanced military systems and commercial markets.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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(U) Schedule Profile:

Plan	Milestones
Jul 00	Demonstrate ion microcolumn for maskless lithography.
Mar 01	Component demonstration of maskless wafer writer.
Aug 02	Demonstrate key components for lithography of 0.07-micron features.
Sep 02	Demonstrate key components for mask writer for sub 0.1-micron features.

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COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
MEMS and Integrated Micro-systems Technology MT-12	75.955	74.711	37.712	37.590	24.000	24.025	10.825	Continuing	Continuing

(U) Mission Description:

(U) The Microelectromechanical Systems (MEMS) program is a broad, cross-disciplinary initiative to develop an enabling technology that merges computation and power generation with sensing and actuation to realize a new technology for both perceiving and controlling weapons systems and battlefield environments. Using fabrication processes and materials similar to those that are used to make microelectronic devices, MEMS provides the advantages of miniaturization, multiple components and integrated microelectronics to the design and construction of integrated electromechanical and electro-chemical-mechanical systems. The MEMS program addresses issues ranging from the scaling of devices and physical forces to new organization and control strategies for distributed, high-density arrays of sensor and actuator elements. These issues include microscale power and actuation systems as well as microscale components that survive harsh environments. The microfluidic molecular systems program will develop automated microsystems that integrate biochemical fluid handling capability along with electronics, optoelectronics and chip-based reaction and detection modules to perform tailored analysis sequences to monitor environmental conditions, health hazards and physiological states.

(U) The MEMS program has three principal objectives: the realization of advanced devices and systems concepts; the development and insertion of MEMS into DoD systems; and the creation of support and access technologies to catalyze a MEMS technology infrastructure. These three objectives cut across a number of focus application areas to create revolutionary military capabilities, make high-end functionality affordable to low-end systems and extend the operational performance and lifetimes of existing weapons platforms. The major technical focus areas for the MEMS program are: 1) inertial measurement; 2) fluid sensing and control; 3) electromagnetic and optical beam steering; 4) mass data storage; 5) chemical reactions on chip; 6) electromechanical signal processing; 7) active structural control; 8) analytical instruments; and 9) distributed networks of sensors and actuators.

(U) Compact portable power sources capable of generating power in the range of a few hundred milliwatts to one watt are critical to providing power for untethered sensors and other chip-scale microsystems. This program aims to replace today's technologies relying on primary and rechargeable batteries, which severely limit mission endurance and capabilities, by extending microelectronic machine technology to develop micro-

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power genrators based on mechanical actuation and thermal-electric power generation. Operating with traditional fuels, these micro-power generators will be capable of generating sustained power in the desired range for use with remote, field-deployed microsensors and microactuators.

(U) Within this project is the development of totally integrated microfluidic chips to enable ubiquitous yet unobtrusive assessment of the warfighter's body fluids. These microchips integrate detection, diagnostics and treatment in one chip-scale system called Bio-Fluidic chips.

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- MEMS Devices and Processes. ($ 17.344 Million)
  - Demonstrated radio frequency electromechanical signal processing; MEMS-based mass data storage; massively parallel read/write structures; micro thrusters for satellite attitude, propulsion and control.

- MEMS System Design and Development. ($ 20.379 Million)
  - Initiated concept demonstrations for systems in the form of aerodynamic control of model aircraft; low-power wireless integrated microsensor for structural health, maintenance and monitoring; gas-phase microinstruments; polymer-based MEMS; and micro power sources.
  - Demonstrated a MEMS miniaturized fuze/safety and arming device for use in small diameter submarine torpedo counter weapons.

- MEMS Support and Access Technology. ($ 19.132 Million)
  - Integrated development in robotics and ultra-miniaturized electronics to design, construct and field mutiple, high performance, mobile, autonomous systems.

- CAMD. ($ 3.863 Million)
  - Continued micro device manufacturing processes at the Center for Advanced Microstructures and Devices (CAMD).

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- Microfluidics. ($ 15.237 Million)
  - Demonstrated a microfluidic sensor system capable of indicating specific DNA hybridization events.
  - Demonstrated detection of pathogens or protein molecules without requiring reporters by using coated beads and DEP/FFF/IS (dioelectrophoresis-field flow fractionation-impedance sensor).
  - Demonstrated prototype microfluidic system to reconstitute a 20-ml volume of lyophilized material in one minute to five-percent reconstitution accuracy using thermocapillary pumping and mixing.
  - Demonstrated automated isothermal DNA analyzer: multichannel, microchip device with integrated aerosol collector.
  - Demonstrated portable biodetector prototype with sensitivity for three types each of bacteria, viruses and toxins as well as sensitivity to unknown toxicants by cell or coated beads.

(U) FY 2000 Plans:

- MEMS Devices and Processes. ($ 20.500 Million)
  - Develop new devices and processes that survive extremely harsh environments and facilitate the integration of micro-mechanical as well as micro-chemical systems into electronic circuits. These new devices include micro power sources, mechanical-microprocessor units, micro actuators, communication components, MEMS aerodynamic pressure sensors on flexible adhesive tape substrate; modular, monolithically integrated MEMS Inertial Measuring Unit (IMU); and MEMS high-temperature sensor and actuator arrays.
  - Demonstrate micro devices that will reduce communication equipment to the size of a credit card; optimize the aerodynamics of an airplane wing for lift and drag; provide intelligence to machine components to allow them to report their condition and state of readiness (e.g., “smart wheel bearings”); and increase the resistance of jamming of GPS used on smart munitions.
  - Integrate power sources with the MEMS devices and expand the use of MEMS in fluidic applications.

- MEMS System Design and Development Phase II. ($ 16.211 Million)
  - Initiate technology demonstrations relevant to micro airborne sensor/communicator platforms and chemically powered remote sensors; subsystems for PicoSatellites; electromechanical signal processing; and nanoelectromechanical systems.

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- CAMD. ($ 4.000 Million)
  - Continue microdevice manufacturing processes at the Center for Advanced Microstructures and Devices (CAMD).

- MEMS MicroPower Generation. ($ 25.000 Million)
  - Demonstrate feasibility and practical limits of converting chemical energy into electrical energy on the micro-scale using MEMS technology. The goal is to replace primary and rechargeable batteries with micro power generators that have at least one order of magnitude higher energy density, and thus drastically reducing weight and volume of power sources.
  - Develop high-energy density power generation on micro-scale from fuels.
  - Develop stand alone, remotely distributed MEMS sensor networks.

- Bio-Fluidic Chips (BioFlips). ($ 9.000 Million)
  - Design microscale fluidics integrated with optical and/or electronic detection to monitor cellular activities of body fluids.
  - Design chip interface with bio-fluids for continuous sampling and fluids delivery.
  - Develop on-chip reagent storage and reconstitution.

(U) **FY 2001 Plans:**

- MEMS Micro Power Generation . ($ 19.844 Million)
  - Demonstrate chip-level integration of components for fuel processing, thermal management, energy conversion and exhaust management for micro power generation. Enable stand alone, remotely distributed micro sensors with built-in power supply and RF communication in addition to various sensing functions.
  - Develop MEMS free-piston knock engine.
  - Develop an integrated fuel cell and fuel processor for microscale power generation from liquid fuels.
  - Develop integrated chemical fuel microprocessor for power generation in MEMS applications.
  - Develop 3-D monolithically-fabricated thermoelectric microgenerator.

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- Bio-Fluidic Chips (BioFlips). ($ 17.868 Million)
  - Develop closed-loop bio-fluidic chips to regulate cellular transduction pathways and precise dosage of chemicals/drugs/ reagents/enzymes.
  - Fabricate and test individual microfluidic chip components and integrated sensors for flow control.
  - Manipulate (pump/valve/sense) bio-fluids in integrable microfluid components.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Mar 00	Demonstrate electromechanical signal processing.
May 00	Demonstrate MEMS aerodynamic pressure sensors on flexible, polyamide belt.
Jun 00	Demonstrate modular, monolithically integrated MEMS Inertial Measurement Unit (IMU).
Aug 00	Demonstrate subsonic roll, pitch and yaw control via MEMS.
Sep 01	Demonstrate atomic resolution data storage.
Aug 02	Demonstrate MEMS micro combustion.
Feb 03	Demonstrate MEMS heat engines.
Sep 03	Demonstrate MEMS electrical power generation.

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COST *(In Millions)*	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Mixed Technology Integration MT-15	0.000	22.291	49.476	52.959	56.800	57.300	57.300	Continuing	Continuing

(U) Mission Description:

(U) The goal of the Mixed-Technology Integration project is to leverage advanced microelectronics manufacturing infrastructure and DARPA component technologies developed in other projects to produce mixed-technology microsystems that will revolutionize the way individuals see, hear, taste, smell, touch and control their environment at-a-distance, a paradigm that addresses many of the present and future needs of the DoD. These 'wrist watch-size', low-cost, lightweight and low power microsystems will improve the battlefield awareness and security of the warfighter and the operational performance of military platforms. At the present time, systems are fabricated by assembling a number of mixed-technology components: Microelectromechanical Systems (MEMS), microphotonics, microfluidics and millimeterwave/microwave. Each technology usually requires a different level of integration, occupies a separate silicon chip and requires off-chip wiring, fastening and packaging to form a module. The chip assembly and packaging processes produce a high cost, high power, large volume and lower performance system. This program is focused on the monolithic integration mixed technologies to form batch-fabricated, mixed technology microsystems 'on-a-single-chip' or an integrated and interconnected 'stack-of-chips'.

(U) Microelectronics incorporates micrometer/nanometer scale integration and is the most highly integrated, low-cost and high-impact technology to date. Microelectronics technology has produced the microcomputer-chip that enabled or supported the revolutions in computers, networking and communication. This program extends the microelectronics paradigm to include the integration of heterogeneous or mixed technologies. This new paradigm will create a new class of 'match-book-size', highly integrated device and microsystem architectures. Examples of component-microsystems include low-power, small-volume, lightweight, microsensors, microrobots and microcommunication systems that will improve and expand the performance of the warfighter, military platforms, munitions and UAVs.

(U) The program includes the integration of mixed materials on generic substrates including glass, polymers and silicon. The program is design and process intensive, using 'standard' processes and developing new semiconductor-like processes and technologies that support the integration of mixed-technologies at the micrometer/nanometer scale. The program includes the development of micrometer/nanometer scale isolation, contacts, interconnects and 'multiple-chip-scale' packaging for electronic, mechanical, fluidic, photonic and rf/mmwave/microwave technologies. For example, a mixed-technology microsystem using integrated microfluidics, MEMS, microphotonics, microelectronics and

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microwave components could provide a highly integrated, portable analytical instrument to monitor the battlefield environment, the physical condition of a warfighter, the identity of warfighters (friend or foe) or the combat readiness of equipment. The ability to integrate mixed technologies onto a single substrate will drive down the size, weight, volume and cost of weapon systems while increasing their performance and reliability.

(U) Program Accomplishments and Plans:

(U) FY 1999 Accomplishments:

- Not Applicable.

(U) FY 2000 Plans:

- Three-D Imaging Devices. ($ 7.310 Million)
  - Initiate program to develop new high speed imaging device technology to rapidly acquire a high-resolution 3-D image of a tactical target at ranges of 7-10 kilometers increasing identification range of tactical targets, especially from fast moving platforms.
  - Develop near infrared materials with point defect density less than 1000/sq cm.
  - Demonstrate 4x4 array of detectors with gain of 30 at 1GHz.
  - Complete investigation of novel high gain detector concept.

- Steered Agile Laser Beams. ($ 6.830 Million)
  - Initiate program to develop compact, lightweight, man-portable, electronically steered lasers to replace large, heavy gimbal mounted lasers in lasercom links and smart weapon target designators.
  - Develop small, lightweight laser beam scanner system technologies for replacement of gimbaled mirror systems.
  - Initiate system design and component specifications; select system design.

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- RF Lightwave Integrated Circuits (R-FLICS). ($ 8.151 Million)
  - Initiate program to demonstrate, with heterogeneous integration, lightwave and RF technologies to route, control and process analog RF Signals in the 0.5-50 GHz range.
  - Develop RF-Photonic modules to enable links with better than zero net RF loss from input to output.
  - Develop and demonstrate optically integrated modules capable of performing complex RF functions such as signal channelization or single chip generation of multiple RF signals.

(U) FY 2001 Plans:

- Three-D Imaging Devices. ($ 16.825 Million)
  - Complete design of high-speed electronics for sub-nanosecond detection.
  - Integrate high-speed electronics with 5x5-detector array and integrate into brass board imaging system.
  - Demonstrate laboratory imaging with 5x5 array.
  - Select detector design for 128x128 3-D imaging array.

- Steered Agile Laser Beams. ($ 17.825 Million)
  - Develop electronically steered laser beam technology for use in covert, anti-jam, high bandwidth battlefield communications - hand held ground-to-ground recon units, which are able to transmit images and geo-location data of targets, and for use in target designators for small unit operations in high threat environments.
  - Fabricate beam steering emitters and detectors.

- RF Lightwave Integrated Circuits (R-FLICS). ($ 14.826 Million)
  - Focus program on identified key applications for integrated RF-Photonic modules and produce initial prototypes and demonstrate methods for evaluation of their performance.
  - Initiate parallel efforts to develop components for efficient RF links exhibiting better than zero net loss and to demonstrate the advantages of integrated optical-RF modules for RF systems.
  - Down select among technology options and develop prototype module for demonstration.

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(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
3-D Imaging:	
May 00	Develop low defect density near infrared materials suitable for high speed imaging.
Aug 00	Demonstrate detector test arrays with gain/bandwidth product capable of sub-nanosecond detection at long range.
Feb 01	Integrate novel, high gain/bandwidth detector array with low noise electronics.
Steered Agile Laser Beams:	
Feb 00	Select system configuration that best meets insertion target performance goals.
May 00	Derive component specifications.
Aug 01	Fabricate beam steering emitters and detectors.
R-FLICS:	
Feb 01	Demonstrate High Performance R-FLIC Components to 50 GHz bandwidth.
Aug 01	Demonstrate integrated R-FLIC functions such as channelizer with 10 GHz selectivity over 0-50 GHz bandwidth.