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SUMMARY OF THE GOVERNMENT/INDUSTRY WORKSHOP ON NEW MATERIALS AND PROCESSING TECHNOLOGIES FOR INDUSTRIAL APPLICATIONS

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EXECUTIVE SUMMARY

This report presents a summary of the 1-day workshop conducted at Ann Arbor, Michigan, on April 16, 1992, between the National Center for Manufacturing Sciences (NCMS) and the U.S. Department of Energy Advanced Industrial Materials Program (DOE AIM). The workshop objectives were to: 1) encourage collaboration between DOE, the DOE national laboratories, and NCMS material manufacturers and 2) assist the DOE AIM program in targeting research and development (R&D) more effectively.

During the workshop, participants from industry and DOE laboratories were divided into three working groups. Representatives from the DOE national laboratories currently conducting major research programs for AIM were asked to be working group leaders. The groups developed recommendations for NCMS and AIM managers using a six-step process.

As a result of the workshop, the groups identified problems of key concern to NCMS member companies and promising materials and processes to meet industry needs. Overall, the workshop found that the research agenda of DOE AIM should include working with suppliers to develop manufacturing technology. The agenda should not be solely driven by energy considerations, but rather it should be driven by industry needs. The role of DOE should be to ensure that energy-efficient technology is available to meet these needs.

CONTENTS

1.0 INTRODUCTION

A 1-day workshop was conducted on April 16, 1992, between the National Center for Manufacturing Sciences (NCMS) and the U.S. Department of Energy Advanced Industrial Materials Program (DOE AIM). The workshop was organized under the auspices of the DOE Advanced Industrial Concepts Division (AICD) Systems Analysis Project, managed by Pacific Northwest Laboratory.[a] There were two objectives of this workshop: 1) to encourage collaboration between DOE, the DOE national laboratories, and NCMS material manufacturers and 2) to assist the DOE AIM program in targeting research and development (R&D) more effectively.

The NCMS currently focuses on supporting technology development and deployment in several strategic areas, including environmentally conscious manufacturing, manufacturing processes and materials, product equipment and design, and management processes. NCMS prepared presentations at the workshop for each of these initiatives. An agenda is shown in Figure 1.1. Industrial participants from two member companies also attended the meeting (Ford and General Motors [GM]). A presentation was given by David Andres of General Motors (GM) describing the strategy for future collaboration between GM and the DOE national laboratories.

Representatives from the DOE national laboratories currently conducting major research programs for AIM were asked to be working group leaders. At the request of NCMS, working groups were organized under existing AIM research areas. However, the discussions within these working groups were primarily concerned with industry problems and were not confined by existing AIM research areas.

This workshop summary was prepared to ensure the workshop recommendations are available to all potential and existing AIM principal investigators within the DOE national laboratories and industry. Appendix A contains the

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(a) Pacific Northwest Laboratory is operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

viewgraphs from the presentations. Appendix B contains a list of participants. This summary presents the recommendations of the working groups only; it does not represent the strategic viewpoint of AIM management. Information from the workshop represents valuable input to the strategic plan for AICD.

Government/Industry Collaborative Workshop on
New Materials and Processing Technologies for Industrial Applications

April 16, 1992
National Center for Manufacturing Sciences
Ann Arbor, Michigan

8:00 - 8:30 a.m.	Introductions/Opening Remarks
8:30 - 9:30 a.m.	Collaborative Research Opportunities with the U.S. Department of Energy--Overview of DOE Office of Industrial Technologies Advanced Industrial Materials Program **Dr. Charles Sorrell**
9:30 - 11:30 a.m.	Overview of NCMS Strategic Initiatives **NCMS Staff**
11:30 - 12:00 p.m.	General Motors Presentation **David Andres**
12:00 - 1:00 p.m.	Lunch
1:00 - 3:00 p.m.	Break into Working Groups Develop Group Reports: • High-priority industry problems • Areas of mutual interest to NCMS and DOE • Follow-on actions

Topic	Leaders
Plastics recycling, polymers and biobased materials processing	Helena Chum, NREL Date Schaefer, SNL
Industrial applications of surface modification technologies	Al Sylwester, SNL Joseph Laia, LANL
Development of ceramics, metals, intermetallics including alloys and composites	Peter Angelini, ORNL

3:00 - 4:00 p.m. Presentation of Group Reports, Summary and Close-Out

FIGURE 1.1. Workshop Agenda

2.0 NATIONAL CENTER FOR MANUFACTURING SCIENCES

The NCMS is a not-for-pro.it collaborative research, development, and technology transfer corporation organized under the National Cooperative Research Act of 1984 and incorporated under the laws of the State of Delaware. NCMS consists of 125 member companies with plans for 150 small manufacturing applications centers. The role of NCMS is to establish a national R&D agenda for advanced manufacturing. Last year, NCMS created the International Center for Manufacturing Sciences (ICMS) which seeks to enhance the business competitiveness of North American membership through collaboration with international research organizations.

Collaboration is the foundation of NCMS's mission, charter, and initiatives. NCMS members identify initiatives to pursue, define the resources needed, and form the teams to execute them. NCMS staff works with member companies to establish collaborative research initiative programs by forming teams to execute them.

The DOE and the DOE laboratories are ex-officio members of NCMS. Through mechanisms such as the Cooperative Research and Development Agreement (CRADA) that NCMS has with several DOE laboratories, NCMS members perceive a significant role for government agencies to develop and exchange manufacturing R&D information with industry. However, there is a strong need for the DOE national laboratories to identify the areas where they have special expertise that can be used by NCMS.

The NCMS research agenda is currently divided among the following five Strategic Initiative Groups:

- Computer-Integrated Operations: concerned with information technology and systems, as required for the efficient creation and definition of product, engineering, operating, and manufacturing data

- Manufacturing Processes and Materials: seeks rational applications of enhanced and/or innovative process technologies, and the rapid adoption and utilization of new material technologies

- Production Equipment and Systems: conducts activities to foster both incremental and next-generation advances of manufacturing equipment

- Management Practices: addresses important business concerns, such as education, training, accounting practices, and quality

- Environmental Conscious Manufacturing: manages a portfolio of activities to resolve the manufacturing-related environmental concerns of NCMS members.

Presentations were given by NCMS members in each of these areas. These initiatives are described more fully by the viewgraphs provided in Appendix A. The strategic initiatives in Manufacturing Processes and Materials and Environmentally Conscious Manufacturing seem to be particularly relevant to the AIM research agenda.

The NCMS Technology Sourcing Manager, Mr. John Sheridan, described the efforts of NCMS to negotiate the CRADA between the DOE and NCMS pursuant to the Memorandum of Understanding (MOU) signed on July 25, 1991. The CRADA will serve as the master terms and conditions for cooperative research projects between NCMS and the DOE national laboratories. Eight of the 10 signatures needed for the CRADA to become legal have been obtained to date. As individual research projects are identified under the CRADA, the DOE national laboratories will provide descriptions of the work to be performed to the DOE field office contracting officer for final approval.

The CRADA has the following features that facilitate increased cooperation between DOE and the private sector: 1) points of contacts and strategic initiatives of interest to DOE and NCMS are identified; 2) issues of intellectual property, conflict-of-interest, and protection of proprietary information are negotiated; and 3) only signatures of DOE field office contracting officers are required before work can be initiated.

Many DOE national laboratories may participate in the CRADA. A "bottom-up" approach is recommended as the best way to become involved in joint DOE/NCMS projects. This approach begins with the negotiation of a statement of work that later forms part of the CRADA agreement.

To facilitate the TCI, DOE has developed a laboratory coordination board with the managers of technology transfer offices from Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory (LANL), Sandia National Laboratories (SNL), and Lawrence Livermore National Laboratory (LLNL). Members on the coordination board have identified individuals at their laboratories to serve as central points of contact in several specific areas. Five Technology Area Coordinating Teams (TACTS) have been formed to date.

3.0 ADVANCED INDUSTRIAL MATERIALS PROGRAM

The mission of AICD is to develop and maintain a balanced program of high-risk, long-term, directed interdisciplinary research and exploratory development for the industrial sector.[a] AICD is responsible for proving evidence of technical feasibility for advanced industrial concepts in materials and processing as well as combustion, thermal sciences, and biological and chemical processing.

AIM develops a technology base of advanced materials and processing technologies that will allow U.S. industry to achieve increased energy productivity by increasing the reliability, durability, and service life of industrial products and processes. In addition, AIM seeks to develop less energy-intensive materials processing methods that also use less expensive raw materials, fewer processing steps, and produce less waste. The current focus is in two key areas:

- Engineered Industrial Materials - e.g., intermetallic alloys, crack-resistant composites, thermal insulators, and innovative materials.
- Materials Processing Technologies - e.g., microwave processing, surface modification, plastic recycling, biobased materials processing, and innovative processing.

Current activities being funded at the DOE national laboratories are listed in Dr. Sorrell's presentation in Appendix A.

The research agenda of AIM is changing rapidly. New initiatives are being considered in the following areas:

- multifunctional foams and membrane materials
- intermetallic bonded oxides and carbides
- protective and functional surfaces for plastics, metals, and ceramics
- in-situ processing of composites.

(a) The AIM supports the AICD of the DOE Office of Industrial Technology (OIT) of the Office of Conservation and Renewable Energy (CE).

AIM managers seek to 1) identify the materials research and development needs of industry and 2) conduct cooperative research and development with industrial firms to meet these needs. An example of this commitment is the CRADA between the GM Saginaw Division and ORNL. The $1.3 million joint research effort will determine if nickel aluminide intermetallic alloys can be subjected to the intense and prolonged heat of industrial furnaces for hardening metal automobile and truck components. The CRADA was signed in only 15 days after representatives from ORNL met with GM officials. ORNL researchers developed nickel aluminide intermetallics in the mid-1980s, with funding from both DOE CE and Basic Energy Sciences (BES). Approximately 30 months of testing will be conducted at both ORNL and GM Saginaw to evaluate if nickel aluminides can be used in industrial carburizing furnaces.

To get industry input, AIM managers recognize that they must work with industry at all levels (i.e., government policymakers, managers, and researchers). Policymakers must be aware that collaborative R&D with industry is not just a matter of increasing the budget. Mechanisms must be established that support industry needs. For example, U.S. industries prefer to work closely with the suppliers of technology rather than directly with competitors. CRADAs legally support such collaboration, but it remains to be seen if this will be politically acceptable.

Industrial managers must work with their technical staff to identify their R&D needs. Ideally, these needs should be prioritized and consolidated before meeting with representatives from DOE laboratories. Visits and staff exchanges with the DOE laboratories will facilitate one-to-one technical interactions so that collaborative opportunities can be identified. Identification of these opportunities will enable licensing, subcontracts, and CRADAs to be made available for industry to access the technology and capabilities of the DOE laboratories. However, the goals of these projects must overlap with the missions and objectives of the AIM program, if the project is to be considered for potential AIM funding.

4.0 INDIVIDUAL WORKING GROUP MEETINGS

Participants were divided into the following three working groups:

- plastics recycling, organic polymers, and biobased processing
- surface modification technologies
- ceramics, intermetallics, and metals (including alloys and composites).

Working groups were asked to develop recommendations for NCMS and AIM managers using the following six-step process:

1. List high-priority industry problems that could be solved by new and improved materials and processing technologies--limit to about five problems.

2. Identify candidate materials and processing technologies that could be used to solve the problems identified in step 1--limit to two or three per problem.

3. Identify promising applied research and exploratory development activities needed for the technologies identified in step 2.

4. Prioritize the activities listed in step 3 (e.g., Which activities are needed the most? Which activities are of joint interest to DOE and NCMS?).

5. Recommend a set of follow-on actions for the top two or three activities listed in step 4.

6. Prepare a 15-minute presentation of results for the close-out session. The presentation should include a list of high-priority industry problems, list of candidate materials and processing technologies to solve each high-priority problem, and recommendations for follow-on actions.

Summaries of the working group conclusions and recommendations are provided in the following sections.

4.1 PLASTICS RECYCLING, ORGANIC POLYMERS, AND BIOBASED MATERIALS

This working group included the following members:

- Helena Chum, National Renewable Energy Lab (NREL), co-leader
- Dale Schaefer, SNL, co-leader

- Michael Wixom, NCMS
- James Anderson, Ford Motor Company

4.1.1 Identification of Industry Problems

To target industry needs in materials R&D, AIM managers must understand the regulatory drivers. Some important drivers for the automotive manufacturing industry are 1) the proposed Corporate Automobile Fuel Efficiency (CAFE) standards, 2) the recycling legislation being passed in Germany and Japan, and 3) the need for products and manufacturing processes that use recycled materials. CAFE legislation would require the development of lighter, more fuel-efficient passenger vehicles.

German recycling legislation requires that all cars introduced after 1993 must be taken back and recycled by the original manufacturers. Similar legislation is being drafted by the European Economic Community (EEC), Japan, and possibly the United States. Even if similar legislation is not passed in the United States, this legislation would be effective trade barrier to cars manufactured in the U.S. unless they could be recycled in European facilities. Such recycling legislation requires that recyclable polymers be developed. In addition, that the location and formulations of resins must be standardized to make recycling cheaper.

Recycled plastics are being produced in waste streams much faster than they are being used in manufacturing. To help demand meet supply, the properties of recycled materials need to be better understood, the limitations addressed, and suitable manufacturing processes and markets developed.

4.1.2 Technologies to Solve Problems

Four general areas of technology development were identified by workshop participants:

- Materials Compatibility Studies - Materials compatibility issues dictate the feasibility of applications and manufacturing processes using recycled materials. For example, there is a need to understand how much virgin material must be added to a recycled plastic before it can be used again. It may even be possible to recycle plastics with other materials still intact (e.g., paint, adhesives, reinforcements) for certain applications, especially if reinforcements are added. In some cases, resins can be recycled only a

specific number of times before they lose their integrity; therefore, data about aging are important. For these reasons, the performance of recycled materials in actual applications must be understood before these materials can be marketed in products and processes requiring a high degree of reliability.

- Recycling Technology - Technology is needed to help the demand meet supply for products from used plastics and organic matrix composites. This includes manufacturing processes which allow recycled products to be manufactured that are competitive or superior to products from virgin materials.

- Manufacturing Processes - Manufacturing processes for products from recycled materials (e.g., epoxies and polyamides) need to be demonstrated at federal facilities.

- Fundamental Studies - The goal of these studies should be to understand if materials compatibility can be improved as a result of manipulating molecular parameters.

4.1.3 Next Actions

Demonstrations are needed of applications of recycled plastics and associated manufacturing processes. NCMS and industry participants suggested that DOE support pilot-scale manufacturing facilities for materials such as recycled epoxies. The properties of recycled materials can be tested in promising applications so that needed data on manufacturing processes can be made available to industry.

4.2 SURFACE MODIFICATION

Members of the surface modification working group included:

- Al Sylwester, SNL, leader
- Ron Roberts, General Motors
- Robert Reynolds, NCMS
- Mark Smith, SNL.

4.2.1 Identification of Industry Problems

Current industrial needs that require surface modification technology include:

- Sensors - Sensor application needs include measurement of contaminants in products and waste streams, real-time monitoring and process control, measurement of movement and stresses in systems components, telemetry, and biomedical applications.

- Barrier Coatings - Coatings provide barriers to corrosion, mechanical wear, heat, and erosion. Coating materials often have thermal expansion coefficients that are different than the underlying substrate, which results in locked-in stresses, cracking, and lack of adhesion upon cooling. Thin-film coatings are difficult to apply uniformly in high-production applications. Manufacturing processes are needed for coatings that minimize in-place stresses, increase uniformity, and minimize the production of secondary waste streams.

- Lubricating Films - Modified surfaces and new lubricants are needed that allow manufacturing equipment or other machinery to operate with no oil.

- Porous Surfaces - Surfaces with carefully controlled porous microstructures are needed for applications such as membranes, catalysts, and sensors.

- Metallization - Metallization is an important surface finishing process. Currently, plating operations result in excess acids and plating bath materials that contain contaminants such as nickel, chromium, cadmium, and zinc. As a result, metallization is a source of hazardous wastes for many industries.

4.2.2 Technologies to Solve Problems

Materials and processing capabilities needed to solve industry problems in surface modification include:

- Nondestructive Testing (NDT) Methods - NDT methods are needed to measure the thickness and hardness of thin films or coatings. NDT will allow process and quality control to minimize internal stresses and increase uniformity.

- Process/Materials Modeling - Advances in computational capabilities hold promise for computer-assisted materials design (CAMD). CAMD is an emerging approach that can minimize wastes and focus materials synthesis and processing efforts.

- Spray Coating Processes - The next generation of spray coating processes is needed. These processes should be continuous and demonstrate high control of the application rate, good adhesion, and limited carrier requirements. A promising technology at SNL is thermal spray coating for deposition of molten metal and carbide powders on a substrate.

- Carbon Films - Thin carbon films are very promising for lubricating, corrosion resistant, and heat-rejection surfaces. New capabilities for low-temperature deposition of new forms of carbon (e.g., fullerenes) should be explored.

- Engineered Porous Materials - Engineered porous materials offer significant potential as membranes, catalysts, sensors, and barrier coatings. The porosity of materials is often dictated by control of the microstructure during growth conditions using innovative processing methods.

4.2.3 Next Actions

NCMS staff expressed considerable interest in several areas of AIM research in surface modification. They requested that additional information be made available about AIM programs. Opportunities should be explored for additional interaction between NCMS members and the DOE national laboratories conducting research in surface modification. Packages of information on laboratory capabilities would be beneficial.

Sensors, membranes, thermal barriers, and spray coatings seemed to be the most promising areas for future collaboration. New areas recommended by NCMS that AIM should consider include developing thin films for microelectronic applications, conducting non-destructive evaluation of thin films, studying the thermal stability of coatings, and coupling the chemical response of sensor materials to actuators for improved characterization and fast manipulation of system parameters.

4.3 CERAMICS, INTERMETALLICS, AND METALS (INCLUDING ALLOYS AND COMPOSITES)

Working group members included:

- Peter Angelini, ORNL, co-leader
- Joseph Laia, LANL, co-leader
- Dan Maas, NCMS
- John Petrovic, LANL

4.3.1 Identification of Industry Problems

Industry problems driving the development of new ceramic, metal, and intermetallic materials include:

- Need for Weight Reduction - Weight reduction is a primary concern in the transportation industry, because it is a means to achieve more stringent emissions and fuel-efficiency standards.

- Reduction in Scrap - Wastage of material during machining, cutting, and fabricating is a key concern for NCMS members. Wastage results in higher product cost, the need for recycling and disposal of wasted stock, and the potential for generating metal slivers and cuttings that damage dies and other components.

- Need for Standards - Standard test procedures are needed for measuring materials properties as a function of processing and use.

- Recycling of Materials - Recycling of materials is being demanded by U.S. consumers. Legislation in Germany mandates recycling of automobiles and other consumer products.

4.3.2 Technologies to Solve Problems

The following technologies are listed in prioritized order:

- Materials Design and Manufacturing Process Design Methodologies - About 80% of the cost of a system is incurred during the design stage. Concurrent engineering tools are needed 1) to allow design for the entire life cycle of the product (so that manufacturing, recycling, and other costs can be anticipated) and 2) to allow prediction of load and energy management performance in actual applications without extensive testing.

- Materials Property Data - Data on the properties of lightweight materials are needed, so that component design using these materials is simplified. Materials of interest to NCMS members include metal-matrix composites, intermetallics, and heat-treatable steels. Properties of interest include cost; deterioration in service; and problems with machining, features manufacturing, casting, joining, and repair.

- Lightweight Materials - Safe, cost-effective methods are needed for synthesis and processing of metal-matrix composites, engineered plastics, and low-density materials (e.g., intermetallics). Currently, many of these materials cannot be cost-effectively manufactured into complex shapes and repair is difficult.

- Net Shape Manufacturing - Net shape manufacturing methods would allow many machining and stamping processes to be eliminated.

These methods need to be continuous operations for the production of discrete parts in high-production operations. Materials of interest include plastics, aluminum, magnesium, and some castable metal-matrix composites.

4.3.3 Next Actions

NCMS staff should identify the engineered materials specification (e.g., formulations, types, shapes, components) of highest interest to their membership. This list can be made available to the DOE national laboratories so that they can tailor their capabilities to developing technology to manufacture to these specifications.

DOE should coordinate the capabilities of the DOE national laboratories and key universities in the areas of high interest to industry. Currently, it is difficult for industry to understand where the capabilities of the DOE national laboratories reside and to determine who is responsible for establishing programs to transfer existing research results to the private sector. DOE needs to categorize work to date, even if tangible results are not available.

5.0 CONCLUSIONS

The ability to fabricate products from advanced materials using low-cost processes is critical to U.S. economic competitiveness. The research agenda at DOE AIM should include working with suppliers to develop manufacturing technology. The agenda should be driven by both energy conservation considerations and by industry needs. DOE should ensure that energy-efficient technology is available to meet these needs.

Problems of key concern to NCMS member companies include the:

- need for pilot-scale demonstrations of recycling processes for plastics and organic matrix composites
- need for materials with tailored surface properties for sensors and barrier coatings
- need for carefully controlled surface modification technologies that generate no waste
- need for manufacturing processes that do not generate scrap.

Promising materials and processes to meet industry needs include:

- recyclable plastics, composites, carbon films, engineered porous materials, and low-density materials
- continuous processes for spray coating and net-shape forming
- sensors and NDT methods for quality control (e.g., measuring the thickness and hardness of coatings).

Materials development activities should be conducted in conjunction with materials compatibility studies, derivation of standards and materials property data, and the development of design tools. Building pilot-scale production facilities and evaluating new and recycled materials in federal facilities should be an essential part of DOE's research agenda in advanced materials.

Finally, active technology transfer through CRADAs and technical exchange with industry is encouraged. An important focus of the research

should be to transfer the results of existing research into products and processes that are usable by the manufacturing industry.

APPENDIX A

WORKSHOP PRESENTATIONS

ADVANCED INDUSTRIAL CONCEPTS MATERIALS PROGRAM
OFFICE OF INDUSTRIAL PROCESSES
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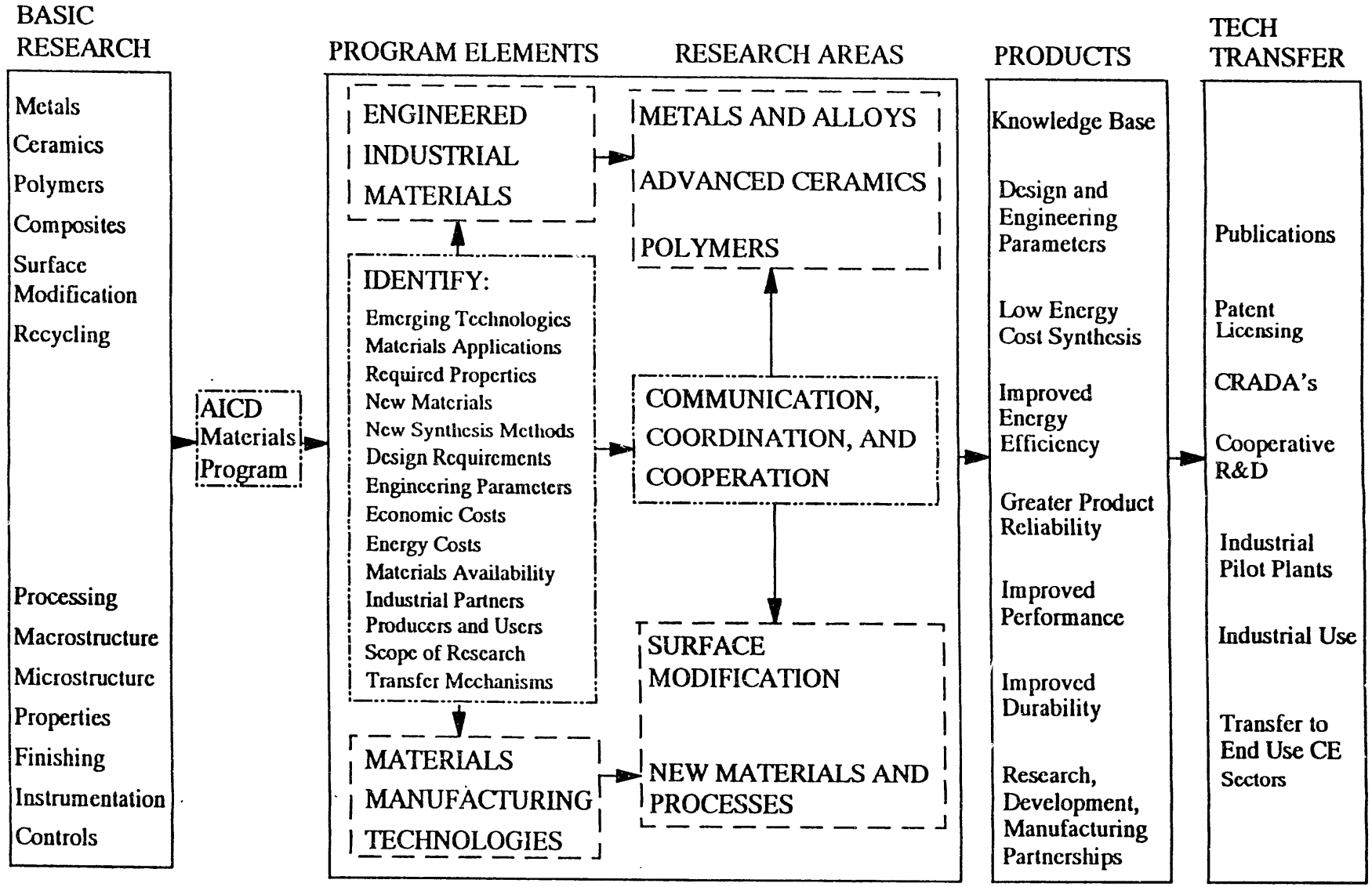
Advanced Industrial Concepts Materials Program



MISSION

- Conduct applied research and development to help bridge the gap between basic research and industrial application of energy saving materials and materials processing methods
- Develop materials that save energy by enabling improved system efficiencies and service lives
- Develop less energy intensive and less expensive materials processing methods using less expensive raw materials and fewer processing steps
- Serve as a resource for end-use programs and transfer work to those programs when appropriate
- Work with industry to identify materials needs, conduct cooperative research and development, and transfer technology to industry

CERAMICS

- Chemical Vapor Deposition of SiC - Sandia Livermore
- Chemical Vapor Infiltration of TiB2 - Oak Ridge
- X-Ray Tomography of Composites - Lawrence Livermore

- Microwave Spray Drying and CVI - Los Alamos
- Microwave Sintering of Oxides - Oak Ridge

- Aerosphere Ceramic Insulation - Georgia Tech
- Aerogel Insulation - Lawrence Berkeley

ADVANCED ALLOYS AND COMPOSITES

- Ordered Intermetallic Alloys - Oak Ridge
- Intermetallic Alloy Composites - Los Alamos
- Rapidly Solidified Alloys - Idaho Nat'l. Eng. Lab.

POLYMERS

- Chemical Recycling of Plastics - NREL
- Polymers from Renewable Materials - NREL
- Magnetic Field Processing, Organic - Los Alamos
- Magnetic Field Processing, Inorganic - Idaho

SURFACE MODIFICATION

- Conducting Thin Films - Los Alamos
- Surface Modification of Polymers - Oak Ridge
- Chemically Specific Thin Films - Sandia Albuquerque
- Biomimetic Coatings and Thin Films - Pacific Northwest
- Synergistic Coatings - Sandia Livermore and Magnaplate

NEW MATERIALS AND PROCESSES

- Multifunctional Foams and Membrane Materials - TBD
- Intermetallic Bonded Oxides and Carbides - Oak Ridge
- Composites by Metal Infiltration - Sandia Albuquerque

LINKAGES FOR PROGRAMMATIC FOCUS

- Surface Modification
  - -- Protective Surfaces
    - -- New Coatings Development (SNLL, ORNL, Magnaplate, Rutgers)
    - -- Surface Treatment of Polymers (ORNL, LANL)
    - -- Magnetic Field Processing of Polymers (LANL)
    - -- Biomimetic Processing (PNL)
    - -- Intermetallic Alloys (ORNL)
  - -- Functional Surfaces
    - -- Chemically Specific Surfaces (SNLA)
    - -- Biomimetic Processing (PNL)

LINKAGES FOR PROGRAMMATIC FOCUS (cont'd)

- New Materials and Processes
  - -- In Situ Formation of Composites to Near Net Shape
    - -- Composites (Metal or Ceramic) by Reactive Metal Infiltration (SNLA)
    - -- Molybdenum Disilicide Composites (LANL)
    - -- Bonded Oxide and Carbide Composites (ORNL)
    - -- X-Ray Tomography (LLNL)
    - -- Processing Modeling (ORNL, NIST)
  - -- Fiber Reinforced Ceramic Composites
    - -- Titanium Diboride Composites (ORNL)
    - -- Microwave Assisted CVI (LANL)
    - -- X-Ray Tomography (LLNL)
    - -- Processing Modeling (ORNL, NIST)

LINKAGES FOR PROGRAMMATIC FOCUS (cont'd)

- Membrane Materials

  -- Aerogels (LBL, NIST)
    -- Applications for insulation, filtration, catalysts, adiabatic demagnetization, ion exchange, batteries, sensors
    -- Treatment of interior pore structure for chemically specific activity

  -- Chemically Specific Surfaces (SNLA)
    -- Can be adapted as is or used to treat interior pores
    -- SNLA has powerful computer modeling capability

LINKAGES FOR PROGRAMMATIC FOCUS(cont'd)

- Membrane Materials (contd)

  -- Magnetic Field Processing of Inorganic Polymers (INEL)
    -- Processing can change rates and selectivity

  -- Conducting Polymer Thin Films (LANL)
    -- Membrane characteristics can be tailored and altered in situ

  -- Microwave Processing (LANL, ORNL)
    -- May have application for processing of sol-gels and CVI

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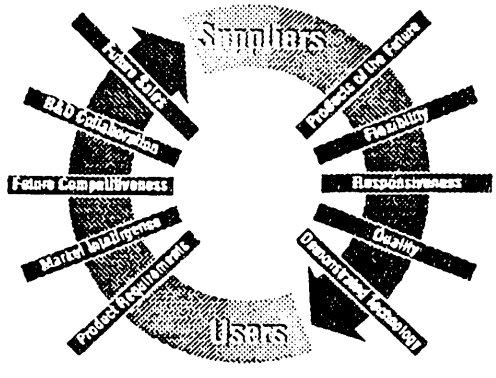
NCMS

National Center for Manufacturing Sciences

National Center for Manufacturing Sciences

NCMS

The NCMS Advantage



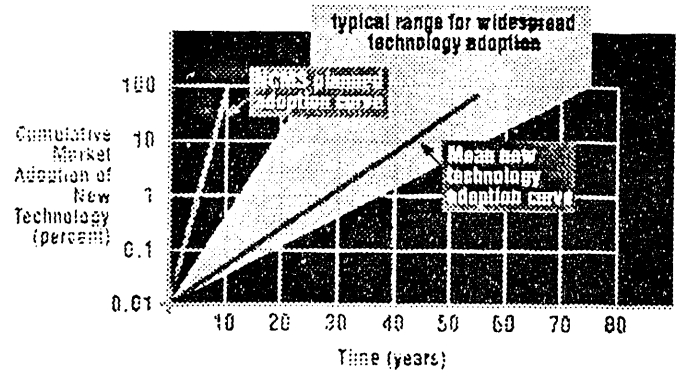
"The Collaborative Process"

National Center for Manufacturing Sciences

Problem Statement

- Manufacturing in North America is going downhill
- Technology is available in the marketplace - but technology is not being used or distributed effectively
- Need a mechanism to effectively transfer technology
  - Need to make people aware of technology
  - Need to make available known technology
  - Need to effectively apply existing technology
  - Need to efficiently bring technology to readiness
  - Need applicable technology development

Technology Adoption Time Frames



NCMS Background

- The National Center for Manufacturing Sciences is a not-for-profit cooperative research corporation.
- NCMS was organized under the National Cooperative Research Act of 1984.
- The purpose of NCMS is to fund research in manufacturing.
- NCMS will lead the effort to develop technologies and systems that will improve U.S. manufacturing processes and materials.
- The goal of NCMS is to see technologies implemented in its member companies.
- Achievement of World Class Manufacturing in a Global Peacetime Economy is our mission.

NCMS Strategy

- Through partnerships with industry and government - identify, support and field programs that increase competitiveness in American/Canadian manufacturing.
- Provide atmosphere for member company collaboration - thus increasing competitive leverage.
- Development of broad-based Technology Transfer Network for:
  - New processes
  - Underutilized processes
  - Adaptation/enhancement of existing technologies

Selected Members

AT&T	Hurco Companies, Inc.
Digital Equipment Corporation	Litton Industrial Automation Systems, Inc.
Ford Motor Company	Measurex Automation Systems, Inc.
General Motors Corporation	Rockwell International Corporation
The Gleason Works	Texas Instruments Incorporated
GTE Valenite Corporation	United Technologies Corporation

Over 125 Member Companies

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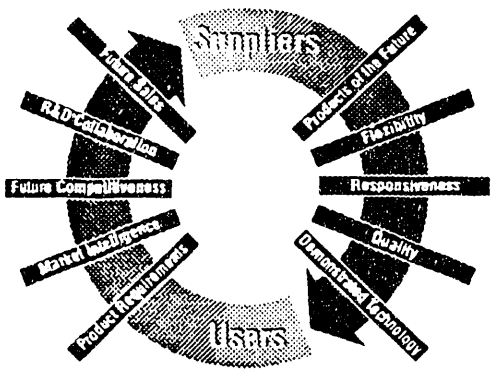

"The Collaborative Process"

National Center for Manufacturing Sciences

Decreasing the cost of R&D and operations

- NCMS helps members benchmark against the competition.
- We offer significant leveraging of R&D budgets.
  - typical savings of 80%
- We enable technology sharing, thereby reducing redundant R&D.

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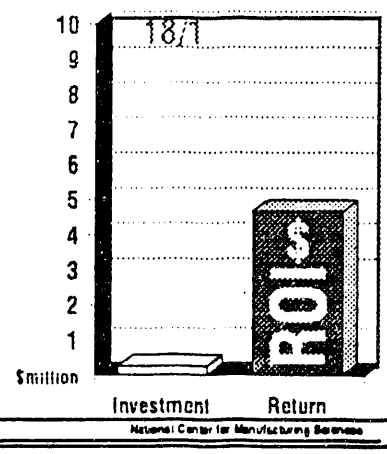
"Typical" Large Company Leverage

"NCMS offers manufacturing companies a great opportunity to leverage their manufacturing R&D investment. TI and its NCMS partners are able to get more "bang for their buck" by pooling talent, R&D investment, and equipment into projects solving common problems"

Jack E. Swindle
Senior Vice President
Texas Instruments, Inc.



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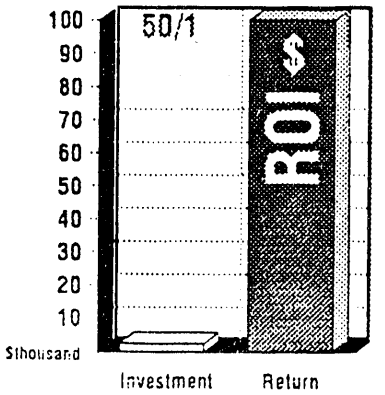
"Typical" Small Company Leverage

"NCMS provides small companies like Kinefac with unparalleled access to the latest manufacturing technology and a great opportunity to join with other large and small companies alike in the research needed to enhance their competitiveness in U.S. and world markets."

Howard A Greis
President
Kinefac Corporation
Worcester, Massachusetts



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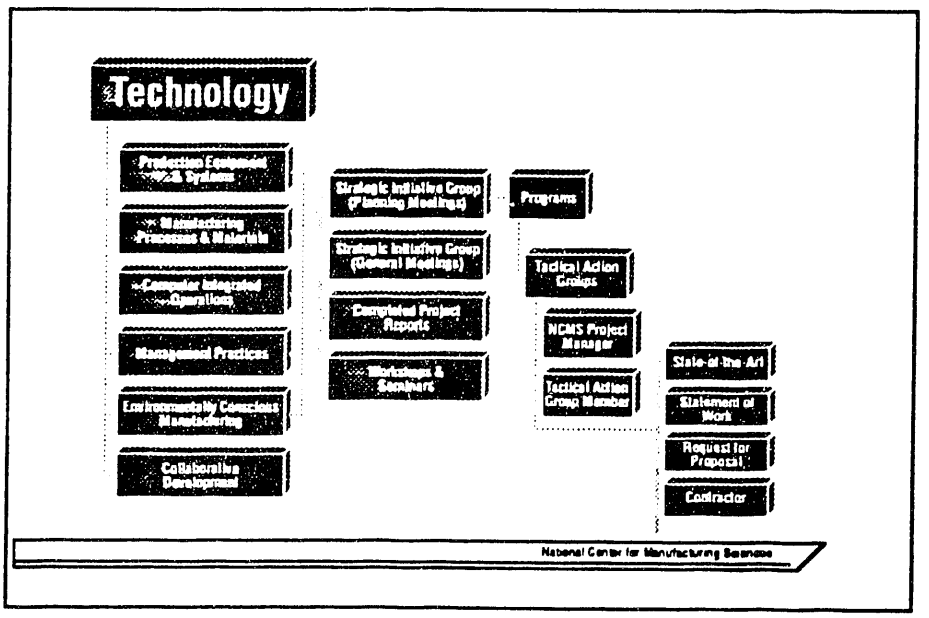

Management Practices

Mission

- To significantly improve North American manufacturing competitiveness in areas of:
  - Quality
  - Cost
  - Delivery
  - Flexibility
  - Customer Satisfaction
- By forecasting, acquiring, generating, and deploying world-class manufacturing management practices

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Management Practices

Programs

- Enterprise Management
  - Achieving Manufacturing Excellence
  - Benchmarking
- Human Resources
- Financial Policies
- Manufacturing Operations
- External Business Environment

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Computer Integrated Operations

Mission

- To monitor, analyze, research, develop and promote computer-based system integration technologies that enable an extended North American enterprise to operate and be competitive globally

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Computer Integrated Operations

Programs

- Business Case for Computer Integrated Manufacturing
- Reference Models
- Integrated Support Program
- Beta Site Deployment

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Manufacturing Processes and Materials

Mission

- To significantly improve the capability of North American manufacturers to deliver high- quality cost-effective products in a dynamically evolving international marketplace by distinctive execution of four critical programs

Manufacturing Processes and Materials

Programs

- Advanced Processing Technologies
- Quick Prototyping
  - Rapid Prototyping Technology Advancement
- Predictive Process Control
- Materials and Process Selection

Production Equipment and Systems

Mission

- Advance the international competitive position of North American manufacturers
- Impact the national defense users, and machine tool builders' manufacturing bases for greater global competitiveness

Production Equipment and Systems

Programs

- Next Generation Controller
- Low End Controller
- High Productivity and Precision Machining
- Next Generation Inspection Systems
- Rapid Response Manufacturing

Environmentally Conscious Manufacturing

Mission

- To establish and implement an advanced and innovative portfolio of science and technology R&D programs to ensure and facilitate environmentally conscious manufacturing
- To disseminate results to NCMS members, North American industry and academia
- To be the best source of environmentally conscious manufacturing science and technology

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Environmentally Conscious Manufacturing

Programs

- Manufacturing Solvents & Their Substitutes
- Remediation of Industrial Wastes
- Metal Working Fluids
- Emissions from Painting Operations
- Reduced Lead Use in manufacturing
- Emissions from Plating Operations
- Emerging Environmental Technologies
- Environmental Practices
- Life Cycle Design Environmental Compatibility
- Waste Minimization/Energy Conservation Interactions
- Sensors for Environmental Monitoring
- Bioplastics Initiative
- Appropriate Packaging Concepts

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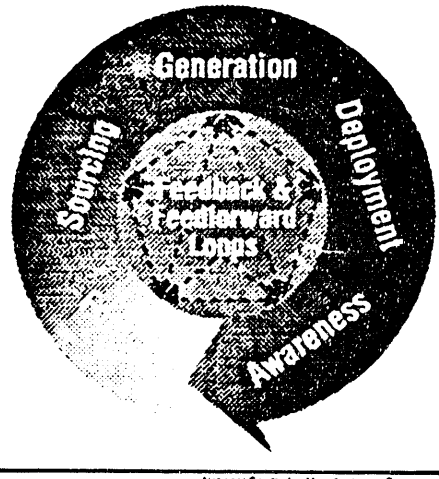
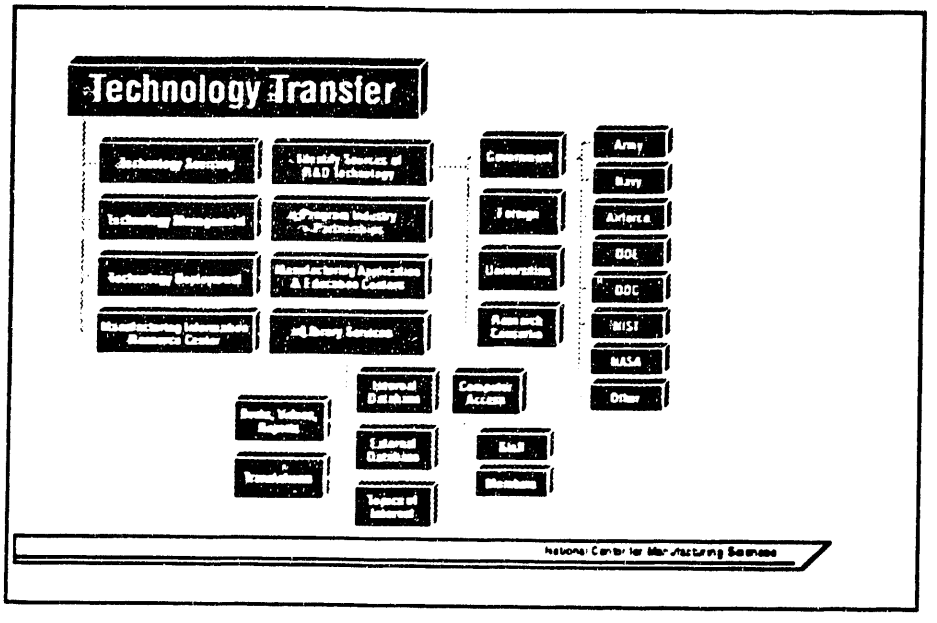
Collaboration (other members)

- Printed Wiring Board Consortium (NIST ATP award)
  - AT&T, TI, UTC/Hamilton Standard, DEC, Sandia, NIST
- Rapid Response Manufacturing (NIST ATP proposal)
  - GM, TI, UTC, Ford, Oak Ridge (Y-12), Aries, Cimplex, Cimflex Tecknowledge, ICAD, Parametric Tech., Spatial Tech.
- Sourcing from member laboratories

NCMS

The Technology Cycle





Sourcing Advanced Manufacturing Technology

Sourcing and deploying advanced manufacturing technology from

- Government labs and production facilities
- Global sources
- Member companies
- Universities
- Other consortia and related research organizations

Sourcing Advanced Manufacturing Technology

Developing a pull approach

- Seeking technology that will support current or planned R&D programs
- Identifying members' technology needs/opportunities
- Identifying technologies that can improve competitiveness of members

Sourcing Advanced Manufacturing Technology

Developing general memoranda of understanding and cooperative research and development agreements to expedite the sourcing process

- Standard terms and conditions covered in generic MOUs and CRADAs
- Individual project agreements can be developed rapidly under generic MOUs and CRADAs

Sourcing Advanced Manufacturing Technology

MOUs and CRADAs in place with:

- Dept. of Energy - Generic CRADA to be signed
- Watervliet Arsenal / Benet Labs - Generic CRADA
- Environmental Protection Agency - Generic CRADA
- Microelectronics and Computer Consortium - MOU
- Others in Process:
  - NASA
  - Navy
  - Air Force

** There are 14 separate existing NCMS technical projects awaiting the signing of the DoE CRADA. These projects will involve $19M of DoE effort and $54M of NCMS funds and in-kind contributions.

Sourcing Advanced Manufacturing Technology

CRADA Activity at Watervliet Arsenal / Benet Labs:

- Manufacturing Processes & Materials:
  - Total Productive Maintenance / Tool Monitoring
  - Waterjet cutting
- Environmentally Conscious Manufacturing:
  - Metal Working Fluids
  - Plating Fluids
  - Replacing Volatiles in Coatings

Global Sources

- Importing Ukrainian Technologies
- Liaison Technologists in Europe and Asia

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Global Sources

Importing Ukrainian Technologies
Candidate Technologies

- Paton Institute
  - Electron Beam Physical Vapor Deposition of Carbide Coatings
  - Electron Beam Melting of Metals (Ti, Ni-superalloys)
  - Gyrotron Microwave Processing for Coatings
  - Thermal Barrier Coatings
- Dnepropetrovsk Metallurgical Institute
  - Ductile White (Cast) Iron
  - Anisotropic Porous Materials
- TEMP Electronic Factory
  - Thick Film Pastes for Circuit Boards
  - Soldering Metal to Glass

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Sourcing Advanced Manufacturing Technology

Ukrainian Materials Technologies

- Six original technology areas expanded to eight TAG projects.
  - ** Electron Beam (EB) Carbides and Diamond-like coatings,
  - EB fiber coatings,
  - ** EB Thermal Barrier Coatings,
  - Gyrotron Processing of Electron Circuit Boards,
  - Microlaminates,
  - Anisotropic Porous Materials,
  - ** PICT Cast Iron,
  - Diamond Honing.

Three projects starred (**) chosen as first priority for immediate TAG development and importation of technical samples.

Sourcing Advanced Manufacturing Technology

Ukrainian Materials Technologies

- ONR will fund 2Q92 travel of Soviet scientists to US for additional workshops, as well as partial funding for technical samples.
- Second Ukraine trip conducted 1/27-2/7/92.
- Gorky gyrotron completed and ready to ship to Los Alamos National Lab for use by industry and laboratory personnel.

PICT - Iron

- Plasticity Induced Carbide Transformation
- New composition and process
- But conventional mill equipment
- Low cost
- High hardness — 62 to 68 Rc
- Wear resistant
- Improved toughness

Cooperation with Other Consortia

National Issues

- Establish industry-driven manufacturing vision, metrics, common process
- Establish master Manufacturing R&D agenda
- Deal with barriers to cooperation
- Create interplay between standards committees and R&D groups
- Develop the business case for manufacturing modernization
- Address issues relevant to small companies

Cooperation with Other Consortia

- CIO project, "A Business Case for CIE" developed linkages to CAM-I program " CIE Guidelines and Methodologies".
- NCMS joined the MCC project "Enterprise Integration Net" with the intent of using that network as an electronic communications vehicle between NCMS, its members, other networks and between members.
- EPRI considering providing additional funding for selected MP&M programs
- Discussing similar interest from GRI

Sourcing Advanced Manufacturing Technology

Member to Member Collaboration

- New start March '92
- Effort to source member-owned technologies that members decide not to implement in their own strategic plans.
- Plan NCMS "garage show(s)" in summer/fall, inviting labs which have generic CRADA.

Managing the Technology Deployment Process

Building deployment and commercialization capabilities into the project team

- Both users and suppliers of the technology included on member project team — provides built in pull
- An organization capable of taking the technology to market must be included in the contract team

Managing the Technology Deployment Process

Building Technology Deployment into the Technology Development Programs

- NCMS Technology Transfer staff participates in SIG technology planning process
- Technology Transfer and Deployment requirements specified in all project agreements/contracts

Technology Deployment

Manufacturing Application & Education Network

- The Manufacturing Application and Education Network (MAEN) made up of Manufacturing Application and Education Centers (MAEC)
  - They will be analogous to the teaching hospital
  - It will bring together all the necessary functions needed for manufacturing improvement in one place

Strategic Model

How the NCMS strategy will work

- NCMS contracts management and operation
- NCMS works as a partner
  - NCMS representative at each center
  - NCMS responsible to help identify optimum approaches
  - NCMS programs will be deployed through the Centers

Each MAEC to be a Business in Itself

- The purpose of each center to include the following:
  - Train users within an operational and hands-on environment
  - Educate users in applications
  - Demonstrate current and potential SOA technology and best practices
  - Harden technology in a production environment
  - Validate technology for specific applications
  - Advance applicable technology through continuous improvement
  - Produce parts
  - Develop formal degreed program

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Short History of the MAEN

- Started with the idea of 20 facilities - now thinking 150 or more
  - Want to reach a maximum number of firms
  - Practical limit of about a 100 mile radius of service
  - Believe organizations are available for number required
  - Studies identified about 30 major economic centers and 55 major industries
- Believe that financing is available to support the idea
- Working on legislation to help MAEN concept
- Working a coalition of groups to further support this initiative

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Why the Time is Now for MAEC

- We have all the successful ingredients for MAEC in the U.S. today
  - Good model educational systems at all levels
  - Operating demonstration facilities
  - Well developed business systems
  - Accessible production facilities
  - Great opportunity for staffing manpower
  - Good equipment
  - Excellent R&D facilities and personnel
- No One has Brought the Pieces Together --

  THIS IS OUR TASK!

Building the Manufacturing Information Resource Center

- NCMS has created a unique Information Resource Center focused exclusively on manufacturing and manufacturing technology
- The Manufacturing Information Resource Center provides the following services:
  - Library Services to members, staff and research contractors offering a collection of more than 11000 documents, audio/visual materials and software focused on manufacturing and manufacturing technology
  - Research Services to members, staff and research contractors with on-line access to more than 400 technical and business databases via 17 services.

Manufacturing Information Resource Center (continued)

- Publication and Distribution of NCMS technical reports
- Access to the NCMS TRACK on-line full text database on manufacturing and manufacturing technology
- Global information sourcing and translation services

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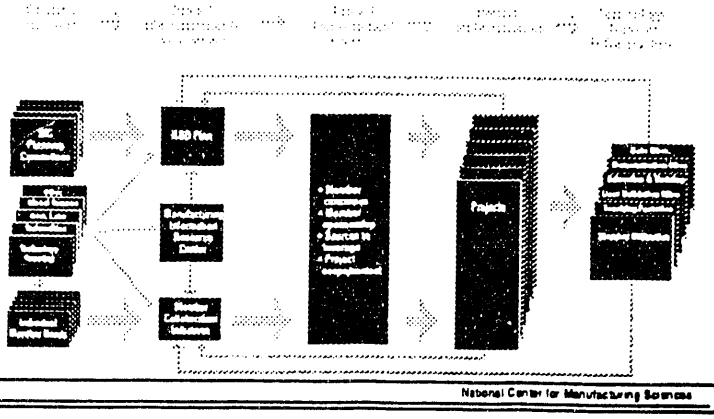
NCMS – From Concepts to Member Companies Utilization for Profits



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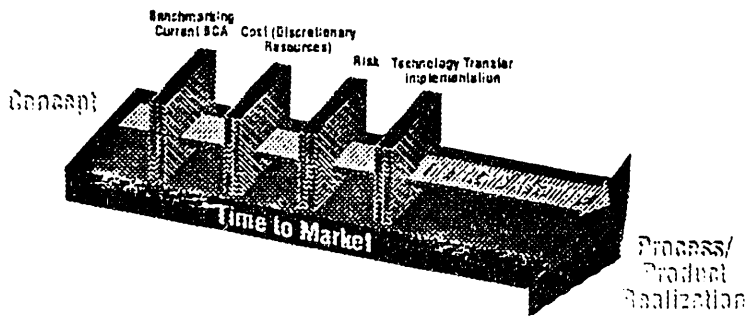
NCMS

The NCMS Advantage



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Sourcing Advanced Manufacturing Technology
NCMS – DOE Generic CRADA

Approach

- Flat Management Structure to Promote DOE/LAB Teamwork
- Single Infrastructure for Consistency
- Need to leverage Limited Human Resources
- Delegate Authority for Speed
- "Up Front" Industry Involvement

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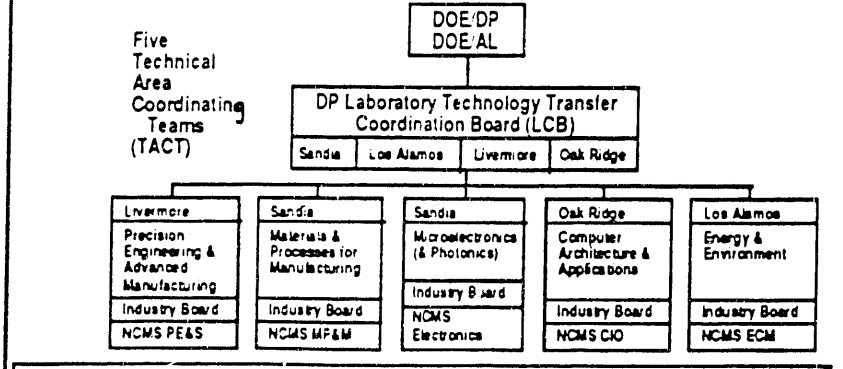
Sourcing Advanced Manufacturing Technology
NCMS – DOE Generic CRADA

DOE Management Structure



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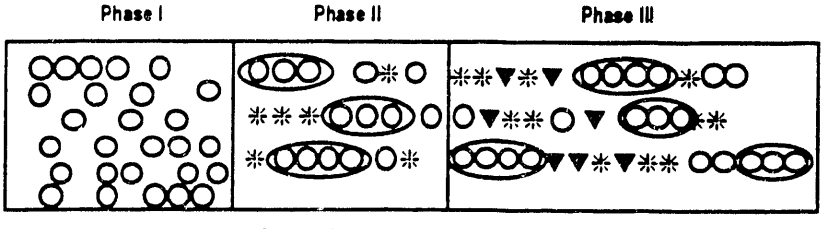
Sourcing Advanced Manufacturing Technology
NCMS – DOE Generic CRADA

Why LCB/TACTs?

- Consistency
- Promote Teamwork
- Provide Infrastructure
- Speed
- "Best Ball"
- Bridge the Gap

Sourcing Advanced Manufacturing Technology
NCMS – DOE Generic CRADA

Bridging the Gap



"1000 Flowers Bloom"

- Individual CRADAs
- Industry Consortia
- Major Program Initiatives

"Clusters"
- Tech. Areas
- Consortia

Major Program Initiative
- National Level Impact
- By Sector
- "Leap Frog" Advances in Enabling Tech. Areas

Sourcing Advanced Manufacturing Technology
NCMS - DOE Generic CRADA

Roles and Responsibilities of DOE Defense Programs

- Overall Technology Commercialization Initiative (TCI)
  - Final approval authority for all activities
  - Provide high level guidance to DP Technology Transfer Coordinating Board
- Long Term Strategic Planning and Program Direction
- Budget Allocation
- Participate in Program Development, New Initiatives, etc.
- Interface between TCI, other government organizations and program sponsors
- Knowledge of Industries needs, wants and problems with the process

Sourcing Advanced Manufacturing Technology
NCMS - DOE Generic CRADA

Roles and Responsibilities of DOE/AL and DOE Area Offices

- Participate in Strategic Program Direction Activities
- Approval Authority for Joint Work Statements (JWS)/CRADAs
- Budget oversight
- Provide progress reports
  Respond to DOE/DP Information requests
- Interface with laboratory budget office
- Interface with laboratory Tech Transfer Office
- Proactively Facilitate CRADA Processes.

Sourcing Advanced Manufacturing Technology
NCMS – DOE Generic CRADA

Roles and Responsibilities of Laboratory Coordinating Board

- Serve as the Single DOE/DP Infrastructure for TCI
- Recommend Program Funding Requests
- Develop Business Terms and Conditions
- Management of TACT Activities to include:
  - Oversight of Proposal Review Process
  - Recommendations for Approval of TACT Strategic Plans
  - Facilitate Inter-TACT Coordination
  - Funding Recommendations for Technical Areas
- The CB is to provide an Ombudsman's role

Sourcing Advanced Manufacturing Technology
NCMS – DOE Generic CRADA

Roles and Responsibilities of Technology Area Coordinating Teams

- Manage existing Technology Transfer Portfolios in Technology Areas
- Identify "Clusters"
  - By Technology Areas
  - Multiple Partners
- Work with Industry Advisors to Identify and Develop Recommendations for Major Program Initiatives
- Develop and Coordinate Strategic Plans with Industry for Technology areas
- Manage Proposal Development and Selection (e.g., call, review, prioritize, rank, recommend, review, etc.)
- Conduct Project Reviews Quarterly
- Adjust Strategic Plans
- Provide Capabilities Assessments of DP Complex

NCMS ENVIRONMENTALLY CONSCIOUS MANUFACTURING

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NCMS Environmentally Conscious Manufacturing

1991 Initiated Programs/Projects

- Manufacturing Solvents and Their Substitutes
  - Environmental Impact Assessment of Alternative Solvents
  - Environmental Impact Assessment Monitoring & Modeling
  - Material Compatibility Issues in Electronic Components
  - Electronic Component Compatibility Testing
  - Definition & Measurement of Clean Electronic Components
  - Solventless Cleaning of Electronic Components
  - Definition & Measurement of Clean Cut Metal Parts
  - Definition & Measurement of Clean Composites

NCMS Environmentally Conscious Manufacturing

1991 Initiated Programs/Projects (continued)

- Remediation Of Industrial Wastes
  - Assessment of Bioremediation Applications
  - Advanced In-Situ Bioremediation Developments
- Emissions from Surface Finishing Operations
  - Advanced Methods of Paint Application
  - Assessment of Plating Emissions Control Technology
- Handling and Disposal of Metal Working Fluids
  - Machine Tool Design Optimization for Metal Working Fluid Use
- Reduced Lead Use in Manufacturing
  - Advanced Mechanical Interconnects in Electronic Components

Environmentally Conscious Manufacturing

Manufacturing Solvents & Their Substitutes

Material Compatibility Electronic Components

Purpose:

To understand the compatibility of various materials used in electronic assemblies with potential Ozone Depleting Chemicals (ODC) alternatives, prior to implementing them within assembly processes.

Participants:

Texas Instruments (Lead); United Technologies Hamilton Standard and Norden; AT&T; General Motors Delco and Hughes; Ford.

Status:

Solvents & Materials Selected

Testing Protocol Approved (IPC considering for standard)

Work Distribution Agreed Upon

Testing Initiated

Environmentally Conscious Manufacturing

Manufacturing Solvents & Their Substitutes

Material Compatibility Electronic Components

Materials:	Solvents:
Metals	Freon TMS (Control)
Platings and Conversion Coatings	1,1,1 Trichloroethane (Control)
Polymers	HCFC Vertrel 245
Composites	Terpene Bioact EC-7R
Elastomers	Terpene Petroferm/Alpha
Adhesives	Isopropyl Alcohol
Non-Metallic Coatings	High Boiling Alcohol Ionox HC
General Marking Materials	Organic Blend EC-5 Petroferm
Miscellaneous Materials	Reactive Aqueous Defluxing System

Environmentally Conscious Manufacturing

Existing Programs - New 1992 Projects

- Manufacturing Solvents & Their Substitutes
  - Solvent Alternatives Hand Wiping Applications
  - Environmental Compatible Processes for Non-Destructive Testing Cut Metal Parts
  - Assessment of Aqueous Cleaning Equipment Cut Metal Parts
  - Vapor Degreasing Equipment Alternatives Cut Metal Parts
  - Solvent Waste Minimization Electronic Components
  - Advanced Cleaning Equipment Electronic Components

Environmentally Conscious Manufacturing

Existing Programs - New 1992 Projects (continued)

- Emissions from Surface Finishing Operations
  - Low VOC Production Paints
  - Environmentally Compatible Plating Processes Aerospace Applications
  - Conformal Coating Characterization Electronic Components
  - Chromate Bath Life Optimization
- Remediation of Industrial Sites
  - Sand Binders in Foundry Wastes
  - Assessment of Methods for PCB Remediation
- Reduced Lead Use in Manufacturing
  - Lead Free Solders
  - Alternatives for Fixturing Alloys

Environmentally Conscious Manufacturing

New 1992 Programs

- Environmental Practices
  - Risk Assessment Methods
  - Manufacturing Application & Education Center Implementation
  - Strategic Developments
  - Environmental Management Practices
  - Formal Technology Sharing
  - Pollution Prevention Program Development
- Sensors for ECM Processes
  - Assessment of Sensor Needs in ECM
- Life Cycle Design for Environmental Compatibility
  - Assessment of Current Practices and Trends
  - Concept Implementation
- ECM Packaging Initiative
  - Packaging Minimization
- Waste Minimization\Energy Conservation Practices

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Environmentally Conscious Manufacturing

Summary

- The Environmental Issues in Manufacturing Conference summarized the NCMS member coincidental activites and initiated the planning for collaborative and cofunded activities in the environmental area
- A new initiative directed toward Environmentally Conscious Manufacturing is established and the planning includes collaborative and cooperative partners

National Center for Manufacturing Sciences

NCMS PRODUCTION EQUIPMENT AND SYSTEMS SIG. 1992 PROGRAM/PROJECT LISTING

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ADVANCED MACHINING TECHNOLOGY INITIATIVES (AMTI) PROGRAM

Defined Projects:
- Advanced Vertical Grinder
- Adaptive Controls for Turning Centers
- Real Time Error Correction for Piston Turning Machines

Planned Projects:
- Light-Weight, High-Power Spindles
- Innovative Spindle Concepts
- Structural Characterization of Machine Tools

PRODUCTION SYSTEM METROLOGY (PSM) PROGRAM

Defined Project:
- Next Generation Inspection System (NGIS)

Planned Project:
- Optical Gaging

MACHINE TOOL ACCURACY INITIATIVES MTAI) PROGRAM

Defined Projects:
- Machine Tool Accuracy Procedures
- Volumetric Accuracy Software Tools
- International Standards Evaluation
- Technology Transfer

Planned Project:
- Machine Tool Accuracy Benchmarking

RELIABILITY AND MAINTAINABILITY (R&M) PROGRAM

Defined Projects:
- Reliability and Maintainability Guidelines
- Total Productive Maintenance

MANUFACTURING PROCESSES AND MATERIALS 1992 PROJECTS

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MANUFACTURING PROCESSES AND MATERIALS - 1992 PROJECTS
March 16, 1992

- Waterjet and Abrasive Waterjet Machining - Phase I
- Automatic Inspection System for Surface and Edge Finishing
- Distributed Laser Processing System
- Diamond Film Phase Ib
- Cure Sensor Systems for Composite Materials
- Advanced Tools and Methods for Machining Non-Homogeneous Materials
- ECM Process Control
- Joining of Composites and Dissimilar Materials
- Adaptive Process Control of Compression Molded Composites

MANUFACTURING PROCESSES AND MATERIALS - 1992 PROJECTS (cont'd)
March 16, 1992

- Rapid Prototyping Technology Advancement
- Thermal Spray Coatings Technology Advancement
- Low Pressure Direct Suspension Waterjet Process Development
- Predictive Model and Methodology for Heat Treatment Distortion
- Thixomolding Engineering Database for Magnesium

EXPERIENCES FROM THE FRONT LINE

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MAJOR EVENTS

- GM Scouting Missions
- November, 1991 Saginaw Conference
- Ongoing Series of Technical Discussions and Visits
- January, 1992 GM "Garage" Show
- August, 1992 Manufacturing Technology Exposition

NOVEMBER, 1991 SAGINAW CONFERENCE

- Saginaw Developed/Circulated One Page "Needs" Abstracts
- Labs Identified Areas of Interest and Capability
- Strong Matches Formed Conference Agenda
- 42 Abstracts Presented

Results

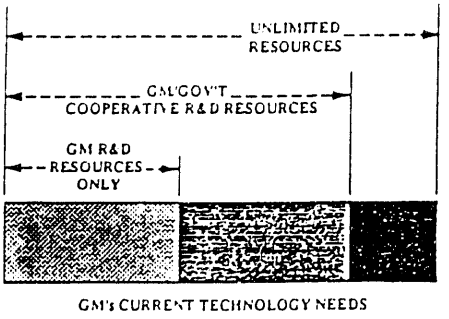
2 CRADA's in Place
5 More CRADA's in Final Negotiations
20 More Folded into Mega Projects

SAGINAW - OAK RIDGE CRADA

- First GM/DOE CRADA - Signed February 4, 1992
- 2 1/2 Year Project
- Develop Improved, Longer Life Assemblies for Heat Treat Furnaces
- Apply Proprietary Nickel Aluminide Materials Developed by Oak Ridge
- Expect 3X - 4X Life Improvement of Assemblies

WHY UTILIZE GOVERNMENT LABS?

1. To Address GM's Technology Needs



WHY UTILIZE GOVERNMENT LABS? ((cont'd)

2. To Access a Wealth of Expertise and Capability

- Approximate yearly non-defense R&D budget for Federal laboratories = $20,000,000,000
- 100,000 federal engineers and scientists
- U.S. industry must learn how to supplement in-house R&D

WHY UTILIZE GOVERNMENT LABS? (cont'd)

3. To Compete in the New Paradigm
Simply Put... One Company Cannot Compete Against Several Countries

- Government Perspectives:
  - Focus shift from military to economic
  - U.S. won cold war but losing economic war
  - Military challenges similar to industry (quality, cost, lead time, and technology acceleration)
  - Supplier base competence and competitiveness an issue
- Industry Perspectives:
  - Too expensive to engage in redundant research (especially to fulfill broad social needs)
  - Need to level international playing field through synergistic cooperation
  - Supplier base competence and competitiveness an issue

SAGINAW DIVISION APPROACH

- Load Internal Resources into Areas of Core Competency
- Leverage External Resources in All Other Areas
- Know Your Needs
- Work From Your Home Base
- Network!--It's a Contact Sport

GEARING UP!

A Manufacturing Forum for Getting Competitive, Staying Competitive

The Ryder Center
Saginaw Valley State University
Saginaw, Michigan

August 24-26, 1992

Dinner & Open House
August 24, 1992
Invited Key Note Speaker:
Governor John C. Engler

Exposition
August 25-26, 1992

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Sponsors

Saginaw Division, General Motors
The Dow Chemical Company
National Center for Manufacturing Sciences
National Institute of Standards and Technology
State of Michigan Department of Commerce
Michigan Manufacturer's Association
Saginaw Valley Manufacturer's Association
Saginaw Valley State University
GMI Engineering & Management Institute

Invited: Dow Corning Company
Whirlpool Corporation

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A Manufacturing Forum for Getting Competitive,
Staying Competitive

Purpose

A manufacturing forum for the 1990's and beyond. We're inviting thousands of small and medium size manufacturers and trying to bring Federal, State, and local manufacturing technology expertise directly to people who can make change happen!

The focus is pragmatic, hands-on advice, technology, and techniques.

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Staying Competitive

Audience

CEO's
Presidents
Plant Managers
Manufacturing Managers
Engineering Managers
R&D Managers
manufacturing Engineers

of small and medium size manufacturing firms

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Staying Competitive

Exposition Groupings

1. Improving Current Processes
2. Applying Available Technologies
3. Integrating Advanced Technologies
4. Accessing the Resources

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The event is non-profit and will be funded from a $35 admission fee

Participants are asked to accept responsibility for their own personnel, lodging, travel, food, and exhibit costs

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Participants:
Argonne National Laboratory
Federal Laboratory Consortium
Idaho National Engineering Laboratory
Lawrence Livermore National Laboratory
Los Alamos National Laboratory
NASA Regional Technology Transfer Centers
National Center for Manufacturing Sciences
National Institute of Standards and Technology
Regional Manufacturing Technology Centers
Shop of the 90s
National Technology Transfer Center
Oak Ridge National Laboratory
Pacific Northwest Laboratories
Sandia National Laboratory
Wright Laboratory - Wright-Patterson AFB

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Participants: State of Michigan Department of Commerce
MERRA
Michigan Manufacturing Technology Association
Saginaw Valley State University
GMI Engineering and Management Institute
GM Knowledge Center
GM EDS
GM Value Management Committee
Society of American Value Engineers
Regional Skills Development Network
Bay City Growth Alliance, Inc.
Midland County Growth Council
Saginaw Future, Inc.

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Staying Competitive

Participants

We are continuing to identify and invite laboratories, agencies, universities, and any other organizations who have talents applicable to the target audience.

APPENDIX B

LIST OF ATTENDEES

APPENDIX B

LIST OF ATTENDEES

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For Industrial Applications
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