

Free Executive Summary



Defense Manufacturing in 2010 and Beyond: Meeting the Changing Needs of National Defense

Committee on Defense Manufacturing in 2010 and Beyond, Commission on Engineering and Technical Systems, National Research Council

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The end of the Cold War, the evolving mission of the U.S. Armed Services, the dramatic improvements in commercial manufacturing--these and other trends are changing how we provide for the common defense. What will we need in the way of defense manufacturing in the year 2010--a short few years away? How should we best spend our defense funds? Defense Manufacturing in 2010 and Beyond sets forth a vision for the nation's defense manufacturing, including policies, technologies, systems, processes, practices, and financial implications. Eight specific trends are forecast--defense spending, the relationship between defense and commercial industries, the nature of the threat to our nation, the emergence of new technologies, and other areas--and their implications for defense manufacturing are explored. The committee describes manufacturing advancements that are around the corner--virtual enterprise, and more--and examines how these breakthroughs will likely meet or fail to meet defense manufacturing requirements. This expert panel identifies the highest priorities and recommends strategies for matching future manufacturing capabilities with our defense needs. February

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Executive Summary

Manufacturing¹ has played a vital role in the development and production of weapons systems used for the defense of the nation. During the Cold War, when defense manufacturing practices and capabilities evolved to meet specific threats to national security, defense products were manufactured largely by a dedicated defense industry. Since the end of the Cold War, however, changing circumstances have significantly influenced defense manufacturing. These include: changing threats to national security; declining defense budgets; consolidation of the defense industry; the increasing globalization of industry; the increasing rate of change of technology; and requirements for environmentally compatible manufacturing.

The National Research Council's Committee on Defense Manufacturing in 2010 and Beyond was formed to identify a framework for defense manufacturing in 2010 and to recommend strategies for attaining the capabilities that will be needed. To accomplish these objectives the committee (1) reviewed major trends that are changing the context of defense manufacturing and identified challenges to be met; (2) reviewed existing defense planning documents to identify defense-critical and defense-unique manufacturing capabilities; (3) reviewed advances in commercial manufacturing and identified those with the potential to meet defense manufacturing challenges, and (4) recommended strategies for developing the manufacturing capabilities that will be required in 2010 and beyond.

¹ For the purposes of this study, "manufacturing" has been broadly defined to include activities throughout the product life cycle (from needs assessment to concept formulation to production to disposal), as well as required resources (materials, infrastructure, information, people, time, money).

REQUIRED DEFENSE MANUFACTURING CAPABILITIES

After reviewing the technologies and manufacturing requirements described in defense planning documents and presentations by industry experts, the committee identified defense manufacturing capabilities required for 2010 that were defense-unique and/or defense-critical. These manufacturing capabilities, either broadly applicable to a number of weapons systems or specific to certain weapons systems, fall into the following six categories: composites processing and repair; electronics processes; information technology systems; weapons system sustainment²; design, modeling, and simulation; and production processes.

ADVANCES IN COMMERCIAL MANUFACTURING

The committee identified the following advances in commercial manufacturing as having the greatest potential for benefiting defense manufacturing: industry collaboration, adaptive enterprises, high-performance organizations, life-cycle perspectives, advanced manufacturing processing technology, environmentally compatible manufacturing, and shared information environments. These advances interact with each other and are composed of the following elements:

- **advanced approaches to manufacturing accounting**, including activity-based accounting and cost-as-an-independent-variable accounting
- **advanced approaches to product design**, including life-cycle design, integrated product and process development, three-dimensional digital product models, simulation and modeling, and rapid prototyping
- **advanced approaches to manufacturing processes**, including generative numerical control, adaptive machine control, predictive process control, high-speed machining, flexible tooling, soft tooling, tool-less assembly, embedded sensors, flip chips, nanotechnology, and biotechnology
- **environmentally compatible manufacturing technologies**, including cleaning systems, coatings, and materials selection, storage, and disposal
- **advanced approaches to business organization**, including teaming among organizations, virtual enterprises, long-term supplier relationships, high-performance organizations, cross-functional teams, lean enterprises, adaptive enterprises, agile enterprises, and knowledge-based and learning enterprises
- **information and communications technologies**, including electronic commerce, virtual co-location of people, data interchange standards, Internet technologies, intranet technologies, browser technologies, intelligent agents, seamless data environments, telecommunications, and distance learning

² For the purposes of this study, “sustainment” refers to the provision of personnel, logistics, and other support required to maintain operations until successful accomplishment of a mission.

NEW PRIORITIES FOR DEFENSE MANUFACTURING

Barring unforeseen international crises, defense budgets are unlikely to increase significantly in the near future. The committee believes that the principal criterion for prioritizing manufacturing capabilities should be potential cost savings (i.e., return on investment). Capabilities that meet this criterion are those that (1) will be applicable to many weapons systems or many elements of life-cycle costs, (2) will benefit from substantial nondefense resources, (3) will address large expenditure budget items for the Department of Defense, (4) could lead to significant performance or productivity gains, (5) will address problems likely to become more important in the future, or (6) will not be developed as a result of commercial investment.

Recommendation. Current Department of Defense research and development efforts in defense manufacturing should be augmented in four high-priority areas:

- efficient sustainment of weapons systems
- modeling and simulation-based design tools
- leveraging of commercial resources
- cross-cutting defense-unique production processes

Recommendation. Current and future Department of Defense research and development efforts aimed at improving manufacturing capabilities for sustainment of weapons systems should emphasize the following areas:

- application of advanced production processes and practices to maintenance, repair, and upgrade operations
- technology insertion for new and existing systems
- self-diagnostics for mechanical and electronic systems
- new technologies for remanufacturing
- design methods that improve sustainment

Recommendation. The Department of Defense should further encourage defense industry efforts to make the most of the simulation-based design environment and focus on the following activities:

- promote the development of models of defense products, manufacturing processes, and life-cycle performance
- develop algorithms for design trade-offs to optimize life-cycle costs
- develop enhanced and easily usable parametric models that facilitate design trade-offs at the conceptual stage
- initiate the development of product databases that will permit simulation at various levels of resolution

Recommendation. Advances in commercial manufacturing should continue to be monitored and adapted to defense applications as appropriate. Technology road maps created by commercial industry should be used to help defense manufacturing programs keep abreast of developments and forecasts.

Recommendation. The following development areas should be pursued to facilitate the widespread application of commercial, off-the-shelf (COTS) products:

- new weapons systems designed for open architecture and technology transparency
- a central program and mechanisms to maintain awareness of, document, and plan for new COTS technologies that can be incorporated into current and future weapons systems, as well as to disseminate this information to individual program offices
- improved methods of inserting COTS products in fielded weapons systems
- low-cost validation methods for determining the adequacy of COTS parts for military applications

Recommendation. Defense manufacturing programs should continue to address the development and improvement of defense-unique and defense-critical processes. The following defense-unique and/or defense-critical processes have the broadest range of applications:

- processes that enable rate-transparent production (i.e., production where the per unit cost is independent of the production rate)
- processes for the low-cost fabrication of composite structures
- processes for the low-cost production and application of coatings and structures with low observability
- defense-unique electronic technologies
- design, information, and manufacturing technologies that provide dimensional control in the production of large, complex parts

REORIENTING DEFENSE MANUFACTURING PROGRAMS

The Department of Defense Manufacturing Technology (ManTech) Program is a joint program of the armed services and the Defense Logistics Agency. The purpose of the ManTech program is to develop manufacturing technologies for the affordable, low-risk development and production of weapons systems. The current ManTech program has six thrust areas: metals processing and manufacturing; composites processing and manufacturing; electronics processing and manufacturing; advanced industrial practices; manufacturing and engineering systems; and sustainment/readiness. The committee believes that the ManTech program is an ideal vehicle for developing many of the required defense

manufacturing capabilities described in this report and recommends the following ways in which the program can be reorganized to meet future demands.

Recommendation. The ManTech program should play the following roles in the 2010 time frame (some of these roles require only a change in emphasis of existing roles; some are new roles that should be incorporated into the program charter):

- *Leader in affordability.* The ManTech program should be considered the primary means of achieving affordability throughout the life cycle of weapons systems.
- *Focal point for cross-cutting defense technologies.* The ManTech program should focus on projects whose results are expected to be widely applicable.
- *Technology middleman.* The ManTech program should aggressively promote the implementation and dissemination of new technologies.
- *Information broker and planner.* The ManTech program should expand its role in providing information on new technologies to the defense community.
- *Expert in weapons systems technologies.* The ManTech program should provide expertise in the technologies important to major weapons systems.

Recommendation. The ManTech program should consider revising its division of effort if it is to implement the new roles and development initiatives that the committee has recommended. The following changes are recommended:

- *Production processes.* This area should remain a major thrust area, but the emphasis should be shifted toward cross-cutting technologies.
- *Advanced industrial practices.* This area should be expanded beyond industrial best practices to include technologies for enhancing cost-effectiveness.
- *Manufacturing and engineering systems.* The ManTech program should establish an initiative for the development of simulation-based design tools.
- *Sustainment of weapons systems.* This area should be greatly expanded and should be given as high a priority as production processes.
- *Leveraging of commercial resources.* The ManTech program should establish an initiative for leveraging commercial resources with an emphasis on COTS products.

The committee believes that the ManTech program could be reoriented without compromising the important initiatives already under way. Investments in the ManTech program already provide a return through cost savings and cost avoidance. The recommended emphasis on projects and technologies with broad applicability should ultimately increase the return on investments.

Defense Manufacturing in 2010 and Beyond

MEETING THE CHANGING NEEDS OF NATIONAL DEFENSE

Committee on Defense Manufacturing in 2010 and Beyond

Board on Manufacturing and Engineering Design

Commission on Engineering and Technical Systems

National Research Council

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This report has been reviewed by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the authors and the NRC in making the published report as sound as possible and to ensure that the report meets the institutional standards for objectivity, evidence, and responsiveness to the study charge. The content of the review comments and draft manuscript remain confidential to protect the integrity of the deliberative process. We wish to

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Acronyms and Abbreviations

ADA	software programming language (U.S. Department of Defense)
CAD	computer-aided design
CAM	computer-aided manufacturing
CAIV	cost as an independent variable
COTS	commercial, off-the-shelf (products)
DOD	U.S. Department of Defense
DTAP	Defense Technology Area Plan
FLIR	forward-looking infrared (sensors)
<i>g</i>	gravity
GNC	generative numerical control
GOCO	government-owned, contract-operated
HM&E	hull, mechanical, and electrical
HSM	high-speed machining
IPPD	integrated product and process development
IRST	infrared search and track (sensors)
LCD	liquid crystal display

ManTech	Manufacturing Technology Program
MLRS	multiple launch rocket system
MMIC	monolithic microwave integrated circuit
NDI	nondestructive inspection
RDT&E	research, development, test, and evaluation
SALT II	Strategic Arms Limitation Talks II
TOW	tube-launched, optically-tracked, wire-guided (missile)
VSA	variation simulation analysis