

Department of Defense
Small Business Innovation Research
&
Small Business Technology Transfer Programs



Fiscal Year 2007 Annual Report Submission

on

***Executive Order 13329:
Encouraging Innovation in Manufacturing***

September 2008

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Department of Defense

Fiscal Year 2007 Annual Reporting on Executive Order 13329 – Encouraging Innovation in Manufacturing

Manufacturing-Related Topics and Awards Statistics

Innovation in art, science and practice of manufacturing remains very important to the Department of Defense. As evidence of this, in Fiscal Year 2007 (FY07), 29.2% of DoD SBIR/STTR topics were manufacturing-related, based on the current Manufacturing-Related Research and Development (R&D) Search Terms list from the Office of Science & Technology Policy (OSTP). The percentage of manufacturing-related contract awards was 21.4% in FY07, an increase from FY06 in which 19.8% of awards were manufacturing-related. The number of manufacturing-related topics and the number of awards and total award amounts by DoD Component are summarized below. Note that most of the Phase II awards made in FY07 were from topics developed or solicited in FY05.

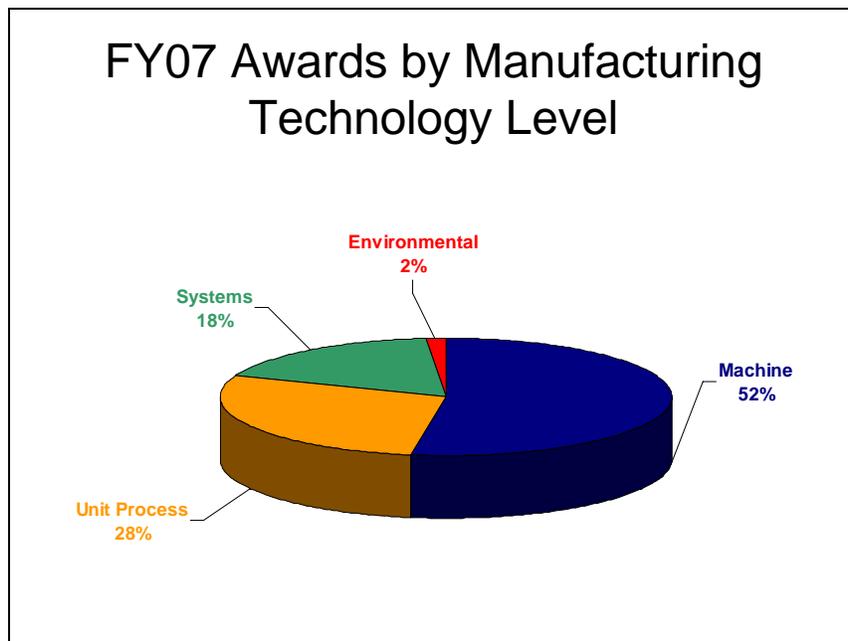
Manufacturing Topics Summary by DoD Component for FY07:

Agency	SBIR	% of total SBIR	STTR	% of total STTR	SBIR & STTR	% of total SBIR & STTR
Air Force	118	23.6%	12	42.9%	130	24.7%
Army	78	36.1%	11	27.5%	89	34.8%
CBD	3	18.8%	0	0.0%	3	18.8%
DARPA	22	25.3%	3	30.0%	25	25.8%
DLA	1	100.0%	0	0.0%	1	100.0%
DMEA	3	100.0%	0	0.0%	3	100.0%
DTRA	1	8.3%	0	0.0%	1	8.3%
MDA	19	35.8%	3	27.3%	22	34.4%
Navy	72	33.5%	18	46.2%	90	35.4%
NGA	0	0.0%	0	0.0%	0	0.0%
OSD	5	19.2%	1	16.7%	6	18.8%
SOCOM	3	42.9%	0	0.0%	3	42.9%
Totals	325	28.7%	48	33.3%	373	29.2%

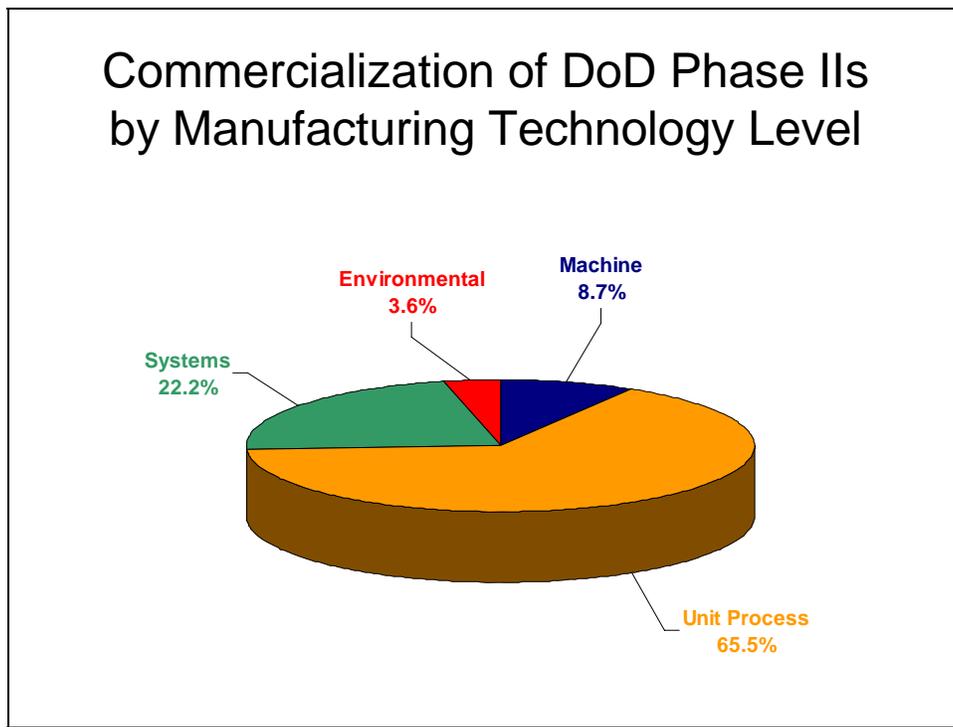
Manufacturing Awards Summary by Agency for FY07:

Agency	SBIR				STTR				SBIR & STTR			
	Phase I		Phase II		Phase I		Phase II		Phase I		Phase II	
	Total Dollars	Total # Awards										
AF	8,198,548	82	55,045,640	70	2,597,468	26	6,317,406	9	10,796,016	108	61,363,046	79
Army	3,334,363	47	15,304,926	21	298,509	3	749,400	1	3,632,872	50	16,054,326	22
CBD	139,873	2	7,818,038	7	0	0	0	0	139,873	2	7,818,038	7
DARPA	2,226,094	21	7,054,419	10	296,930	3	2,245,442	4	2,523,024	24	9,299,861	14
DLA	891,492	9	0	0	0	0	0	0	891,492	9	0	0
DMEA	0	0	0	0	0	0	0	0	0	0	0	0
DTRA	199,998	2	0	0	0	0	0	0	199,998	2	0	0
MDA	3,694,484	37	22,352,873	24	999,826	10	1,999,945	2	4,694,310	47	24,352,818	26
Navy	9,656,942	94	35,406,654	50	839,291	12	4,917,628	11	10,496,233	106	40,324,282	61
NGA	0	0	0	0	0	0	0	0	0	0	0	0
OSD	2,888,981	29	8,973,391	12	495,961	5	1,499,942	2	3,384,942	34	10,473,333	14
SOCOM	499,303	5	0	0	0	0	0	0	499,303	5	0	0
Totals	31,730,078	328	151,955,941	194	5,527,985	59	17,729,763	29	37,258,063	387	169,685,704	223

Again, based on OSTP characterizing guidance, FY07 DoD SBIR contract awards are mainly concentrated on machine-level manufacturing, versus unit process, systems and environmental levels, as shown below.



In addition, the Department began tracking manufacturing-related commercialization (sales and investment) resulting from its Phase II awards in response to Executive Order 13329. To date, 23% of DoD Phase II awards reported in the DoD Commercialization database have been identified as manufacturing-related (from awards made in 1983 through 2007). The majority of these are in unit process level technologies (see chart below). Of these manufacturing-related projects, 62% have sales and/or additional follow-on investment. Total Commercialization resulting from DoD SBIR/STTR Phase II manufacturing-related projects reported to date by firms participating in the DoD SBIR/STTR programs is \$6,376,189,817 (\$4,739,732,037 in sales and \$1,636,457,780 in investment) with an average of over \$2.1 million in total commercialization per reported project.



I. Examples of DoD Manufacturing-Related SBIR/STTR Projects

Examples of DoD manufacturing-related SBIR/STTR projects are described on the pages that follow. More are available upon request, and several are featured on DoD and DoD Component web pages as success stories.

Army

1. Hittite Microwave Corporation. The Hittite Microwave Corporation's project "Joint Tactical Radio System (JTRS) Handheld Manpack and Small form fit (HMS) Core Transceiver Power Amplifier (PA)" is an example of a successful manufacturing related SBIR effort. Hittite has been working on the Affordable Software Defined Radio (SDR) Components for JTRS Army

Technology Objective - Manufacturing (ATO-M) as well as the SBIR. Hittite enhances and develops the manufacturing techniques to reliably and cost-effectively manufacture Gallium Nitride (GaN) Monolithic Microwave Integrated Circuits (MMIC) for the core transceiver PA that will potentially be transitioned into the JTRS HMS Core Radio 2 system. This PA will provide a 96% reduction in size, 23% reduction in power consumption and a 70% reduction in Unit Production Cost (UPC) over the standard Commercial Off-the-Shelf (COTS) parts that are currently being used in the JTRS system and final prototypes will be delivered in September 2008. GaN MMICs are currently widely used in the commercial world and this is the first major manufacturing development addressing this technology area. Finally, this PA that Hittite Microwave Corporation is developing has a great deal of potential as a commercial product in the cellular industry and the manufacturing improvements provided under the ATO-M and this SBIR effort are greatly contributing to GaN MMIC's viability in the commercial and military arenas.

Contract#: W15P7T-06-C-P243

Award Amount: Received total funding through Phase II of \$729,305

Organization: U.S. Army Communications-Electronics Research, Development, and Engineering Center (RDECOM-CERDEC)

2. Universal Display Corporation. In the program entitled "Flexible and Conformal Environmental Barrier Technology for Displays," leveraged with the Army Technology Objective - Manufacturing (ATO-M) titled "Flexible Display Manufacturing Technology," Universal Display Corporation (UDC) implemented a new approach to encapsulate a long-lived, Active-Matrix Organic Light Emitting Device (AMOLED) display prototype built on flexible metal foil. The thin film encapsulation technology transitioned from the Princeton Lab to UDC, a Principal Partner in the Flexible Display Center (FDC), a government/industry/university consortium at Arizona State University. UDC is integrating their OLEDs with FDC backplanes, and will include the encapsulation technology. Ultimately, the process will transition to the FDC. UDC has filed patents on the technology. In this SBIR-funded manufacturing-related project, UDC developed a novel technology by which alternating layers of Polymerized Hexamethyl Disiloxane (PHMDSO) and silicon oxide (SiO_x) or silicon Oxycarbide (SiO-_xCy) films are deposited in a single chamber Plasma-Enhanced Chemical Vapor Deposition (PECVD) system. The goal of this project is to apply this multilayer encapsulation technology to low power consumption Phosphorescent OLED (PHOLED) technology to enable the low cost manufacture of flexible encapsulate a long-lived, AMOLED displays on either plastic or metal foil substrates—a technology that does not exist anywhere in the world today.

Contract#: W911QX-06-C-0134

Award Amount: \$730,000 / \$2.2M Phase III

Organization: U.S. Army Research Laboratory (RDECOM-ARL)

3. Kyma Technologies - "Manufacturing of Non-polar Gallium Nitride Substrates" is a project undertaken by Kyma Technologies of Raleigh, NC and funded by the U.S. Army Research Office through two STTR awards for the development of non-polar gallium nitride (GaN) substrates. In these programs, Kyma has worked with researchers at North Carolina State University to develop crystal growth techniques and manufacturing processes for the

production of large area, non-polar GaN substrate. Gallium nitride is a compound semiconductor useful for producing optoelectronic devices (such as light emitting diodes (LEDs), laser diodes (LDs) and photodetectors) and electronic devices (such as diodes and field effect transistors (FETs)). Devices based on GaN materials are currently found in LEDs that emit light in the UV, blue, and green spectra, and these LEDs are used to generate white light in combination with phosphors or other LEDs. GaN-based LEDs used in solid state lighting (SSL) for general illumination are expected to replace incandescent and fluorescent light sources as more efficient and less toxic alternatives as the GaN device technology improves, eventually providing significant energy savings for lighting applications. The GaN-based LED market for SSL is predicted to be over \$1.5 billion in 2012, while the total GaN LED market is forecast to be over \$9 billion. For electronic applications, GaN-based rectifying diodes and power switches are expected to handle higher power densities and operate more efficiently due to lower on-resistance and higher mobility, enabling smaller, lighter, and more efficient power electronics for inverters, converters, and power supplies.

Kyma Technologies has developed the hydride vapor phase epitaxy (HVPE) growth technique for fabricating non-polar GaN substrates. During a Phase I STTR effort, the basic crystal growth process was developed and non-polar GaN substrates were fabricated from GaN crystals grown using the HVPE process. These substrates exhibited excellent materials properties, including a low number of crystalline defects, very good uniformity of crystal quality, and high quality surfaces ready for epitaxial growth. Due to the strong interest in these products for research and development, Kyma was able to rapidly commercialize these substrates and has sold them to industry and university customers in the U.S., Europe, Japan, Korea, and Taiwan. The main area of commercial interest for these substrates has been for LED development. The ongoing Phase II STTR program focuses on increasing the size of the substrates through improvements in crystal growth, as well as improving the manufacturability through the production process. Kyma has benefited tremendously from the STTR support provided by ARO in moving this technology forward from demonstration to commercialization.

4. nGimat. Future multiband communications systems demand frequency agile filters. While such devices are available at millimeter wave, they suffer from large size and high cost, among other limitations. Under this STTR Phase II effort, nGimat, working with Georgia Tech, will develop a miniaturized, low-loss, tunable Ka-band bandpass filter using its low-cost tunable thin film technology. In Phase I, nGimat successfully demonstrated the feasibility of several filter designs using the tunable dielectric thin films, which showed adequate tuning and acceptable loss. New materials were also developed. In Phase II, a fully packaged prototype filter, deliverable to Army and industrial partners, will be developed through comprehensive design, optimization, and test efforts. A cost model will be provided and path forward for large scale manufacturability will be discussed.

Navy

For several years the Navy SBIR and STTR Programs have sought technology innovations related to manufacturing processes, machine-level technologies, use of advanced materials in manufacturing, manufacturing of electronics hardware and ship signature reduction materials,

etc. A list of related success stories is provided below. Most of these success stories can be found in the examples of Navy SBIR/STTR success compiled in four volumes: the *Black Book* (1999), the *Blue Book* (2001), the *Red Book* (2004), and the *Gold Book* (2007). These books can be accessed by reaching the Navy SBIR/STTR Website, www.navysbir.com, and selecting “What’s New”.

Topic Number	Title	Firm	pg book
N93-261	Fibrous Monoliths	Advanced Ceramics Research, Inc.	4, blue; 12, black
N01-001	Radiation Hardened Electronics Packaging for Strategic Missile Guidance System Upgrades	Aguila Technologies, Inc.	
N94-172	Low-Cost, Lightweight Night Vision Capability for Hand Launched Unmanned Aerial Vehicle (UAV) System	Bodkin Design & Engineering, LLC	7, red
N95-209	Develop New Towed Array Technology	Chesapeake Sciences Corporation	44, black
N90-321	Equipment Support Structural Concepts	Ebert Composites Corporation	56, black
N86-132	Z-Fiber	Foster-Miller, Inc.	16, blue
N88-137	Liquid Crystal Polymers (LCP')	Foster-Miller, Inc.	17, blue
N02-001	Durability Improvement of Lightweight Track and Suspension Components for Armored Vehicles	GS Engineering, Inc.	
N93-004	Technology for Affordability	IntelliSense Corp.	21, blue
N95-033	Structural Fatigue Assessment via NDT/I Techniques	JENTEK Sensors, Inc.	23, Gold
N98-141	Ultra-Light Structural Steel Fabrication Technology	Jonathan Aerospace Materials Corp	
	Low Cost Magnetic Attitude Heading Reference Systems (M-AHRS) for Autonomous Flight Vehicles Effect	KVH Industries, Inc.	30, black
N93-137	Acoustic Transducer Material Fabrication	Materials Systems Inc.	58, Black
N95-083	Two-Dimensional Ultrasonic Imaging Array Transducer	Materials Systems Inc.	25, blue
N92-067	Development of Advanced Intercommunications Systems	Mathtech	16, red
N95-083	Two-Dimensional Ultrasonic Imaging Array Transducer	MicroSound Systems, Inc.	
N98-001	Metal Plate Forming	Native American Technologies Co	18, red
D97-T003	Embedded Capacitors for Multichip Modules and Printed Circuit Boards	nGimat Co.	20, red
N03-T007	Power Dense and Thermally Tolerant Passive Components for Power Electronics Filtering Applications	nGimat Co.	

N96-103	Materials Research in Sliding Electric Contacts	Noesis, Inc	21, red
N94-125	Giant Magnetoresistive Sensors	NVE Corporation	62, black
N93-004	Technology for Affordability	Page Automated Telecommunications Systems, Inc.	24, red
OSD95-017	PAWS Off-Line Programming System	PHT, Inc.	
N90-064	SENSOR FOR AMPLITUDE MODULATED ELECTROMAGNETIC FIELD (AMF) BUOY	Polatomic, Inc.	32, black
N94-162	Ship Construction Process Modeling	SURVICE Engineering Company	
N94-085	Low Cost Integrated Circuit Design and Fabrication using Shared Mask Methodology	Tanner Research, Inc.	
N97-030	In-Field Composite Damage Assessment	Thermal Wave Imaging, Inc.	
OSD98-043	Carbon Foam Fiberlock Material for Laminated Composite Structures	Touchstone Research Laboratory, Ltd.	35, red
N87-159	Microencapsulated Phase Change Materials	Triangle Research and Development Corporation	
N93-004	Technology for Affordability	TRITON SYSTEMS, INC.	
N95-156	Durable Coatings for Navy Helmet Visors	TRITON SYSTEMS, INC.	38, black
N95-T008	Specific Functional Materials	TRS Ceramics, Inc.	66, black
N96-T003	Haptic Sensing and Display for Telerobotic Manipulation and Virtual Environment Applications	Virtual Technologies, Inc.	45, blue
N96-150	Four Dimensional (4-D) Atmospheric and Oceanographic Instrumentation	Zivko Aeronautics, Inc.	48, blue
N01-004	Composite Armor System	Armor Works, LLC	12, Gold
03SBI-0031	PMN-PT Single Crystals	H.C. Materials Corporation	17, Gold
N02-045	k-Core Thermal Management System	k Technology Corporation	25, Gold
N01-024	Low Plasticity Burnishing	Lambda Technologies	26, Gold
N98-149	Ceramic Matrix Composites	Materials Research & Design	28, Gold
N00-056	VPS Net Shape Manufacturing	Plasma Processes, Inc.	36, Gold
N99-141	Laser Fabrication of Ship Structures	Technology Systems, Inc.	45, Gold
N02-066	Shear Mode Vector Sensor	Wilcoxon Research, Inc.	50, Gold

In addition, the following short narratives summarize two exemplary technologies, developed by Materials Research & Design and Technology Systems, Inc.

1. Materials Research & Design. The Navy has an immediate need for an alternative to the metallic blast shield currently being used on the AV-8B Harrier aircraft. The blast shield protects the fuselage from the harsh exhaust environment, but the existing component exhibits severe degradation due to the high thermal and acoustic loads. Blackglas™ Ceramic Matrix Composites (CMCs) have been identified as potential replacement for existing steel blast shields

that require significant maintenance because of thermal and acoustic loads. However, the composites cannot be employed in the fleet until further testing, development, and repair procedures have been established. Materials Research & Design (MR&D) has developed ceramic matrix composites, which can be used to manufacture replacement parts for certain Navy jet and helicopter metal components. MR&D's test data demonstrated that the repaired panel restored 95 percent of the load-carrying capability of the baseline composite. In addition, a micromechanical model and a thermal/acoustic finite element model were created to evaluate the effects of damage and design repairs on ceramic matrix composites. These models help MR&D to further develop repairs that arise from normal wear, abuse, and battle damage. MR&D received funding to develop analytical models and perform experiments to understand the effects of the operating environment (temperature, chemical species) on the structural properties of the CMC nozzle components in the AV-8B Joint Strike Fighter. MR&D has also received a contract from NAVSEA to design and analyze CMC components that have been successfully ground tested in the divert and attitude control system Standard Missile-3 Trident.

MR&D's ceramic matrix composites increase the cycle life and reduce repair costs of wing metal components on Naval jets and helicopters, such as AV-8B. Ceramic matrix composite materials tolerate a higher operating temperature in power turbines, which increases their efficiency and reduces the amount of oil needed for their operation.

Applications for Naval Air Systems Command (NAVAIR) include AV-8B Joint Strike Fighter - Design and Firescout unmanned aerial vehicle design, analysis, fabrication, and flight test. Applications for Naval Sea Systems Command (NAVSEA) include Standard Missile-3 Trident-Develop analytical models and performing experiments for CMC nozzle components and Land-based turbines, power generation equipment for the commercial sector.

2. Technology Systems, Inc. Technology Systems, Inc. (TSI), along with its partner Applied Thermal Sciences (ATS), has developed a laser-welding process control system, using both autogenous laser and hybrid (laser and gas metal arc) welding technology, that provides for high-speed, precision, low distortion, and affordable fabricated structures. The application of industrial lasers in producing structural shapes for shipbuilding creates enormous savings and results in higher quality products than those produced by present methods. Components fabricated from plate steel are inherently more precise and of lower weight than those produced from traditional rolled steel. The process control system is designed to automate categorization, nesting, and handling of steel plates used in the fabrication of structural shapes such as I-beams and T-beams. The system includes a quality-assurance capability that provides in-process weld pool monitoring and after-weld inspection. The controller is referred to as the Process Control/Quality Assurance system. Initially developed to fabricate stiffeners for ship construction, the technology has allowed for the development of high strength-to-weight ratio sandwich panels, which is appropriate for a number of shipboard applications such as decks, bulkheads, and system platforms. The technology is going through certification of applications on the CVN and DDG 1000 platforms.

The TSI/ATS program has enabled the Navy and shipbuilders to produce better ships at substantially lower cost. In addition, leveraging Federal funding with state and private investments has enabled Precision Light Systems, a joint venture between TSI and ATS, to

achieve world-wide recognition as a leader in laser fabrication development, both in the military shipbuilding community and in commercial markets as well.

Applications include the Program Executive Officer (PEO) for Carriers, PEO Ships, DDG 1000, CVN-78, Stiffeners, bulkheads, decks, and system platforms for the Naval Sea Systems Command and walls, ceilings, floors and roofs, stadium and parking lot decks, bridges, truck trailers, rail cars, ships and off-shore oil rigs for commercial construction.

Air Force

The Air Force has four efforts underway, two beginning in the 2008.3 solicitation, plus another two coming in the 2009.1 solicitation; all contributing to a single broad, integrated effort. Northrop Grumman has agreed to certify the result of this broad-scope project—a robotic system—and once certified, will go directly onto the production floor for the F-35 Lighting II fighter plane, formerly called the Joint Strike Fighter. This unprecedented effort is summarized below:

Air Force SBIR Topic Number: AF063C-011

Title: Terminally Guided Robots and Robotic Application in Confined Spaces

Problem and Proposed Solution: Manual drilling inside ducts & attaching frames around the duct is ergonomically difficult with excessive span time. A robotic system could drill most of the holes saving time and money.

Issues and Approach: Placing the robot's arm in the correct location and direction for drilling followed by an inspection using the same single robotic arm required development of several technologies. By breaking down the complete robotic system into parts and using as many commercial off the shelf (COTS) parts as possible, each small business could select a part and team together or propose the complete system. Five Phase I SBIRs were contracted by AFRL's ManTech division. Four of the contractors formed a team and one contractor took on the total system. This four contractor team also subcontracted with a large business (Comau) that had experience with robot arm manufacturing, but lacked the closed loop precision location capability required for this project. The team developed a work breakdown structure based on their roles in the development activity.

Phase I Results: In Phase I of the SBIR, each of the teamed contractors demonstrated their aspect or component of the integrated cell in a laboratory environment. The team was able to drill and countersink numerous holes within the required tolerances on test samples of the inlet duct materials which Northrop Grumman provided. They also demonstrated actual robotic drilling, and cell design verification and high level cell integrated operations using simulation software. All this testing verified they achieved a manufacturing readiness level (or MRL) of 4. The single contractor was only able to meet MRL 3 in Phase I since no equipment was set-up in a laboratory environment using the manufacturing processes needed to establish a robotic cell. The single contractor had a good manufacturing concept and had identified a complete operating cell.

Phase II Results: The original Phase I team of contractors formed a new team of companies for Phase II to provide a marketable product solution. One small business contractor (VRSI) from the original team took the lead and was the single prime contractor with the new integrated team. The Phase II team added new contractors who provided a new drill head and new, more mature cutters. Progress during Phase II was tracked under an integrated master schedule, based on the work breakdown structure, which also includes MRL achievements as major milestones. This IMS was developed in close cooperation between the SBIR prime, Northrop Grumman, the F-35 program office and AFRL ManTech to ensure proper task scoping, demonstration goals, and alignment of insertion milestones with the end user to promote transition of the technology into production. Phase II has taken the project from an MRL 4 to an MRL 6 so far. The technology program has demonstrated:

- Precision closed loop laser metrology
- Improved cutters including countersink
- Improved accessibility thru compact drill design
- Integration into a production assembly process

MRL Milestone Achievements:

MRL – 4: Phase I completion - Jun 07

MRL – 5: Key component demonstrations completed - Mar 08

MRL – 6: Completed Sept 08 - partial cell integration and full component demonstration

MRL – 7: To complete by Dec 08 - full cell integration and demonstration on an actual F-35 inlet duct

Summary: The Inlet Duct Robotic Drilling project is successfully integrating a closed loop laser metrology guidance system into a robotic cell overcoming the ergonomic challenges and reducing span time, resulting in a potential ~\$17,000 Unit Recurring Flyaway (URF) cost reduction for F-35. This technology also cuts tooling and manpower costs, and reduces floor space. The integrated cell enhances the manufacturing process repeatability, improving product quality. The Integrated Robotic Drilling Cell is an excellent example of a “Critical” SBIR project to develop a total integrated product using the creativity of small businesses, teamed with the integration and marketing experience of large business. Teaming and use of critical commercial technology from small business has produced a marketable affordable product for manufacturing the end products for the DoD customer. Northrop Grumman will begin transitioning the automated robotic drilling cell during 2009, and targets producing F-35 Joint Strike Fighter inlet ducts with this technology on the production floor in 2011. This technology can potentially be applied to other demanding drilling requirements for other DoD weapon system and industry applications.

Defense Advanced Research Projects (DARPA)

Nanosolar, Inc. Under the DARPA SBIR program, Nanosolar, Inc. developed improved production techniques to create high-efficiency solar cells that are light weight, flexible, low cost and durable. These techniques produce rolls of thin-film solar cells that are printed directly on the substrate material with an ink made up of nanoparticles containing the proper ratio of elements required to make the cells absorb solar energy. For warfighters, especially in remote or

hazardous situations, this technology can extend mission durations, increase range of mission distance, and minimize supply chain logistics and personnel risks typically associated with re-supplying energy sources. It has also dramatically improved the cost efficiency, yield and throughput of solar cell production in the areas of nanostructured components, printable semiconductors, printable electrodes, rapid thermal processing, low-cost substrates, roll-to-roll processing and fast assembly.

Nanosolar has also successfully transitioned from Phase II to Phase III in the funding cycle. Nanosolar has successfully raised additional private equity capital including a Series C stock financing, which brought in over \$75 million in late 2006. Nanosolar is working with the U.S. Army and the U.S. Marines to define requirements for military applications, and with the U.S. Air Force on developing flexible photovoltaics. Nanosolar has also signed a long-term agreement with Conergy – the largest solar company in Europe – to develop large-scale photovoltaic systems that will provide custom-tailored, cost-efficient solar solutions to the U.S. commercial rooftop market.

Missile Defense Agency (MDA)

1. Enser Corp - Automated Quality Control for Thermal Battery Pellets. Thermal batteries are mission-critical components utilized in virtually every strategic defense and tactical weapon system. Examples of tactical applications include: (1) Smart Bombs: Joint Direct Attack Munition (JDAM), Small Diameter Bomb (SDB) and Paveway, (2) Guided Munitions: Extended Range Guided Munition (ERGM) and Long Range Land Attack Projectile (LRLAP), and (3) Air-to-Air Missiles: AIM-9X Sidewinder and Advanced Medium Range Air-to-Air Missile (AMRAAM). Strategic applications range from missile thrust vector control to vehicle avionics, and include: Terminal High Altitude Area Defense (THAAD), Standard Missile 3 (SM-3), and Patriot Advanced Capability 3 - Missile Segment Enhancement (PAC-3 MSE). The aforementioned examples represent but a few of the systems which: (1) require a maintenance free 20+-year shelf life, (2) provide extremely high levels of reliability, (3) function safely under extreme environments, and (4) are cost effective. Because of their ability to satisfy this wide range of requirements, tens of thousands of thermal batteries are manufactured and fielded each year.

Thermal battery manufacturing is very capital intensive (cost of a greenfield facility estimated to be >\$20M), hence it is simply not economically viable to maintain different facilities for strategic (low volume) and tactical (high volume) systems. In order to meet these seemingly contradictory requirements, tomorrow's successful thermal battery manufacturers must achieve extremely high reliability while embracing high rate, low cost production methods, thereby allowing strategic applications to enjoy the benefit of lower cost without sacrificing reliability and tactical applications to enjoy the benefit of extremely high reliability without sacrificing affordability.

A key process step in manufacturing thermal batteries is the pellet fabrication process, where discrete anode, cathode, separator and heat pellets of varying diameter and thickness (design features are battery specific) must be manufactured to extremely tight weight and density tolerances. As the pellet production rates increase, the need for automated pellet QC becomes

significantly more apparent. Pellet production has long been a rate limiting step in the manufacture of thermal batteries. The utilization of highly automated presses has helped in reducing this limitation. However the issue has shifted to the fact that the increased production rates are severely hampered by a slow manual QC inspection of pellets. This leads to problems of either not fully utilizing the capabilities of the high-rate presses or producing significant numbers of pellets that may need to be scrapped if adjustments are needed.

Next-generation systems are pushing the performance capabilities of thermal batteries to their limits while requiring high reliability and lower cost. The introduction of an automated pellet QC system is therefore critical to achieving the production goals of making high quality pellets of uniform weight and density and free of physical defects that can affect battery performance and life. By integrating an automated vision & measuring system and automated weighing capability with the real time SPC data acquisition / SPC software, pellet pressing cycle times can be reduced to their minimum practical values and labor costs associated with pellet movement and inspection can be substantially reduced. Based on the capabilities demonstrated during Phase I, transitioning from manual pellet inspection and open-loop control to automated pellet QC and SPC-driven closed-loop control is achievable.

2. Luna Innovations - Three-port IR/Visible FPA Sensor Interface Electronics with Multiplexing, Compression, and Encryption: Luna Innovations Incorporated (Roanoke, VA) developed a modular set of electronic hardware to simultaneously control and retrieve data from two 256x256 IR focal plane arrays and one 512x512 visible focal plane array, using SBIR Phase I and Phase II funding (MDA05-006). These arrays are typically used for target acquisition in Kill Vehicle (KV) platforms. The Luna electronics were successfully used in the Missile Defense Agency's Next Generation Sensor Producibility flight experiment (FE-1) launched from Wallops Island, VA in June of 2008. In the FE-1, Luna's electronics exhibited extremely low-noise performance for all three sensors and no data transmission errors.

Luna successfully addressed a number of technical challenges during the development:

- Enabling three separate experiments using telescopes and imaging arrays from three different vendors.
- Multiplexing and framing the three separate video data streams into a variety of formats required for S-band and Ku-band data links to the ground station.
- Compressing the video for the narrow band link (S-Band), encrypting the data, and framing it with telemetry for three 10 Mbps S-Band downlinks.
- Multiplexing for an un-compressed Ku-band downlink at 200 Mbps using CCSDS Proximity-1 framing and AES encryption.
- Separately encrypting each video stream to protect proprietary data between the three sensor vendors.

The sensor interface electronics flown in NGSP FE-1 paved the way towards a common set of electronics that can be used with a variety of imaging arrays and data processing requirements for future KV platforms. In doing this, future programs will benefit by choosing the best sensor and guidance processor technology, along with the best suppliers for each technology, without requiring substantial system hardware re-design. Beyond KV platforms, the sensor interface electronics are applicable to space-based IR systems, FLIR systems, and commercial satellite imaging platforms.

3. UTRON- Near Net Shape Fabrication of Refractory Metal Components. Liner components manufactured by UTRON, Inc. are now the top candidate for use in the Aegis BMD SM-3 Block IB kill vehicle divert and attitude control system (DACS). The DACS, or the end-game propulsion system, is solid-fueled and requires refractory metal components made from molybdenum and rhenium (MoRe) for operation. Even if used as a liner, other manufacturing methods for these components require the liners to be machined out of solid bar stock, leading to significant scrap waste. UTRON has developed a combustion driven compaction process (CDC) that allows components to be manufactured to near-net-shape, eliminating much waste. The CDC process is becoming more advantageous as rhenium, once \$700/lb in 2005, has exceeded \$4000/lb in 2008. In addition to cost savings, the CDC process has demonstrated improved quality over alternate manufacturing methods.

The CDC manufacturing process is also being developed for future propulsion systems. Alternate alloys will be explored using UTRON's process for use in higher performance systems. The manufacturing system is adaptable to small samples for materials characterization and testing. Other manufacturing methods require a minimum purchase quantity that makes it unfeasible to explore a large set of alloys for improved performance characteristics. UTRON has utilized awards from the FY04-06 SBIR Phase I and II solicitations to aide in developing this technology.

Office of the Secretary of Defense (OSD)

1. Jadoo Power Systems - High Energy Hydrogen Sources for Fuel Cell Applications. Jadoo Power proposes an ammonia borane based hydrogen generation system exceeding 1000 Whrs/kg. While suitable for a wide range of portable power applications, the developed cartridges will initially be targeted at unmanned vehicles in the 65 to 150 W power range. More specifically, 25 cartridges will be designed, fabricated, and delivered for customer evaluation on an unmanned ground vehicle manufactured by Kuchera Defense Systems. Ammonia borane based hydrogen generation facilitates the use of low temperature PEM fuel cell architectures without the need for water loops. This approach has repeatedly shown its applicability to a wide range of commercial and military applications. The low-temperature / no-water-loop PEM architecture enables high reliability (>7000 hours), low cost (100W system under \$1000), instant startup (less than 2 seconds), start/stop resilience (>7000 start/stops), and a wide environmental temperature (-20 to 55°C). The cartridge development tasks will be focused on scaling the present architecture, design optimization for higher power portable applications, environmental qualification, and deliverable unit fabrication.

2. TDA RESEARCH, INC - Novel Fuel Reformer for Undersea Applications. The major drawback to the use of fuel cells as electric generators in unmanned undersea vehicles (UUVs) is their inability to directly use battlefield fuels. In order to efficiently use heavy hydrocarbon fuels (e.g., JP-8, diesel, dodecane) in an air independent environment, the fuel must first be reformed to a hydrogen-rich synthesis gas stream in a highly energy intensive process which is inherently inefficient. TDA Research, Inc. (TDA) proposes to develop a novel fuel processor that allows the heat generated in the Solid Oxide Fuel Cell (SOFC) stacks to be utilized to drive the endothermic steam reforming process. Due to the better heat management by coupling the reformer with the SOFC stacks, TDA's fuel processor operates very efficiently and minimizes the amount of fuel

and oxidant storage needed to support the operation of the fuel cell. In Phase I, we showed that our fuel processing approach is a viable solution for a high energy density power generator that could meet the future requirements of the UUVs (the proposed system could achieve a specific energy of 372 W-hr/kg and an energy density of 428 W-hr/L, meeting NUWC's requirements of 350 W-hr/kg and 350 W-hr/L. We demonstrated the performance capabilities of a commercial reforming catalyst under representative conditions and carried out the system design, showing favorable weight and volume characteristics. In Phase II, the key objective is to demonstrate the effectiveness of all fuel processing system components at full-scale first in a stand-alone manner and then in combination with a fuel cell. In achieving this goal, we will develop a follow a breadboard fuel processor to demonstrate the key aspects of the novel fuel processor. The concept demonstrations will be carried out on a breadboard system that will not be designed for compactness and lightweight; nevertheless it will serve as an excellent platform to support future design and development. Finally, in our collaboration with a leading SOFC manufacturer, we will demonstrate the full potential of the integrated power generation system.

3. MATERIALS & SYSTEMS RESEARCH, INC. - Development of Lightweight and Compact Air-Independent Planar SOFC for Navy's Undersea Applications. The overall objective of the Phase II effort is to demonstrate a solid oxide fuel cell stack to power unmanned undersea vehicles (UUVs). We will use established and proven solid oxide fuel cell (SOFC) technology developed at MSRI to achieve this objective. Based on the success of Phase-I effort, a scaled-up stack of 1~3 kW size with peak power of ~6 kW will be demonstrated. The stacks will be operated on reformat gas as fuel and pure oxygen as oxidant. Several novel cell/stack designs will be investigated in parallel, and promising technologies will be implemented into the final stack design. The stack will be optimized for compactness and maximum performance as well as other requirements such as fast start-up and ability to thermal cycle. A prototype 3 kW stack will be built, and will be integrated with balance-of-plant components for final demonstration of the fully integrated system.

4. SYNERTECH P/M, INC. - Advanced Manufacturing Techniques for Liquid Rocket Engine Components. The proposal addresses the development of a novel, efficient manufacturing technology demonstrated during Phase 1. This novel technology has clearly shown specific benefits to critically loaded components of liquid rocket engines using advanced process modeling and computer aided design. Examples of these critically loaded components that will be fabricated are static and rotating parts of turbo-machinery from high strength and environmentally compatible Ni and Fe-based superalloys as well as Ti alloys. A deliverable of Phase 2 will be engine component prototypes with acceptable properties, predictability and repeatability for Boeing-Rocketdyne. The process to manufacture fully dense, complex shaped products is based on a novel "selectively net shape" approach developed, and routinely employed by Synertech P/M utilizing advanced technologies such as Hot Isostatic Pressing of powders (HIP), Computer Aided Design (CAD) and Direct Metal Fabrication (DMF) of HIP tooling. A necessary constituent of this approach is advanced process modeling that enables significant reduction of development and manufacturing costs by as much as 30-50% due to the innovative prediction of material behavior during powder processing.

Special Operations Command (SOCOM)

Polyshok, Inc. Polyshok, Inc. is tasked by USSOCOM under its SBIR Program to develop a 12 gauge shotgun door breaching round with performance beyond anything currently available to the US Military. Concurrent with the development of the ammunition is a task to develop the technology to manufacture to door breacher using modern high speed commercial loading equipment.

By nature, 12 gauge door breaching ammunition is complex with many more components than conventional shogun rounds. In addition, all door breaching rounds carry a unique payload designed to defeat locksets and door hinges. These payloads usually consist of compressed metal powders or metal impregnated wax slugs. The complexity of a large number of components and unique payloads have, to date, required door breaching ammunition be hand loaded. This greatly increases the cost of the ammunition while making it problematic with respect to quality and reliability. Polyshok's development of the technology to manufacture this type of ammunition using high speed commercial loading equipment will solve these problems.

Polyshok, Inc. manufactures a patented Law Enforcement (L/E) 12 gauge anti-personnel round that essentially eliminates the potential for collateral damage. The door breacher uses a modified version of this patented technology. The payload of the door breacher ammunition is a fine, hard steel powder. This payload is carried to the target in an enclosed projectile body at almost 2000 feet per second. Upon impact with the door, the projectile penetrates the door and then expands radically using a device which diverts the steel powder at 90 degrees to the direction of travel. This process is similar to that of a shape charge. This is a very different approach to door breaching that is not only extremely effective against door hardware but also a missed shot that penetrates the door becomes non-lethal within a few feet. This limits unintended collateral damage which is a major problem with current door breaching ammunition.

This fine steel powder has a Rockwell Hardness of 55 and is approximately 0.017 inches in diameter. Commercial loading equipment obviously has many moving parts. Two of the primary parts are slider bars which move back and forth on top of each other as they carry the round to each component loading station. The size and hardness of the steel powder would not only cause the loading machine to seize up if it got between the slider bars but would severely damage the machine and shut down production. Consequently, Polyshok has designed and built a pre-loading system which loads and seals the steel powder into the projectile body prior to being carried to the commercial loading machine. This pneumatically operated and computer controlled device is designed so that any spilled steel powder does not effect its function. An additional requirement given to Polyshok regarding the manufacturing technology development is that it meets Six Sigma quality standards. No commercial shotgun ammunition of any type has ever been required to meet these strict quality standards. To this end, Polyshok has integrated sensors into each individual component loading station on the machine as well as the pre-loader device. These sensors feed information to a computer which allows every round to be monitored for quality during each step of the loading process. This enables quality control and tracking of not only each individual completed round of ammunition but for each step of the loading process. This will be unique to the entire small arms ammunition industry. The loading system will be capable of producing up to two million door breaching rounds per year.

During Phases I and II of this SBIR effort, Polyshok has used not only its own in-house expertise but also a team of five sub-contractors. Each sub-contractor has special skills required to help accomplish the assigned tasks. It is critical that small businesses attempting a large, highly sophisticated development put together a competent team covering all areas of the development process. Polyshok and its team have expertise in terminal ballistics, ammunition loading, machine design, plastics molding, custom high speed manufacturing, coating of parts to meet environmental hazards and government contracting. This team effort has resulted in several additional new patent pending technologies. The new round will be pressure proof to a depth of 70 feet of sea water and a new hull coating process will insure its resistance to multiple chemical contaminants as well as salt corrosion.

Several government agencies have also assisted in this development. Mil Tech, which is a DOD pilot program to assist small business with financial models as well as technical support, has been deeply involved. They have provided grant funding to assist in the development and have produced a sustainability model which demonstrates to the government the price structure and quantities required to be purchased to keep the product viable for Polyshok. Mil Tech also has provided technical assistance in finding government certified test laboratories which can independently perform some special Design Verification Testing of the production ammunition.

Georgia Institute of Technology, Center for Manufacturing Excellence, in conjunction with a grant from "One Georgia" (a state grant program for small businesses), has completely developed the Six Sigma Quality Assurance Program, assisted in developing the Defense Contract Management Agency (DCMA) Quality Assurance and Safety logistic programs and will be instrumental in assisting with Design Verification Testing Data Management and Analysis.

This highly coordinated technical effort by Polyshok, Inc. will provide the US Warfighter, as well as US L/E agencies, with effective, reliable and high quality ammunition.

Joint Science and Technology Office for Chemical and Biological Defense (CBD)

RVM Scientific, Santa Barbara, CA - Low Power Gas Chromatograph Column Technology. RVM Scientific, Inc., founded and operating as a small business was acquired in FY2008 (18 June 2008) by Agilent Technologies, Inc. The funding opportunities provided by the SBIR program resulted in a technology that includes innovations in manufacturing – specifically, the production of Low Thermal Mass Gas Chromatography (GC) columns. The innovative development is that any commercial-off-the shelf (COTS) GC column from any column manufacturer may be adapted to the low thermal mass technology. The low thermal mass column technology results in rapid heating with low power demand permitting more rapid analysis with analytical results more quickly generated. Agilent (previously Hewlett-Packard), a leader in analytical chemistry instrumentation, was sufficiently impressed by the innovative process by which RVM Scientific adapted their manufacturing process to all GC columns, that Agilent acquired the small business. Potential commercial sales revenue from the low thermal mass GC column technology seemed to merit the acquisition of RVM Scientific.

During FY07, six CBD SBIR Phase I projects did include manufacturing or manufacturing practices that successfully transitioned to FY08 Phase II contract awards. The manufacturing innovation, as a portion of the overall development effort, may lead to competitive and cost effective manufacturing practices should the Phase II pre-production prototype prove advantageous and meet DoD CBD Program mission requirements.

A list of Phase II projects that include aspects of improved manufacturability or incorporate innovative processes or products having future manufacturing implications follows:

<u>TOPIC</u>	<u>PHASE II PROPOSAL TITLE</u>
CBD07-101	Sequencing of Multiple Chemical/Biological Aircraft Decontamination Agents
CBD07-102	Immediate Biodecon System (*)
CBD07-103	Generic Adsorptive Carbon Residual Life Indicator (*)
CBD07-104	Spectroscopic Imaging Technology for THz Biosensor Integrated with a Lab-on-Chip Platform
CBD07-105	Enhanced Capability Point Combined Bio and Chem Sensor (*)
CBD07-106	Automated Objective Speech Intelligibility Assessment System (*)
CBD07-108	CB Sensor Network Architecture Development Tool for Improved Probability of Cloud Intercept
CBD07-109	Source Term Model for Fine Particle Resuspension from Indoor Surfaces (1001-173)
CBD07-112	Respiratory Function Measurement System
CBD07-113	Development of a Field-Ready Antimicrobial Wound Dressing for the Treatment of Vesicant Burns (*)
CBD07-114	Development of a Database Management System to Enable Rapid, Efficient Assay Design for Use in Detection and Diagnosis of Human Exposure to Biological Threats
CBD07-115	Lightweight, Efficient Blower for Personal Air Ventilation System (*)
CBD07-116	Omni-Directional, Wind and Water Tolerant Inlet for the DFU

(*) – this topic conveys opportunities to encourage innovation in manufacturing; results of these efforts will be highlighted in future reports addressing the compliance with EO13329.

Defense Microelectronics Agency (DMEA)

To date DMEA has awarded five Phase I contracts against three topics. All three topics are manufacturing-related and resulted in three Phase I contracts/projects. Two of the Phase I contracts/projects have progressed to Phase II. The Phase II projects have only recently begun, so the success of these efforts with respect to manufacturing has not been determined. Two of these SBIR topics are described below:

- Topic DMEA07-001: High-Throughput Experimentation Physical Vapor Deposition (PVD) Chamber for Accelerated Microelectronics Materials Research and Development

The objective of this topic is to develop a PVD chamber capable of precisely controlled multiple material depositions in discrete sites on a single silicon wafer, thereby enabling multiple experimental data points (from hundreds to thousands) to be fabricated rapidly on a single silicon wafer. The discrete sites with incremental variations in semiconductor materials and process parameters at each data point will be analyzed. This will provide data to tailor the manufacturing materials and processes to achieve the exact semiconductor characteristics required. If successful, this will result in orders of magnitude reduction in both time and cost in the research, development, and optimization of materials and processes used in microelectronics manufacturing.

DMEA awarded two Phase I contracts and one Phase II contract against this topic.

- Topic DMEA007-002: In-Line Characterization System for Advanced High K Dielectric/Metal Gate Complementary Metal Oxide Semiconductor (CMOS) Transistor Stack for the Development of High Speed, Low Power Microelectronics

The objective of this topic is to develop a contactless, in-situ system to electrically characterize advanced high-K dielectric / metal gate CMOS transistor stacks during the semiconductor manufacturing processing. The system will use a non-contact Kelvin probe and specially-designed test structures to effectively characterize critical electrical parameters of each material in-situ immediately following the material deposition in a throughput-matched manner. The access to in-situ data will accelerate the development/manufacturing process and result in more effective and cost-efficient fabrication of new advanced transistor stacks. If successful, this rapid characterization process will be a key to optimizing materials and processes used in microelectronics manufacturing.

DMEA awarded one Phase I contracts and one Phase II contract against this topic.

Defense Logistics Agency (DLA)

A total of 11 Phase I awards were made from DLA's very first solicitation in 2007—all are manufacturing-related. One Phase II award has been made and two others are awaiting contracting action. These efforts cover diverse manufacturing technologies including metal casting, nanocrystalline powder molding for optical components, high speed grinding, battery manufacturing, polymer matrix composites, laser assisted machining and advanced concepts for drilling metal-composite stackups. The work should be sufficiently advanced to report achieved or anticipated technical success next year.

II. Procedures and Mechanisms Used to Date to Give Priority to Manufacturing Related Projects

The Department continues to take many steps to give priority to manufacturing-related projects, including the following:

- Added a section to its internal DoD SBIR/STTR Program Managers website addressing EO13329 Manufacturing Innovation to make DoD efforts in support of the EO available to all participating laboratories, centers, and other SBIR/STTR personnel. At this website, the Executive Order 13329, the Department of Commerce “Manufacturing in America” document, statistics, success stories and other items are maintained and updated with the most current information. It is anticipated that additional success stories will be identified as attention is generated for manufacturing-related technologies. Further, these efforts will represent successes across the entire spectrum of DoD SBIR/STTR funded activities and reflective of the various technologies being pursued in support of the initiatives of the Department.
- Encouraged Components, as well as their participating laboratories and centers, to develop manufacturing related topics and/or to emphasize the linkage to manufacturing innovation.
- Expanded the note in the SBIR and STTR solicitations to include the four main areas included under the EO that the DoD is looking for innovative methods of manufacture that reduce cost and increase efficiencies in producing the item/process identified in the topic.
- Encouraged Components to develop and test pilot programs aimed to increase manufacturing innovation R&D within their mission.
- Encouraged each Component to outline any unique aspects of manufacturing or manufacturing-related topics in their own instruction sections as part of each solicitation.

Specific DoD component procedures and mechanisms follow:

Army

1. In response to Executive Order 13329, PM, Army SBIR established a closer collaborative relationship with the U.S. Army Manufacturing Technology (ManTech) Program. Initial efforts to gather manufacturing-related data began with the 06.2 Topics, and continue to the present. The Army ManTech Program and the individual Army Technology Objective - Manufacturing (ATO-M) Managers continue to review, evaluate, and provide endorsement of the SBIR topics, with the intention of facilitating the possible integration and alignment of SBIR efforts directly into ATO-M projects. As was done with past Topics, the Army ManTech Program and the ATO-Ms will review all of the Army SBIR Topics for manufacturing-relatedness using the following categories:
 - a. Core Manufacturing Innovation Topic
 - Addresses manufacturing process, technique or innovation as the primary objective of the topic
 - Topic addresses the development and application of advanced technologies for manufacturing processes, tools, and equipment
 - Targets manufacturers of manufacturing equipment or applicable to the manufacture of many systems or production lines (i.e., pervasive)
 - Addresses the affordability, producibility or manufacturability of a demonstrated Technology
 - b. Research Topic with Significant Manufacturing-related Innovation (Shared Objective)

- Research for a process or product that has significant manufacturing implications, although not the sole purpose of the topic.
 - Topic addresses the development or application of advanced technologies for manufacturing processes, tools, and equipment.
 - Topic includes manufacturing issues associated with technology under Development.
- c. Research Topic that has Product or System Focus, Addressing Manufacturing Aspects of that Product
- Primary objective of topic is to develop a system or weapon-specific capability
 - Manufacturing, producibility, cost and yield are referenced but not the primary objective of the task
 - Manufacturing-related activities may be part of Phase II
- d. Topic with No Direct Manufacturing Innovation, but Potential to Apply Techniques Developed to Manufacturing
- Research topic may include a process or product that has manufacturing implications or could apply to a manufacturing process as a secondary application, even if not stated in the topic description, may include manufacturing-related activities as part of Phase II
- e. Topic with Some Indirect Manufacturing Applications
- Topic does not address any manufacturing process or product, but may indirectly improve the manufacturing base through training, protection of domestic manufacturing capability or other methods of strengthening the manufacturing base
2. Comments and endorsements provided by the Army ManTech Program and the ATO-Ms are forwarded to the Army SBIR Source Selection Board and are used in their analysis and recommendations of the Army SBIR Topics submitted to the Office of the Secretary of Defense, Office of the Director, Defense Research and Engineering, USD (AT&L) for final approval.
3. In May 2006, the Army SBIR program incorporated the Army ManTech Program and the ATO-M Managers into both the Phase I and Phase II source selection process. The intent was to use the ManTech review and comments of the proposals as a discriminator by the Source Selection Board and to facilitate the possible integration and alignment of SBIR efforts directly into ATO-M projects. The Army employs the use of manufacturing-related as a tiebreaker in the evaluation process to the maximum extent possible without adversely impacting other critical mission areas.
4. In the evaluation of Army STTR proposals, adding a brand new fabrication technique to the repertory of manufacturing methods is generally considered to be an automatic technology transition success. That is, the Army views the incentive to advance manufacturing technology to be implicit in the standing criterion set for proposal selection. Further, Army reviewers may use the prospect of a secondary or spin-off fabrication advance as a tie-breaker between proposals.

Navy

1. In 2004 the Navy published in its SBIR/STTR Website the guidance related to EO 13329.
2. In 2005 the Navy introduced its focus on manufacturing-related topics by adding a special section in the topic submission format. This format requires the author to address the topic's relevance to manufacturing and manufacturability.
3. In 2005 the Navy solicitation for SBIR/STTR proposals introduced an emphasis on EO 13329 by encouraging firms to address the manufacturing needs in the Defense sector.
4. In connection with the Navy's current emphasis on affordability and with a focus on innovation in affordable manufacturing, the SBIR/STTR Program Office has maintained constant coordination with the Navy's major acquisition programs, viz., the Littoral Combat Ship, Aircraft Carrier, Destroyer, and the Virginia Class submarine programs.
5. In each solicitation for SBIR/STTR proposals, the Navy has continued its emphasis on EO 13329 by encouraging the firms to address the manufacturing needs in the Defense sector.

Air Force

The Air Force has established the following procedures and mechanisms giving priority to manufacturing-related projects:

1. The addition of manufacturing technology as a tie-breaker in their solicitations, evaluation of the primary research effort and the proposal will be based on the scientific review criteria factors (i.e., technical merit, principal investigator (and team), and commercialization plan). Please note that where technical evaluations are essentially equal in merit, and as cost and/or price is a substantial factor, cost to the government will be considered in determining the successful offeror. The Air Force anticipates that pricing will be based on adequate price competition. The next tie-breaker on essentially equal proposals will be the inclusion of manufacturing technology considerations.
2. The Air Force has set aside additional topics for special manufacturing technology topics. In Solicitation 2006.3, the Air Force had their first special topic focused upon remote robotic drilling. Once successfully demonstrated, this robot will go through Title IX certification and will then be incorporated by the JSF production line. This is a specialized multi-million dollar phase II effort that combines technologies from 5 separate small businesses into one prototype robot.
3. The Air Force had manufacturing topics in Solicitation 2007.3, 2008.1 and 2008.3, and will have in 2009.1.

DARPA

In the FY 2008.2 solicitation, approximately 17 out of 64 topics are related to manufacturing. This represents 27% of DARPA's topics and is a 2% increase compared to FY07. The source selection process for this solicitation is not yet completed; therefore, DARPA is unable to report at this time whether or not use of manufacturing-related technology as a tie-breaker will be necessary.

MDA

The Producibility and Manufacturing Directorate (DEP) is the Missile Defense Agency's primary organization for assessing manufacturing and producibility issues and problems across the Ballistic Missile Defense System and determining investment strategies to solve these issues/problems. This Directorate continues to be the focal point for implementation of E.O. 13329. The Missile Defense Agency, in standing up this organization recognized the importance of manufacturing-related research and development, engineering to the success of the Agency mission. In FY 08, the Directorate was assigned the additional function as the "Transition Agent" for the Agency, to enhance technology maturation, assessment, and transition to the Program Elements.

Since FY02, DEP has been participating in the MDA SBIR/STTR program. In FY05, MDA established SBIR and STTR Research Areas. The Manufacturing and Producibility Research Area Lead (RAL) is a senior staff member in the DEP Directorate. This brings added focus to the development of SBIR/STTR topics, the recommendation of Phase I and Phase II SBIR/STTR awards and the SBIR/STTR Phase II Transition Program that cover manufacturing in the following areas: Advanced Materials and Structures, Propulsion, Energy and Power Systems, Electro-optics, RF Devices/Sensors, Radiation Hard Components, and Advanced Manufacturing Processes. The topics, while different in scope, address common themes such as innovative processes that reduce cost, reduce manufacturing cycle time, and improve performance, and/or reliability. In addition, DEP participates significantly in other Research Areas including Interceptors, Radar, Information Assurance (Anti-Tamper), and BMC2I (End-to-End Communications) for example.

Through broadly defined SBIR topics directed toward manufacturing capability, DEP has awarded Phase I and Phase II projects to numerous small companies across the U.S. DEP regularly conducts on-site visits, and proactively assists in correlation with BMDS Suppliers and their manufacturing needs to enhance transitioning those small technology firms into Defense suppliers whose manufacturing capabilities enhances the U.S. industrial base.

Currently, DEP consists of 24 full-time equivalent government and contract individuals. DEP has integrated the SBIR/STTR activity into their overall investment strategy. Virtually every individual within DEP is involved to some extent with the SBIR/STTR program (on average 16% of their time). This involvement is greater than \$500K per year, which does not include the support of the various Army, Navy, and Air Force field activities.

In FY09, DEP will be a stakeholder in 23% of the total MDA SBIR and STTR topics (15 of 64). Additionally, the annual commitment of funding increased in FY09 by 37% (\$17.1M vs. \$12.5M) for the Manufacturing and Producibility Research Area. The intent is to look for Manufacturing and Producibility issues across relevant areas. DEP is directly responsible for 15.5% of the FY09 SBIR and STTR topics and participates in an additional 7.5%. The FY09 DEP topics support 10 of the 11 Program Elements.

OSD

The Office of the Secretary of Defense SBIR and STTR Programs, managed by the Office of the Director of Defense Research and Engineering, solicited 8 Manufacturing Technology topics. In FY 2007/2008 OSD focused on Phase II follow on contracts having budgeted \$6,000,000 for these projects. To date \$2,731,619 in contracts have been awarded as referenced in Section I with the remaining \$3,000,000 in contracts to be awarded by the end of the fiscal year.

Manufacturing Technology Area

Manufacturers of electrochemical power devices (mainly batteries and fuel cells) used in military systems are all faced with a common problem: they lack the basis for a suitable business case to develop and implement process and technology improvements that are necessary to respond to the Warfighter's changing demands. A fundamental reason for their inability to innovate is the lack of predictable, steady weapons system procurement. Without a suitable financial base, the manufacturers must rely on Government-funded investments to allow battery and fuel cell technology development for military applications.

A reasonable approach to help mitigate the resulting risk is to invest SBIR funds and provide these battery and fuel cell companies with the ability to modernize their manufacturing processes to achieve some of the very same goals that the warfighter has. These include improving their production efficiency, lowering operating costs, implementing scalability to better handle expected surge/sustain procurement cycles and spiral/evolutionary technology improvement.

Proposed manufacturing technology thrust areas include development of the following:

- **General Improvements.** Innovative approaches to manufacturing processes common to battery and fuel cell production include improvements in pasting active materials on substrates, controlling impurities, enhanced data collection of in-process variables, conformable packaging ability, touch labor reduction and suitable levels of automation.
- **Nonrechargeable Batteries.** Innovations that improve production scalability, reduce costs, minimize variability or increase throughput for battery and fuel cell manufacturers will help minimize risk to the Warfighter by helping to ensure a stable future supply of batteries that are used in such applications as radios, GPS receivers, night vision equipment, guided weapons and munitions. Manufacturing process improvements that enhance the safety, performance (e.g. higher energy density, higher power density), reliability and consistency of these batteries are also highly desirable.

- **Rechargeable Batteries.** As with nonrechargeable batteries, the same innovations that assist manufacturers to modernize their production processes are highly desirable. Additionally, production improvements that allow for fabrication of rechargeable batteries with improved cycle life, deeper depth-of-discharge ability, higher charge efficiencies, improved tolerance of over-charge and over-discharge conditions, lower rates of self-discharge and advanced thermal management for high rate conditions (e.g. directed energy systems) are highly desirable. Automation of processes unique to rechargeable battery fabrication is also an important aspect of advanced manufacturing technology improvement to improve yield, quality and reduce labor costs.
- **Fuel Cells.** As with the applicable improvements listed in the sections above for batteries, manufacturability and manufacturing costs of fuel cells also benefit from manufacturing technology improvements. Manufacturing technology innovations will enable the fabrication of smaller, lighter, more efficient fuel cells (e.g. man portable fuel cells capable of producing 200 to 600 Whr/day), fuel cells that are readily capable of using military logistics fuels (e.g. JP-4, JP-8, diesel), have improved “observability” characteristics, reduced start-up time and increased power and energy density levels. Other manufacturing innovations include the ability to produce ruggedized fuel cells, regenerative and other closed-loop type fuel cells, and fuel cells with enhanced modularity, power management capabilities, scalability and versatility for multiple uses under military environment conditions.
- **Separator Materials.** Many military battery and fuel cells rely on specific separators to be able to perform as needed. Innovations to improve the manufacturing processes of these separators for military uses will help reduce the high cost, supply chain risk, variability and long-lead times. Some of these separators are acceptably produced by a single manufacturer, resulting in the risk of a single point supply chain failure.
- **Precursor Materials.** Manufacturers of military batteries and fuel cells often need raw materials (e.g. chemicals that form battery cells, catalysts for fuel cells, specialty connectors) that have long-lead times and/or high costs. Demand for some of these materials is very small compared to that of the commercial market. Suppliers for these materials will often makes changes to accommodate their other customers but make the material unsuitable for military use. Innovation that accommodates such military-specific requirements is desirable.

The Manufacturing Technology topics are:

- OSD05-MT1 High Energy Hydrogen Sources For Fuel Cell Applications
- OSD05-MT2 Power Source Materials & Subcomponents Manufacturing Improvements
- OSD05-MT3 Solar Cell Manufacturing Improvements
- OSD05-MT4 Nonrechargeable Battery Manufacturing Improvements
- OSD05-MT5 Lightweight Air Pumps/Blowers For Man Portable Fuel Cells
- OSD05-MT6 Reforming Solutions for Undersea Applications
- OSD05-MT7 Rechargeable Battery Manufacturing Improvements
- OSD05-MT8 Fuel Cell Solutions for Undersea Applications

SOCOM

1. During Topic Generation and Award Selection Processes, SOCOM increased Manufacturing Innovation in their SBIR program by requiring the topic authors to consider / investigate manufacturing improvements for each topic as well as to ensure they use applicable manufacturing keywords in the topic descriptions.
2. Developed future data (using SBA-issued keywords) to monitor innovative manufacturing awards and funding.
3. SOCOM emphasized new opportunities for Manufacturing Related Research and increased Manufacturing Innovation in their SBIR program by requiring the topic authors to consider / investigate manufacturing improvements for each topic as well as to ensure they use applicable manufacturing keywords in the topic descriptions.
4. Proposals that included innovative technology improvements could become a “tie-breaker” during the award selection process when appropriate.

CBD

1. The CBD SBIR PMO has provided a copy of Executive Order 13329 to all SBIR coordinators located at participating DoD laboratories and centers.
2. The CBD SBIR program will comply with DoD procedures and mechanisms related to the Executive Order.
3. Future SBIR topics will be developed, where appropriate, for the annual CBD SBIR Phase I solicitation that address EO 13329 requirements. The intent is to develop, approve, and publish those topics that will likely improve opportunities for future commercialization and manufacturing by incorporating one or more of the following attributes to selected topics, when appropriate:
 - Conduct research for a process or product that has significant manufacturing implications, although not the sole purpose of the topic
 - Include manufacturing issues associated with technology under development
 - Address the affordability, producibility or manufacturability of an innovative technology
 - Introduce the development and application of advanced technologies for manufacturing processes, tools, and equipment
 - Target manufacturers of manufacturing equipment or those entities applicable to the manufacture of many systems or production lines (i.e., equipment deployed and used by individual soldiers in a theater of operations such as badge-type sensors, personal protective masks, or personally administered medical therapeutics)
 - Develop activities/tasks in the SBIR Phase II Work Plan (e.g., Statement of Work) associated with manufacturing or manufacturing-related processes.
 - Include innovative processes or products that have future manufacturing implications
 - Assess the Manufacturing Readiness Level (MRL) at the start of an SBIR Phase II contract and re-assess the MRL at the conclusion of the Phase II period of performance.

4. The CBD SBIR program will attempt to maximize the transition from Phase II to product commercialization by one of the following approaches:
 - Address manufacturing process, technique or innovation as the primary objective of the topic
 - Incorporate the technology into a CBD acquisition program of record through the Joint Program Executive Office for Chemical and Biological Defense (JPEO-CBD). The JPEO-CBD is responsible for the execution of advanced technology development funds (e.g., '6.4'/'6.5' funding). JPEO-CBD also conducts Advanced Concept Technology Demonstrations (ACTDs) and Advanced Technology Demonstrations (ATDs) to determine the battle-ready status and assess operational capabilities of new technologies.
 - Work with the Technology Transition/Operations Division of the Joint Science and Technology Office for Chemical and Biological Defense to identify opportunities to conduct test and evaluation (T&E) of mature Phase II projects.
 - Incorporate the SBIR-developed technology into the core CBD S&T program to conduct further development (via non-SBIR funds).
 - Facilitate Phase III opportunities for Phase II candidate technologies as follow-on to Phase II SBIR funding.
5. The CBD SBIR program will employ the use of manufacturing as a tie-breaker in the evaluation process to the maximum extent possible without adversely impacting other critical mission areas.

DMEA

The DMEA SBIR program began in FY2007. As an in-house fabricator of semiconductors, DMEA is naturally interested in manufacturing topics. As part of the process of developing and vetting potential SBIR topics, DMEA considers whether the proposed topics are manufacturing-related and would address mission related challenges.

DLA

In 2007, the first year for SBIR at DLA, DLA allocated 100% of the SBIR budget to a manufacturing – oriented topic, “Advanced Technologies for Discrete Parts Manufacturing.”

III. Actions DoD Has Taken Toward Promoting and Supporting Manufacturing-Related Research Projects

The Department has taken many steps to promote and support manufacturing-related projects, including the following:

- Maintained EO 13329 and the Department of Commerce “Manufacturing in America” document on DoD SBIR/STTR website.
- Published information about EO 13329 in SBIR and STTR solicitations.

- Educated small businesses on the Executive Order at regional and national SBIR/STTR conferences.
- Continued to have a presence supporting manufacturing innovation in DoD at the annual Defense Manufacturing Conference through attendance, exhibits, and conference sessions.

Specific DoD Component actions follow:

Army

1. The Army focuses many efforts on promoting manufacturing-related projects. These efforts include the Army SBIR and STTR website, the Army SBIR Achievement Awards, and the annual Commercialization Brochure. One of the most successful methods of promoting manufacturing-related projects is through the Army SBIR and STTR website. This website brings together the small business community, Army researchers, Army Programs of Record and prime contractors, and the ManTech community for possible collaboration on new and ongoing SBIR projects.
2. PM, Army SBIR tracks and reports SBIR and STTR success stories through the annual Commercialization Brochure. The Army Commercialization Brochure is an excellent opportunity for Army organizations and Small Businesses to share information about their SBIR and STTR projects and the success of their projects. The brochure is distributed at Army, Defense, and National conferences providing exposure to these exceptional SBIR and STTR projects.
3. PM, Army SBIR participates in the Defense Manufacturing Conference (DMC) as a way to promote the SBIR program within the manufacturing community.
4. PM, Army SBIR will continue to incorporate the Army ManTech program in topic writing and the Phase I and Phase II source selection processes. This closer collaboration should stimulate opportunities to transition successful manufacturing-related SBIR projects in the future.
5. The Army STTR Program Manager's annual call for topic nominations includes the text: "Topic Authors will be aware of Executive Order (EO) 13329 – Encouraging Innovation in Manufacturing issued in February 2004 though it is not mandatory for STTR to align with EO 13329." The actual submittal website again references the EO. However, topics that promise merely incremental improvement in manufacturing efficiency usually are not selected on the basis of scientific content being too low.

Navy

1. Since 2004, at all SBIR/STTR conferences, the Navy has coordinated with other SBIR/STTR agencies to emphasize a joint focus on EO 13329.

2. Since 2004, in the SBIR/STTR National Conferences, the Navy has promoted to the industry the importance of manufacturing-related innovations in research.
3. Since 2004 the Navy adopted policy of tracking and compiling manufacturing-related success stories for reporting to the OSD Office of Small Business Programs (OSBP).
4. The Navy has maintained outreach efforts with prime contractors utilizing available opportunities, e.g., at the Navy's SBIR/STTR Forum and other conferences, towards their partnership with the SBIR/STTR firms.
5. As part of DoD data compilation, the Navy continually tracks SBIR/STTR manufacturing-related awards by searching for abstracts containing the SBA-issued manufacturing-related terms.

Air Force

The Air Force has taken the following actions toward promoting and supporting manufacturing-related research projects.

1. The Air Force manufacturing technology office has established a lead SBIR manager.
2. The lead SBIR manager has participated in the AF Small Business efforts such as the Manufacturing Technical Assistance Production Program (MTAPP) - assists in increasing and enhancing the competitiveness of small manufacturing firms in support of the Air Force, Department of Defense, and their major Prime Contractors.
3. In the special instructions section of the solicitation the Air Force gives reference to MRL information:

“Successful offerors will benefit from consideration of technical as well as manufacturing and business readiness levels when preparing responses to Manufacturing SBIRs. Guidance and information on these three readiness measures can be found in the SBIR Mall Web site located at <http://sbirsttrmall.com/Library/Default.aspx>. “

4. The Air Force has presented specialized briefings focusing on manufacturing in SBIR to the JSF S&T Summit in May 2008 and the SAE Aerospace Automation Conference in September 2008.

DARPA

DARPA plans to participate in the 2008 Defense Manufacturing Conference being held December 1-4, 2008, with an exhibit to showcase one or two small companies with successful manufacturing-related SBIR projects. This event focuses on key manufacturing technology program development status, impact on system/subsystem development, acquisition and

sustainment affordability, diminishing supplier sources, assuring domestic technology transfer and the opportunity for greater use of world-wide defense and commercial industrial processes and business practices for defense needs. Attendees will also have the opportunity to interface with over one hundred government, large and small business, and academic exhibitors that will depict current, near and far term manufacturing and sustainment initiatives and technologies in transition from the laboratory to the production floor.

DARPA has a grant with the Foundation for Enterprise Development to assist the DARPA Small Business Program Director in implementing the Transition Support Pilot Program described below.

- **Transition Assistance:** The Foundation will provide DARPA SBIR Phase II funded companies identified to participate in the Pilot with guidance and assistance in identifying potential Phase III funding sources, and potential government and commercial partners, with requirements for the technology under development. The Foundation will also provide guidance in the development of project materials and facilitate introductions to the potential funding sources and partners.
- **Success Reports:** The Foundation will document company transition successes in a brochure or other printed material for distribution at outreach events. Success Reports will continue to be posted on the DARPA SBIR Web site. The 2007 DARPA SBIR Success Reports can be viewed at this link:
http://www.darpa.mil/sbir/Success_Story_Main_Page.htm

These success reports cover a wide range of advance materials and manufacturing technologies, including (but not limited to):

- **Advanced communications** (e-textiles antennas; lightweight flexible material that conducts electricity like metal)
 - **Advanced equipment** (testing equipment for hypersonic projectiles; nano-positioning tool for infrared imaging; miniature robotics; miniature sensors)
 - **Chemical and biological warfare** (eye scanning diagnostics device)
 - **Language devices** (real-time translation device; hand-held behavior-modeling device)
 - **Underwater warfare** (crystal technology for improved detection)
- **Outreach/Process Improvement:** The Foundation will capture lessons learned, best practices and help develop and implement process improvements to increase transition success for DARPA SBIR funded companies. The success reports are a key way for sharing lessons learned from manufacturing small business.

DARPA initiated a grant with the Virginia Center for Innovative Technology (CIT), Virginia's economic development organization, to conduct the Manufacturing Initiatives Pilot Program. The pilot program was conducted over a 15-month period and included two major elements: (1) mentoring and consultation for six DARPA Phase II awardees in the area of the companies' manufacturing and commercialization plans; and (2) compilation of a list of resources in Virginia to help SBIR awardees with their manufacturing partnerships, plans and strategies.

MDA

MDA has taken the following actions toward promoting and supporting manufacturing-related research projects:

1. Referenced and established a link to EO 13329 on the main page of the Missile Defense Agency SBIR/STTR website (<http://www.winmda.com>).
2. Starting in 2003, DEP developed a process to bring many small businesses face-to-face with prime contractors. Dubbed “Industry Days”, these forums are intended to provide various small businesses an opportunity to present their manufacturing capability directly to the users: the Prime Contractors and manufacturers of major military weapons systems. In 2003 and 2004, a total of 34 companies were represented during a total of 12 events. DEP’s most recent event occurred 14 Aug 2007, at Lockheed Martin Missiles and Fire Control in Dallas, TX, with 15 companies represented. There will also be an industry day sponsored by Lockheed Martin, Sunnyvale in February 2009 to include participants from the Producibility and Manufacturing and Advanced Technologies Directorates, as well as approximately 24 companies.
3. All SBIR/STTR Phase I and Phase II awardees are offered, free of charge, the services of the National Technology Transfer Center (NTTC). The services provide individualized business assistance through regional workshops funded by MDA. The NTTC leverages the expertise of technology and business experts to accelerate the maturation and commercialization of technology. The NTTC collects and maintains extensive data on MDA technology developments and their uses. The NTTC provides wide and highly positive exposure for technology developments and their benefits to MDA and the country through a high traffic web site and award winning publications.
4. Conducted several planning meetings in FY07 with representatives from the National Institute of Standards and Technology (NIST) Manufacturing Extension Partnership (MEP). Should MDA participate in the commercialization pilot program in FY09, NIST MEP may be funded to provide focused efforts to DEP SBIR awardees.

OSD

As discussed above, the Office of the Secretary of Defense SBIR and STTR Programs, managed by the Office of the Director of Defense Research and Engineering, solicited 8 Manufacturing Technology topics resulting in 34 Phase I awards totaling \$3,352,130, all funded in 2006. The program is in the process of reviewing, evaluating and selecting the Phase II follow on contracts having budgeted \$6,000,000 for these projects in FY 2007. To date \$2,731,619 in contracts have been awarded as referenced in Section I with the remaining \$3,000,000 in contracts to be awarded by the end of the fiscal year.

SOCOM

1. Emphasized the need for innovative manufacturing in all USSOCOM SBIR/Small Business briefings and placed E.O. 13329 on USSOCOM's website.
2. Coordinated with other SBIR agencies prior to attending national SBIR conferences to develop a dedicated session on manufacturing opportunities for the small business community.
3. Utilized SBA funded state services provided under the Federal and State Technology Transfer Program (FAST) for Manufacturing Innovation outreach to small companies.
4. Described the purpose of E.O. 13329 in all briefings to small businesses and at all SBIR conferences.

CBD

PM, CBD SBIR continues to participate at the semi-annual National SBIR conferences, in addition to a number of regional SBIR public events. In FY08, the CBD SBIR program was presented at the Fall National SBIR Conference in Dallas, the Spring National SBIR Conference in Orlando, FL, in addition to a state conference in Pittsburgh, PA; program representatives are scheduled to participate in the Fall National SBIR Conference in Hartford, CT. The CBD SBIR PM and JPEO-CBD representatives participated in the second annual Beyond SBIR Phase II conference in Arlington, Virginia in August 2007, and the third annual conference in Palm Desert, CA. At each of these venues, one-on-one discussions were conducted between SBIR program personnel and the small business representatives to investigate application of their technologies to the mission and requirements of the Joint Chemical and Biological Defense Program. Encouraging innovation in manufacturing is one aspect of the message conveyed to small businesses.

DMEA

The DMEA SBIR program has a very small budget. However, DMEA also sponsors the Federal Technology Center, a partnership intermediary, to facilitate contracting opportunities, training, and technology transfer with small businesses. We also support various regional small business conferences.

DLA

In 2007, DLA provided free booth space to SBIR contractors at the Defense Manufacturing Conference (DMC), and plan to repeat this at the 2008 DMC. Also, in 2007 DLA's SBIR manager briefed the Coalition for Manufacturing Technology Infrastructure, and the Department of Defense Joint Directors of Manufacturing Technology on the DLA SBIR program.