Overview Briefing on the Division of Design and Manufacturing Innovation

Warren R. DeVries, Division Director
Design and Manufacturing Innovation

for the
Engineering Advisory Committee
May 3-4, 2006

Presentation Agenda

- Changes, Recommendations and Actions since the 2003 COV.
- DMI’s Role and Resources - the 2006 COV.
- DMI’s management and organizational challenges and intellectual opportunities.

Changes Since the 2003 COV

- The Division's name reflects the fact that the SBIR/STTR portion of the Division became a separate Office of Industrial Innovation.
- The DMI Grantees' Conference
  - Annual event for 30 years, is going to an 18 month cycle
- DMI phased out support of the Innovation and Organizational Change program.
- DMI and the rest of the Engineering Directorate:
  - Completed its strategic planning activity in FY 05,
  - In the process of reorganization and realignment that will join DMI with the Division of Civil and Mechanical Systems to form the Division of Civil, Mechanical and Manufacturing Innovation, and
  - FY 07 budget submitted with this new structure.

Recommendations of the 2003 DMI COV- Short Term

- Moving forward on programs: (1) Environmentally Benign Design and Manufacturing and (2) Research in Service.
- Response
  - Service Enterprise Engineering is growing, new PD position beginning FY 06.
  - Unable to begin Environmentally Benign Design and Manufacturing program because of decrease funds in FY 05, but accept investigator initiated proposals.

- Regarding caution on (3) Inter-agency Cooperative Programs.
- Response
  - Maintained our long-standing relationship with the DOE/Sandia and DOE/FreedomCAR.
  - Cooperated with SEMATECH and SRC in FY 04 on “Semiconductor Factory and Supply Chain Operations”.
  - In FY 05 EPA did not have the resources for the joint NSF/EPA Technologies for a Sustainable Environment solicitation.

- Global design, manufacture and service and (4) International Collaboration.
- Response
  - Germany’s DFG; National Research Foundation (RSA) of South Africa; Business Aspects of Closed-Loop Supply Chains in Fontainebleau, France; and National Science Foundation of China (NSFC)

Recommendations of the 2003 DMI COV-Resources

- Resources to grow: (5) Proposal success rate, (6) Administrative support, and (7) Travel funds for PDs.
- Response
  - 3 Administrative and Program Staff moved to OII, 2 new FTEs: a Program Director and a Science Assistant.
  - The success rate for research awards in the Division for FY 03-05 has remained stable, and in FY 05 at 17%, the best in ENG!

Recommendations of the 2003 DMI COV- Long Term

- Opportunity areas: (8) Manufacturing for the hydrogen economy, (9) Multifunctional-manufacturing systems, (10) Security of the manufacturing/service infrastructure, and (11) “Servicizing” the economy- a special Challenge and beyond.
- Response:
  - Manufacturing for the hydrogen economy is not a DMI priority, but we accept innovative investigator initiated unsolicted proposals.
  - *Building a Better Delivery System: A New Engineering Healthcare Partnership* and 2 workshops (one completed 4/11-12) with NIH to focus research agenda.
  - Micro-manufacturing study by WTEC completed.
  - Assessing how these and other recent studies can be used to define multidisciplinary investments in manufacturing frontiers and complex systems research.

Recommendations of the 2003 DMI COV

- Review of (12) Industry-Academia collaboration through the GOALI program.
- Response:
  - GOALI moves to Office of Industrial Innovation and Partnerships, with $1M more in the FY 07 request.

- Recommendation on (13) Increasing the number of innovative and high-risk proposals.
- Response:
  - The National Science Board established a Task Force on Transformative Research.
  - In addition to Small Grants for Exploratory Research (SGER), special solicitations, such as NER or PREMISE, have an exploratory component.
  - DMI estimates that between FY 02 and FY 04 our investments in SGERs were constant at $0.8M, while investments in other exploratory programs were at $3.5M.

DMI’s Mission

Enabling the Nation’s future through discovery, learning, and innovation by identifying and supporting:

- Fundamental research that defines the frontiers of design, manufacture, and service, and interfaces with other disciplines, to create the enterprises of tomorrow and assure the future competitiveness and productivity enterprises today.
- Integration of education and research that develops the diverse, adaptable and knowledge-enabled engineering workforce vital in assuring global competitiveness.

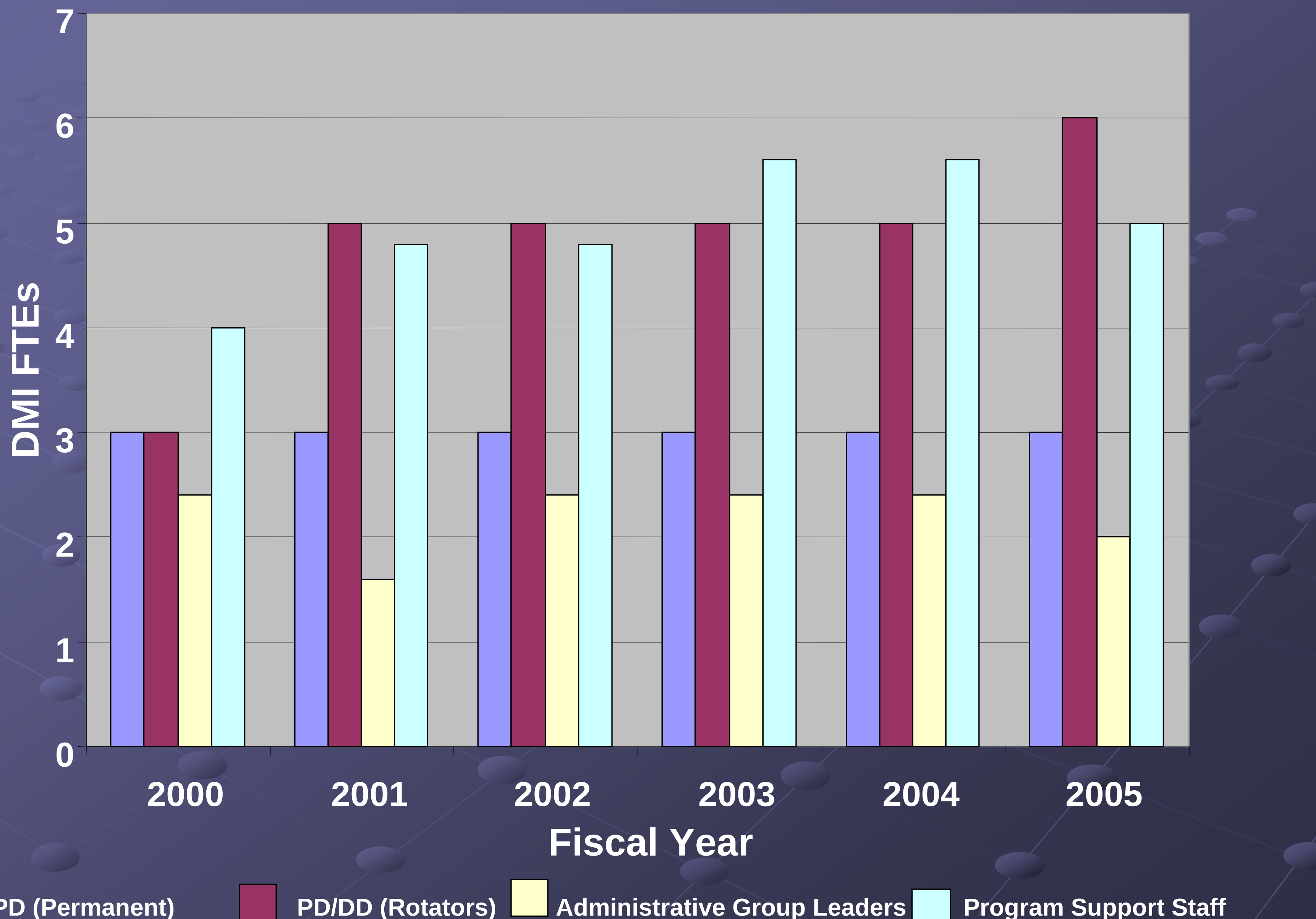
DMI Goals

- Goal 1 - DMI will lead the exploration of new frontiers in design, manufacturing, and service that engages the best minds to address issues of national need.
- Goal 2 - DMI will be recognized as the division that enhances the productivity of wealth-generating enterprises through the use of discovery and innovation and the application of the fundamentals of systems thinking.
- Goal 3 - DMI will develop people, both in the community and in the division, who have the knowledge, skills and ability to be leaders in the profession and in the NSF organization.
- Goal 4 - DMI will be agile, responsive, and fiscally robust to achieve our other goals

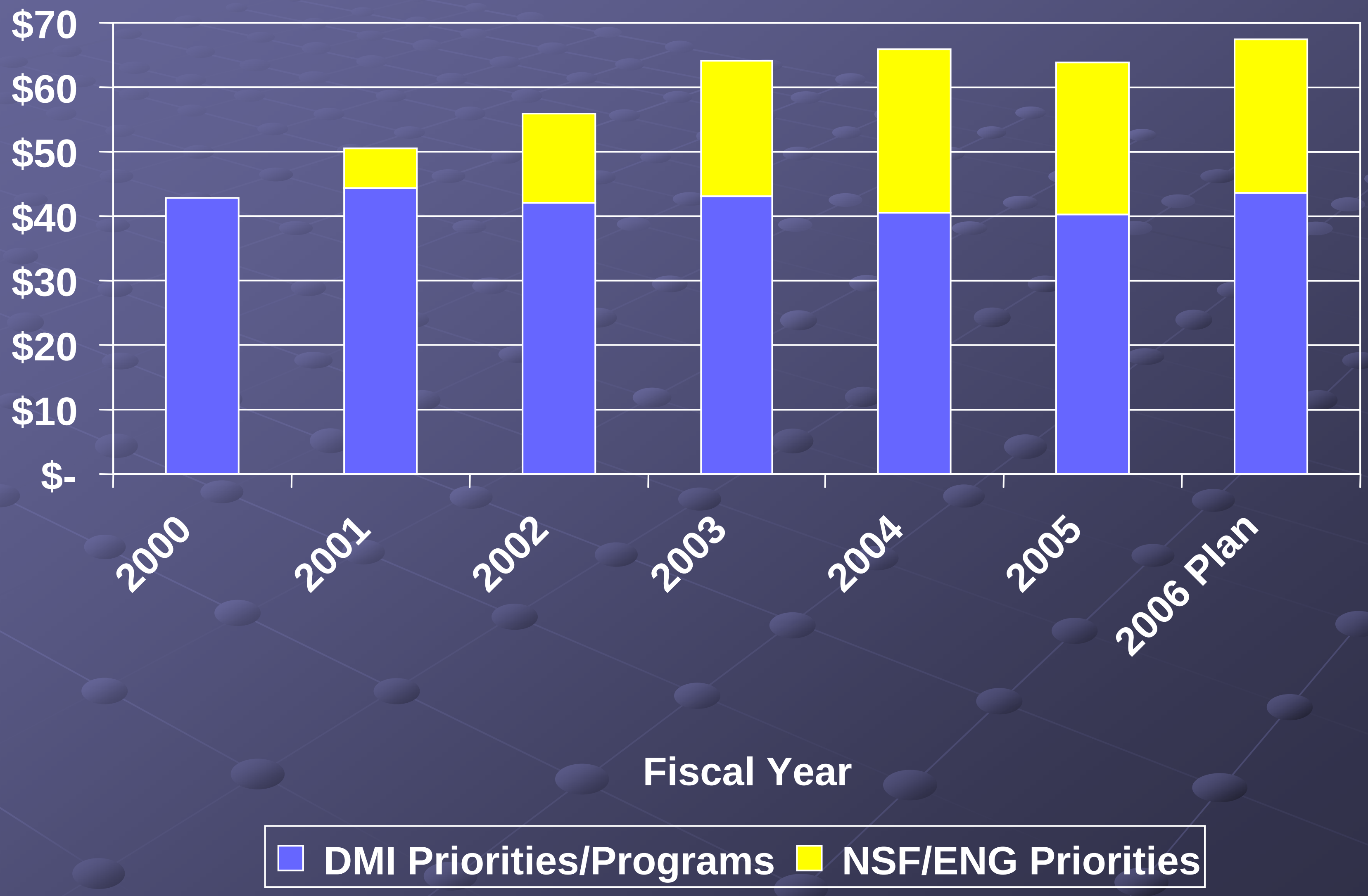
Priorities for DMI

- Focus resources in core programs to achieve a 25% success rate for competitive research proposals, with program officers managing $10M core programs.
- Manufacturing Frontiers: … a critical national priority, and build on the Division’s investments …, to enable creation of new enterprises.
- Complexity in Engineered and Natural Systems: have an intellectual richness … of engineered service systems …, micro/nano scale machines and process …, and multi-scale modeling …

DMI Staffing Resources



DMI Budget Resources



DMI's Structure

Division of Design & Manufacturing Innovation
Division Director
(Warren DeVries)

(Beverly Corley)

Admin. Mgr,
(Betty Person)
Center Mgr.
(Dianne McCormick)
Stay in School
(LaTanya Williams)

Engineering Decision Systems

Engineering Design
(Delcie Durham)
Mfg Enterprise Sys.
(Abhi Deshmukh)
Operations Research
(Stephen Nash)
Serv. Enterprise Engr.
(Matthew Realff)

(Beverly Corley, Carolyn McKinnon & Donnice Wynn-Coleman)

Grant Opportunities for Academic Liaison with Industry

(Don Senich)

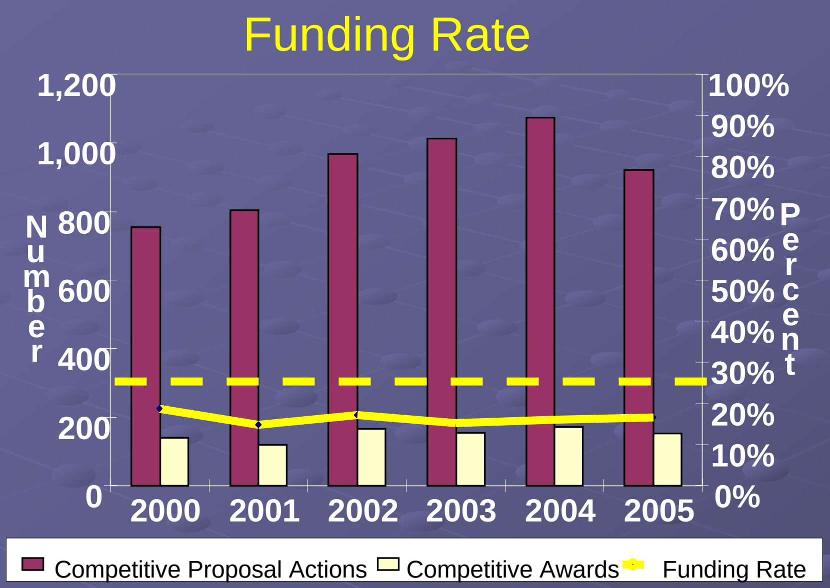
(Veronica Calvo)

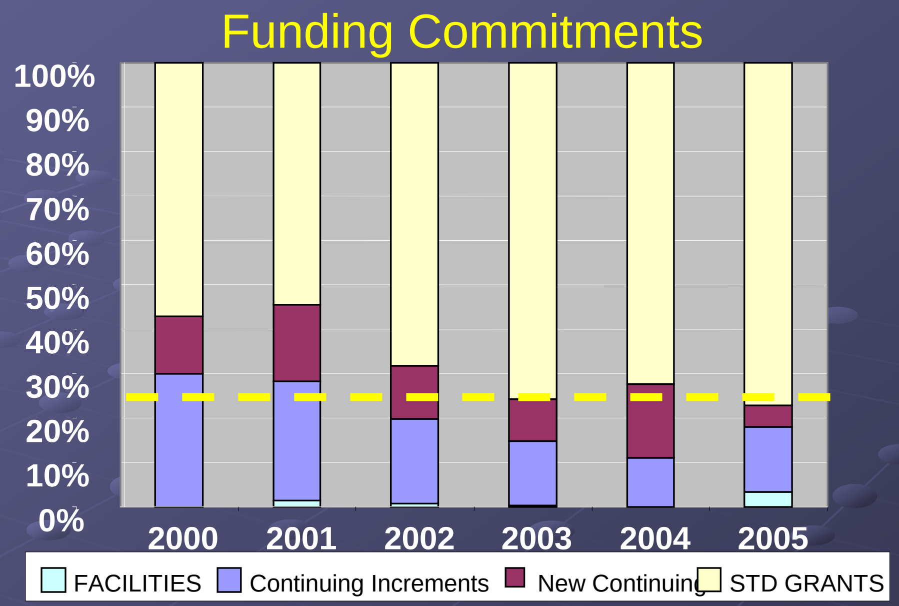
Materials Processing & Equipment Systems

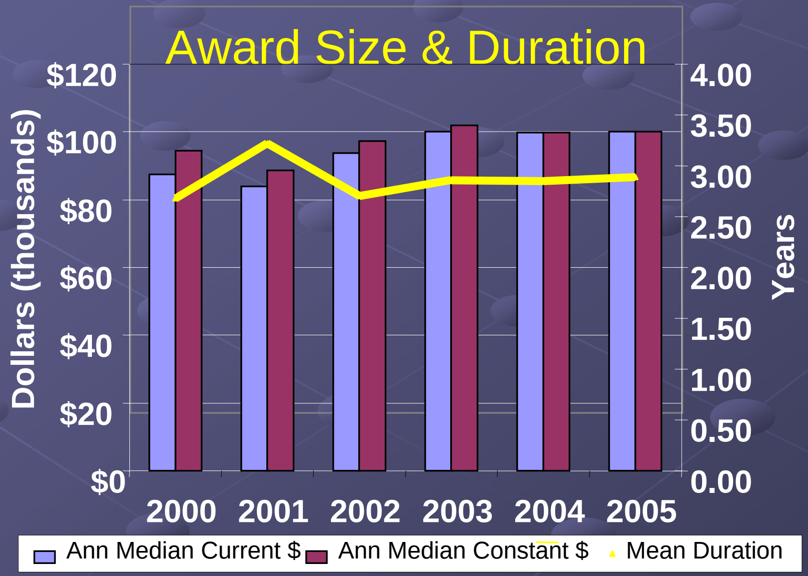
Mfg. Machines & Equipment.
(George Hazelrigg)
Mat'l Processing & Mfg
(Mary Lynn Realff)
NanoManufacturing
(Kevin Lyons)

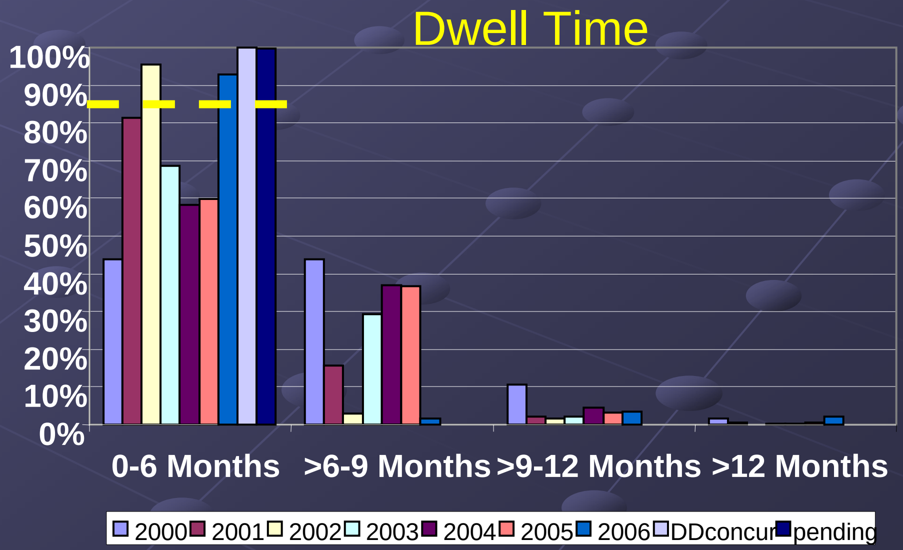
(Veronica Calvo, William Foster & Carolyn McKinnon)

DMI by the Numbers









Continuing Management Challenges

- Recruiting & Developing People
  - Recruiting Program Directors, particularly career PDs
  - Developing Program Staff with new types of skills.
- Financial resources for effective outreach and award oversight.
- Balancing
  - PI's expectations and NSF goals for reasonable success rates in core programs, and
  - NSF continuing goals of larger and longer duration awards.

Special Management Challenges In a Time of Organizational Change

- Maintaining momentum and focus on improved operational performance.
- Space to bring the new CMMI division together.
- Retaining and Contributing the best features of DMI's culture to CMMI:
  - Grantees' Conference.
  - Incentive funds to invest in CAREER, REU/RET and first time PIs from underrepresented groups in engineering.
  - DMI's focus on funding using standard grants.

Intellectual Challenges

- Compelling multidisciplinary ideas, originating in DMI, that grow into a NSF priority area.
- Fostering **giant** steps, 10 or 20 years out, that will define a completely new frontier in design, manufacturing and service.
- Taking advantage of the new opportunities and synergies created in CMMI.

Opportunity Areas

- For DMI
  - Environmentally Benign Design & Manufacture
  - Health Care Delivery Systems – Service and Miniaturization
- Contributions to CMMI and Engineering
  - Manufacturing Frontiers
  - Complex Engineered and Natural Systems
  - CyberInfrastructure

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Thank You and

What Questions Do You Have?

DMI 02-00162 Strategic Reverse Production System Design

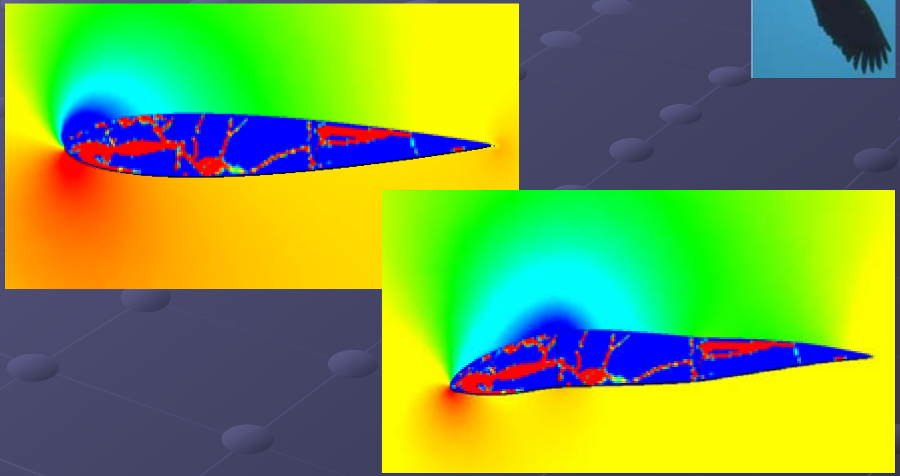
Jane Ammons, Georgia Institute of Technology

- Strategic reverse production system design
  - End-of-life for electronic products
  - Infrastructure for e-scrap
- High school, undergraduate and graduate student involvement
- Developed model for recycling and e-scrap for the state of Georgia

DMI 03-48759 CAREER: A Biomimetic Approach to the Design of Shape-Controlled Systems

Kurt Maute, University of Colorado at Boulder

- Mimicking natural organisms in direct transfer to a formal design framework
- New computational optimization tools for the biomimetic design of adaptive, shape-controlled macro and micro systems (e.g. optical MEMS switches and aircraft structures)
- Validation in the Air Force Research Lab
- Middle school girls learn about flow, form, and function



DMI- 00-99360: Agile Fabrication of Mesoscale Periodic Composites

Jennifer A. Lewis, University of Illinois at Urbana-Champaign

Research Objectives:

To fabricate designer (3-D periodic) composite materials with controlled connectivity and architecture.

Approach

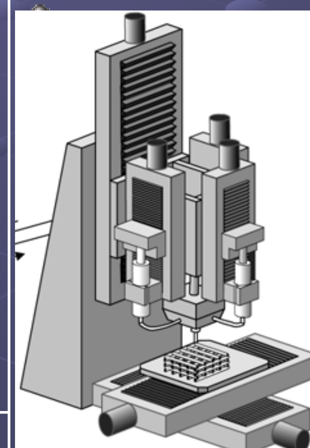
We have developed concentrated colloidal inks for robotic deposition of 3-D periodic structures comprised of spanning elements. Our ink design must meet two criteria: (1) it must flow through a fine deposition nozzle (D = 100 μm) and (2) it must rapidly set to facilitate shape retention of the as-deposited features.

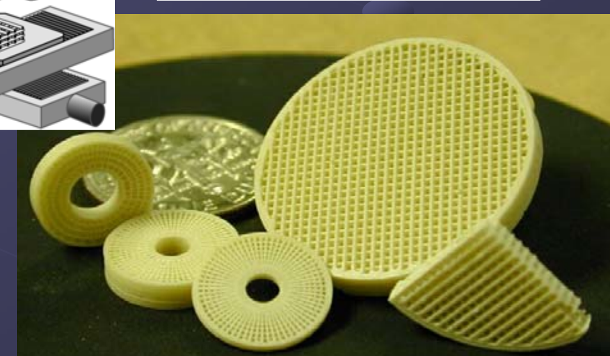
Broader Impact:

We have developed a fundamental understanding of the flow behavior of concentrated colloidal inks. This knowledge can be broadly applied in materials processing as well as the design of new coatings and inks.

Significant Results:

We have demonstrated for the first time the fabrication of 3-D periodic structures with features on the order of 100 μm - 1 mm. Such structures have been shown to lead to a 70-fold increase in their piezoelectric figure of merit over monolithic structures.





DMI- 03-48375: CAREER Programmable Nanoscale Self-Assembly on Solid Surfaces

Wei Lu, University of Michigan

•Research Objectives:

Identify surface effects in molding nanostructures. Model manipulation field-guided self-assembly. Develop simulation and design tools to engineer self-assembly for nanofabrication.

•Approach

Investigate surface elastic and electric interactions

Develop dynamic models for self-assembly

Incorporate manipulation fields in the framework

Develop efficient numerical methods and perform parametric studies

Experimental validation and demonstration

•Broader Impact:

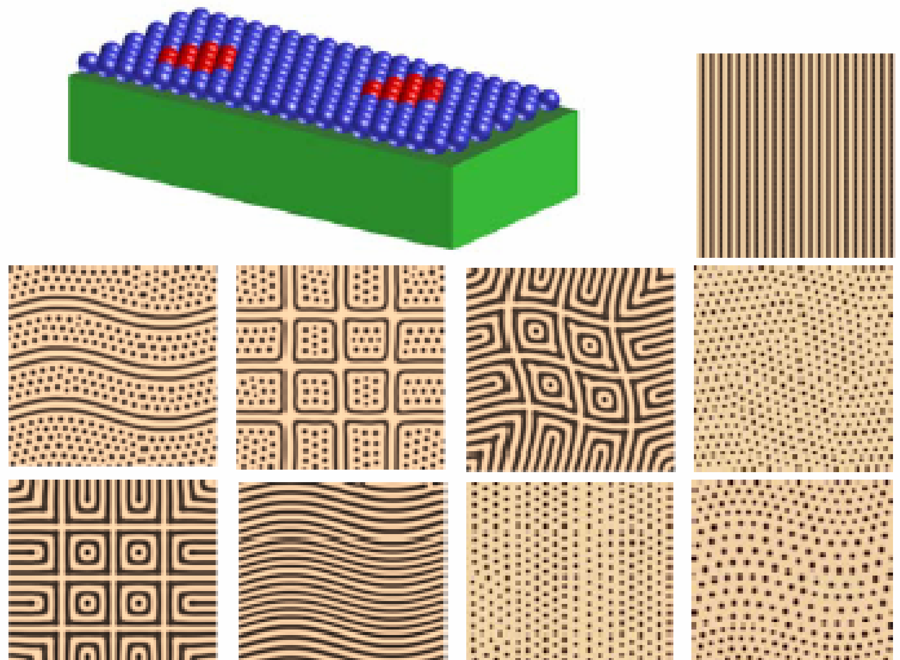
The result of the project will enable engineered self-assembly as a low-cost, high-throughput nanofabrication method to produce various nanostructures in diverse material systems.

•Significant Results:

Developed the theoretical foundation of strain-guided self-assembly and surface chemistry-guided self-assembly.

Developed efficient numerical techniques to simulate the entire self-assembly process.

•Graphic: Various patterns produced by stain-guided self-assembly.



DMI- 03-00549: GOALI Development of a Comprehensive Drilling Simulation Tool

David A. Dornfeld, University of California at Berkeley
Paul E. Pfield, Boeing Corporation

•Research Objectives:

The three-year study will develop fundamental models for the design and operation of drilling process for burr minimization in precision products.

•Approach

- Develop a finite element model of single layer drilling
- Evaluate, model, and design of drill bit and feed motion for burr minimization/prevention
- Develop a finite element model of multi-layered drilling and investigate inter-layer gap formation
- Develop experimental database on burr/chips formation and online expert system
- Develop guidelines for the use of the simulation models and database as a design and optimization tool for the burr-less drilling process

•Broader Impact:

•The comprehensive drilling simulation tool will streamline and standardize drilling methods for a number of precision applications.

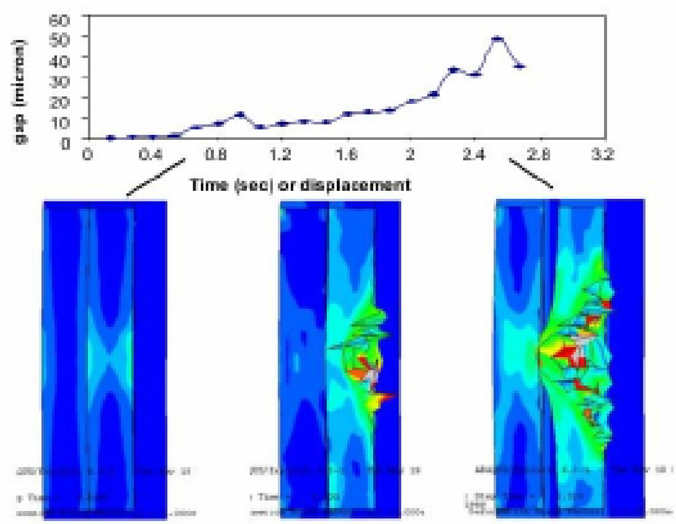
•This research will standardize drill hardware and reduce significant inventory. The tools developed are expected to reduce cycle time from process design to production transition and spur existing and new process improvement.

•The proposed research will also have a significant impact on the education and training of students for careers or additional study.

•Significant Results:

- Fundamentals of drill burr formation at interface determined
- FEM analysis of simple interlayer burr formation
- Analytical representation of drill exit developed for drill shape optimization.
- Extending study to graphite composite/titanium material combinations

•Graphic:



FEM analysis of interlayer burr formation in sandwich material; graph shows "gap" at interface with time and drill advance