Materials and Processes

MP.01.01 Laser Protection for Personnel and Sensor Systems

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MP.08.06 Affordable Multimissile Manufacturing ATD

MP.13.11 D-Day Fuel Support for Expeditionary Forces ATD

MP.14.11 Wartime Contingencies and Bare Airbase Operations

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MP.18.06 Cleanup of Contaminants

MP.24.06 Composite Structures for Missile Defense Systems

MP.25.01 Lean Aircraft Production and Sustainment

MP.26.01 Condition-Based Maintenance/Integrity Monitoring

MP.27.01 Materials for Small-Target Detection Capability in High-Clutter Environments

MP.28.01 Enhanced Coastal Trafficability and Sea State Mitigation for Logistics-Over-the-Shore ATD

MP.29.01 Materials and Processes for Integrated High-Payoff Rocket Propulsion Technology

MP.30.01 Sustainable Military Use and Stewardship of the Environment

MP.32.01 Assured Supply Chain Responsiveness

MP.33.01 Metalworking Affordability Initiative for Castings and Forgings

MP.34.01 Composites Affordability Initiative—Aircraft

MP.35 Smart Materials and Structures for Defense Systems

MP.36 Integrated Survivable Composite Structures

MP.37 Low Observable Materials, Processes, and Maintainability

MP.38 Manufacturing Technology for Infrared Cooled and Uncooled Staring Sensors

MP.39 Combat Equipment Repair Cycle Enhancement

MP.01.01 Laser Protection for Personnel and Sensor Systems

Objectives. Develop materials technology to protect personnel and sensor systems from lasers. The laser eye protection (LEP) solutions will protect aircrews and ground personnel from multiple lasers including rangefinders, illuminators, designators, and dedicated antipersonnel laser weapons. The sensor hardening solutions will protect fielded and future electro-optic sensor systems from laser countermeasures.

Payoffs. For personnel, the technical effort will provide protection from a larger number of laser threats while reducing visual performance penalties associated with traditional protection technologies. The payoff of these efforts will enable aircrews to conduct day and night missions without visual jamming or eye damage from near- and mid-term laser threats. Additionally, these new technologies will produce eyewear that is compatible with displays, night vision goggles, and helmet-mounted displays. Within the Air Force, two major commands have ranked multiple wavelength laser eye protection, andsensor protection in the top 10% of all laboratory efforts. In addition, user commands within the Navy and Marine Corps have endorsed the development and demonstration of laser protection as high-priority efforts. For sensor systems, the technical effort will provide laser protection solutions for fielded and future electro-optic systems with minimal degradation to sensor system performance. The major payoff is continued mission capability in the presence of evolving laser threats. The advanced sensor hardening technologies can be retrofitted into the sensor system with no changes to the external package and only minor changes to the internal optics.

Challenges. The most immediate challenge for personnel protection is to block laser threats with enough transmission for use in night operations. A related challenge is in ensuring crewstation display visibility while selectively eliminating laser radiation. The technical approach to accomplish this challenge is to use high-performance reflective filters capable of providing eye protection over the complete field of view. Lastly, it is necessary to mature the materials technologies that will facilitate the rapid generation of new protection devices to meet an ever-changing laser threat. The most immediate challenge for protecting sensor systems is to develop retrofittable hardening technologies that provide complete protection against known and unknown laser threats. Another challenge is to package advanced sensor protection materials into electro-optic systems without impacting the systems optical performance. The technical approaches to accomplish these challenges include the completion of a detailed system and threat analysis to establish specific system-hardening parameters. Next, sensor-hardening materials will be enhanced to provide optimal jamming and damage protection while maximizing the system's optical performance. In addition, a series of laboratory and system-level tests will be conducted to evaluate the sensor system protection technologies. These tests will determine the laser protection performance, sensor system optical performance, and implementation costs.

Milestones/Metrics.

FY2000: Demonstrate rugate and enhanced dielectric filters on lenses capable of supporting ballistics requirements, conduct field tests of hardened sensor modules on ACC and Air Force Special Operations Command (AFSOC) aircraft, and develop hardening techniques for staring-sensor focal plane array systems.

FY2001: Demonstrate optical filters and eyewear suitable for use with the panoramic night vision goggle (PNVG). Demonstrate high-performance protection filters for alternate viewing systems.

FY2002: Demonstrate next-generation laser protective filter technologies suitable for transition to a variety of tri-service, mission-specific EMD programs. Evaluate staring sensor system hardening in field/flight demonstration.

FY2003: Demonstrate hardening technologies suitable for the PNVG program. Candidate technologies include gated power supply, filmless tube architecture, rugate filters, and the use of tunable liquid crystal filters.

Customer POC

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USD(A&T) POC

Dr. Lewis SLOTER
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MP.01.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4348	0.6	0.0	0.0	0.0	0.0	0.0
0602234N	00000	0.4	0.4	0.4	0.0	0.0	0.0
0603112F	2100	6.9	5.7	4.7	2.5	0.0	0.0
	DTO Total	**7.9**	**6.1**	**5.1**	**2.5**	**0.0**	**0.0**

MP.02.01 Materials and Processes for Integrated High-Performance Turbine Engine Technology

Objectives. Develop affordable, low-density, high-strength, high-temperature materials and processing technologies for all classes of future and derivative military gas turbine engines—a critical element in attaining the overall goal of the Integrated High-Performance Turbine Engine Technology (IHPTET) program to double the thrust-to-weight ratio (T/W) of U.S. aircraft turbine engines.

Payoffs. The following capabilities will be achieved: a doubling of range by decreasing fuel consumption in advanced fighters, a doubling of turbine engine thrust-to-weight ratio for increased fighter aircraft maneuverability and payload capacity, and increased fuel efficiency in transport aircraft and cruise missiles for enhanced range. This program will also benefit the technology base for the development of improved propulsion for uninhabited combat air vehicles.

Challenges. Technical barriers include long-life environmental durability at very high temperatures, high temperature capability with low density and balanced engineering properties, oxidation resistance at very high temperatures, affordable processing techniques, improved life prediction methodology, and testing capability. For example, a multifaceted approach has been taken to develop advanced high-pressure turbine blade materials. One approach has been to continue to mature single-crystal Ni-base superalloys to reach in-service metal temperatures approaching 1,900°F. These advanced Ni alloys have been combined with emerging thermal barrier coating (TBC) technologies that will enable significant advancement in the high temperature capability and long-life durability of turbine blades. Concomitantly, advances in turbine blade materials are being pursued in alloy systems that provide higher temperature capability than afforded by Ni alloys. With this in mind, Nb and Mo refractory/intermetallic alloy systems are being developed as revolutionary high-pressure turbine blade materials for demonstration in Phase III demonstrator engines (FY03) and advanced concept systems.

Milestones/Metrics.

FY2000: Explore fabrication technology for improved single crystal/polycrystalline Ni (nickel) compressor disks, thermal barrier coatings for advanced Mo (molybdenum) alloys, and novel compact heat exchangers.

FY2001: Continue exploration of advanced turbine disk fabrication technology using single crystal/polycrystalline Ni alloys, advanced coatings for Mo alloys, and compact heat exchangers.

FY2002: Develop materials to support a proof-of-concept demonstrator for the Phase III developments showing an 80% improvement in T/W with a fuel requirement reduction of 35%. Demonstrate advanced woven preforms and new ceramic matrix composite cooling approaches; transition to commercial production of a new fiber. Run a bling containing orthorhombic TMC (Ti matrix composite) and gamma TiAl in a demonstrator engine. Downselect low-density, oxidation-resistant Nb (niobium) and Mo alloys for high-pressure turbine blades.

FY2003: Full-up Phase III demonstration of a 100% improvement in T/W and a 40% fuel savings for turbine engines using new materials that operate at 1,500°F (gamma TiAl) in compressors, at 2,200°F (Nb and Mo alloy systems) in turbine components (high-pressure turbine blades), and at 2,400°F (CMCs) in turbine components. Demonstrate compact fuel/air heat exchanger. Provide the enabling materials for Phase III of IHPTET.

Customer POC	Service/Agency POC	USD(A&T) POC
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Mr. Daniel KUNEC JSFPO/PPM	Dr. Steven G. FISHMAN ONR	
Col George MONROE, USAF HQ ACC/DRAO	Mr. Paul SMITH, USAF AFRL/MLLM	
Mr. Olen SISSON APEO/T	Dr. Jeff SWAB, USA ARL	

*MP.02.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4347	6.3	8.0	3.5	2.3	0.0	0.0
0602234N	00000	2.5	2.5	2.5	2.5	0.0	0.0
	DTO Total	**8.8**	**10.5**	**6.0**	**4.8**	**0.0**	**0.0**

*The decision with regard to out year funding for propulsion was made late in the Budget Review. Out year DTO funding for this effort will be determined during the next planning and programming cycle.

MP.03.01 Nondestructive Evaluation for System Life

Objectives. Develop new and improved nondestructive evaluation/inspection (NDE/NDI) methods and equipment to ensure the safety, reliability, and cost effectiveness of weapon systems.

Payoffs. Development and enhancement of crack and corrosion nondestructive detection and characterization methods are required to enable older aircraft systems to continue to operate safely well beyond their original design lifetimes. Improvement and implementation of current Airframe Structural Integrity program fleet management tools are entirely dependent on improved NDE/NDI methods for early crack detection. Higher-resolution methods are being developed for enhanced and more reliable flaw detection and evaluation. Semiautomated scanning methods with improved ultrasonic transducers and eddy current probes and arrays are enhancing the ability to scan for corrosion damage and hidden cracks in second layers in transport fuselage structures. This DTO will address the high costs associated with the labor-intensive nature of currently available methods. New digital x-ray technologies are being developed to reduce the hundreds of millions of dollars being expended for x-ray film, processing, storage, and the related hazardous waste stream treatment. The inspection time required for the F/A–18E/F composite horizontal stabilator will be greatly reduced by the development of a new noncontact thermographic inspection technique. The Composite Ship Mast Inspection program will be significantly improved by using noncontact, wide-area microwave inspection methods. New technology, universal, and lower-cost single-crack-artifact calibration standards, which have been developed for the inspection systems, will reduce the multiple standards ($20,000 each) used at each of the 33 current inspection stations. The new-technology eddy current instruments resulting from laboratory development efforts will eliminate semiannual calibration costs ($25,000) at each depot and reduce the current replacement spares costs by at least 40%.

Challenges. Technical barriers include the necessity of detecting small cracks and material anomalies in large areas of aging airframe structures with widespread fatigue damage and in rotating engine components experiencing high-cycle fatigue; the complexity of upgrading older inspection systems; and the difficulty of differentiating corrosion from benign conditions. The onset of widespread fatigue cracking and the very real potential for link-up of the cracks are compromising flight safety in the aging fleet. A new requirement will be for the detection of cracks less than .05 inch in second layers and under fastener heads. Quantification of corrosion damage is essential to extend the economic life of the KC–135 and P3C fleets. Current depot methods cannot meet the demand for future engine designs. Fleet groundings due to high cycle fatigue in rotating turbine engine components have required the development of all new methods for in-service inspection of these components. Current R&D efforts are addressing multiple issues to bring new technology into these inspection systems. These methods require the ability to detect volumetric material property changes in components before any measurable cracks are present.

Milestones/Metrics.

FY2000: High-resolution NDI methods available to differentiate and quantify the types of corrosion. Demonstrate advanced hidden-corrosion detection (less than 10% material thickness loss) methods on transport-type aircraft.

FY2002: Transition to advanced development new detection methodologies for widespread small crack (less than 0.05 in) detection.

FY2003: Transition new structural cracking and corrosion detection to Air Force logistics centers and Navy rework facilities.

Customer POC	Service/Agency POC	USD(A&T) POC
Ms. Deborah BAILEY ASC/SMA	Mr. James KELLY ONR	Dr. Lewis SLOTER ODDR&E/PMT
	Dr. James MALAS, USAF AFRL/MLLP	
	Dr. Mark ROBERTS, USA ARL	

MP.03.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4349	1.9	2.9	3.0	0.0	0.0	0.0
0602234N	00000	1.1	1.0	1.0	0.0	0.0	0.0
0603112F	3153	1.5	1.0	1.6	1.7	0.0	0.0
	DTO Total	**4.5**	**4.9**	**5.6**	**1.7**	**0.0**	**0.0**

MP.05.01 Protective Materials for Combatant and Combat Systems Against Conventional Weapons

Objectives. Develop and demonstrate ultralight materials and new armor principles to be incorporated into individual soldier protection gear, face shields, windows, and primary armor for combat systems.

Payoffs. Enhanced protection, mobility, and offensive capability will be derived from development of lightweight materials and materials systems for individual combatant protection against the small-arms threat. The reduction in individual armor weight represents a 6-lb decrease in a soldier's total load that must be carried into combat, translating into improved mobility and range. Lighter advanced materials and materials systems for armor materials in combat systems will also increase range and performance without sacrificing survivability. Lighter transparent armor for face shields and future armored combat vehicles will provide the same level of protection as current systems. This DTO supports the MOUT JWCO (DTO E.02). This DTO began in FY97. Weight reduction and increased protection over the baseline system have been achieved using a two-layer ultralight armor material system (boron carbide/kevlar).

Challenges. Primary technical barriers are development of methodologies for producing low-cost, ultra-lightweight, and effective armor materials for combatant and combat systems, development of innovative experimental techniques for evaluating and characterizing newly fabricated materials under hostile environments, development of materials model and predictive capability, and optimization of materials fabrication processes for full-scale production.

Milestones/Metrics.

FY2000: Complete feasibility study of fabrication methodologies for four classes of materials: functionally graded materials, nanocrystalline materials, high-modulus and high-strength fibers, and diamond-like ceramics.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Philip BRANDLER SBCCOM–NSC	Dr. Ernest CHIN, USA ARL	Dr. Lewis SLOTER ODDR&E/PMT
Dr. James THOMPSON TARDEC	Mr. Pete DEHMER ARL	
	Dr. Steven G. FISHMAN ONR	
	Dr. Steven WAX DARPA/DSO	

MP.05.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602712E	MPT–01	5.0	0.0	0.0	0.0	0.0	0.0
	DTO Total	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

MP.06.01 Computing and Signal Processing Materials for Use in High-Temperature Shock and Radiation Environments

Objectives. Develop materials technologies with sufficient robustness to survive and function in harsh environments at very high operating temperatures or in ionizing radiation with no reduction in performance. This includes the development of (1) silicon carbide (SiC), a wide-bandgap material, (2) advanced magnetic film memory materials, and (3) thermoelectric cooling and power-generation materials. SiC materials and process technology development is applicable in high-power, high-temperature power electronics and for high-temperature, harsh environment, on-engine and other smart skin sensors. This DTO supports DTOs SE.39, SE.44, and SP.08.

Payoffs. The synergistic development of these technologies has high payoff throughout DoD. Critical applications include turbojet engine control systems, missile and torpedo guidance and control, unmanned vehicles, and satellite applications. Development of SiC technologies will enable high-power semiconductor switching devices operating at current and voltage levels unobtainable in silicon; robust high-temperature operation up to 600°C for on-engine and other hostile environments; enhanced radiation hardness; and uncooled avionics. Magnetic film memories offer radiation-hard permanent information storage with no power consumption; and state-of-the-art speed and data density, thereby eliminating mechanical disks or tapes. Thermoelectric materials can provide more than 100°C of active cooling to electronic systems. These technologies will significantly advance the JWCOs of Information Superiority (surveillance, data analysis), Precision Force (guided-munitions, surveillance) and MOUT (surveillance, navigation) by providing increased system performance and reliability (projected 5X to 10X increase in mean-time between failure (MTBF)) and reduced requirements for maintenance with a resulting increase in system availability and effectiveness (increased time on station or increased sortie rate).

Challenges. SiC substrate materials with 3-in or larger diameters and acceptably low defect densities must be achieved for cost-effective device development to occur. Substrate technology must be improved and transitioned to a production environment to provide higher consistent yield and reduced bulk material cost. Effective polishing processes for both on- and off-axis materials must be developed to facilitate subsequent high-quality epitaxial growth. High-yield, production-capable epitaxial growth processes including thick epitaxy (greater than 50 µm) must be developed. Stable thin magnetic-film materials interfaces must be developed that operate at elevated temperatures or in the presence of ionizing radiation. A method of controlling oxidation of insulators in spin tunneling devices must be developed, and novel ways to insert thin magnetic-film-based memory into systems must be found.

Milestones/Metrics.

FY2000: Begin advanced bulk and epitaxial growth processes for SiC. Refine chem-mechanical polishing processes for SiC wafers. Thermoelectric figures of merit improved 3X, allowing more than 100°C cooling in three stages or less.

FY2001: Transition SiC wafer cutting/polishing technology to production. Develop thick epitaxy process. Fully functional 4-Mb MRAM chip.

FY2002: Demonstrate processing techniques for memory cell density improvement of 10X to 100X, 3-in SiC substrates with no micropipes, SiC epitaxy layers with a 10X reduction in defects, and fully functional 64-Mb MRAM chip.

FY2003: Production-ready SiC epitaxial process.

Customer POC	Service/Agency POC	USD(A&T) POC
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Mr. Ron WILLIAMS ASC/LPP	Mr. Robert DENISON, USAF AFRL/MLPO	
	Dr. Maribel SOTO ONR	
	Dr. Stuart WOLF DARPA/DSO	
	Dr. Kepi WU BMDO/TOS	

MP.06.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4348	1.6	1.4	1.7	2.2	1.6	1.1
0602712E	MPT–01	23.6	14.0	8.0	0.0	0.0	0.0
0603112F	3946	0.7	0.6	0.7	0.0	0.0	0.0
	DTO Total	**25.9**	**16.0**	**10.4**	**2.2**	**1.6**	**1.1**

MP.07.01 Materials and Processes for Metal Cleaning, Corrosion Control, and Coatings

Objectives. Reduce the substantial maintenance costs associated with corrosion control on DoD equipment while meeting the pollution prevention requirements of Executive Order 12856.

Payoffs. This DTO will substantially reduce the $5.5+ billion per year cost to the Navy, Army, and Air Force associated with corrosion control. Payoffs include developing (1) new and environmentally acceptable paints/coatings, metal plating, surface preparation, and cleaning processes that do not rely on hazardous materials to prevent corrosion of ship and submarine hulls or aircraft, ground vehicles, and weapon systems; (2) environmentally acceptable means to detect, describe, predict, and prevent the many forms of corrosion that degrade materials used on DoD platforms and systems; (3) advanced aircraft extended-life coating capability with a 30- to 40-year foundation layer and an 8-year topcoat; and (4) extended durability coatings for nonmagnetic-stainless-steel advanced double hulls for ships.

Challenges. Technical barriers include lack of (1) characterization and demonstration of the suitability of current low-volatile organic compound paints to meet current military performance criteria; (2) a strong science base describing the interaction of cleaning agents and coatings with new alloys; (3) environmental durability, stain resistance, cleanability, and ultraviolet resistance in gloss/matte coatings with very low organic solvent content; (4) understanding of the mechanisms that corrode ship, submarine, and aircraft alloys and that degrade long-life coatings; (5) an acceptable replacement for hexavalent chromium used as a corrosion inhibitor in coatings and surface treatments and for hard chrome plating operations; and (6) an acceptable replacement for cadmium used as a corrosion-resistant hydrogen barrier coating for landing gear steels.

Milestones/Metrics.

FY2001: Evaluate laser-based cleaning technology and the performance of materials and processes developed as alternatives to hexavalent chrome plating. Evaluate field extended-durability (5- to 7-yr) aircraft coating systems that meet increasing environmental and safety requirements and do not require repainting between depot maintenance intervals. Evaluate fast-drying coating system for ammunition.

FY2002: Evaluate new materials for shipboard waste incinerators and metallic coatings for corrosion resistance produced by portable electrospark deposition systems.

FY2003: Demonstrate a complete 5- to 7-yr coating system for conventional non-low-observable aircraft as an extended-life system, and an environmentally acceptable coating system for nonmagnetic-stainless-steel advanced double hulls for ships.

FY2004: Demonstrate an 8-yr aircraft topcoat and a 30- to 40-yr foundation.

FY2005: Demonstrate an 8-yr aircraft topcoat and a 30- to 40-yr foundation and stress-corrosion mitigation technologies for friction stir welding of aluminum alloys used in aircraft construction.

Customer POC	Service/Agency POC	USD(A&T) POC
Dr. Alex KAZNOFF NAVSEA, 03M	Mr. Gume RODRIGUEZ AMSRL/WM/MA	Dr. Lewis SLOTER ODDR&E/PMT
Mr. Dale MOORE NAWCAD, 4.3.4	Dr. John SEDRIKS ONR 332	
SMSgt Gregory STONELAKE, USA ACC/LGMS	Mr. Steve SZARUGA, USAF AFRL/MLBT	
	Dr. Steven WAX DARPA/DSO	

MP.07.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4347	1.3	1.6	2.0	2.1	1.4	0.9
0602102F	4349	1.3	0.5	0.5	0.5	0.5	0.5
0602202F	1900	0.8	0.0	0.0	0.0	0.0	0.0
0602234N	00000	1.3	1.3	1.3	0.0	0.0	0.0
0602712E	MPT–01	0.3	0.0	0.0	0.0	0.0	0.0
0603112F	3153	0.4	0.4	0.7	0.9	0.0	0.0
	DTO Total	**5.4**	**3.8**	**4.5**	**3.5**	**1.9**	**1.4**

MP.07.06 Enhanced Mission Electronics Cost of Ownership

Objectives. Catalyze major reductions in the warfighter's logistics cost burden through enhanced mission electronics or electronic component reliability; and assure sustained, affordable access to supportable, combat-superior electronics for aircraft and missile systems.

Payoffs. Sixty-percent of all life-cycle costs are attributable to equipment maintenance and repair support. Incurred mission equipment failures drive O&S costs and necessitate elevated equipment spares (logistics support and mission operations). Eighteen-percent of all depot maintenance labor-hours are expended in the repair of electronics equipment. The annual DoD depot maintenance burden is in excess of $13 billion. DTO cost-of-ownership efforts will help minimize parts obsolescence impediments by adapting modern microcircuit design, fabrication, and test technology associated with high-quality form, fit, and function equivalent microcircuits; and will assure affordable combat systems sustainment (F–15, Joint Surveillance Target Attack Radar System, Army Tactical Missile System (ATACMS)/Brilliant Antiarmor submunition (BAT), Javelin, etc.). Microcircuit encapsulation technologies will be advanced and applied in support of affordable integrated circuit manufacture to ensure installed components can endure extended storage requirements (10 to 20 yr). Enhancing electronics reliability, achieved through manufacturing and/or sustainment reliability performance improvements, is the most advantageous approach for reducing life-cycle support costs and avoiding parts obsolescence anomalies. This DTO will enable a 40% improvement in existing electronics equipment MTBF rates and a corresponding 25% life-cycle cost reduction. These complimentary payoffs will be achieved by exploiting world-class manufacturing tenets—critical enablers for improving manufacturing quality or upgrading process control—in support of evolving, low-volume/high-mix production (recurring spares manufacture or modification/upgrade programs). This DTO supports the Joint Readiness and Logistics and Sustainment of Strategic Systems JWCO.

Challenges. Implementation hurdles include (1) establishing methodologies for determining optimum avionics reliability investment strategies based on existing or forecasted constraints; (2) demonstrating high-quality manufacturing performance in support of low-volume/high-mix production; (3) fielding wafer coating processes that render moisture and ionic contamination protection at near-comparable levels achieved with hermiticity; (4) advancing physics of failure methodologies in support of original manufacture or the transition to condition-based maintenance; (5) establishing predictive service-life capabilities that can determine commercial parts compatibility with military operating environments/remaining service life; (6) achieving continuous avionics reliability improvement independent of extended equipment utilization and parts obsolescence; and (7) demonstrating high-quality, advanced emulation capabilities for the next generation of obsolete devices.

Milestones/Metrics.

FY2000: Validate closed-loop failure tracking/physics of failure analysis processes to facilitate continuous avionics product improvement to generate 40% reliability growth improvement.

FY2001: Demonstrate greater than 15-yr shelf life for a plastic encapsulated microcircuit in support of storage requirements for ATACMS/BAT, Javelin air-to-ground missile system, and/or Close Combat Antiarmor System.

FY2002: Implement emulation fabrication processes capable of reducing microcircuit replacement cost to 25% of traditional methods.

FY2003: Demonstrate tools/methodologies capable of enabling high-quality manufacturing performance or high equipment reliability (greater than 40% MTBF improvement) in low-volume/high-mix production. Reduce nonprocurable devices by greater than 70%. Implement predictive capabilities to determine commercial parts compatibility with mission operating constraints.

FY2004: Establish capabilities to emulate microcircuits in direct parallel with incurred obsolescence cycle(s). Implement LRIP on 300–K gate complexity and memories of 512 K; increase yield by 20%. Establish capabilities to emulate microcircuits in direct parallel with incurred obsolescence cycle(s).

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. David ALTWEGG, USN PEO/TAD/SC	Mr. Steve LINDER ONR	Mr. Daniel CUNDIFF ODUSD(S&T)OTT
Mr. Thomas BATTERMAN HQ AFMC/LG		
Mr. Jack MCDERMOTT Joint STARS/JPO		
Mr. James STEELMAN PEO/TM		

MP.07.06 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603712S	None	5.3	10.1	10.2	10.4	10.4	0.0
0708011F	None	9.5	9.5	7.8	3.7	0.6	0.0
0708045A	None	2.6	2.0	0.0	0.0	0.0	0.0
0708045N	None	5.9	2.8	0.9	0.0	0.0	0.0
Industry	None	3.0	1.5	1.2	0.7	0.0	0.0
	DTO Total	**26.3**	**25.9**	**20.1**	**14.8**	**11.0**	**0.0**

MP.08.06 Affordable Multimissile Manufacturing ATD

Objectives. Demonstrate advanced missile design and manufacturing enterprise concepts and systems that can reduce the cost of tactical missiles by 25% to 50%.

Payoffs. A key concept is the use of flexible multimissile manufacturing, as opposed to dedicated production lines for each missile. Benefits for the missile acquisition community include the ability to afford up to twice as many missiles within a fixed budget, faster development cycles to keep up-to-date technology in the field, and a residual base of new competitive capabilities that can respond rapidly to warfighter needs. This DTO supports the Joint Theater Missile Defense JWCO.

Challenges. A key technical barrier is the development of product line architectures to increase design reuse and parts commonality. Additional challenges are the integration of heterogeneous information systems and processes across missile supply chains, and the development and integration of flexible assembly/test systems for multiproduct production.

Milestones/Metrics.

FY2000: Implement new production methods at two (cost-shared) pilot multimissile factories. Make progress towards affordable production of a diverse mix of missiles to include a range of complexity from the APKWS, JSOW,and BAT levels to systems such as the standard missile.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. David ALTWEGG, USN PEO/TAD/SC	Dr. William SCHEUREN DARPA/TTO	Mr. Daniel CUNDIFF ODUSD(S&T)OTT

MP.08.06 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603739E	MT–08	15.3	0.0	0.0	0.0	0.0	0.0
	DTO Total	**15.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

MP.08.06 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
Industry	None	11.0	0.0	0.0	0.0	0.0	0.0
	DTO Total	**11.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

MP.13.11 D-Day Fuel Support for Expeditionary Forces ATD

Objectives. Demonstrate the capability to efficiently deliver 100,000 gallons of fuel per day from ship to shore in assault operations (D-day to D+5) from standoff distances of up to 200 nmi. This ATD will validate the use of cost-effective, lightweight, high-strength, collapsible fuel bladders meeting rugged handling and load requirements via landing craft air cushion (LCAC) delivery.

Payoffs. This project will provide an assault echelon fuel transfer capability that is compatible with amphibious (L-class) shipping and LCAC operations. LCAC sorties will be reduced from the planned 19 roundtrips with hard-shell fuel containers to 7 sorties, thereby releasing LCAC assets to move other critical supplies. Present ship-to-shore fuel transfer capabilities such as the Amphibious Assault Bulk Fuel System (AABFS) and the Offshore Petroleum Discharge System (OPDS) will not arrive on site in the first 5 to 20 days. In any case, adequate fuel cannot be provided ashore during the assault echelon due to the retirement of the LST. Further, the AABFS and OPDS cannot be installed in Sea State 3 conditions. For future operational tempos, the AABFS and OPDS cannot support the emerging operational-maneuver-from-the-sea operations due to limited standoff distance (4 miles) capability. The urgency of achieving improved near- and far-term logistics capability is expressed in the Marine Corps Warfighter Imperatives identified in the Expeditionary Warfare Roundtable and in the Navy’s 1997 S&T Requirements Guidance. The fuel bladder will transition to procurement via the Amphibious Tactical Support Project. This DTO supports Joint Readiness and Logistics and Sustainment of Strategic Systems and Force Projection/Dominant Maneuver JWCOs. This DTO demonstration was started in FY97. LCAC-instrumented test runs of a 15,000 gallon system were completed in preparation for fleet demonstrations in FY00.

Challenges. Technical barriers include applying combined simultaneous spiral and helical weaving technology to high-strength bladders; thin membrane performance modeling; composite structural analysis; materials properties, shelf life, fatigue testing, and abrasion-resistant-oriented fibers; and surge-suppression and explosion-effects modeling.

Milestones/Metrics.

FY2000: Demonstrate at fleet exercise a 5X cost-effective, lightweight, high-strength, collapsible, continuous-spiral-woven fuel bladder prototype meeting pressure and dynamic load requirements of up to 2.2 g for LCAC delivery from 25 miles offshore within the 30-min load/offload LCAC cycles. Demonstrate forward-fit capability with LVS USMC assets and operational capability with LPD–17 platforms.

Customer POC	Service/Agency POC	USD(A&T) POC
CDR Thomas NICHOLAS, USN CNO, N853	Mr. Andy DEL COLLO NAVFAC–15R	Mr. Robert BOYD DUSD/S&T/Biosystems

MP.13.11 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603712N	R1910	0.5	0.0	0.0	0.0	0.0	0.0
	DTO Total	**0.5**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

MP.14.11 Wartime Contingencies and Bare Airbase Operations

Objectives. Demonstrate technologies for wartime contingencies and modernization of Air Force and Army mobile base infrastructure, including air-transportable shelters and utility systems, to reduce airlift, response time, workforce, and costs for expeditionary force operations. This DTO supports establishment, operation, and recovery of mission-critical functions on mobile airbases.

Payoffs. The DTO will reduce the airlift requirements for an 1,100-man bare base by 35%. Using high-performance, lightweight composite materials and innovative structural elements, such as large high-pressure air beams, new air-transportable shelter systems will reduce weight, thermal losses, costs, required manpower, and setup time. Environmental control units (ECUs) with advanced heating and cooling cycles will be developed to reduce weight/volume and increase efficiency. New hydrothermal conversion technologies will reduce the risks and logistics problems associated with waste disposal. Reduced deployment and logistics needs for bare base operations will greatly enhance the expeditionary warfighting capability and reduce costs for contingency operations. The DTO supports the Joint Readiness and Logistics and Sustainment of Strategic Systems and Force Projection/Dominant Maneuver JWCOs.

Challenges. Technical barriers for shelters include the development of large high-pressure air beams, inflatable shelter materials, and self-erecting inflatable concepts. The major technical barrier for the advanced-cycle ECU is the design of efficient heat exchangers for optimizing fluid-to-air heat transfer. Additional barriers include cogeneration and heat/gas recovery for advanced waste processing systems.

Milestones/Metrics.

FY2000: Demonstrate advanced air beam frames for large shelters that reduce weight and volume by 50% and costs by 20%. Complete field demonstration of advanced cycle ECU.

FY2001: Demonstrate new disposal systems that reduce waste volume by 50%.

FY2002: Complete field demonstration of advanced air-inflatable shelters.

FY2003: Demonstrate small-footprint fuel cell reformer capable of converting logistic fuels into hydrogen for fuel cells for base power generation.

FY2004: Demonstrate new advanced integrated power system that reduces weight/volume by 40%.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Joe FISHER HQ ACC/CEXX	Mr. Philip BRANDLER SBCCOM–NSC	Mr. Robert BOYD DUSD/S&T/Biosystems
COL Brian KELLER, USA AMSSC	Dr. Jon PORTER AFRL/MLQC	Dr. Robert FOSTER ODUSD(S&T)

MP.14.11 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602201F	4397	0.8	0.8	0.4	0.7	0.5	0.0
0602786A	H98	1.0	3.0	0.5	0.0	0.0	0.0
0603106F	2745	0.8	0.7	0.0	0.0	0.0	0.0
0603112F	3946	2.0	2.0	1.1	1.2	1.5	0.0
0603205F	4398	0.7	0.3	0.1	0.1	0.0	0.0
	DTO Total	**5.3**	**6.8**	**2.1**	**2.0**	**2.0**	**0.0**

MP.16.06 Firefighting Capabilities for the Protection of Weapon Systems

Objectives. Develop and demonstrate technologies that will provide a mobile, semiautonomous aircraft rescue and firefighting (ARFF) vehicle with enhanced fire suppression systems to improve functional and emergency response capabilities. Specifically, this DTO will integrate advanced efficient and environmentally acceptable agents, semi-autonomous ARFF vehicles, voice recognition system activation, computer-controlled high-performance suspension, and all-weather response capabilities within a mobile firefighting unit.

Payoffs. This DTO program will significantly reduce fire injuries, fire casualties, and weapon system damage and will reduce labor-intensive aircraft firefighting operations. It will deliver a new generation of advanced and efficient fire-suppression agents reducing overall costs and manning requirements for firefighting operations. It will also deliver high-performance suspension systems for vehicle rollover prevention, unimproved surface traversing capabilities, and computer-controlled fluid leveling. This program will also result in the integration of forward-looking infrared (FLIR) for all-weather fire scene response, global positioning and accountability of assets for enhanced fire ground management, voice-activated system controls, and an emergency data access heads-up display reducing operator functions by 25%. These technologies will be transitioned to the Agile Combat Support Systems Program Office for EMD and acquisition strategy development. This DTO supports all military services' crash rescue operations and the Joint Readiness and Logistics and Sustainment of Strategic Systems and Combating Terrorism JWCOs.

Challenges. Technical barriers include the development of tropodegradable, efficient agents and fire suppression systems; integration and synchronization of semiautonomous vehicles, FLIR, and firefighting system activation; maintenance of ARFF vehicle footprint and axle weight differentials to prevent rollover; and integration of voice recognition for acquisition.

Milestones/Metrics.

FY2000: Develop and demonstrate tropodegradable agents for use in firefighting vehicles.

FY2001: Demonstrate all-weather response capability with 90% accuracy.

FY2003: Refine all-weather response capability to 100% accuracy.

FY2004: Demonstrate self-contained, semiautonomous ARFF vehicle. Reduce operator functions (25%).

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Joe FISHER HQ ACC/CEXX	Dr. Juan VITALI AFRL/MLQC	Mr. Robert BOYD DUSD/S&T/Biosystems

MP.16.06 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602201F	4397	0.6	0.5	0.3	1.0	1.1	0.0
0603205F	4398	0.6	0.3	0.1	0.1	0.0	0.0
	DTO Total	**1.2**	**0.8**	**0.4**	**1.1**	**1.1**	**0.0**

MP.17.06 Hazardous and Toxic Waste Treatment/Destruction for DoD Operations

Objectives. Develop, demonstrate, and implement technologies and predictive models to reduce difficult-to-destroy wastes from DoD operations.

Payoffs. Processes to significantly decrease or completely destroy waste propellants, explosives, pyrotechnics, nitrous oxides, volatile organic compounds, and metallics will greatly reduce DoD's mission constraints at logistics centers and industrial operations commands due to environmental laws. Operations and maintenance of weapon systems and installations will be more effective and cost less throughout DoD, ultimately improving training, testing, maintenance, and deployment. Production capabilities will be maintained and compliance costs reduced 20% to 30% ($307 million in 1995) using solid- and liquid-waste treatment/destruction technologies.

Challenges. Technical challenges include handling unstable, highly energetic materials and destroying or converting waste/contaminants without producing unwanted toxic byproducts. Also, DoD must develop lower-cost, energy-efficient chemical and physical separators for unique and often complex waste streams; and destroy unique recalcitrant wastes derived from military operations.

Milestones/Metrics.

FY2000: Demonstrate that reductive electrochemical treatment can destroy volatile organics and VOCs.

FY2001: Develop sequential bioreactor technology for treatment of energetic contaminated industrial facility waste to reduce the operating cost by 20%–30%.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. George CARLISLE DAIM/ED–C	Mr. Gary SCHANCHE ERDC/CERL	Mr. Robert BOYD DUSD/S&T/Biosystems
Dr. Frank STONE CNO, N45G		

MP.17.06 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602720A	048	1.1	1.1	0.0	0.0	0.0	0.0
	DTO Total	**1.1**	**1.1**	**0.0**	**0.0**	**0.0**	**0.0**

MP.17.11 Airfields and Pavements to Support Force Projection

Objectives. Enhance force strategic deployment from the continental U.S. and operational employment in theater of operation (TO) by providing improved reliable airfields and pavements.

Payoffs. The program will increase reliability of airfields and pavements to support the current generation of military and civilian reserve air fleet aircraft and vehicles through the use of local materials (which may be of inferior quality) and pavement binder modifications, resulting in a 10% reduction in construction and maintenance cost. Construction effort will be decreased by 10% for expedient surfaces in TO for military aircraft and vehicles. The project will also provide reliable airfields and pavements to support multiple passes of proposed future-generation aircraft. The results of the research will increase the functional life of airfields and pavements by 10 years resulting in a 20% reduction in maintenance costs and a 10% reduction in construction costs. The technologies will be transitioned to the user community by incorporating the computer programs into existing design programs through technical reports, recommendations for input into FM15–430–002, “Planning and Design of Roads, Airfields, and Heliports,” and construction guide specifications. This DTO supports military contingency site operations and the Joint Readiness and Logistics and Sustainment of Strategic Systems and Force Projection/Dominant Maneuver JWCOs.

Challenges. New technologies are required for material characterization, specifically in nonlinear visco-elastic and visco-plastic behavior and how that behavior affects airfield and pavement performance. Technical barriers include a limited understanding of multiple tire interaction, dynamic loading, and linear and nonlinear material response to those loadings. Specific aircraft that can damage airfields include C–141, C–17, and the proposed million-pound aircraft. Vertical-/short-takeoff and -landing aircraft also pose a significant problem. In general, aircraft loads will continue to increase, but the landing gear for proposed cargo aircraft will remain similar to the Boeing 777 configuration. Larger landing gear is not desirable because it consumes too much of the cargo space. Therefore, the load per tire and tire pressures will continue to increase resulting in the need for airfields with an increased load-carrying capability.

Milestones/Metrics.

FY2002: Provide reliable airfields and pavements to support multiple passes of proposed future-generation aircraft, reducing maintenance costs 20% and construction costs 10%.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Larry BLACK DAIM/FDF/B	Dr. Lewis E. LINK USACE/CERD/ZA	Mr. Robert BOYD DUSD/S&T/Biosystems
Mr. Jim GREENE AFCESA/ENC		

MP.17.11 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602784A	T40	1.2	1.3	1.3	0.0	0.0	0.0
0602784A	T42	0.4	0.4	0.4	0.0	0.0	0.0
	DTO Total	**1.6**	**1.7**	**1.7**	**0.0**	**0.0**	**0.0**

MP.18.06 Cleanup of Contaminants

Objectives. Develop a suite of technically effective and affordable technologies to clean up a variety of chemically contaminated DoD sites.

Payoffs. This program reduces the DoD cost of contaminant cleanup over the Future Years Defense Plan. Development focuses on technologies to characterize and treat explosives/energetics and heavy-metals-contaminated soils and groundwater. DoD sites currently number about 21,000, with projected cleanup costs of $30–$35 billion. High-payoff technologies include the DoD framework for environmental risk assessment, onsite risk contaminant fate prediction models, advanced sensors and samplers, and valid guidance on novel remediation processes for explosives cleanup. Lastly, advanced extraction and treatment processes will cut lead removal costs from $100–$300/ton to $50–$150/ton.

Challenges. Technical barriers include the multitude of differing geographic sites (soil, water, and climate) across DoD land; the large number, varying concentrations, state of mixing, and yet unmapped contaminants encountered at military-unique cleanup sites; the inherent complexity of biological, chemical, and physical phenomena and technologies; and the rapidly changing regulations to which to respond.

Milestones/Metrics.

FY2001: Develop fate and transport models/simulators that integrate data on treatment media, provide rapid contaminant fate predictions, and reduce cleanup design costs by 30%. Develop an in situ extraction and treatment process for lead that gets below existing structures.

FY2002: Increase efficacy and flexibility of advanced groundwater remediation for TNT and other energetics, thereby cutting overall costs to $0.10–$2.00/kgal.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. George CARLISLE DAIM/ED–C	Dr. M.J. CULLINANE CEERD–EP–J	Mr. Robert BOYD DUSD/S&T/Biosystems

MP.18.06 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602720A	835	1.0	1.1	1.1	0.0	0.0	0.0
0602720A	F25	1.7	1.9	1.9	0.0	0.0	0.0
0603716D	P470	6.5	6.5	6.0	0.0	0.0	0.0
	DTO Total	**9.2**	**9.5**	**9.0**	**0.0**	**0.0**	**0.0**

MP.24.06 Composite Structures for Missile Defense Systems

Objectives. Develop and insert multifunctional composite structural components into missile defense systems. To accomplish this objective, the program must (1) develop and flight test multifunctional structure for cableless interceptor, (2) develop and demonstrate high-thermal-conductivity resin matrix composite trays for ground-based radar systems, (3) develop and test advanced SiC divert system components, and (4) codevelop and flight test advanced composite shrouds for endo-interceptors.

Payoffs. A composite integral radar pedestal mount and bulkhead for the Patriot anticruise missile (PACM) will provide a 40% weight savings compared to a comparable cost baseline aluminum. SiC components provide double the mechanical strength at temperature at half the cost of components currently used in liquid divert systems, with a growth path to replacing exotic components used in solid divert systems. Use of composites in antenna modules for a theater high-altitude air defense (THAAD) ground-based radar restores thermal margins unattainable with baseline aluminum and eliminates the need for special coolants.

Challenges. The primary technical challenges are to demonstrate and evaluate the fabrication and performance of interceptor composite components with high-strength, high-stiffness, high-strain-to-failure fibers; and to demonstrate which of several competing fabrication processes, such as resin transfer molding, will provide repeatable components within the narrow statistical band needed to achieve technology insertion. Process definition and certification efforts will lead to defining costs for low-rate initial production. The specific program challenges are to provide fully acceptable advanced composite components at a cost comparable to baseline aluminum, and to develop and demonstrate cost-effective and statistically repeatable manufactured composite missile components.

Milestones/Metrics.

FY2000: Insert composite antenna module into THAAD radar system.

FY2002: Flight test advanced shroud with integrated thermal control. Hot fire test a high-temperature SiC DACS thruster.

FY2003: Flight test multifunctional kinetic kill vehicle composite structure.

Customer POC	Service/Agency POC	USD(A&T) POC
Dr. Allen ALEXANDER PEO/AMD	Dr. Alok DAS AFRL	Dr. Lewis SLOTER ODDR&E/PMT
Mr. Richard BROWN SMDC/TC/WC	Mr. James KELLY ONR	
	Ms. Wendy LEONARD, USA ARL	
	Maj James SHOEMAKER, USAF BMDO/STS	

MP.24.06 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603173C	1282	1.4	1.1	1.8	0.4	0.0	0.0
	DTO Total	**1.4**	**1.1**	**1.8**	**0.4**	**0.0**	**0.0**

MP.25.01 Lean Aircraft Production and Sustainment

Objectives. Accelerate the implementation of lean manufacturing methods in the development, production, and repair of defense weapon systems by demonstrating and documenting dramatic cost and lead-time reductions on current aircraft and electronic warfare programs that emulate the 50% reductions being achieved through comparable implementations within the commercial sector.

Payoffs. This is a joint activity implementing high-risk/high-payoff recommendations and findings from the Lean Aerospace Initiative to reduce acquisition and sustainment costs for aircraft, rotorcraft, and unmanned aeronautical systems. Lean demonstrations will pave the way for greatly broadened implementation of efficient business and manufacturing practices for military systems such as the F–22, C–17, JSF, and RAH–66 as well as unmanned aeronautical systems. Similar implementations in commercial industry have reduced unit cost by more than 50%, inventory by 90%, and cycle time by 45%. Modular factory pilot projects within this DTO will demonstrate cycle-time savings of 45% and cost reductions of up to 50% for selected demonstration articles. Lean concepts will also be transitioned across all services and into other major defense industrial sectors such as shipbuilding and space. This DTO supports the Combat Identification, Joint Theater Missile Defense, Military Operations in Urbanized Terrain, and Electronic Warfare JWCOs.

Challenges. Cultural isolation in defense industries tends to exaggerate the risks and difficulties of implementing efficient approaches to product development and production that have shown dramatic success in other industries. Existing business and management practices deter DoD access to commercial facilities and stifle change within DoD production programs. DoD-unique requirements result in inefficient operations in areas such as inventory control, property management, inspection, purchasing, data rights, supplier relations, and job training. Traditional accounting principles obfuscate true costs and create difficulty in illustrating the benefits of lean practice implementation. Adaptation of successful commercial models is problematic due to extreme differences in business volume and funding stability. Transition of findings from industry assessment and benchmarking hinges on identifying incentives toward their adoption.

Milestones/Metrics.

FY2000: Initiate Lean Aircraft Initiative Phase III, a 3-year effort emphasizing integrated research on cross-cutting enterprise topics.

FY2001: Demonstrate lean manufacturing or repair of military systems at a cost savings of 30% to 50% in support of one major military subsystem. Transition lean manufacturing concepts from the military aircraft sector to at least two other major defense industrial sectors (e.g., shipbuilding, space).

FY2003: Achieve progress towards demonstrating reductions in (1) cycle time up to 75%, (2) supplier lead time up to 50%, (3) inventory levels up to 75% and (4) life-cycle cost up to 10% via the application of lean enterprise principles to two or more weapon systems.

Customer POC

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Service/Agency POC

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USD(A&T) POC

Mr. Daniel CUNDIFF
ODUSD(S&T)OTT

MP.25.01 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0708011F	00000	4.9	5.2	3.6	0.1	0.0	0.0
Industry	None	1.5	1.5	1.5	0.0	0.0	0.0
Misc Gov't	00000	0.8	0.8	0.8	0.0	0.0	0.0
	DTO Total	**7.2**	**7.5**	**5.9**	**0.1**	**0.0**	**0.0**

MP.26.01 Condition-Based Maintenance/Integrity Monitoring

Objectives. Demonstrate and insert condition-based maintenance (CBM) enabling technologies in fleet weapon systems, and rapidly develop a new generation of mechanical diagnostics technologies that are powerful, affordable, and extremely reliable.

Payoffs. CBM is a tool for equipment asset management that will pay off in three major areas: safety, affordability, and asset visibility. (1) *Safety*: CBM will allow real-time, onboard mechanical diagnostics of critical power-train, drive-train, and structural components and act as a "watchdog" as these aging platforms operate. Studies have shown that vibration suppression using smart materials will substantially increase the fatigue lifetime of both helicopters and fixed-wing aircraft. (2) *Affordability*: CBM has the potential to significantly reduce (by 30%) O&S costs, which account for approximately 65% of total life-cycle costs. The insertion of CBM enabling technologies can save manpower, significantly reduce spare parts usage, reduce depot-level maintenance, and provide accurate data. (3) *Asset visibility/readiness*: Inherent in CBM are technologies that allow rapid and accurate assessment of platform health. CBM systems will provide the commander with intelligence on the status of his equipment, allowing deployment options never before available.

Challenges. There are several challenges facing CBM enabling technologies including development and integration of self-powered, wireless microelectromechanical systems (MEMS) devices for robust, inexpensive diagnostics; new techniques for oil analysis and monitoring that provide early indications of wear and impending failure; robust methods of detecting corrosion and fatigue in remote locations using intelligent sensors; and advanced signal processing, neural network classifiers, hybrid model development, data fusion, approximate reasoning, and advanced human–computer interface techniques. Furthermore, there are requirements for developing design philosophies for smart materials and structures; continuing development of robust, fast-response sensors and actuators; developing methods for attachment of sensors/actuators; determining number and placement of sensors/actuators; developing hybrid sensors/actuators systems; selecting local or global control; exploring linear vs. nonlinear control theories; selecting the control approach (e.g., neural networks, fuzzy logic); determining the durability, reliability, and maintainability of the sensors, actuators, and information processing network; energy coupling between the actuator and structure; and further reducing size, weight, and power requirements.

Milestones/Metrics.

FY2000: Demonstrate first generation of self-calibrating, self-organizing, software-reconfigurable, wireless MEMS devices on fleet weapon systems. Flight test demonstration of diagnostic system.

FY2001: Demonstrate first generation of remote fatigue-sensing NDE devices on fleet aircraft systems.

FY2001: Demonstrate second generation of self-powered, distributed MEMS sensor arrays with onboard signal processing, neural network classification, and wireless communications to intermediate sensor nodes for sensor data fusion, systems-level diagnostics, and communications with platform-level condition assessment systems. Eliminate the cost and weight of wires in naval installations. Reduce the cost per sensor node from $2,000 at present to $50.

Customer POC

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Dr. Epharim GARCIA
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Dr. R. POHANKA
ONR

Dr. Mark ROBERTS, USA
ARL

USD(A&T) POC

Dr. Lewis SLOTER
ODDR&E/PMT

MP.26.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602122N	00000	1.6	0.0	0.0	0.0	0.0	0.0
0602233N	00000	0.7	0.6	0.0	0.0	0.0	0.0
0602234N	00000	0.8	0.0	0.0	0.0	0.0	0.0
0603712N	R1910	1.6	0.0	0.0	0.0	0.0	0.0
	DTO Total	**4.7**	**0.6**	**0.0**	**0.0**	**0.0**	**0.0**

MP.27.01 Materials for Small-Target Detection Capability in High-Clutter Environments

Objectives. Develop and demonstrate electronic materials that will enable development of conventional and cryogenic electronic components that significantly enhance capabilities in detecting small targets or signals in a high-clutter environment.

Payoffs. The payoffs from these technologies will be (1) a revolutionary capability in cruise missile defense in littoral (close-to-shore, wide range of sea-state environments) operations and related low-angle airborne or space-borne radar detection scenarios, (2) a factor of 2 to 3 range enhancement for wireless intercepts and communications, and (3) the ability to detect unintended electromagnetic emissions from ground sites at larger standoff distances. The technologies to achieve these payoffs are (1) cryogenic components consisting of very low-phase-noise resonators, very high-performance filters, Josephson-junction-based A/D components, and other RF components; and (2) frequency-agile ferroelectric and ferrite materials to provide wideband tuneability and large phase shifts at very low loss and at low cost for filters and phased-array antennas. Under this DTO, which began in FY98, para-electric materials have been demonstrated to have low loss and adequate tunability to build a prototype electronically steerable array for mobile and missile applications. Also, a lightweight SATCOM patch antenna utilizing a composite para-electric/styrofoam dielectric was tested and exhibited excellent performance.

Challenges. Very low-loss ferroelectric and ferrite materials need to be fabricated for significant utilization in frequency and phase agile components. Robust high-temperature superconducting single- and multiple-layer technologies, including Josephson junctions, need to be established for the fabrication of advanced A/D and other digital and analog high-performance components. The main challenges for the cryogenic technologies are in refrigeration and cryo-packaging.

Milestones/Metrics.

FY2000: Demonstrate voltage-controlled oscillator tunable over a frequency range of 2:1 for secure communications.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Bob ANDERSON NAVSEA	Mr. Robert DENISON, USAF AFRL/MLPO	Dr. Lewis SLOTER ODDR&E/PMT
	Dr. Constantine FOUNTZOULAS, USA AFRL/IFT	
	Dr. Frank PATTEN DARPA/DSO	
	Dr. Deborah VAN VECHTEN ONR	
	Dr. Stuart WOLF DARPA/DSO	

MP.27.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602712E	MPT–01	5.0	0.0	0.0	0.0	0.0	0.0
	DTO Total	**5.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

MP.28.01 Enhanced Coastal Trafficability and Sea State Mitigation for Logistics-Over-the-Shore ATD

Objectives. Develop and demonstrate technologies that will permit cargo vessel discharge to lighterage in highly adverse sea conditions and trafficability, both on beaches and between beaches and the inland transportation network. The products from this effort will support combat operations of all military services.

Payoffs. This DTO will greatly enhance the DoD logistics-over-the-shore (LOTS) capability, including (1) a fully functional prototype Rapidly Installed Breakwater System (RIBS) to attenuate wave energy and, through a reduction of adverse sea conditions, the ability for cargo vessel-to-lighterage discharge to continue through Sea State 3; and (2) lightweight materials and construction techniques to rapidly increase trafficability in coastal areas to the level required to support logistics throughput requirements. Design, deployment, employment, and training guidance will be transitioned to the Army through the U.S. Army Engineer Waterways Experiment Station to the U.S. Army 7th Transportation Group in accordance with the *Joint Vision 2010 JLOTS Master Plan* requirements. This DTO supports the Joint Readiness and Logistics and Sustainment of Strategic Systems and Force Projection/Dominant Maneuver JWCOs.

Challenges. Specific technical barriers to this effort include the development of optimal RIBS designs; fabrication of RIBS using lightweight, high-strength materials; development of a deployment mechanism; and development and selection of moorings for RIBS. Criteria, materials specifications, and construction practices will need to be developed that address affordable soils stabilization and surfacings that can withstand 10,000 passes of military-unique loadings such as the 10 x 10 Palletized Loading System with wheel loadings up to 9,000 lb.

Milestones/Metrics.

FY2000: Complete engineering design for full-scale breakwater(s) based on detailed engineering analyses, laboratory tests, and one-fourth-scale field tests. Provide the capability to rapidly stabilize beach sands with minimum logistics burdens and reduced engineer equipment.

FY2002: Demonstrate rapidly installed breakwaters for reduction of wave conditions in sea states up to lower end of Sea State 4 by 50%. Demonstrate improved techniques to rapidly stabilize soft soils for roads and material storage areas associated with LOTS operations.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. W. ADAMS ATSE/CD	Dr. Lewis E. LINK USACE/CERD/ZA	Mr. Robert BOYD DUSD/S&T/Biosystems
LTC Steve LOOMIS, USA AFZF/ENL		

MP.28.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603734A	T08	3.6	5.2	4.7	0.0	0.0	0.0
	DTO Total	**3.6**	**5.2**	**4.7**	**0.0**	**0.0**	**0.0**

MP.29.01 Materials and Processes for Integrated High-Payoff Rocket Propulsion Technology

Objectives. Develop the technology for advanced spacelift vehicles with an overall objective of (1) low-cost, high-performance access to space for military and nonmilitary space launch systems; and (2) improved performance in tactical and spacecraft propulsion systems. This DTO supports the Integrated High-Payoff Rocket Propulsion Technology (IHPRPT) DoD initiative, which continues through 2010.

Payoffs. The payoff of this DTO is lower-cost, high-performance access to space for military and nonmilitary space launch systems, and improved performance in tactical and spacecraft propulsion systems. The key components of liquid-fuel engines that advanced materials can significantly impact include lightweight ducts, turbo pumps, injectors, and nozzles. The key material advancements in the solid systems will provide lightweight performance enhancements in the nozzle/throat, insulation, and cases.

Challenges. Technical barriers include the development of affordable materials and processes sustained by maintaining an adequate industrial base. Liquid-fuel engine systems require material systems to improve fuel compatibility, reduce component weight and volume, increase rotodynamic speeds (to decrease turbo pump assembly size), increase turbine blade and disk capability of withstanding thermal shocks and high stresses (at high temperatures), reducing composite processing costs, utilizing advanced bearing concepts, and identifying advanced bearing concept limitations. Material and processes technology challenges include carbon-carbon densification and cost reduction; oxidation-resistant coatings; higher-temperature and higher-strength-to-weight metallics, intermetallics, metal matrix composites, and ceramic matrix composites; and higher-strength-to-weight and durable organic matrix composites and polymers. Technical challenges for solid engine systems include adapting polymeric materials for use in manufacturing reduced weight components, eliminating bondlines, and identifying high-strength case materials for decreased component mass/volume.

Milestones/Metrics.

FY2001: Evaluate Cu and Al metal matrix composites (MMCs) compositions in cryo-environments through design and analysis tools for significant weight reductions. Cu-based MMC will be leveraged through efforts on the NASA RLV program. Cast-Al MMC approaches offer up to 35% weight savings over Ni alloys, and 50% increase in yield strength over Al alloys in O_2-rich environments. Efforts address critical IHPRPT Phase II component demonstrator goals. Design analysis tools will evaluate polymeric matrix composites to further lighten housings, ducts, and lines (Phase III).

FY2003: Evaluate Cu and Al MMC approaches (pump housing, ducts, and lines) for best material selection and insertion into Phase II IHPRPT demonstrator efforts. Evaluate use of noneroding materials approaches for tactical and solid rocket nozzle systems (Phase II and III goals).

FY2004: Demonstrate materials and processes to achieve liquid cryogenic propulsion system demonstrations (Phase II) that will attain 34%–100% ELV/RLV payload increase with cost reductions of 40%–60%. Design and analysis approaches for nonerosion throats and advanced composite case processing for solid boost and tactical materials systems approaches (Phase III).

Customer POC

Maj Randy KORRELL, USAF
AFSPC/XPX

Service/Agency POC

Dr. Corky CLINTON
NASA Marshall

Dr. Steven G. FISHMAN
ONR

Mr. Michael STROPKI
AFRL/MLO

USD(A&T) POC

Dr. Lewis SLOTER
ODDR&E/PMT

*MP.29.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4347	0.9	1.0	0.0	0.0	0.0	0.0
0602203F	4847	0.0	9.5	0.0	0.0	0.0	0.0
	DTO Total	**0.9**	**10.5**	**0.0**	**0.0**	**0.0**	**0.0**

*The decision with regard to out year funding for propulsion was made late in the Budget Review. Out year DTO funding for this effort will be determined during the next planning and programming cycle.

MP.29.01 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
NASA	None	9.4	3.8	0.0	0.0	0.0	0.0
	DTO Total	**9.4**	**3.8**	**0.0**	**0.0**	**0.0**	**0.0**

MP.30.01 Sustainable Military Use and Stewardship of the Environment

Objectives. Achieve maximum land and range use while complying with federal environmental regulations by developing effective technologies to predict, prevent, control, or remediate environmental damage to military training and test ranges.

Payoffs. Tri-service warfighters would have broader use of airspace, training areas, and ranges, improving DoD readiness and avoiding the impact of corrective practices that deny range access. Services currently lack the tools to respond to civilian concerns that training schedules, patterns, and loads will not damage land and ranges, their inhabitants, or adjacent areas. Manual downloading of data that are labor- and time-intensive and costly would be automated, enabling real-time access to accurate and reliable data. Advanced knowledge-based computing, coupled with accurate modeling of impacts and resource interaction, will reduce areas restricted to the military by 60%.

Challenges. The major challenge is in developing the ability to predict maximum allowable stress on ecosystems (soil, protected species, habitats, water resources, etc.) without causing irreversible damage. Military stressors are often intense involving many species and complex natural processes. Impact assessment often requires costly, complex data collection. Integrating monitoring data into common model and object-oriented software and comprehensively packaging information, processors, and software are added challenges. Also, data need to be inserted into range management models, and the true impacts of military activities on resources need to be calculated.

Milestones/Metrics.

FY2000: Develop database and guidance on (1) activities impacting key protected species, (2) monitoring protocols, (3) impact assessment guidance, and (4) impact prediction technologies for the protected species.

FY2001: Simulate mission impacts on key populations, habitats, and ecosystems components; model effects of management actions that can reduce ecological conflicts with training and testing areas by 50%.

FY2002: Increase impact and mitigation predictive capabilities of training and testing activities on environmental processes by 50%–75%.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Vic DIERSING OEDP/SFIM/ED	Dr. William SEVERINGHAUS, USA ERDC/CERL	Mr. Robert BOYD DUSD/S&T/Biosystems

MP.30.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602720A	896	2.0	1.5	0.9	0.0	0.0	0.0
	DTO Total	**2.0**	**1.5**	**0.9**	**0.0**	**0.0**	**0.0**

MP.32.01 Assured Supply Chain Responsiveness

Objectives. Demonstrate and validate advanced business practices and information technologies that integrate and streamline supply base management functions in all defense industrial base tiers and that result in continuous supplier capability improvement to ensure that warfighters have assured access to responsive, superior combat materiel support.

Payoffs. Suppliers, especially small businesses, generate the majority of manufacturing value added in weapon systems (80% or more in some systems), and are the most responsible for expanded lead times involving new systems and fielded system replacement items. This DTO will demonstrate the capability to reduce supplier lead time and costs by 20% and acquisition lead times for manufactured parts by 90%. Most DoD suppliers (in excess of 80%) are small businesses, and these smaller suppliers rarely possess the technical capabilities and financial resources needed to improve their cost and time efficiency. Customer organizations in DoD and industry could realize substantial cost and time improvements by integrating their internal information systems and business processes, and reduce total supply-chain lead times by implementing advanced technologies for scheduling and exchanging product data. Defense customer firms could achieve major improvements in their suppliers lead times and costs by assisting their small suppliers in improving all areas of their businesses, a practice used by leading commercial companies. Today's warfighters are postured for rapid expeditionary force projection contingent upon a minimal logistics footprint, which necessitates responsive combat materiel replenishment capabilities be entrenched within the industrial base. The efforts in this DTO attack the key challenges to implementing these advanced practices and technologies for both acquisition and logistics environments.

Challenges. Technical barriers include development of product data exchange technologies to permit suppliers to use one CAD system with different customers, and development of automated process planning capabilities applicable to the smaller suppliers who produce the majority of new and replacement parts for DoD. Business barriers include development of business practices that permit sharing cost reductions among all participants in the value chain, design management practices that facilitate effective supplier participation in the design process, and customer processes to stimulate continuous supplier capability improvement.

Milestones/Metrics.

FY2000: Demonstrate reduced lead time by 50% (from 122-day baseline) with commensurate reductions in inventory for apparel items by integrating DoD systems for product data, procurement, and ordering with industry systems for factory planning, scheduling, order release, and shop floor tracking. Demonstrate collaborative Web-based manufacturing cost estimating between customer and supplier.

FY2001: Complete technologies for seamless exchange among commonly used CAD systems of technical and geometric information needed for manufacturing planning; demonstrate a generative process-planning environment suitable for smaller suppliers; and demonstrate gainsharing approaches and business rationale for customer firms to help suppliers improve their capabilities.

FY2002: Implement short-lead-time apparel acquisition capabilities in support of service recruit induction centers.

FY2003: Validate gainsharing approaches and demonstrate 20% reduction in supplier costs and lead times through continuous supplier improvement assisted by customers.

FY2004: Establish a seamless interface between warfighter and military apparel supply base.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Thomas BATTERMAN HQ AFMC/LG	Mr. Steve LINDER ONR	Mr. Daniel CUNDIFF ODUSD(S&T)OTT
Mr. Darrell BORUM DSCR/VE		
Mr. Art DIVENS, USN NAVSEA, 91R		

MP.32.01 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0708011F	None	2.9	3.3	3.7	3.7	0.0	0.0
0708011N	None	0.2	0.0	0.0	0.0	0.0	0.0
0708011S	None	2.6	2.6	2.8	2.8	2.9	0.0
	DTO Total	**5.7**	**5.9**	**6.5**	**6.5**	**2.9**	**0.0**

MP.33.01 Metalworking Affordability Initiative for Castings and Forgings

Objectives. Deliver a supplier base that can provide critical turbine engine and aircraft components costing significantly less (30% to 40%) than current components and with lead times much more responsive to DoD requirements (50%).

Payoffs. Aerospace quality castings and forgings are among the longest lead components of most modern weapon systems and comprise a substantial portion of weapon system cost. Cost analyses performed by engine OEMs, for instance, indicate approximately 47% of the cost of a turbine engine is associated with castings and forgings. Typical production military engines (e.g., F100, F110, F404, F414) range in cost from $2 to $5 million. Advanced engines (e.g., F119) can cost in the range of $8 to $11 million. This translates to $0.9 to $2.4 million in forgings and castings for a typical production military engine and $3.8 to $5.2 million for advanced engines. Although not as significant a percentage of the system cost, castings and forgings applications for aircraft structures are growing and are among the longest lead items. This DTO will reduce the cost and lead time of these types of components by 25% to 50% by putting more effective factory and business processes in place within the supplier base. Representative high-cost production components will be used to establish baseline costs and cycle times. Improved manufacturing approaches achieving both cost avoidance and reductions in overall production cycle time will be demonstrated. Initial work will focus on turbine engine processes and suppliers, with later projects transitioning selected lessons learned to airframe casting and forgings. The results of this DTO will substantially improve the ability of industry to respond to compressed acquisition and repair-cycle needs of DoD while markedly reducing acquisition and sustainment costs.

Challenges. Key technical barriers include lack of effective, validated collaboration practices between engine primes and suppliers in efforts to improve quality, reduce cost, and improve lead time; ineffective process control approaches; poor understanding of the impact of process variables on product quality for advanced processes; and lack of validated tools and techniques to support integrated product/process development between engine prime contractors and key lower-tier suppliers of forgings and castings.

Milestones/Metrics.

FY2000: Demonstrate a 20% reduction in manufacturing cost for integrally bladed rotor forgings.

FY2001: Demonstrate a 25%–50% reduction in cycle time for F119 airfoil castings. Demonstrate potential for 10% reduction in manufacturing cost for the F119 engine. Demonstrate a 25% reduction in the manufacturing cost for forged turbine disks. Demonstrate the use of computer-based designer assistant tools in small casting companies.

FY2002: Demonstrate 50% reduction in lead time (from 14 months to 7 months) and 25% reduction in acquisition cost for high-value critical forged components ($50,000 to $37,000) through implementation of lean practices. Demonstrate a 35% cost reduction and 50% lead-time reduction for selected forged components of fielded weapon systems, engine, and airframe.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Rafael VILLALBA ASC/LPZ	Mr. Steve LINDER ONR	Mr. Daniel CUNDIFF ODUSD(S&T)OTT

MP.33.01 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0708011F	0000	9.8	11.4	4.6	0.0	0.0	0.0
0708011N	0000	1.0	1.1	1.0	0.0	0.0	0.0
0708011S	None	2.2	3.0	3.7	0.0	0.0	0.0
	DTO Total	**13.0**	**15.5**	**9.3**	**0.0**	**0.0**	**0.0**

MP.34.01 Composites Affordability Initiative—Aircraft

Objectives. Develop the tools, methodologies, and technologies necessary to design and manufacture a composite airframe utilizing revolutionary design and manufacturing practices to enable breakthrough reductions in cost, schedule, and weight.

Payoffs. This DTO will reduce the acquisition cost of a fighter airframe structure by 50% (approximately $5 million/airframe) through the revolutionary utilization of composite materials. As a secondary payoff, this DTO will increase the use of composites in DoD systems to maximize weapon system effectiveness. The application of an affordable, low-risk composite structure can increase the performance of the system by reducing the weight and signature of structures allowing for increased range, payload, maneuverability, survivability, and speed while achieving reduced corrosion and fatigue problems. The focus of the Composites Affordable Initiative (CAI)—Aircraft DTO will be on fighter structures, with the first opportunity for insertion being the JSF. Pervasive design, manufacturing, assembly, analysis, and process control technologies will be matured and validated for initial demonstration on fighter structures. Documentation of these developments will facilitate their transition to other DoD weapon systems. Affordable composites methodologies and technologies will be transitioned to JSF EMD at an acceptable level of risk and will lead to increased applications of composites for JSF. This DTO supports the Combat ID and Force Projection/Dominant Maneuver JWCOs. This DTO, which began in FY98, has advanced a number of technologies that have the potential to reduce cycle time by an order of magnitude as well as dramatically reduce assembly tooling and fastener count. Tools and methodologies required to transition these technologies, such as the first analysis tools for 3D loaded bonded joints, a database capturing all materials and process data including lessons learned, and the most advanced composites cost model in the industry, also have been developed. Validation and scale-up efforts will continue over the next 1 1/2 yr to demonstrate a 50% cost reduction for an entire fighter airframe.

Challenges. Technical barriers include the limited availability of effective design, cost, and analysis tools; restrictive business practices for composites; lack of integrated databases to support design and development; insufficient understanding of process capability shortfalls and cost drivers; and risk involved in the early implementation of advanced technology into an EMD vehicle.

Milestones/Metrics.

FY2001: Demonstrate/validate, using the CAI cost baseline and cost model, a $4.7 million reduction in acquisition costs for a fighter airframe structure through major demonstrations of revolutionary design/manufacturing/assembly concepts. Transition affordable technologies at an acceptable level of risk into JSF EMD.

Customer POC	Service/Agency POC	USD(A&T) POC
LTC Earl WYATT, USA JSFPO/PPM	Mr. Steve LINDER ONR	Mr. Daniel CUNDIFF ODUSD(S&T)OTT

MP.34.01 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602201F	2402	0.3	0.0	0.0	0.0	0.0	0.0
0603211F	486U	2.0	0.0	0.0	0.0	0.0	0.0
	DTO Total	**2.3**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**

MP.34.01 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0708011F	None	4.8	3.2	0.0	0.0	0.0	0.0
0708011N	None	5.7	0.0	0.0	0.0	0.0	0.0
0708045A	E25	1.5	0.0	0.0	0.0	0.0	0.0
Industry	None	11.8	3.9	0.0	0.0	0.0	0.0
	DTO Total	**23.8**	**7.1**	**0.0**	**0.0**	**0.0**	**0.0**

MP.35 Smart Materials and Structures for Defense Systems

Objectives. Design, fabricate, and test fully integrated structural systems aimed at achieving aerodynamic and hydrodynamic flow control, vibration and noise suppression, optimization of lifting surfaces, modification of structural dynamics and aeroelastics, and provisions for flight path controls. Smart materials and structures is a broad but strongly interdisciplinary field that seeks to apply multifunctional capabilities to existing and new structures. By definition, smart structures and materials are those that can sense external stimuli and respond with active control to that stimuli in real or near real time. There are four elements that must work together to meet this definition: a sensor is required to measure the appropriate stimulus; a control system is required to convert the measured stimulus into an activation signal; an actuation mechanism is required to provide mechanical displacement; and an efficient source of power is required to effect the actuation.

Payoffs. These smart structures technologies are expected to provide new and innovative capabilities in future military aircraft, including fighter and transport aircraft, unmanned aerial vehicles, and helicopters and tilt rotorcraft as well as in surface ships, underwater vehicles, and spacecraft. Some of the expected benefits are (1) enhancement of aircraft and rotorcraft handling by changing control surface shape or by affecting flow conditions over the lifting surface, thereby manipulating lift or reducing drag; (2) reduction of structural vibrations such as panel flutter, tail buffet, and blade–vortex interaction, including those caused by other mounted components like motors or gear boxes; (3) reduction of interior cabin noise; and (4) integration of electronic systems for improved aerodynamics and low observable characteristics as well as reduced manufacturing and assembly costs.

Challenges. The overall challenge is one of designing and constructing the material and structures to realize the anticipated performance gains. Environmentally robust, durable, low-power, high-authority, high-strain, fast-response actuators are critical to this program. Actuator materials being developed include shape-memory alloys, single-crystal electro-active ceramics, piezoelectric fibers, and injection-molded piezoelectric ceramics. These projects are focused on actuators having strain capabilities of greater than 3% and failure stresses of greater than 400 MPa with responses in the kilohertz frequency range as well as on single-crystal piezoelectrics having an increased operational bandwidth. Specific challenges for shape-adaptive structures include developing innovative design processes, enhancing maneuver performance, and eliminating discrete control surfaces.

Milestones/Metrics.

FY2000: In-water test of torpedo demonstration for self- and radiated-noise reduction completed. Whirl tower and wind tunnel tests of MD900 full-scale active flap rotor completed. Water tunnel test of subscale submarine demo of acoustic reduction and flow control by quasistatic shape and high-rate flow control of surfaces completed. Final wind tunnel tests of full-scale aircraft engine inlet for flow control and smart wing completed.

FY2001: Hull-mounted SmartPanel one-quarter-scale demonstration for submarine quieting at Integrated Smart Material System (ISMS) completed or multiple active hybrid mount one-quarter-scale demonstration for machinery vibration suppression at ISMS completed. MD900 helicopter flight test of active flap rotor completed.

FY2002: Demonstrate laboratory-scale targeted naval sonar device/system performance using advanced single-crystal piezocrystals.

Customer POC	Service/Agency POC	USD(A&T) POC
LtCol Ken BEST, USMC OPNAV, N88/OF1	Dr. Alok DAS AFRL	Dr. Lewis SLOTER ODDR&E/PMT
Mr. Joseph MEIJIDE NAVSEA, 92R	Dr. Steven DONALDSON, USAF AFRL/MLBC	
Mr. Pete PERRY PEO/USW, PMS–404	Dr. Epharim GARCIA DARPA/DSO	
	Dr. R. POHANKA ONR	
	Dr. John STUBSTAD BMDO/TOS	
	Dr. Shawn WALSH, USA ARL	

MP.35 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602234N	00000	1.3	1.3	1.3	0.0	0.0	0.0
0602712E	MPT–01	10.0	10.0	10.0	0.0	0.0	0.0
	DTO Total	**11.3**	**11.3**	**11.3**	**0.0**	**0.0**	**0.0**

MP.36 Integrated Survivable Composite Structures

Objectives. Increase survivability, reduce the parasitic weight, and reduce the total cost of ownership of ships, ground vehicles, and aircraft by developing affordable means for incorporating multifunctional composite materials into weapon system structures.

Payoffs. The survivability of the warfighter and weapons platforms depends on protection from detection and from a variety of threats. This protection has traditionally been supplied by parasitic layers of armor, signature control, or camouflaging materials, adding to the cost and weight of warfighting equipment but not contributing significantly to the structural performance. This DTO will support the development of affordable processes capable of making multifunctional composites and multilayer or hybrid composite structures that provide enhanced survivability for affordable reduction of parasitic weight in ships and ground vehicles. This DTO will reduce the weights of some structures up to 30% while reducing total cost of ownership of these multifunctional components by as much as 40%. Projected benefits to ground vehicles include a $91 million life-cycle cost avoidance for Crusader due to weight savings using composites. Tailored layered systems, including thick composites, have shown potential for reducing the weight of vehicles and at the same time, improving survivability and situational awareness and reducing the detectability of these structures. Similar thick structures have demonstrated performance improvements in naval applications where one of the major contributors to damage is the corrosive nature of the environment. Composites, alone or in layered systems tailored for specific applications, can provide structural integrity and multispectral signature reduction, EMI resistance, NBC protection, or ballistic armor protection. Thick nonparasitic composites can provide these benefits while also functioning as part or all of the structure. Further, composites are resistant to corrosion, thereby reducing life-cycle cost for some applications.

Challenges. Thick nonparasitic composite structures are difficult to manufacture by traditional methods because extensive debulking, fiber waviness, and lack of process controls. In addition, the multiple layers traditionally require multiple processes, adding to the cost and reducing the reliability. The ability to combine diverse performance characteristics into a single structure is an underlying challenge.

Milestones/Metrics.

FY2000: Demonstrate affordable composite shipboard deckhouse structures that possess the required structural, signature, ballistic, and fire/smoke and toxicity characteristics (DDG–51). Develop preliminary requirements packages for both an Army land combat vehicle thick, multifunctional armor and a Navy marine application.

FY2001: Demonstrate effective intelligent process control systems for shop floor using sensors and process models. Complete detail design and requirements document for Army and Navy demonstration articles.

FY2002: Transition technology at an acceptable level of risk into Crusader EMD and a Navy marine system. Demonstrate affordability and performance through primary structure component demonstrations.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. R. ASOKLIS AMSTA/FSCS	Mr. Steve LINDER ONR	Mr. Daniel CUNDIFF ODUSD(S&T)OTT
COL W. SHEAVES, USA AMSTA/AR, Crusader PO		

MP.36 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602105A	H84	0.5	0.5	0.5	0.0	0.0	0.0
	DTO Total	**0.5**	**0.5**	**0.5**	**0.0**	**0.0**	**0.0**

MP.36 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603854D	505	0.5	1.5	3.0	0.0	0.0	0.0
0708011F	None	0.9	0.0	0.0	0.0	0.0	0.0
0708011N	None	4.4	0.0	0.0	0.0	0.0	0.0
0708045A	None	1.6	1.3	0.0	0.0	0.0	0.0
	DTO Total	**7.4**	**2.8**	**3.0**	**0.0**	**0.0**	**0.0**

MP.37 Low Observable Materials, Processes, and Maintainability

Objectives. Develop the materials and processing technology for gap treatments, nondestructive evaluation (NDE) (low observables (LO) inspection), radar-absorbing material (RAM) tapes/durable adhesives, radar-absorbing structure (RAS) repair, and RAM repair/removal techniques. The highest priorities are materials and processes solutions to make current materials and configurations more maintainable and developing advanced processes and design tools that minimize RF scattering sources by minimizing part count and part mismatch.

Payoffs. The following capabilities will be achieved: high durability, electrically conductive gap treatment fillers that reduce maintenance time to less than 1 MMH/fhr; and improved NDE (LO inspection) techniques that will increase mission readiness, reduce maintenance costs, enable supportable/maintainable LO, and increase reliability/confidence. Increased mission readiness, reduced maintenance costs, increased reliability, and improved processing are expected payoffs from improved RAM tapes/durable adhesives. Advanced precision-oriented processes and design tools will dramatically reduce part count and mismatch, hence reducing the number of scattering sources, which are major limitations in achieving stealth requirements.

Challenges. Technical barriers include the development of intrinsically conductive polymers and elastomers; materials and process development for durable, quick-cure adhesives; development of new quick-curing materials and techniques for high-temperature RAM repair; and development of hand-held RF and optic measurement devices. Other challenges include the fusion of inspection data, development of easily applied, multiuse gap fillers, and standardized testing techniques; field-level repair procedures for low-temperature and high-temperature RAM; and a meaningful test of high-temperature RAM durability. The development of precision tolerance composite materials requires identifying and remedying the drivers associated with variations in raw materials and processed parts. The longer-term challenge is optimizing non-autoclave processes (i.e., oven curing and e-beam) to achieve aerospace-grade properties.

Milestones/Metrics.

FY2000: Develop RAM removal techniques. Define RAS field repair needs and identify improved adhesives for tapes. Identify best intrinsically conductive polymer candidates. Identify and explore materials and techniques for fast, affordable, high-temperature RAM coating repair.

FY2001: Develop the methodology to predict and control part dimension during cure within the tolerance required to reduce RF scatter of outer mold line composite components.

FY2002: Develop low-temperature RAM repair techniques and identify environmentally compliant RAM. Develop RAS repair techniques. Scale-up intrinsically conductive polymers. Develop intrinsically conductive elastomers. Optimize high-temperature RAM repair techniques and durability and downselect coating repair approach.

FY2003: Develop deployable flight line repair techniques for RAM and RAS. Scale-up high-temperature RAM coatings for engine exhaust and airframe applications. Transition low-temperature RAM repair and removal techniques. Transition improved tape adhesive. Transition and train RAS field repair techniques. Scale-up intrinsically conductive elastomers. Demonstrate fast, durable, high-temperature RAM coating repair.

Customer POC	Service/Agency POC	USD(A&T) POC
Maj Mike PLUMBER, USAF ACC/DR	Mr. Doug CARTER, USAF AFRL/MLSA	Dr. Lewis SLOTER ODDR&E/PMT
Mr. Wayne WARD AFRL/SNS	Mr. James KELLY ONR	

MP.37 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4347	0.4	0.3	0.3	0.1	0.0	0.0
0602102F	4349	2.0	2.4	2.8	2.7	0.0	0.0
	DTO Total	**2.4**	**2.8**	**3.1**	**2.8**	**0.0**	**0.0**

MP.38 Manufacturing Technology for Infrared Cooled and Uncooled Staring Sensors

Objectives. Develop and demonstrate manufacturing processes to accelerate the production of affordable staring cooled and uncooled IR focal plane arrays (FPAs) and components operating in the near IR (NIR), mid-wave IR, and long-wave IR. Emphasis will be placed on developing and applying manufacturing processes, materials, tooling, and testing to support higher production yields and lower the production costs of these items. The results of this DTO will broaden the availability of affordable and higher-performance uncooled and cooled staring IR sensors.

Payoffs. This program will reduce the unit acquisition cost for cooled and uncooled staring FPAs and associated components making available more affordable, higher-performance FPAs for use in planned and emerging weapon and surveillance systems. Monolithic uncooled staring FPAs with reduced pixel size will provide increased sensitivity and resolution, allow for smaller and lighter-weight man-portable systems, and allow for future product improvements of cooled FPA applications (thermal weapon sights, Javelin seekers). The goal for uncooled FPAs is to achieve unit cost reductions of up to 50% based on current prices ($1,000 to $9,000 depending on performance) over a 10-year expected production of 85,000 units. Large-area cooled staring FPAs will also provide increased sensitivity, improve capability to detect and identify low-signature targets, and add the capability of 360-deg panoramic coverage. The goal for cooled FPAs is to achieve unit cost reductions of up to 60% based on current prices (up to $180,000 for 640 x 480 LWIR FPAs) over a 15-year expected production of 20,000 units. The warfighter will benefit from the availability of higher-performance IR imaging systems for Driver's Vision Enhancer systems, man-portable weapon sights, remote surveillance systems, man-portable mine detectors, missile seekers, Future Scout Cavalry System, Future Infantry Vehicle, Future Combat System, Amphibious Assault Vehicles, surface ships, and airborne surveillance and threat warning systems.

Challenges. Technical barriers for uncooled FPAs include developing manufacturing processes that maintain or increase FPA sensitivity while reducing the pixel size by a factor of 4, and producing low-cost, high-vacuum sensor packages. For cooled FPAs, the barriers include improving array fabrication processes to maintain thermal cycling stability of large staring arrays, and reducing FPA-driven packaging fabrication and assembly requirements.

Milestones/Metrics.

FY2000: Demonstrate greater than 50% yield for 288 x 384 uncooled FPAs with reduced pixel size.

FY2002: Demonstrate 20% improvement in yield and a 50% cost reduction for 480 x 640 cooled FPAs/dewers. Transfer improved manufacturing processes from 480 x 640 to 480/960 x 1,280 cooled FPAs/dewers.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. William BISHOP SFAE/MSL/AM/E	Mr. Steve LINDER ONR	Mr. Daniel CUNDIFF ODUSD(S&T)OTT
COL Jeffrey SORENSON, USA SFAE/PEO/IEW&SD		

MP.38 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0604710A	None	0.5	0.0	0.0	0.0	0.0	0.0
0708045A	E25	3.0	3.0	3.0	0.0	0.0	0.0
Industry	None	5.7	1.1	1.0	0.0	0.0	0.0
	DTO Total	**9.2**	**4.1**	**4.0**	**0.0**	**0.0**	**0.0**

MP.39 Combat Equipment Repair Cycle Enhancement

Objectives. Establish, demonstrate, and implement improved and cost-effective, depot-level workload management practices, emphasizing cycle-time and inventory reductions in support of significantly reducing the DoD's $13 billion annual organic maintenance burden.

Payoffs. An Air Force Materiel Command survey of 10 depot maintenance work centers identified 600 high-value, reparable assets deferred to awaiting parts (AWP) status, and over 400 of these units had been frustrated in excess of 90 days. Over $4.3 billion in warfighting equipment is snagged in the AWP syndrome, imposing compounded waste and degraded support upon the warfighter. Project success will (1) attack head-on the 60% life-cycle cost burden imposed by weapon system sustainment, (2) enable accelerated reparable asset movement through the repair pipeline and assure schedule delivery compliance while shifting to a more austere materiel inventory posture, (3) establish the vanguard model for achieving 20% depot repair-cycle time reductions (FY98 DoD Strategic Logistics Plan—FY04 goal), (4) minimize frustrated work in progress due to replacement parts impediments, (5) synchronize repair workload flow with replacement parts generation/availability, (6) enable reduced combat materiel inventories by eliminating waste and inefficiencies within the depot repair cycle, (7) incorporate world-class industrial capabilities into representative depot maintenance activities that will lead to pervasive migration across the entire support enterprise, and (8) facilitate improved warfighter depot support confidence and assure combat materiel inventories elevate mission readiness.

Challenges. Vanguard approaches such as “Just-in-Time” (JIT), capable of generating revolutionary industrial enterprise change, must be adapted to a complex, archaic problem space. Impediments are numerous, and insidious mass-production philosophies in inventory management and an unresponsive supply system are preeminent barriers. Actual status (prevailing materiel support condition) of items inducted for repair vacillates; the bill of materials is uncertain because repair activities lack the inherent capabilities to integrate replacement materiel requirements with workload flow. The confluence of these conditions imposes excessive inventory levels to support readiness; parts shortages are endemic, nonetheless. Strict application of continuous flow principles is not straightforward in this environment.

Milestones/Metrics.

FY2000: Demonstrate cycle time reductions (approaching 25%) in the repair of at least two DoD systems.

FY2001: Demonstrate inventory reductions (approaching 25%) associated with supporting the repair of at least two DoD systems. Incorporate lean, agile processes from the commercial sector and apply them to an equivalent government circuit-board production facility in a manner that will enable labor cost avoidance approaching $900,000 annually.

FY2002: Implement inventory management practices that enable JIT material delivery required to support the unimpeded repair and overhaul of fixed-wing aircraft systems or major subsystems. Generate 25% repair-cost reductions through this implementation.

FY2004: Expand implementation of advanced repair principles to at least two other repair activities. Demonstrate 50% reductions in repair cycle time and required inventory levels for selected repair activities.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Thomas BATTERMAN HQ AFMC/LG	Mr. Steve LINDER ONR	Mr. Daniel CUNDIFF ODUSD(S&T)OTT
Mr. James STEELMAN PEO/TM		

MP.39 Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0708011F	None	3.5	4.1	4.2	4.3	0.4	0.0
	DTO Total	**3.5**	**4.1**	**4.2**	**4.3**	**0.4**	**0.0**

MP.40 Materials and Processes for Affordable, High-Performance Thermal Management

Objectives. Develop and demonstrate affordable, lighter-weight, more efficient conductivity materials to enhance system performance and to meet future system requirements. Carbon has the highest specific thermal conductivity next to diamond of all materials. A composite reinforced with carbon fibers possesses very high, tailorable thermal conductivity and very low density. Carbon-carbon composites inherently possess the thermal properties of carbon and the mechanical integrity of a composite material. Additionally, carbon or graphitic foams have been developed and have demonstrated isotropic thermal conductivity of carbon and mechanical properties unmatched by current core materials. These foams allow for the development of isotropic conductivity composites as well as thermally conductive core. These polymers, polymer matrix composites, and carbon-carbon composites must be developed and demonstrated as an affordable alternative to current state-of-the-art materials as current thermal management systems for aircraft and spacecraft are currently operating at maximum efficiency.

Payoffs. The following capabilities will be achieved by the development of affordable materials and processes: 10% increase in aircraft mission range by decreasing thermal management system weight; doubling of spacecraft system payload capability by developing materials with lower weight and increased thermal conductivity; increased electronic reliability by at least 2X for both spacecraft and aircraft; increased aircraft heat exchanger lifetime by 2X–10X; and a 50% increase in spacecraft radiator performance utilizing core materials.

Challenges. The material and process technical challenges are to create a polymer carbon-carbon and polymer matrix composite materials possessing the required properties at a cost that ensures usage. This includes the development of lower-cost constituent materials, lower-cost processes with reduced processing times, oxidation stability for moderate temperature uses, and the appropriate coating for contamination or oxidation protection.

Milestones/Metrics.

FY2001: Demonstrate a 50% reduction in processing times for carbon-carbon thermal planes, thermal spreaders, and doublers.

FY2003: Demonstrate an affordable, reproducible, oxidatively protected carbon-carbon that can perform for 2,000 hr in a 1,200°F corrosive environment.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Thomas FISCHER F–22 SPO	Dr. Larry KABACOFF ONR 332	Dr. Lewis SLOTER ODDR&E/PMT
Mr. Larry JENKINS ASC/EN	Ms. Kristen KEARNS AFRL/MLBC	
Dr. Yolanda KING SBR Office	Ms. Wendy LEONARD, USA ARL	

MP.40 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602102F	4347	2.0	2.0	2.0	2.0	0.0	0.0
	DTO Total	**2.0**	**2.0**	**2.0**	**2.0**	**0.0**	**0.0**

MP.41 Enhanced Detection, Discrimination, and Characterization of Buried Unexploded Ordnance for Environmental Remediation and Active Range Clearance

Objectives. Reduce unexploded ordnance (UXO) site characterization costs by 75% by reducing nuisance-alarm rates by 80% over a wide variety of conditions while maintaining or improving current probability of detection (P_d) levels (90% to 95%).

Payoffs. The principal objective of this technology effort is to produce more cost-effective detection and discrimination processes and procedures for environmental restoration of UXO at DoD sites. Technologies that meet DoD P_d/false-alarm goals are not currently available in the commercial sector. Even though almost all UXO remediation is done by contract to the commercial sector, that community does not have the independent capability to evolve the sophisticated technology required. Integrated technology development incorporating the expertise of DoD and private sector assets are necessary to meet the objective of this effort. The 80% reduction of the number of nuisance detections will reduce the cost and the time required to remediate UXO contaminated sites to at least one-third of their current values.

Challenges. Technical barriers include the multitude of differing geographic sites (soil, water, and climate) across DoD land in which, under certain ranges of environmental and geophysical conditions, signatures from some types of UXO may be too weak for available sensors due to the attenuation of the signature below detectable levels or background clutter and dispersed UXO contamination that may mask the target signatures.

Milestones/Metrics.

FY2000: Obtain comprehensive sensor performance specifications (P_d, nuisance-alarm rates, false-alarm rates, and receiver operating characteristics curves) for UXO target, environmental, geophysical, and clutter combinations using advanced electromagnetic, magnetic, ground penetrating radar, and chemical sensors.

FY2001: Develop validated UXO signature models of emerging sensors to support multisensor systems development and improved sensor data fusion analysis techniques. Develop autonomous navigation and advanced sensor data collection for unmanned systems.

FY2003: Develop UXO sensing and data fusion analysis technologies integrated onto man-portable and unmanned system platforms reducing false-alarm rates by 80% over a wide variety of conditions while maintaining the current P_d levels of 90%–95%.

Customer POC	Service/Agency POC	USD(A&T) POC
Mr. Robert SCHROEDER ODEP, DAIM–ED–P2	Dr. M.J. CULLINANE CEERD–EP–J	Dr. Lewis SLOTER ODDR&E/PMT
	Capt David SHAHADY, USAF AFRL/MLQC	

MP.41 S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0602720A	835	0.3	0.4	0.4	0.0	0.0	0.0
0602720A	F25	0.9	0.9	1.0	0.0	0.0	0.0
0603716D	P470	3.5	3.5	3.5	4.0	0.0	0.0
	DTO Total	**4.7**	**4.8**	**4.8**	**4.0**	**0.0**	**0.0**

MP.41Non-S&T Funding ($ millions)

PE	Project	FY00	FY01	FY02	FY03	FY04	FY05
0603709D	406507	0.7	0.8	0.8	0.8	0.0	0.0
	DTO Total	**0.7**	**0.8**	**0.8**	**0.8**	**0.0**	**0.0**