Next Generation Manufacturing Technology Initiative and the Model-Based Enterprise

NDIA Systems Engineering Conference
San Diego, California
October 26, 2005

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Strategies for Manufacturing Technology Management

**Information**
- The Manufacturing Analyst for Science and Technology
  - The Automated Knowledge Discovery System
  - Unprecedented Instant Access to Exactly What YOU Need to Know

**Plans**
- A Rich Set of Technology Roadmaps
- Comprehensive Manufacturing Technology Management Plans
  - Dramatic Improvement in ROI From YOUR R&D Investment

**Solutions**
- Implementation Plans Singular Wins
- Focused Technology Investment for Business Success
  - A Revolution in Manufacturing
The NGMTI Team

**Three non-profit organizations with strong expertise and experience in facilitating collaborations.**

- **IMTI:** a technology/research management organization with a mission to support the nation’s manufacturing infrastructure
- **NACFAM:** a long-term builder of leadership-level, nationwide manufacturing technology public-private partnerships
- **ATI:** a deeply experienced manager of advanced manufacturing technology research collaborations.
“NGMTI is dedicated to transforming the U.S. manufacturing base through technology driven innovation”
Importance of Manufacturing to Innovation

- Drives innovation: Manufacturers invest $135 billion annually in R&D, which is 70% of industry R&D investment and more than all federal R&D.

- Innovative mfg process technologies are **the most effective means** to reduce China’s low-wage advantage.

- Yet industry gives low priority to process technologies and is moving R&D offshore.

- Only 2% of federal $132 billion R&D budget spent on basic and applied manufacturing tech.

- Manufacturing R&D has never been a White House “Grand Challenge”
The NGMTI Solution

- Provides a mechanism for building and executing an innovative manufacturing R&D strategy for both economic growth and national security goals
- Represents a sustainable organization meeting critical success factors: strategic planning, industry-government collaboration, national tools
- Coordinates research and development projects focused by strategic investment plans
- Leverages university, federal, industrial labs, and research consortia nation-wide
NGMTI Provides for Future Common Needs

- Provide breakthroughs that produce transformational technologies
- Provide technologies that improve affordability and sustainability
- Create innovative opportunities for fast response manufacturing of new products
Implementation/Transition Plan

1. Develop Thrust Area Roadmap
   - Current State Assessment
   - Future State Vision
   - Goals & Requirements
   - Notional Timeline

2. Prioritize Top-Level Goals
   - Value to Industry, DoD, Nation
   - Value-Based Prioritization
   - Risk, Readiness, Return

3. Define White Paper Topics
   - Single or Multiple Related Goals from Roadmap
   - Suitable for Single Project

4. Generate White Papers
   - Challenge & Approach
   - Draft SOW
   - Benefits & Business Case
   - Project Plan
   - Risk/Readiness Assessment

5. Industry/SME Reviews
   - Validate Challenge & Approach
   - Refine SOW & Plan
   - Begin "Engagement" Process

6. Launch Projects
   - Form Teams
   - Finalize SOW & Plan
   - Secure Funding (Federal Agency & Industry Investment)

7. Develop Technologies
   - Industry Collaborative
   - Focused Corporate R&D
   - Govt-Funded (e.g., SBIR)
   - Leverage NGMTI TestNet

8. Deliver Breakthroughs
   - NGMTI Experiments & Pilots
   - Industry Commercialization
   - Technology Deployment to Defense Industrial Base
NGMTI Thrust Areas

- Emerging Process Technologies
- Model-Based Enterprise
- Safe, Secure, & Reliable Manufacturing Operations
- Enterprise Integration
- Intelligent Systems
- Knowledge Management
Model-Based Enterprise Prioritization

Roadmap contains 80 Goals w 300 Requirements

KT Analysis

Top 20 Goals

Compilation of Important Themes

15 White Papers

Previous Workshops

Interviews

Web-Based Search

Literature

Cross Cutting

Topic Specific

- Product Realization
- Resource Management
- Strategic Management

Project Roadmaps
Model-Based Enterprise
White Papers

- Flexible Representation of Complex Models
- Shared Model Libraries
- System-of-Systems Modeling for the Model-Based Enterprise
- Enterprise-Wide Cost Modeling
- Intelligent Models
- Configuration Management for the Model-Based Enterprise
- Product-Driven Product & Process Design
- Model-Based Product Life-Cycle Management
- Model-Based, Real-Time Factory Operations
- Model-Based Distribution
- Multi-Enterprise Collaboration
- Model-Based Resource Management
- Information Delivery to Point of Use
Emerging Process Technologies

600 + Technologies

- Previous Workshops
- Interviews
- Web-Based Search
- Literature

Expert Screen

120 Significant Technologies

- Cross Cutting
- Topic Specific

KT Analysis

1-20 White Paper Topics

Project Roadmaps and Investment Plans

15 White Papers
EPT White Papers

- Low-Cost Titanium Powder Production
- High-Frequency Laser Machining
- Friction Stir Joining Technologies
- Improved Thin-Film Processes for Semiconductor Fabrication
- Microreactors & Processing Methods
- Digital Direct Manufacturing
- Affordable, Lightweight Large Structural Composites Manufacturing
- Nanomaterials for Glass Coatings
- Smart, Reconfigurable Multifunction Machine Tools
- Thin-Film Coatings for Paint Elimination
- Manufacturing Applications for Carbon Nanotubes
- Advanced Aerospace Casting Processes
- Precision Optical Finishing
- Hybrid Bearing Manufacture
- Military Fuel Cell Technology
NGMTI Current Status

- 28 project plans developed for MBE and EPT, with “High-interest” from both defense and commercial firms
- Project teams now being formed for 13 of the White Paper topics
- MBE Forum being planned for the fall
The NGMTI Thrust Areas

- Model-Based Enterprise
- Emerging Process Technologies
- Safe, Secure, Reliable, and Sustainable Manufacturing Operations
- Enterprise Integration
- Intelligent Systems
- Knowledge Applications
Model-Based Enterprise: A Single Objective

- MBE - an integrated digital environment for addressing all aspects of the enterprise
- Requires total sharing of information between all elements of the enterprise.
- New approaches and toolsets are required

Prioritization to Establish What to Do, When
Model-Based Enterprise: The Views
Such an Enterprise Will Be. . .

Thanks to the NNSA for sharing jointly developed visuals and concepts!
Totally Connected

An Integrated Seamless Flow of Information and Knowledge
Knowledge Rich

Product Design & Engineering

Process Design & Engineering

Inspection, Acceptance & Certification

Production Planning

Manufacturing Operations

Product Assurance

Continous feedback and enrichment of information across the life cycle
Science-based analysis supporting every aspect of the life cycle

Simulation Based

Concept Definition

Design/Development

Integrated Analysis & Simulation Environment

Requirements Definition

Production

Retirement & Disposal

Deployment

Operation & Maintenance

Proofout
Instantly Responsive with . . .

Requirements Analysis

Performance Assessment

Producibility

Material Behavior

One-click access to all needed analysis capabilities
Capable of Supporting Closed-Loop Operation

• Product & process definition
• Specs & control parameters
• Resource & schedule requirements

As-Designed

• As-built configuration & properties
• Process performance & material behaviors

Digital feedback deepens the knowledge base for future products
Bottom Line . . .

Validated Models

Validated designs

Validated Processes

In a totally managed enterprise

Validated Products
MBE Roadmap Process

- Define the current state of MBE capabilities
- Develop MBE vision
- Express vision, goals & requirements in strategic investment roadmap document
- Establish priorities
  - “Readiness, risk & return”
  - “Scope, magnitude, vital to US competitiveness”
- Prioritize with Kepner-Tregoe decision-making tool
- Write white papers on critical topics
- Review and validation by TAP
- Refine white papers
Narrowing MBE Focus

Roadmap contains 50 Goals w/ 247 Requirements → Top 20 Goals → 15 White Paper Topics

- Previous Workshops
- Interviews
- Web-Based Search
- Literature

KT Analysis

Compilation of Important Themes

Cross Cutting

Topic Specific
- Product Realization
- Resource Management
- Strategic Management

Project Roadmaps

TAP Review

12 Updated Topics
Configuration Management for the Model-Based Enterprise

Objective: Develop an integrated system that assures association of the right information with any product or process throughout its life cycle.

Benefits:

- Association of correct info with each version of each product or process in the enterprise
- Feedback loop, which enables continuous product improvement.
- Assured ability to reproduce
Flexible Representation of Complex Models

Objective: Develop capability to create collaborative models rich enough to support all MBE functions.

Benefits:
- Enables full evaluation of any decision
- Procurement cost savings in the billions of dollars
- Reduced time to market
- Reduced costs
- Better quality products
System-of-Systems Modeling for Model-Based Enterprises

Objective: To develop capabilities, approaches, and tools for integrated multi-level, multi-system modeling of products, processes, and life-cycle functions.

Benefits:

• Composable and decomposable models enable evaluation of total system performance within its operational context
• Extends SoS philosophy to manufacturing enterprise
• Enhanced ability to simulate, with high fidelity, the effects of wear and tear on complex systems in combat and training
Intelligent Models for Manufacturing

Objective: Develop intelligent models that understand, seek out, acquire knowledge needed to execute their functions.

Benefits:
- Dramatic cost savings through elimination of design iterations
- Improved logistics support for weapons systems
- Significant reduction of design cycle times
Model-Driven Product and Process Development

Objective: Develop simulation capabilities enabling the product model to fully support downstream operations.

Benefits:
- Saves money and assures product quality
- Optimizes use of product and process capabilities
- Reduces the extent and level of design changes
- Enhances risk analysis and mitigation
Model-Based Product Life-Cycle Management

Objective: Provide the capability to create and apply hi-fidelity, scaleable product life-cycle models.

Benefits:

- Provides a toolset for modeling and understanding life-cycle cost and supportability impacts.
- Enables feedback from down-stream experience to improve up-stream functions.
- Improved speed and accuracy of technical and business decisions over the life cycle,
- Ability to analyze and reverse-engineer “as-worn” parts to predict failure.
Information Delivery to Point of Use

Objective: Deliver information to any location in support of any enterprise function

Benefits:

- Largely graphical information delivery
- Job compatible delivery
- Graphical format saves money in multi-lingual support
- Reduced warrantees cost for returns due to fewer mistakes
MBE Enablers for the Electro-Mechanical Industry

Objective: To apply product and process models to define and manage all enterprise processes, and by applying science-based analytical tools to make optimal decisions at every step of the product life-cycle.

Benefits:
- Model-Based testing offers development time savings of 50%
- Elimination of the “disconnect” between development and production
- Rapid response to customer demands
Shared Model Libraries

Objective: Enable centralized access to modular components to support all MBE functions and optimize enterprise decisions

Benefits:
- Provides a core set of models affordable and available.
- Reduction in cycle time and cost by up to 40%.
- Rapid integration and virtual testing of complex weapon systems.
- Elimination/Reduction of redesign/rework costs and time.
Enterprise-Wide Cost Modeling

Objective: Provide the ability to model and predict cost for every element and from every source in the enterprise, including uncertainty and risk.

Benefits:
- Visibility of the cost impacts of design changes
- Eliminating low-ball estimates with directly traceable sources
- Significant areas of cost and expense can be easily identified
- Enables evaluation of Strategic options
Model-Based Real-Time Factory Operations

Objective: To develop enabling technologies for real time, model-based control of factory operations.

Benefits:
- First and every product correct due to process control.
- Maximum use of production capability.
- More efficient, responsive, flexible, and capable manufacturing base.
- Shortened timelines to ramp up production.
Model-Based Distribution

Objective: Provides a framework for supporting design for distribution planning, execution, and re-planning.

Benefits:
- “Engineer out” problems in new products rollout
- Accommodates far more variables in distribution planning
- Improved downstream life-cycle management
- Enables definitive information about where it should be
- Focuses for closing the loop on where it is
Model-Based Resource Management

Objective: Create a cost effective, integrated capability for evaluating options and directing control over all manufacturing resources. Modular and easily integrated are key attributes.

Benefits:
- Provision of model-based resource management capabilities that:
  - Greatly reduce the cost of acquiring, deploying and maintaining a resource management system
  - Enable far greater accuracy and efficiency in managing resources
- Enhanced ability of smaller suppliers to choose resource management tools, and to interface with prime manufacturers
Multi-Enterprise Collaboration

Objective: Provide a tool set to support multi-enterprise collaboration

Benefits:

- Mitigates the cost of transferring or recreating design definitions shared among different members of the supply chain.
- Enables ability to objectively evaluate potential suppliers.
- Reduces contract administration costs by 50% through integrated reporting and management.
Summary

- NGMTI is an important program to the nation
- We are off to a fast start and making great progress
- Project formation is in full swing – opportunity knocks

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