Intelligent and Integrated Manufacturing Systems (IIMS)

National Science and Technology Council
Committee on Technology
Interagency Working Group on Manufacturing Research and Development
Public Forum: March 3, 2005

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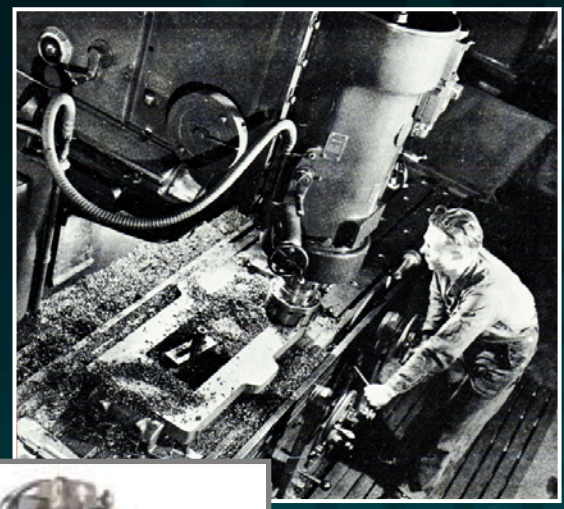
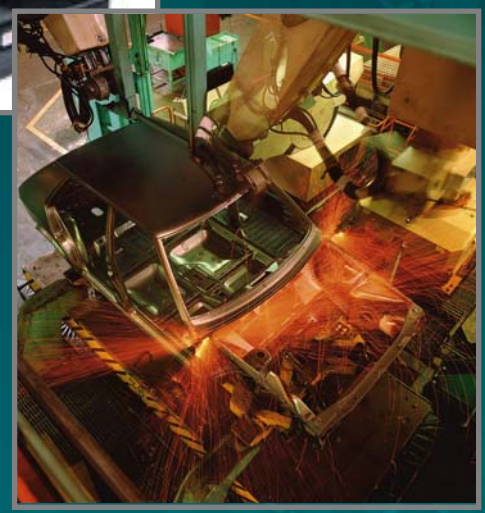
A New Epoch in Manufacturing

1900-1960	Pre-Computer-Numerical Control (CNC) Epoch
1960-1990	CNC Epoch
1990-Present	Knowledge Epoch
Present-????	Intelligent and Integrated Manufacturing Systems Epoch



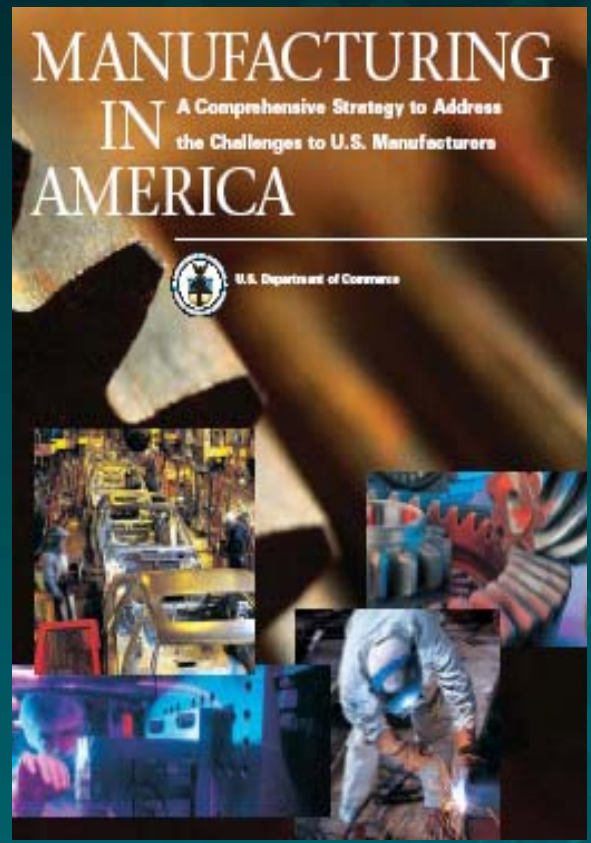


Introduction
A New Epoch in Manufacturing

Intelligent and Integrated Manufacturing Systems

Definition/Characteristics:

- Competition among supply chains rather than individual manufacturers
- Global competition for all supply chain functions
- Success will depend on ability to integrate new technologies rapidly into products and operations



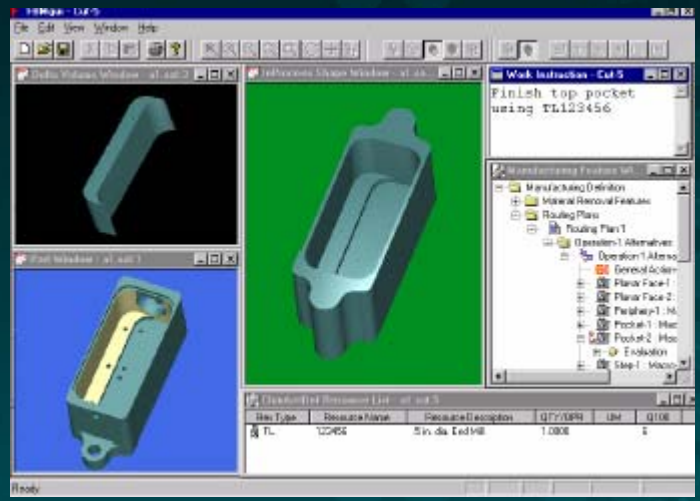
Key Need/Challenge Areas

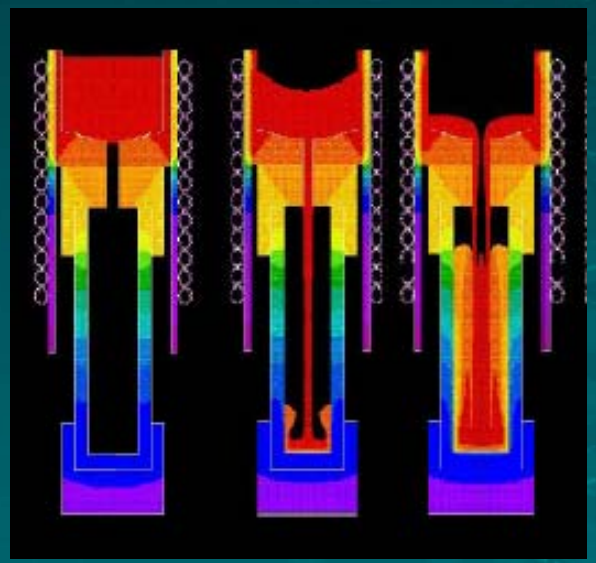
- Predictive tools for integrated product and process design and optimization
- Intelligent systems for manufacturing
- Automated integration of manufacturing software
- Secure manufacturing systems integration
- Sharing and integration of results and theories of manufacturing with other disciplines

Key Research Challenges/Gaps

Predictive Product and Process Design and Optimization Tools

- To predict downstream impacts of design decisions
- To optimize supply chain as a whole
- To improve innovation by broadening participation in manufacturing



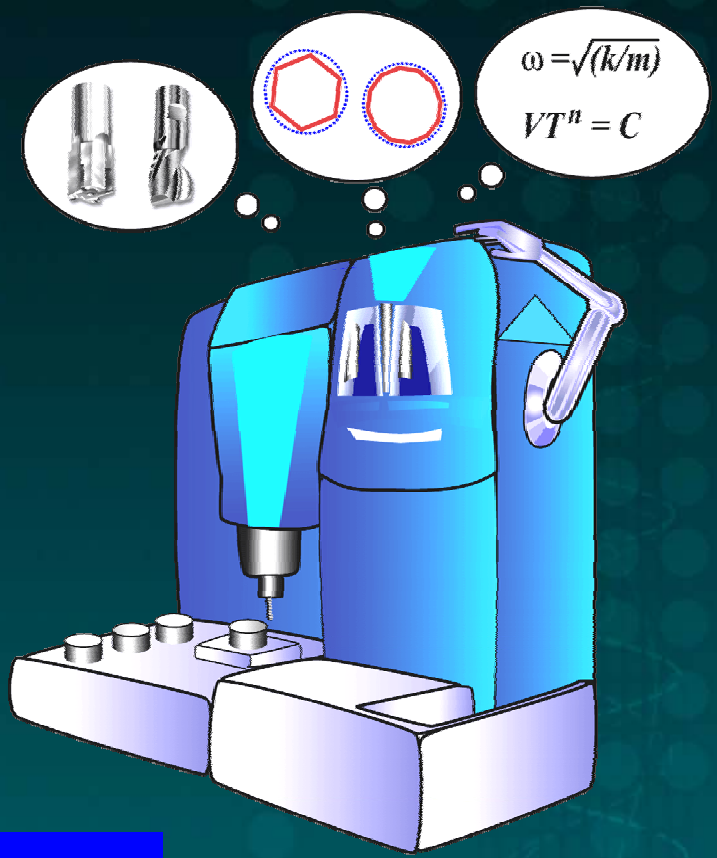


R&D contributions needed:

- Generic algorithms and approaches
- Validated models and data

Key Research Challenges/Gaps

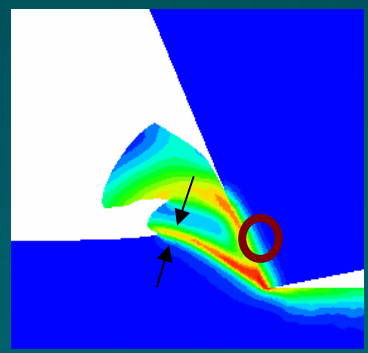
Intelligent Systems for Manufacturing



- To harness the power of emerging sensing and computational capabilities
- To dynamically optimize manufacturing operations
- To reduce trial-and-error in product and process development

R&D contributions needed:

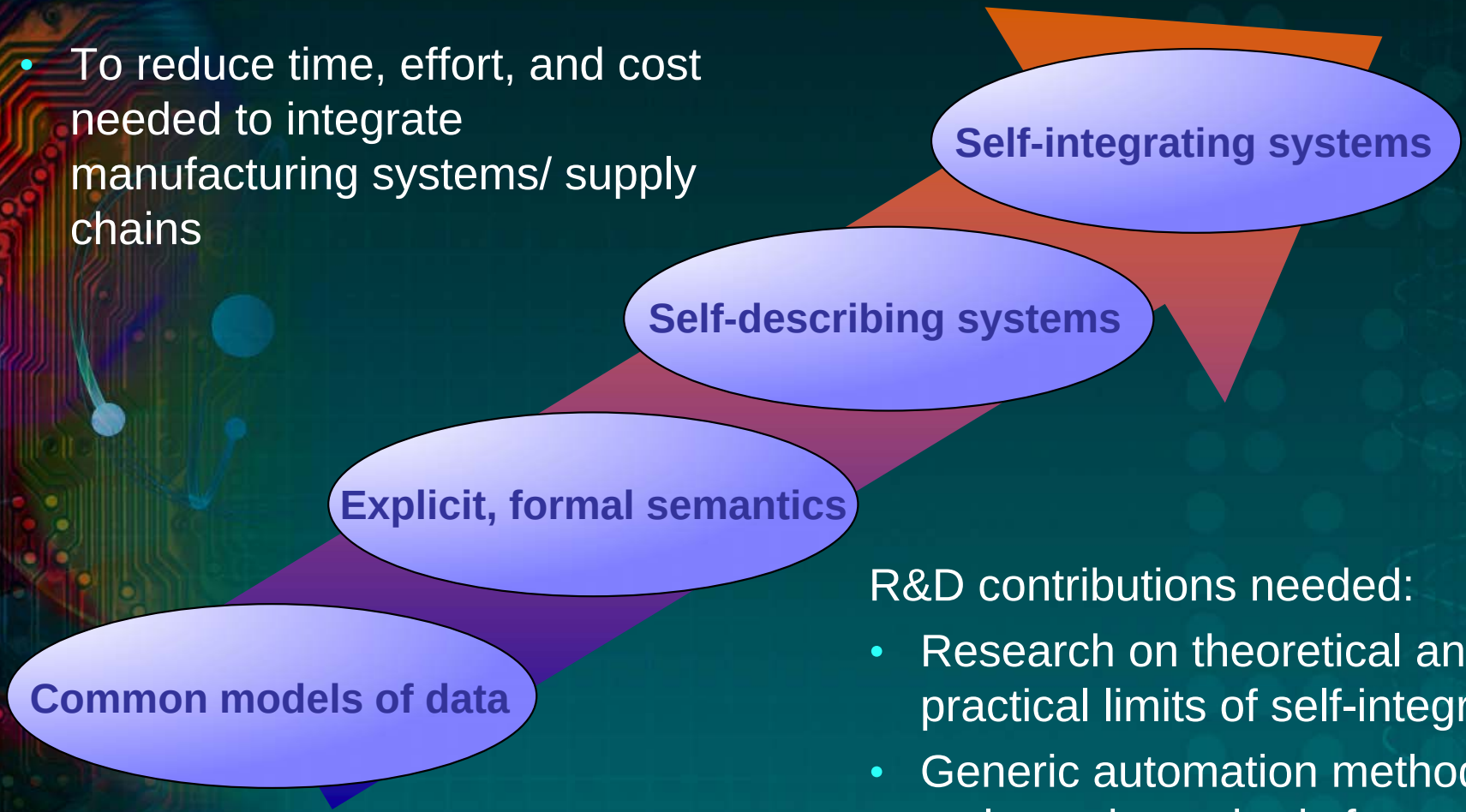
- Generic algorithms and approaches at the equipment/shop floor level
- Models and data at the equipment/shop floor level



Key Research Challenges/Gaps

Automated Manufacturing Software Integration

- To reduce time, effort, and cost needed to integrate manufacturing systems/ supply chains



R&D contributions needed:

- Research on theoretical and practical limits of self-integration
- Generic automation methods, tools, and standards for manufacturing integration

Key Research Challenges/Gaps

Secure Manufacturing Systems Integration

- To maintain security while increasing connectivity and integration

R&D contributions needed:

- Performance metrics, standards, and test methods for applying appropriate security technologies top-to-bottom throughout integrated manufacturing enterprises

Key Research Challenges/Gaps

Interdisciplinary Sharing and Integration

- To increase benefit to manufacturing from results in other fields
- To increase benefit to other fields from results in manufacturing

R&D contributions needed:

- Examination of consistencies of theories and results across disciplines
- Resolution of inconsistencies and translation into practice

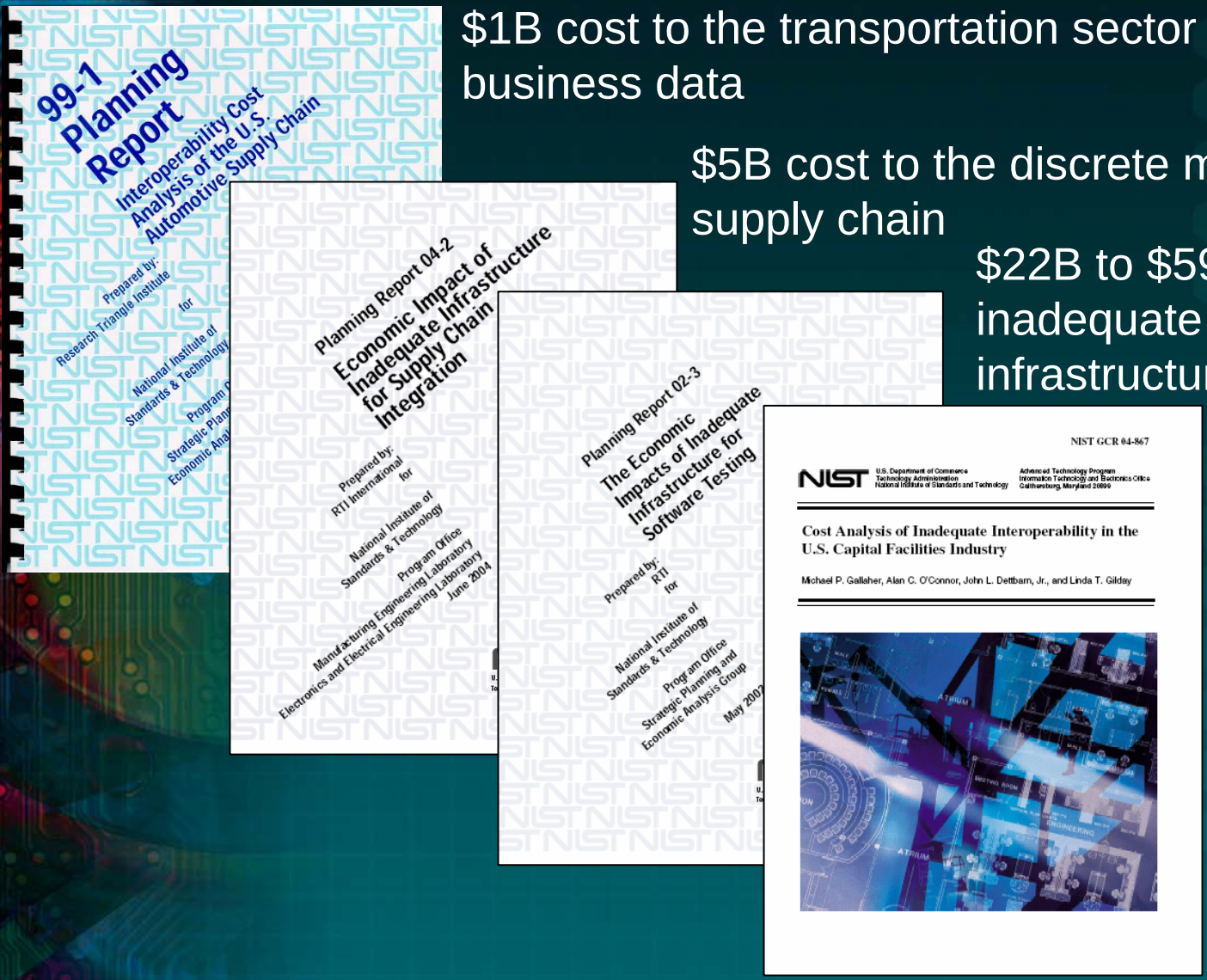
Current Federal Efforts

- Department of Commerce/NIST
  - Smart Machining, Interoperability, Intelligent Systems, Industrial Control System Security
- Department of Defense
  - Next Generation Manufacturing Technologies, Supply Chain Responsiveness
- Department of Energy/NNSA
  - Integrated Design, Engineering, and Manufacturing Predictive Design Tools, Sensors, Automation, Robotics
- National Aeronautics and Space Administration
  - Interoperability, Integrated Design and Manufacturing Tools, Virtual Testing and Qualification, Rapid Prototyping, Collaborative Engineering and Interactive Data Management
- National Science Foundation
  - Reconfigurable Machining Systems, Intelligent Maintenance Systems, Environmentally Benign Semiconductor Manufacturing, e-Design and Realization of Engineered Products and Services

Expected Impacts / Benefits

- **Private sector**: Enhanced manufacturing sector competitiveness, innovation, productivity, profitability
- **Public sector**: Strengthened domestic production and improved affordability of components and systems for defense, space exploration, and other National priorities
- **Both:** Billions of dollars of **cost savings** from **improved information exchange** across the supply chain, **better prediction** of life cycle costs, **better products**, **greater responsiveness**, optimized operations, **energy savings**, reduced **environmental impacts**

Information Exchange Costs



$1B cost to the transportation sector for engineering & business data

$5B cost to the discrete manufacturing supply chain

$22B to $59B cost of inadequate software testing infrastructure

$15B cost to the capital equipment sector

Next Steps for Federal Role

- Pursue coordinated government and academic R&D to provide IIMS technical infrastructure, including
  - Process models
  - Scientific and engineering databases
  - Test and measurement methods, and
  - The technical basis for physical and functional interfaces between the components of systems technologies
  - Mechanisms for interdisciplinary technical exchange

Conclusion

- The changing global competitive environment poses great challenges for the U.S. manufacturing sector
- Intelligent and Integrated Manufacturing Systems R&D will provide the technical foundation needed for manufacturing technological leadership and economic success

We seek your input to further develop and prioritize IIMS research challenges and needs

IIMS Task Team Agency Participants

- Department of Commerce (Chair)
- Department of Defense
- Department of Energy/National Nuclear Security Administration
- National Aeronautics and Space Administration
- National Science Foundation
- Office of Management and Budget
- Office of Science and Technology Policy