Manufacturing Science and Technology Program Review

During July and August 1994, the Office of the Director of Defense Research and Engineering (ODDR&E) conducted Science and Technology Program Reviews. The technical portion of the Manufacturing Science and Technology (MS&T) Program Reviews was conducted on September 7-8, 1994, at the Institute for Defense Analysis. The scope of the review included Service, Defense Logistics Agency, and key ARPA programs in manufacturing technology.

The review was divided into six technical areas: Manufacturing Systems; Electronics Processing and Manufacturing; Metals Processing and Manufacturing; Composites Processing and Manufacturing; JDL Centers Strategy; and Advanced Industrial Practices.

Manufacturing Systems – This area included:
- Computer Aided Manufacturing Engineering
- Virtual Manufacturing
- Virtual Test
- Real-Time Look-Ahead Simulation
- Product Data Technology
- Agile Manufacturing
- CALS Shared Resource Centers

Electronics Processing and Manufacturing – Among the topics and projects presented were:
- T/R Modules
- Tactical FOG
- Solder Technology
- Clean/No Clean Technology
- Tape Automated Bonding Testing
- Magneto-optical Mapper Development
- IRFPA Manufacturing Technology
- GEM
- Plastics Packaging

Metal Processing and Manufacturing – This area was broken down into five sub areas.
- Processing
  - Opticam
  - Machine Tool Initiative
  - Joining
  - Welded Titanium Aircraft Structures
- Process/Machine Intelligence
  - Modeling of the Casting Process (Rapid Cast)
  - Predictive Model and Methodology for Heat Treatment Distortion
- Test and Inspection
  - Precision Absolute Metrology Sensor
  - Semi-Solid Metalworking

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Pollution Mitigation
- Robotic Paint Stripping

Composites Processing and Manufacturing - This area included four sub-areas.

Fabrication Processes
- Composite Manufacturing Technology Teaching Factory
- Advanced Fiber Placement F/A-18E/F
- Composites Electronics Housing
- Improved Airframe Manufacturing Technology
- Manufacturing Technology for Multifunctional Radomes

Process Control
- Improved Process Control Parameters for Adhesive Bonded Structures

Design for Manufacturing
- Design and Manufacturing of Low Cost Composites - Engine

Tooling Technology
- Advanced Tooling Manufacture for Composite Structures

Advanced Industrial Practices

Baselining Programs
- Lean Aircraft Initiative
- Best Manufacturing Practices.

Pathfinder Programs
- Vertical Partnering Subcontractor Facilitation
- Textile Pathfinder
- Manufacturing Process Capability Assessment for Assembly Variability
- Reduction

Industrial Base Pilot Programs
- Military Products from Commercial Lines
- Military Products with Commercial Practices

For DoD points-of-contact for these programs contact MTIAC, 1-800-421-0586.

Plasma-Source Ion Implantation

Plasma source ion implantation (PSII) is a new manufacturing process to make harder, more durable, and longer-lasting parts for a wide variety of machinery applications. Rather than coating the material, this process actually changes the surface layer of the material.

PSII is currently being developed for manufacturing-scale production in a cooperative research and development agreement (CRADA) between Los Alamos National Laboratory (LANL) and General Motors Research Laboratory (GM) with technical assistance from the University of Wisconsin. A major component of the CRADA is a power source (modulator) technology that grew from a BMD-funded project.

Ion implantation is not new. In fact, industry has been using line-of-sight implantation processes to dope silicon semiconductors for several years. Applications for line-of-sight processes, however, have limitations, as described below.

How it works. A low pressure gas, such as nitrogen, is injected into a steel vacuum chamber containing the material to be hardened. The nitrogen is ionized into a plasma using oscillating radio frequency waves to strip electrons from the gas atoms. The material is exposed to short pulses of negative voltage. Positively charged ions are accelerated toward the negatively charged material, and simultaneously bombard the material from all sides.

The ions penetrate and modify the near-surface layers of the material. This process can be used to improve metal and polymer surfaces.

Advantages. PSII offers several advantages over alternative hardening methods, which include the following:

- Longer lifetime. For some applications, PSII can be an improvement over chrome plating. For example, in a recent study comparing the service lives of steel tool punches using various treatments, the service life of nitrogen implanted punches was more than 2 times greater than chrome-plated punches and 5 times greater than untreated punches. Since PSII is not a coating, adhesion and delamination are not concerns.

- Faster and cheaper than other processes. PSII has a much higher current (50 A) than line-of-sight implantation processes (0.030 A), which permits much faster implantation and does not require masking or expensive fixturing to manipulate nonplanar parts.

- Environmentally benign. As a "dry" alternative to chrome plating, PSII may provide environmental benefits over conventional methods for electroplating such as wet chemical baths.

In the CRADA, LANL has used a chamber that is 1.5 meters in diameter and 4.6 meters long. Its large capacity...
Computer Networking Practices in Small Manufacturing Enterprises

This is a 27-page SME Blue Book written by David C. Penning and published by the Computer and Automated Systems Association of the Society of Manufacturing Engineers (CASA/SME). The following is an excerpt reprinted with permission of the Association, copyright 1994, from the SME Blue Book Series.

The 1993 revision of the CASA/SME Manufacturing Enterprise Wheel recognizes the growing importance of computer networking and systems communications by placing these functions at the third tier of the manufacturing infrastructure. Shared knowledge and computer systems enable efficient communications between the customer, manufacturing, customer support, and product/process activities that are the heart of a manufacturing enterprise.

Two major market research projects were carried out to determine statistically valid answers to manufacturing information systems needs. The first study, conducted in 1992, proved the interest of CASA/SME members in computer networking and pointed out that small manufacturers needed more assistance than larger enterprises in getting started with networking. Accordingly, a second research project was commissioned in mid-1993 that focused on the needs of small manufacturing enterprises. Small manufacturers were defined as having fewer than 200 total employees in the enterprise.

The results of the small manufacturing research project are documented in this book. It has been reviewed by the following participants: James G. Ames, Arizona State University; Barbara Fossum, University of Texas at Austin; Ralph Mackiewicz, SISCO; and Donald L. Sage, AT&T Microelectronics.

Blue Book Contents

This blue book identifies conclusions drawn from the survey data. Results are displayed graphically, statistically, and with textual analysis of the basic data. Where feasible, comparisons with the conclusions of the 1992 study are made.

SME Blue Books are available from the Customer Service Department:
1-800-733-4SME.

SME members $8.00
Nonmembers $9.50.

Recognition of rapid technical developments, increasing utilization of computer networks in global manufacturing, and the rise of the concept of virtual manufacturing led CASA/SME to establish a steering committee for communications and networking in manufacturing in 1993. The major purpose of this committee was to determine how CASA/SME could best serve its membership's educational needs by presenting networking opportunities, and to research the needs of manufacturers in this emerging technology application.
Critical Issues in Defense Conversion:  
A Consensus Report of the CSIS Senior Group on Defense Conversion

In August 1993, John Deutch, under secretary of defense for acquisition and technology, asked the Center for Strategic and International Studies (CSIS) to convene a high-level steering committee to evaluate critical issues in defense conversion and to develop a menu of priorities for the Department of Defense. This effort was chaired by Harold Brown and implemented by the Senior Group, made up of members of Congress, other government officials, and private industry representatives. This report covers the findings, conclusions, and recommendations of the Senior Group. The following is an excerpt, reprinted with permission of CSIS, Washington, DC.

Overview

The choice of defense conversion strategies depends very much on how one scopes the problem. At a minimum, defense conversion implies providing some kind of safety net for workers and communities that are affected by the current and expected contraction of defense spending. More broadly, it signifies extensive policy, regulatory, and organizational changes in the way the Department of Defense (DoD) does business. In its broadest sense, it implies a proactive investment in multipurpose R&D and manufacturing to minimize the need for a defense-unique industrial base and to leverage DoD funding in support of multipurpose technologies and economic competitiveness.

The CSIS Senior group on Defense Conversion has concluded that an urgent need exists for a comprehensive framework linking defense conversion to a restructuring of the defense industrial base and a reallocation of defense investments. The United States must meet the nation’s basic security needs at a reduced level of spending; minimize the economic impact of the buildup; and leverage the remaining defense investment for national economic and technological goals. Any one of these challenges would be difficult to meet; in combination, they pose a daunting policy problem.

The Goals of Defense Conversion

1. To preserve critical, defense unique capabilities. Some capabilities within the defense industrial base are critical to preserving even a reduced defense posture and are unique to defense. As long as the need exists, these capabilities will have to be identified, subsidized, and preserved.

2. To expand the industrial base available to defense. A number of commercial equivalents for the items that DoD buys are as good as, if not better than those provided by the defense-unique market.

3. To help defense firms convert or diversify their operations. There is simply not enough DoD business to sustain all of the defense companies at a breakeven point, yet they offer important expertise and manufacturing capabilities to defense. Those companies will either have to find other markets or alternative ways to apply their expertise.

4. To integrate defense investments – past and future – into the larger economic strategy. Past investments in facilities, R&D establishments, and depots need to be rationalized to fit today’s needs.

5. To ensure that core defense R&D needs are met. The issues that need to be addressed include:

   • What are DoD’s core needs for sustained R&D?
   • What research assets must it maintain to meet these needs?
   • Assuming that some of the defense R&D infrastructure will be identified as redundant, can or should those assets be applied to nondefense missions?
   • What should those other missions be and how will they be funded?
   • How can DoD (and other agencies) improve cooperative R&D relationships with industry?

6. To improve ways to assist the defense workforce and communities that rely on defense infrastructure to diversify their skills and local market strengths. Federal retraining programs cannot be effective if they are conducted in isolation from industry’s demand for workers.

Recommendations

1. Preserving Defense-Unique Assets – That the DoD develop a set of guidelines or standards that can clearly identify capabilities that are critical to defense for which there are no commercial alternatives or substitutes. Also that the DoD convene industry-government working groups to discuss options available to assure that critical capabilities are preserved or find ways to offset potential vulnerabilities.

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2. Spinning Off Defense Investments into Civilian Applications – The Senior Group focused on two specific problem areas: the need for a forward-looking depot policy and more rapid transfer of government assets to the private sector and state and local governments.

- eliminating the congressionally mandated set-aside for the depots
- determining a core workload to be retained in government-owned and -operated facilities
- instituting a best-value contracting approach for all maintenance and repair/upgrade work
- amending the Superfund law to limit liability for cleanup of bases and facilities, where such limits are appropriate and reasonable
- restricting requirements for environmental impact statements to those activities associated with base closure, not reuse
- providing block grant assistance to states for base/facility conversion

3. Reforming the Acquisition Process –
- instituting a statutory exemption for commercial item purchases from government-unique terms and conditions
- defining commercial items to include modified commercial items and items that are fabricated in the same production facility using the same workforce and equipment as those sold to the general public

4. Providing Regulatory Relief for Defense Contractors –
- to the extent that the contract cannot be exempted from government accounting requirements, encouraging contracts to adopt activity-based costing systems
- reforming the standardization system offering subsidized participation in retraining programs to employees of diversifying firms

5. Access to Capital –
- establishing a corporation for defense conversion to provide venture capital for conversion efforts
- providing incentives such as a permanent tax credit and a reduced tax on capital gains limited to defense conversion/reinvestment

6. Reforming Specifications and Standards – The problem must be addressed at three levels:
- Requirements Generation
  - instituting formal evaluation criteria to determine if cost-performance trade-offs are being performed aggressively during the system planning and development stages
- adopting the Distributed Interactive Simulation (DIS) approach to system design now used by the U.S. Army
- Performance-based Specifications
  - converting all management and manufacturing standards cited in DoD Instruction 5000.2 to performance-based documents
  - issuing a policy directive that performance-based standards are the preferred alternative for major systems, technology insertions, and commercial and NDI procurement
  - requiring that all outstanding comments must be resolved by the preparing activities before the document can be validated
- Application of Documents on Contract
  - prohibiting the use of military specifications and standards except where the program manager (or the procuring activity) provides a specific rationale for their inclusion

7. Optimizing R&D Investments –
- identifying core defense needs in R&D that will require continued investment in government R&D facilities
- establishing a commission on defense laboratories
- extending the protection offered under the CRADA mechanism to all forms of government-industry R&D collaboration.
- granting laboratory directors authority to negotiate collaborative efforts directly with industry

8. Community and Worker Assistance –
- consulting with the Department of Labor to ensure that some portion of its efforts are targeted toward communities suffering because of job dislocation due to defense plant or base closures
- promoting company-based retraining efforts
- making the DoD a test bed for the administration’s “information superhighway” initiative linking national education and retraining needs to the emerging network of high-capability information processing

This report is available from the Center for Strategic and International Studies, CSIS Books, 1800 K Street, NW, #400, Washington, DC 20006, phone: 202-775-3119, fax: 202-775-3199.
Simplification Approaches and Tools: 
Overview and Methodologies

This is a 27-page SME Blue Book, edited by Dan L. Shunk and published by the Computer and Automated Systems Association of the Society of Manufacturing Engineers (CASA/SME). The following is an excerpt reprinted with permission of the Association, copyright 1994, from the SME Blue Book Series.

The introduction of this Blue Book sets out to answer the following questions:

- What is meant by simplification?
- How can we define it?
- Why should we think about this notion?
- Why is this important?
- What is value added?

The introduction continues with the following subject headings:

- Focus - Definition/Examples, Organizational Issues, and Simple Open Systems
- Fundamental Paradigm Shift - Adversity an Opportunity
- Simplification is viewed as a survival mechanism for the company.
- Simplification is the antithesis of "snob appeal."
- Simplification is leverageable.
- Simplification must occur before integration and automation are attempted.
- Simplification is primarily an organizational issue.
- Simplification allows execution to be "the king."
- Simplification "puts money in the bank."
- Simplification creates and reinforces consistency of purpose.
- The perception of elegant simplicity is critical.
- "Back to the basics" is not necessarily implied, unless the business is very simple.
- Simplification tools must be accessible and be used by all personnel.

Critical Success Factors for Simplification

There are five appendices, which contain specific simplification tools and strategies:

Process Simplification – The goal of process simplification is to establish and follow the highest quality, most effective, and least total cost process. To accomplish this goal and maintain the benefits, an environment must be developed that establishes the simplified process as the one selected most of the time because it contains the least resistance.

Process Mapping for Simplification – Process definition and mapping is a critical element in the process of simplification. The technique presented herein is a simple, yet powerful, technique that lets the system developers and system users gain cohesion and synergy.

“A Delta T” Simplification Tool – “A Delta T,” developed by Digital Equipment Corporation, is a powerful methodology that uses a simple tool, the flowchart, and a simple measurement, time, to significantly improve processes through simplification.

Organizational Preparation for Simplification: A Growth Workshop – You could eventually double your capacity by just doing simplified things, but you must begin by understanding what you are doing today.

Simplification Analysis Techniques for Complex Problems or Situations – These techniques include Pareto charts, cause-and-effect diagrams, histograms, control charts, correlation diagrams, design of experiments, and a number of other tools.

SME Blue Books are available from the Customer Service Department: 1-800-733-4SME
SME members $8.00
Nonmembers $9.50.

IDEF Users Group '94 Fall Enterprise and Systems Integration Conference

IDEF, Users Group, Inc.
October 24-27
LaJolla, CA

Contact: 513-259-4702
Plasma-Source Ion Implantation

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can allow hundreds of automobile parts or thousands of drill bits to be implanted in a single batch. This facility uses a power source with a peak voltage of 100,000 V, a peak total current of 50 A, and an ion/total current ratio of 5 to 25 percent. The power source also has a pulse width of 20 microseconds and a maximum repetition rate of 2,000 pulses per second.

This process can be used in virtually any heavy manufacturing application that requires durability and resistance to corrosion and wear. Examples include automotive, aircraft, and power plant parts, machine tools, and prosthetics.

As stated above, this project is a $14 million, three-year CRADA between LANL and GM, with additional assistance from the University of Wisconsin. GM is focusing on applications to improve automotive manufacturing, provide parts for testing, coordinate field tests, and provide test data from separate experiments. LANL is working with the University of Wisconsin to explore the fundamental physics of the process and seek improvements to the concept. The CRADA team is targeting two applications: nonferrous automobile parts and ferrous tools (i.e., punches and drill bits).

Several companies (i.e., Harley Davidson, Litton, and Kodak) who are interested in this manufacturing technology for specific processes, have approached LANL. The laboratory has also been approached by several defense-oriented companies that produce accelerators and accelerator components.

For more information contact:

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General Motors Research Division
810-986-2836, fax 810-986-0886

Dr. Blake P. Wood
Los Alamos National Laboratory
505-665-6524, fax 505-665-3552

Professor John Conrad
University of Wisconsin
608-263-4739

Meetings

October

AGMA's Fall Technical Meeting
AGMA, October 24-26, St. Louis, MO
Contact: 703-684-0211 or fax: 703-684-0242

Second Annual Flexible Parts Feeding Workshop
Robotic Industries Association, October 25-27, Cincinnati, OH
Contact: 313-994-6088 or fax: 313-994-3338

DTIC Annual Users Training Conference
Defense Technical Information Center (DTIC), October 31-November 3, Arlington, VA
Contact: 703-274-3848 (Patti Miller)

November

30th Annual Air Targets and UAV's Technical Symposium and Exhibition
American Defense Preparedness Association, November 1-3, South Lake Tahoe, NV
Contact: 703-522-1820 or fax: 703-522-1885

SEM Fall Conference: Integration of FEA and Structural Testing with Rapid Prototyping
SEM, November 7-8, Dearborn, MI
Contact: 203-790-6373 or fax: 203-790-4472

AUTOFAC Exposition and Conference
SME, November 15-17, Detroit, MI
Contact: 313-271-1500

Defense Manufacturing Conference '94
Joint Directors of Laboratories Manufacturing Science and Technology Panel, November 28-December 1, Phoenix, AZ
Contact: 513-426-8530

Books on Manufacturing


ManTech Project Schedule

- One of the important steps in a DoD Manufacturing Technology project is the end-of-contract demonstration when the contractor or agency that has developed and/or applied the technology demonstrates the equipment and processes involved.
- The following calendar has been compiled by the staff at MTIAC. It is also available on-line to MTIAC users through the MTIAC On-line Services, which is updated monthly.

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<thead>
<tr>
<th>1994</th>
<th>PROJECT</th>
<th>TITLE</th>
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<td>F33615-91-C-5727</td>
<td>Aerospace Sciences Research and Development</td>
<td>Ken Ronald</td>
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<td>F33615-92-C-5810</td>
<td>Development of an Automated Ion Implanter System for Manufacturing High Definition Liquid Crystal Displays</td>
<td>Robert Cross</td>
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<td>F33615-93-C-4515</td>
<td>Vertical Partnering Subcontractor Facilitation</td>
<td>Brench Boden</td>
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<td>F33615-93-C-4326</td>
<td>Avionic System Test Cones of Tolerances</td>
<td>Ron Bing</td>
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<td>F33615-93-C-4324</td>
<td>Integrated Approach to Achieve a Robust Surface Mount Technology (SMT) Solder Process</td>
<td>Michael Miller</td>
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<td>F33615-91-C-5665</td>
<td>Manufacturing Science and Titanium Aluminide Composite Engine Structures</td>
<td>Katherine Williams</td>
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All data and information herein reported are believed to be reliable; however, no warrant, expressed or implied, is to be construed as to the accuracy or the completeness of the information presented.

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