RDT&E BUDGET ITEM JUSTIFICATION SHEET (R-2 Exhibit)									DATE February 1999	
APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development					R-1 ITEM NOMENCLATURE Advanced Electronics Technologies PE 0603739E, R-1 #41					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost To Complete	Total Cost
Total Program Element (PE) Cost	272.020	265.442	246.023	233.198	232.534	247.767	259.354	258.154	Continuing	Continuing
Uncooled Integrated Sensors MT-03	8.289	12.895	10.791	12.000	7.000	0.000	0.000	0.000	0	N/A
Electronic Module Technology MT-04	65.515	62.985	56.686	41.245	40.849	59.667	63.029	64.829	Continuing	Continuing
Tactical Information Systems MT-05	28.328	30.998	15.605	17.748	18.100	0.000	0.000	0.000	0	N/A
Microwave and Analog Front End Technology MT-06	17.543	3.962	0.000	0.000	0.000	0.000	0.000	0.000	0	N/A
Centers of Excellence MT-07	5.904	6.405	4.000	0.000	0.000	0.000	0.000	0.000	0	N/A
Manufacturing Technology Applications MT-08	26.175	21.991	21.846	4.000	6.000	0.000	0.000	0.000	0	N/A
Advanced Lithography MT-10	49.710	49.362	44.429	45.000	45.000	45.000	45.000	45.000	Continuing	Continuing
Microelectromechanical Systems (MEMS) MT-12	70.556	76.844	70.098	63.350	70.575	93.100	101.325	98.325	Continuing	Continuing
Mixed Technology Integration MT-15	0.000	0.000	22.568	49.855	45.010	50.000	50.000	50.000	Continuing	Continuing

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

(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 both commercial and military applications. Introduction of advanced product design capability and flexible, scalable manufacturing techniques will enable the commercial sector to rapidly and cost-effectively satisfy military requirements and enhance the US industrial base.

(U) The Uncooled Integrated Sensors project addresses a long standing Defense requirement for uncooled, solid state advanced infrared sensor arrays for major weapons systems that do not require costly cryogenic cooling packages.

(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 (MCMs).

(U) The Tactical Information Systems project contains two major programs: Smart Modules and Warfighter Visualization. Smart Modules is a program to design and develop prototype modules, using core technologies that sense, think and communicate, and integrate them into selected personal information products. Warfighter Visualization is a program to demonstrate 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.

(U) The goal of the Manufacturing Technology Applications project 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 will also enable manufacturers to economically produce military variants of their commercial products in limited quantities through the introduction of flexible process technologies.

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

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(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.

(U) The goal of the newly established 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) Finally, one on-going DARPA project completes in FY 1999: MAFET (MT-06) and another Centers of Excellence (MT-07) completes in FY 2000. The Microwave and Analog Front End Technology (MAFET) project has been directed at significantly reducing non-recurring costs for military microwave/millimeter wave sensor systems through improved computer aided design capabilities. The Centers of Excellence project finances demonstration, training and deployment of advanced manufacturing technologies.

(U) **Program Change Summary:** (*In Millions*)	**FY1998**	**FY 1999**	**FY 2000**	**FY 2001**
Previous President's Budget	281.909	244.737	259.014	212.385
Current Budget	272.020	265.442	246.023	233.198

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(U) **Change Summary Explanation:**

FY 1998	Decrease reflects acceleration of MAFET program phase down with anticipated completion by the end of FY 1999 and SBIR reprogramming.
FY 1999	Increase reflects the Congressional adds to the Advanced Lithography, X-Ray Masks, Laser Plasma X-Ray Source Technology, CAMD, NanoTech and Crystalline Arrays and Defense Techlink Center programs.
FY 2000	Decrease reflects completion of the composite CAD program, Smart Module program and reduction associated with inflation.
FY 2001	Increase reflects initiation of the Mixed Technology Integration program and expansion of the Advanced Lithography program.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development					R-1 ITEM NOMENCLATURE Advanced Electronics Technologies PE 0603739E, Project MT-03					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Uncooled Integrated Sensors MT-03	8.289	12.895	10.791	12.000	7.000	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 (IR) 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 1998 Accomplishments:

- Demonstrated uncooled infrared array with thermal sensitivity of 0.05 degrees. ($ 3.289 Million)
- Demonstrated low light level solid state imager with anti-blooming protection. ($ 5.000 Million)

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(U) FY 1999 Plans:

- Uncooled Integrated Sensors - Demonstrate uncooled infrared array with thermal sensitivity of 0.05^{o} C. Demonstrate low power micro-bolometer sensor for unattended ground sensors. Fabricate and test uncooled infrared array and low power solid state low light level array. ($ 10.572 Million)

- Thermal Imaging Devices - Fabricate and evaluate microstructures with thermal isolation properties five to ten times less than current thermal devices. ($ 2.323 Million)

(U) FY 2000 Plans:

- Uncooled Integrated Sensors - Demonstrate 480x640 uncooled with < .05 milli-kelvin, 1 mil pixel. Transfer 480 x 640 uncooled infrared sensor to Army missile seeker program. Field evaluation of high sensitivity uncooled infrared sensor with low light sensor for ground operations. ($ 2.791 Million)

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

(U) FY 2001 Plans:

- Thermal Imaging Devices - Demonstrate 25 gram imaging sensor with performance acceptable for micro-air-vehicles. Optimize read-out structure to read signals with short (approx. 1 msec.) integration time. ($ 12.000 Million)

(U) Other Program Funding Summary Cost:

- Not Applicable.

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(U) Schedule Profile:

Plan	Milestones
Aug 99	Demonstrate feasibility of uncooled infrared array with thermal sensitivity of 0.05^{o} C.
Sept 99	Demonstrate low power micro-bolometer sensor for unattended ground sensors.
Sept 99	Fabricate and test uncooled infrared array and low power solid state low light level array.
Sept 00	Field evaluation of high sensitivity uncooled sensor with low light level sensor for ground operations.
Nov 00	Demonstrate 25 gram imaging sensor with performance acceptable for micro-air-vehicles.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development					R-1 ITEM NOMENCLATURE Advanced Electronics Technologies PE 0603739E, Project MT-04					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Electronic Module Technology MT-04	65.515	62.985	56.686	41.245	40.849	59.667	63.029	64.829	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 (MCMs).

(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; (3) provide a robust manufacturing infrastructure for electronic modules; and (4) demonstrate the system level payoff of electronic module technology through advanced technology demonstrations (ATDs).

(U) The project has the following major elements: Photonic Analog/Digital (A/D) Conversion; Optical Micro-Networks (OMNET); Distributed Robotics; Design Support for Mixed Technology Integration (Composite CAD) and the Molecular-Level Large-Area Printing (MLP) program. OMNET seeks to demonstrate new paradigms for integrating electronic, electromechanical and electro-optical components to enable small, lightweight, battlefield information systems. Distributed Robotics is a new effort to integrate developments in 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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(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Completed Application Specific Electronic Modules (ASEM) program that reduced non-recurring engineering costs for designing and inserting multi-chip modules. ($ 5.083 Million)
- Completed the Multichip Integration (MCI) program that improved substrate fabrication, demonstrated reductions in Multichip Modules (MCM) manufacturing costs and technology insertions. ($ 14.300 Million)
- Optical Micro-Networks (OMNET) - Downselected amongst heterogeneous integration technologies and demonstrated multi-functional integration of electronic, electro-mechanical and optoelectric components targeted to military information systems. ($ 12.700 Million)
- Distributed Robotics - Initiated effort to put together, in one package, low-weight (<2 kg), high-performance payloads including sensors, imagers, countermeasures, designators, communications and munitions. ($ 8.800 Million)
- Composite CAD - Integrated a composable design capability for single chip electronics and MEMS systems. Developed models with parameters optimized for manufacturing variances. Initiated behavior modeling of mixed technology devices. ($ 15.900 Million)
- Molecular-level, Large-area Printing (MLP) - Established preliminary micro-molding process using commercially available (CD manufacturing) tool; initiated studies of alternative micro-printing processes (letterpress, gravure, and tropomorphic). ($ 8.732 Million)

(U) FY 1999 Plans:

- OMNET - Demonstrate integrated optoelectronic transceivers and optical switches for reconfigurable interconnections of sensors to processors and the ability to distribute computation across military platforms 1-100 meters in length for future Electronic Warfare/digital radar and image processors. ($ 11.000 Million)

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

- Composite CAD - Continue 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. ($ 17.993 Million)

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

- Molecular-Level Large-Area Printing (MLP) - Complete experimental characterization of release agents for micromolding; select candidate printing processes (≤2) and compatible readout process for development; and demonstrate writing on non-flat surfaces with radii of curvature in the range 1m to 1cm. ($ 11.992 Million)

(U) **FY 2000 Plans:**

- Phototonic A/D - Demonstrate key optical clock, optical sampler and related optical technologies for photonic A/D converters operating in the 10-100 Giga sample per second range and identify high impact applications for this technology. ($ 15.100 Million)

- Distributed Robotics - Demonstrate feasibility of a variety of different robots (<5cm) to operate in specific military environments and their ability to adapt to varying environments and missions. Initiate effort to develop millimeter sized robots. ($ 18.000 Million)

- Composite CAD - 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. ($ 9.544 Million)

- MLP - Concentrate on the development and choice of non-conventional large-area, MLP techniques for a demonstration system. ($ 14.042 Million)

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(U) FY 2001 Plans:

- Phototonic A/D - Complete initial photonic A/D converter evaluation and finalize design for demonstration module. ($ 14.500 Million)
- Distributed Robotics - Develop prototype millimeter sized robots using fundamental behavioral control mechanisms for sensing and communicating. ($ 13.000 Million)
- Molecular-level, Large-area Printing (MLP) - Concentrate on the demonstration of the use of MLP for realizing a wide area, super-high-resolution (e.g. 100-megapixel, corresponding to about 1,000 TV images) imaging system as needed, for example, for automatic threat warning. ($ 13.745 Million)

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Jul 99	Demonstrate mixed energy domain analysis capability for integrated technology devices.
Aug 99	Demonstrate optical micronetwork with reconfiguration capability.
Nov 99	Initial prototype of tightly integrated adaptive payload technology.
Apr 00	Characterization of single crystal semiconductors on amorphous surfaces.
Jun 00	Establish overlay capabilities for MLP.
Sep 00	Design and initiate fabrication of demonstration sensor array.
Sep 00	Demonstrate initial PCM designs (<10-femtosecond jitter, 100 on W output).
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 Technologies PE 0603739E, Project MT-05					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Tactical Information Systems MT-05	28.328	30.998	15.605	17.748	18.100	0.000	0.000	0.000	0.000	N/A

(U) Mission Description:

(U) This project is a major DoD effort to develop the technology for displays and portable information systems for use in a variety of military systems. The project has two major efforts: Smart Modules and Warfighter Visualization. Smart Modules will design, develop and integrate prototype modules, using core technologies that sense, think and communicate into selected personal information products. Warfighter Visualization efforts demonstrate 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.

(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Demonstrated prototype electronic countermeasures system integrated into a soldier worn vest. The computational capability developed in the FY 1997 program was augmented with two PC cards containing electronic counter measures (ECM) circuitry that allowed dismounted soldiers to instantly locate radio emissions from hostile forces. Demonstrated a prototype waterproof computer for underwater use in Navy SEAL and Explosive Ordnance Disposal applications. ($ 14.200 Million)

- Continued efforts to develop hand and head motion tracking technologies. Tracking head movement will allow a computer to display information to a head mounted display that is registered in the geospatial direction that the individual is looking. Tracking hand motion will allow a computer to recognize pointing and gestures as input mechanisms instead of using a keyboard. ($ 6.400 Million)

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- Demonstrated image capture and geospatial registration of icons on terrain in a moving vehicle. The vehicle was equipped with video cameras that provided a 360 degree view. Inside the vehicle, a person wearing a head tracked, head mounted display was able to look around and view the images obtained from the cameras. Icons and graphical images generated by a computer were overlayed on the camera image in the head mounted display. These images were registered with the viewed real-world terrain. ($ 7.728 Million)

(U) **FY 1999 Plans:**

- Demonstrate 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, will be able to capture an image and rapidly analyze movement or correlate images with all processing done on the focal plane. The camera will be able to be worn by individual soldiers and communicate via a radio to and from geographic information system databases. ($ 9.200 Million)

- Demonstrate 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. ($ 9.900 Million)

- Demonstrate prototype capability for dismounted soldiers to view the real world with overlayed graphic symbology. This capability will allow the soldier to receive visual information that is relevant to his/her mission time or location. It will also allow the soldier to interrogate databases containing information about the specific objects in his/her viewing environment. ($ 5.800 Million)

- Demonstrate prototype “see-through” tank concept. This capability will allow a “buttoned-up” tank crew wearing head mounted displays to view the outside world as though the tank were made of glass. This will be accomplished by placing cameras on the outside of the tank that provide inputs to a mapped memory. Images will be fed to the user’s head mounted display depending upon the direction that the user is looking. This capability will significantly enhance the situation awareness of the tank crew. ($ 6.098 Million)

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(U) FY 2000 Plans:

- Warfighter Visualization:

  - Demonstrate a non-metallic tracking system for mounted and dismounted soldiers. System gives accurate low lag estimates of head position and pose for body oriented battlefield visualization. System is necessary for visual data correlation system and see through combat vehicle applications. ($ 3.300 Million)

  - Develop a two-chip image processing system for integration into battlefield smart camera. This system will shrink multiple electronics boards into a small enough package for applications in night vision goggles, UAV surveillance and headworn image stabilization. ($ 4.105 Million)

  - Demonstrate a prototype supernormal listening system for enhanced battlefield awareness. This system will enhance hearing capability and improve situation awareness and voice communications in both quiet and loud ambient noise environments. ($ 3.600 Million)

  - Portable Sensor Datalink – Demonstrate ultra low power, low cost, fully integrated micro-sensor interconnection network technology for harsh battlefield environments. Assure continuous warfighter medical monitoring in the presence of jammers and other interferers using structured noise. Exploit innovations in ultra-wideband technology to provide reliable links to wearable and other instrumented military systems. ($ 4.600 Million)

(U) FY 2001 Plans:

- Warfighter Visualization:

  - Demonstrate a two-camera prototype image sensor system giving high resolution imaging over 360 degrees with low delay. This system is essential for the realization of a cost-effective “see through” vehicle. ($ 2.048 Million)

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- Demonstrate an experimental low cost, lightweight perimeter monitoring system for dismounted soldiers. System creates a protection "dome" around sleeping soldiers to alert against intruders. ($ 4.100 Million)

- Demonstrate a prototype, bodyworn, 3-D mission re/planning tool. System allows virtual "walk through" of operations area and real-time editing. System also gives visualization of dynamic multi-sensor I/O on the battlefield. ($ 4.600 Million)

- Portable Sensor Datalink – Develop connection solutions for Condition Based Maintenance automated equipment-monitoring systems to vastly improve safety, increase reliability and reduce costs in military systems. Develop command and control system on-a-chip for miniaturized aerial and ground warfighting platforms. ($ 7.000 Million)

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Dec 99	Build and test Advanced Humanistic Platform prototype.
Dec 99	Develop hybrid sensor tracking features and including "smart camera" functions to allow collaborative updates between soldiers.
Jul 00	Develop real-time visual data correlation system in dismounted and mounted warrior applications.
Jul 01	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 Technologies PE 0603739E, Project MT-06					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Microwave and Analog Front End Technology MT-06	17.543	3.962	0.000	0.000	0.000	0.000	0.000	0.000	0.000	N/A

(U) Mission Description:

(U) Microwave and millimeter wave technology for DoD electronic weapon systems is at a critical crossroads. Great progress has been made under the microwave and millimeter wave integrated circuit (MIMIC) program in terms of maturing the gallium arsenide industrial community. The DoD is now far ahead of the commercial world in microwave and millimeter wave technology in terms of performance characteristics. However, in many cases, radio frequency (RF) sub-system costs are still a major impediment to fielding DoD weapon systems. Material, processes and design technology advances must be undertaken to sustain an effective defense capability and to maintain U.S. dominance in this critical technology area. The MAFET program has addressed this problem by: (1) reducing design time and cost for every RF system being developed or upgraded through an improved microwave/millimeter wave design environment; (2) breaking the very expensive cycle and time-consuming current practice of design-build-test--redesign-rebuild-retest; (3) establishing repeatable, robust processes to produce high frequency components; (4) making strategic investments in critical passive, packaging and integrated circuits devices needed for millimeter wave systems; and (5) investigating revolutionary solutions to the long-standing problem of insufficient power in solid-state radar and communications transmitters.

(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Completed microwave/millimeter wave computer aided design environment. Demonstrated design environment effectiveness. Continued implementation of Microwave Hardware Description Language (MHDL). ($ 6.000 Million)

- Completed advanced sensor technology developments in the areas of: advanced fabrication, packaging and multichip assembly (MCA) foundries. ($ 5.200 Million)

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- In novel high-power transistor area, demonstrated 5-W SiGe HBT solid-state power amplifier (SSPA) having near-50 percent power-added efficiency (PAE) in X-band; demonstrated 10-W GaN MODFET having PAE=50 percent in X-band; demonstrated 25-W SiC MESFET having PAE=45 percent in X-band. In quasioptics area, continued development of solid-state quasioptical Ka-band sources with high output power and high coherence; completed and demonstrated numerical design tool. In MEMS-switch area, demonstrated 4-bit true-time-delay phase shifter in (a) X-Band with 2-dB total loss, and (b) Ka-Band with 3-dB loss; demonstrated 20/44-GHz dual-frequency MEMS-switched planar antenna. In micromachined circuits and novel thermal management area, demonstrated micromachined W-band Wilkinson combiners in Si substrates; demonstrated Flourinert cooling of a 10-W X-band MMIC and a 1-W Ka-band MMIC. ($ 6.343 Million)

(U) FY 1999 Plans:

- In quasioptics area, demonstrate a set of quasioptical grid-, array-, card- and slab-combined power amplifiers. ($ 1.962 Million)
- In MEMS-switch area, demonstrate MEMS-tunable Chebyshev filter operating at 20 and 45 GHz; demonstrate MEMS-array transmitting beam-steerer at 44 GHz. ($ 1.000 Million)
- In micromachined circuits and novel thermal management area, demonstrate a micromachined SSPA ("W-Band Power Cube") having 2 W/in^2 intensity radiated from top facet. The power cube will be fabricated with InP Power MMICs that are thermally managed by bump bonding and are coupled to free space by Si-micromachined feed-line and planar-antenna structures. ($ 1.000 Million)

(U) FY 2000 Plans:

- Not Applicable.

(U) FY 2001 Plans:

- Not Applicable.

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(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Mar 99	Demonstrate millimeter wave beam steering module.
Jun 99	Demonstrate > 100-W low cost X-band electronically steerable source.
Sep 99	Demonstrate full interoperability of CAD vendors.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development					R-1 ITEM NOMENCLATURE Advanced Electronics Technologies PE 0603739E, Project MT-07					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Centers of Excellence MT-07	5.904	6.405	4.000	0.000	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 and the Defense Techlink Rural Technology Transfer Project. 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.

(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Completed development of internetting capabilities at the Institute for Advanced Flexible Manufacturing to ensure medium- and small-sized businesses have access to emerging electronic commerce and advanced technologies. ($ 3.804 Million)
- Continued efforts with centers of excellence to support students, researchers and executives to understand Japan's manufacturing infrastructure, culture and language. ($ 1.100 Million)
- Provided funding for the Defense Techlink Rural Technology Transfer Project per Congressional direction. ($ 1.000 Million)

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(U) FY 1999 Plans:

- Complete expansion of the Institute for Advanced Flexible Manufacturing's satellite facilities. ($ 3.961 Million)
- Complete efforts with centers of excellence to support students', researchers' and executives' understanding of Japan's manufacturing infrastructure, culture and language. ($ 1.444 Million)
- Provide funding for the Defense Techlink Rural Technology Transfer Project per Congressional direction. ($ 1.000 Million)

(U) FY 2000 Plans:

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

(U) FY 2001 Plans:

- Not Applicable.

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Oct 00	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 Technologies PE 0603739E, Project MT-08					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Manufacturing Technology Applications MT-08	26.175	21.991	21.846	4.000	6.000	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) The goal of the Low Observable Optical Fibers program is to develop low visibility optical fibers that will have the capability of propagating high data rates over significant distances. The objective is to reduce the diameter of the fibers from the current 150/100-micron levels to a 30-micron range while at the same time maintaining 1 Gbits/s transmission rate over a range of 10 kilometers. Potential applications for "invisible" optical fibers are direct hardware connectivity for tactical operation centers and inter-echelon networking. In addition, such technology could provide the intelligence community and/or special operation forces with a covert high-speed link to concealed remote sensors or listening devices.

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(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Affordable Multi-Missile Manufacturing (AM3). ($ 21.372 Million)
  - Began AM3 Phase 3 implementation of new factory systems and new business practices.
  - Completed initial design and test planning for AM3 multi-missile components and value engineering change proposals.
  - Completed initial demonstrations of supply chain technologies to fill gaps identified in AM3 Phase 1.
  - Continued technical integration and independent cost analysis.

- Interferometric Fiber Optic Gyroscope (IFOG). ($ 4.803 Million)
  - Demonstrated flexible production of navigation grade and tactical grade IFOG units.
  - Demonstrated production of high power, stable, packaged optical sources, low cost couplers and wavelength division multiplexers.
  - Improved Magnetic Field and temperature sensitivity of IFOG Instruments further improved packaging and tests for low cost performance.

(U) FY 1999 Plans:

- Affordable Multi-Missile Manufacturing. ($ 21.991 Million)
  - Continue AM3 Phase 3 implementation of flexible multi-product assembly cells and prototype production of missile hardware.
  - Conduct initial tests of missile seekers built with the Affordable Multi-Missile Manufacturing scalable family of parts and commercial components.

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(U) FY 2000 Plans:

- Affordable Multi-Missile Manufacturing. ($ 19.846 Million)
  - Complete integration of flexible factory assembly areas.
  - Deploy System Integrated Design Environment.
  - Complete design and prototype fabrication of low cost inertial measurement unit (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.

- Low Observable Optical Fibers. ($ 2.000 Million)
  - Develop techniques and capabilities to draw and measure optical fibers on the order of 30-micron range.
  - Conduct perception tests and analysis.

(U) FY 2001 Plans:

- Low Observable Optical Fibers. ($ 4.000 Million)
  - Produce fibers for physical testing including optical transmission, bend tensile strength and durability testing as well as investigate fiber deployment mechanisms.

(U) Other Program Funding Summary Cost:

- Not Applicable.

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(U) Schedule Profile:

Plan	Milestones
Oct 99	Complete integration of flexible factory assembly areas.
Oct 99	Complete common seeker commercial parts test evaluation, producibility analysis, and flight test.
Dec 99	Complete AM3 Phase 3 multi-missile manufacturing demonstrations.
Jan 00	Deploy System Integrated Design Environment.
Jan 00	Complete common inertial measurement unit design verification test, prototype demonstration unit and technology insertion review.
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	Complete integration of guided flight unit, gyro optics assembly fabrication and mid-body casting demonstrations.
Jul 00	Complete electronic procurement and supplier integration demonstrations.
Dec 00	Complete low observable optical fiber production assessment.
Sep 01	Complete low observable optical fiber physical testing.

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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development					R-1 ITEM NOMENCLATURE Advanced Electronics Technologies PE 0603739E, Project MT-10					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Advanced Lithography MT-10	49.710	49.362	44.429	45.000	45.000	45.000	45.000	45.000	Continuing	Continuing

(U) Mission Description:

(U) Microelectronics is a key to improved weapon system performance and 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.

(U) Program Accomplishments and Plans:

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(U) FY 1998 Accomplishments:

- Researched efforts for sub 0.1 micron in maskless lithography (emitter arrays and photocathodes), innovative imaging materials and network of university efforts in novel patterning. ($ 19.400 Million)
- Completed development of crosscutting technology in precision stages and mask making (e-beam writing and inspection) for 0.13 - 0.10-micron features. ($ 6.200 Million)
- Completed point-source x-ray lithography program. ($ 2.800 Million)
- Continued funding of the Lithographic and Alternative Semiconductor Processing Techniques (LAST) Center to develop mask technology for semiconductor device fabrication. ($ 16.700 Million)
- Continued Laser Plasma x-ray source technology. ($ 4.610 Million)

(U) FY 1999 Plans:

- Continue efforts in maskless lithography, including arrays of miniature e-beam columns, novel imaging materials and pattern transfer processes.
  - Continue network of university efforts in novel patterning. ($ 9.062 Million)
  - Complete column test stand for maskless e-beam writer. ($ 17.000 Million)
- Continue laser plasma x-ray source technology. ($ 6.000 Million)
- Continue x-ray mask writer development. ($ 7.000 Million)
- Develop x-ray masks for the F-22, Apache Longbow and other defense programs. ($ 7.000 Million)
- Continue research in nanotechnology and crystalline control arrays. ($ 3.300 Million)

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(U) FY 2000 Plans:

- 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. ($ 26.000 Million)

- Develop support technologies, to include mask technology, resists and metrology. Develop innovative optics designs sand architectures, and new materials and processing beyond the evolutionary trends in the industry. ($ 18.429 Million)

(U) FY 2001 Plans:

- Demonstrate maskless wafer writer and characterize performance. ($ 26.000 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. ($ 19.000 Million)

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Jun 99	Demonstrate switched emitter arrays for maskless lithography.
Jul 00	Demonstrate ion microcolumn for maskless lithography.
Mar 01	System demonstration of maskless charged particle 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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APPROPRIATION/BUDGET ACTIVITY RDT&E, Defense-wide BA3 Advanced Technology Development					R-1 ITEM NOMENCLATURE Advanced Electronics Technologies PE 0603739E, Project MT-12					
COST *(In Millions)*	FY 1998	FY 1999	FY 2000	FY 2001	FY 2002	FY 2003	FY 2004	FY 2005	Cost to Complete	Total Cost
Microelectromechanical Systems (MEMS) MT-12	70.556	76.844	70.098	63.350	70.575	93.100	101.325	98.325	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 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 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. The microfluidic molecular systems program will address issues centered around the development of automated microsystems that integrate biochemical fluid handling capability along with electronics, optoelectronics and chip-based reaction and detection modules to perform tailored analysis sequences for the monitoring of 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 products 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) Among the many accomplishments to date are: a wind-tunnel test of an integrated MEMS sensor and actuator array distributed along the leading edge of a model aircraft wing creating rolling moments of sufficient strength to control aircraft flight, pointing the way to future fighter aircraft with advanced maneuverability unattainable using conventional, large and discrete control surfaces; a demonstration of a MEMS-based accelerometer capable of surviving and operating in the near 100,000 G accelerations generated by firing artillery shells, making possible affordable guidance systems to what are presently unguided munitions and increasing both their effectiveness and life cycle costs; and the establishment of a

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regularly scheduled, shared, MEMS fabrication service for domestic DoD, commercial and academic users. The MEMS program has initiated new efforts in: low power miniaturized communications systems; distributed control aircraft roll and yaw; microscale power; micro airborne sensor/communication systems; data storage; and inertial systems.

(U) Program Accomplishments and Plans:

(U) FY 1998 Accomplishments:

- Devices and Processes - Accelerated and expanded on MEMS system developments that exploit physics and MEMS systems architecture to project micro-scale actions into macro-scale effects such as micro-optomechanical scanners, switches, displays, adaptive optics and aligners. ($ 19.000 Million)

- System Design and Development - Extended present fabrication processes to cost-effective, large area fabrication approaches. ($ 22.600 Million)

- Support and Access Technologies - Integrated developments in MEMS, robotics and ultra-electronics to design, construct and field multiple, high-performance, mobile, autonomous systems. ($ 8.600 Million)

- Microfluidics - Initiated system-level integration through an evolving testbed strategy, in which the development of new microfluidic components and processes occurred concurrently with the integration of early prototypes with available chip-based molecular analysis components. Leveraged analysis and detection technology from industry, Services and other DoD programs when compatible with microsystems integration. ($ 16.656 Million)

- Continued efforts at Center for Advanced Microstructures Devices (CAMD). ($ 3.700 Million)

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(U) **FY 1999 Plans:**

- MEMS Devices and Processes - Demonstrate radio-frequency electromechanical signal processing; MEMS-based mass data storage; massively parallel read/write structures; micro thrusters for satellite attitude, propulsion and control. ($ 10.000 Million)

- MEMS System Design and Development, Phase I - Initiate concept demonstrations for systems in the form of aerodynamic control of model aircraft; low-power wireless integrated microsensors. Demonstrate a MEMS miniaturized fuze/safety and arming device for use in small diameter submarine torpedo counter weapons. ($ 25.500 Million)

- MEMS Systems Design and Development, Phase II - Initiate concept demonstrations for microsensors for structural health, maintenance and monitoring; gas-phase microinstruments; polymer-based MEMS; micro power sources. ($ 22.244 Million)

- CAMD – Continue microdevice manufacturing processes at the Center for Advanced Microstructures and Devices (CAMD). ($ 3.863 Million)

- Microfluidics - Demonstrate a microfluidic sensor system capable of indicating specific DNA hybridization events. Demonstrate detection of pathogens or protein molecules without requiring reporters by using coated beads and DEP/FFF/IS (dioelectrophoresis-field flow fractionation-impedance sensor). Demonstrate 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. ($ 10.000 Million)

- Microfluidics - Demonstrate automated isothermal DNA analyzer: multichannel, microchip device with integrated aerosol collector. Demonstrate 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. ($ 5.237 Million)

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(U) **FY 2000 Plans:**

- MEMS Insertions/Integration - Merge sensing, computing and actuating to realize new systems and strategies. These new approaches will bring new perception and control functions to weapons and battlefield environments. Program is in its third phase, systems demonstrations and insertion, including: microassembled electromechanical signal processing; MEMS aerodynamic pressure sensors on flexible, adhesive tape substrate; modular, monolithically integrated MEMS IMU; and MEMS high-temperature sensor and actuator arrays. ($ 33.906 Million)

- MEMS Devices and Processes - Develop new devices and processes for heterogeneous integration of MEMS, including micro power sources, microprocessor units, micro actuators and communication components. ($ 11.667 Million)

- MEMS System Design and Development - Initiate concept demonstrations for systems in the form of "smart dust," micro airborne sensor/communicator platforms and chemically powered remote sensors. ($ 9.723 Million)

- MEMS Support and Access Technologies - Initiate demonstrations of MEMS microassembly, packaging and fabrication at distributed sites for robust sourcing of Integrated MEMS systems. ($ 6.538 Million)

- Microfluidics – Demonstrate microanalytical systems "on-a-chip" to sense the battlefield environment. Exploit microscale fluidics integrated with optical and/or electronic detection to monitor chemical, biological, fluid and gaseous substances of importance to the safety of the warfighter and military platforms. Develop and demonstrate new non-optical detection methods that can detect, probe and identify fluids, gases, DNA, cells and protein. ($ 8.264 Million)

(U) **FY 2001 Plans:**

- MEMS Integration/Devices and Processes - Continue development of devices and processes for heterogeneous integration of MEMS, including micro power sources, microprocessor units, micro actuators and communication components. ($ 24.456 Million)

- MEMS Integration/System Design and Development - Perform concept demonstrations for systems in the form of "smart dust," micro airborne sensor/communicator platforms and chemically powered remote sensors. ($ 16.930 Million)

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- MEMS Integration/Support and Access Technologies - Complete demonstrations of MEMS microassembly, packaging and fabrication at distributed sites for robust sourcing of Integrated MEMS systems. ($ 8.795 Million)

- Microfluidics – Develop new and more efficient specimen collection and concentrator devices to sample the battlefield and military platform environments. Develop self-contained systems for the "just-in-time" synthesis and precise delivery of small amounts of time-critical chemical or biological substances. ($ 13.169 Million)

(U) Other Program Funding Summary Cost:

- Not Applicable.

(U) Schedule Profile:

Plan	Milestones
Mar 99	Demonstrate scanning probe arrays for mass data storage.
Jun 99	Demonstrate multi-frequency, tunable RF and microwave filters, switches and phase shifters.
Jun 99	Demonstrate local micro-encapsulation of inertial instruments.
Sep 99	Demonstrate distributed, multiple, and miniature thrusters for satellite propulsion and attitude control.
Mar 00	Demonstrate microassembled electromechanical signal processing.
Jun 00	Demonstrate miniature aerodynamic pressure sensors on a flexible, adhesive tape.
Jun 00	Demonstrate a modular, monolithically integrated IMU.
Sep 00	Demonstrate MEMS high-temperature sensor and actuator arrays.

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COST *(In Millions)*	FY 1998	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	0.000	22.568	49.855	45.010	50.000	50.000	50.000	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: microelectronics, 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 and thereby 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

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technologies. For example, a mixed-technology microsystem using integrated microfluidics, MEMS, microphotonics, microelectronics and 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 1998 Accomplishments:

- Not Applicable.

(U) FY 1999 Plans:

- Not Applicable.

(U) FY 2000 Plans:

- 3-D Imaging – 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. ($ 7.357 Million)

- Steered Agile Laser Beams – Initiate program to develop compact, light weight, man-portable, electronically steered lasers to replace large, heavy gimbal mounted lasers in lasercom links and smart weapon target designators. Develop small, light weight laser beam scanner system technologies for replacement of gimbaled mirror systems. Initiate system design and component specifications; select system design. ($ 6.867 Million)

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- RF Lightwave Integrated Circuits (R-FLICS) – 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 that 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. ($ 8.344 Million)

(U) FY 2001 Plans:

- 3-D Imaging – 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. ($ 16.500 Million)

- Steered Agile Laser Beams – 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. Develop beam steering and detection systems. ($ 17.500 Million)

- R-FLICS – 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. ($ 15.855 Million)

(U) Other Program Funding Summary Cost:

- Not Applicable.

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(U) Schedule Profile:

Plan	Milestones
3-D Imaging:	
3Q00	Develop low defect density near infrared materials suitable for high speed imaging.
4Q00	Demonstrate detector test arrays with gain/bandwidth product capable of sub-nanosecond detection at long range.
2Q01	Integrate novel, high gain/bandwidth detector array with low noise electronics.
Steered Agile Laser Beams:	
2Q00	Select system configuration which best meets insertion target performance goals.
3Q00	Derive component specifications.
R-FLICS:	
2Q01	Demonstrate High Performance R-FLIC Components to 50 GHz bandwidth.
4Q01	Demonstrate integrated R-FLIC functions such as channelizer with 10 GHz selectivity over 0-50 GHz bandwidth.