Simulation and Visualization
at the
National Institute of Standards and Technology

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NIST
National Institute of Standards and Technology
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Topics

- Brief NIST / MEL Overview
- Simulation and Visualization Program
  - Manufacturing
  - Education and Training
  - Homeland Security

NIST Locations

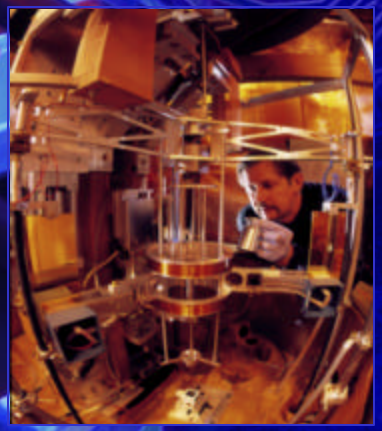
Gaithersburg, Maryland

Boulder, Colorado

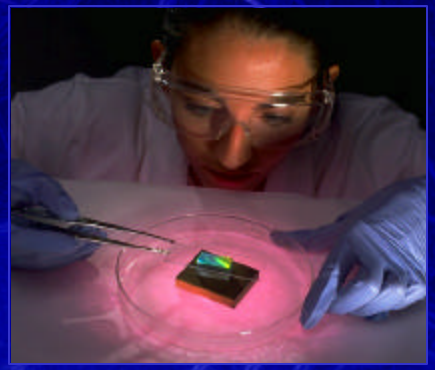
National Institute of Standards and Technology

Develop and promote measurement, standards, and technology to enhance productivity, facilitate trade, and improve the quality of life.

NIST carries out its mission through a portfolio of four programs:



Laboratories



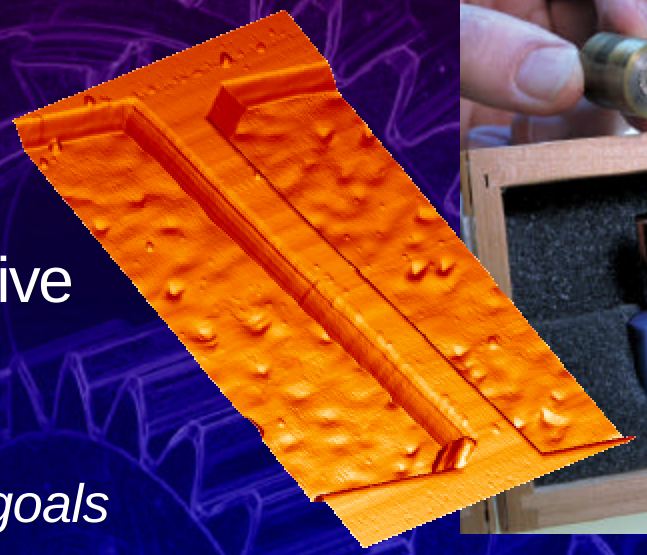
Advanced Technology

Manufacturing Extension Partnership

Baldridge National Quality

NIST 2010 Strategic Plan

- A new and comprehensive approach to envisioning NIST's future
  - *Sets long-term strategic goals*
  - *Demonstrates how NIST can strengthen its impact on productivity, trade, and the quality of life*
- Strategic Focus Areas
  - *Homeland Security*
  - *Nanotechnology*
  - *Information and Knowledge Management*
  - *Health-care*



NIST Laboratories

Manufacturing Engineering

Physics

Building and Fire Research

Information Technology

Chemical Science and Technology

Technology Services

Materials Science and Engineering

Electronics and Electrical Engineering

- Measurement methods
- Calibration Services
- Standard Reference Materials
- Evaluated scientific data
- Standards development
- Industrial technologies
- Testing laboratory accreditation

manufacturing engineering laboratory • measuring for success

U.S. Economy Depends on NIST Measurements

Basic Units
Maintained by NIST

- Time • Length • Mass • Temperature
- Electric current • Light intensity
- Amount of substance (mole)

Derived Units
Maintained by NIST

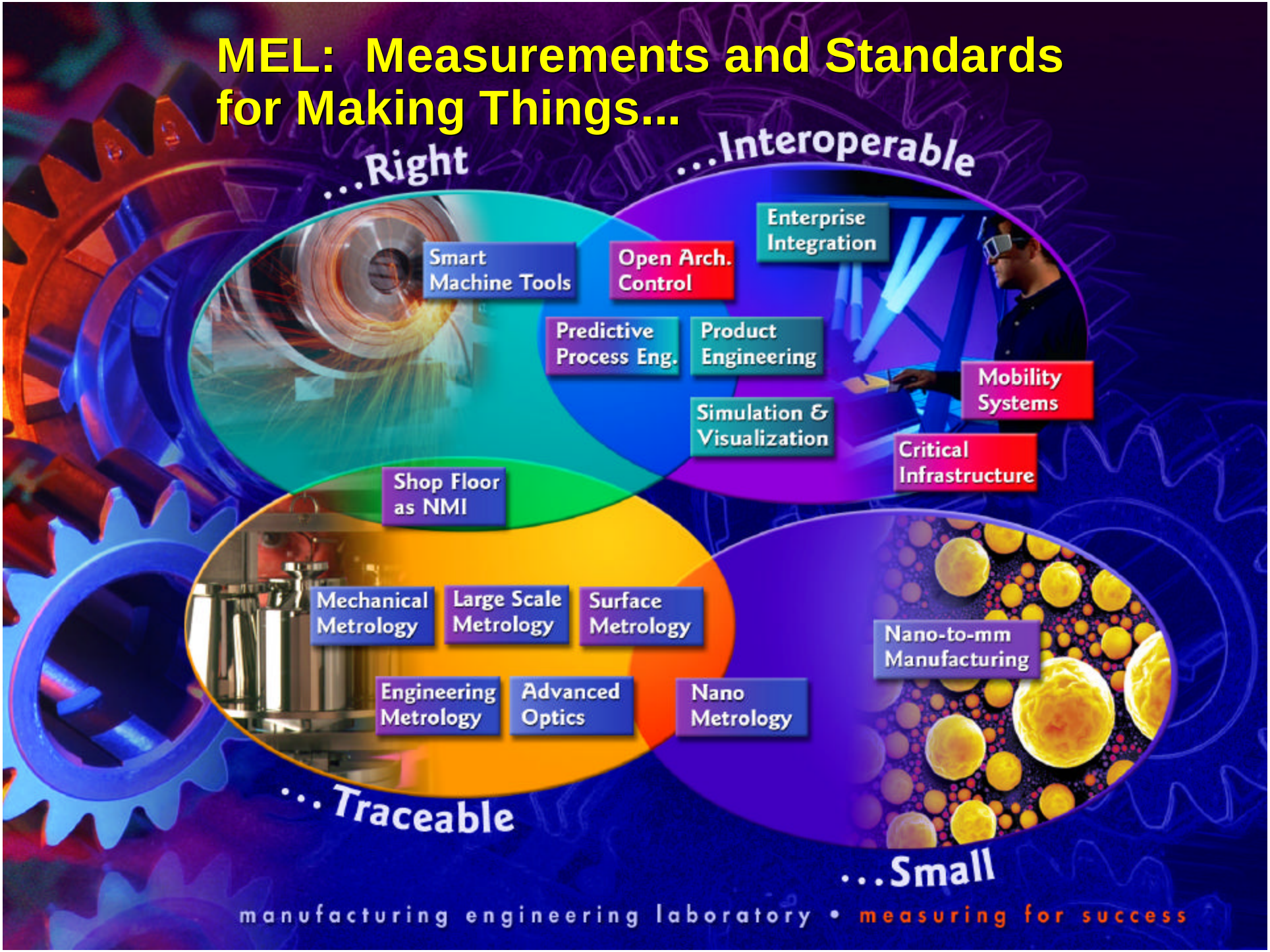
- Frequency • Diameter • Volume
- Acceleration • Density • Force
- Pressure • Voltage • Radiation

Standards & Calibrations
Traceable to NIST

- Global time service
- Laser frequency • Gage blocks
- Line standards • Radioactivity
- Electrical quantities
- Reference materials and data

Applications

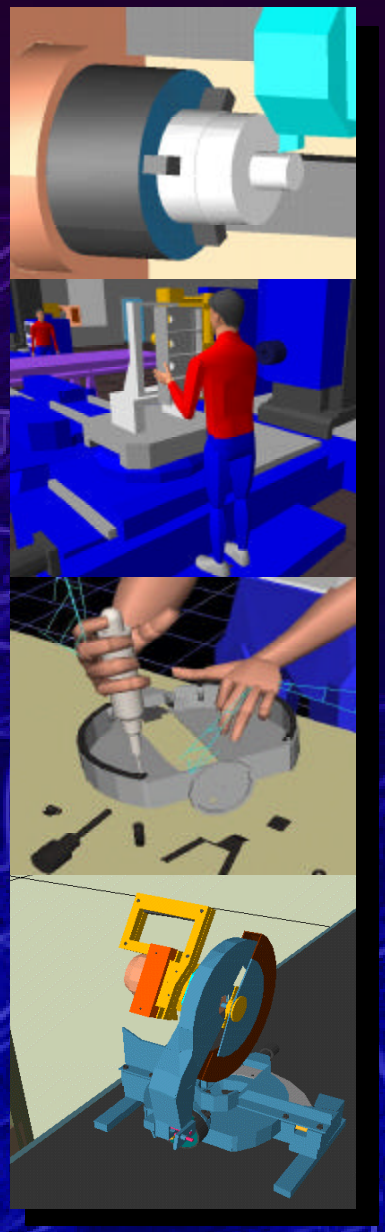
- Telecommunications
- Computer "chips"
- Pharmaceuticals
- Medical imagers
- Gasoline pumps
- Digital clocks
- TV signals
- CD-Roms
- Aircraft...


MEL: Measurements and Standards for Making Things...
...Right
...Interoperable
Smart Machine Tools
Open Arch. Control
Enterprise Integration
Predictive Process Eng.
Product Engineering
Mobility Systems
Simulation & Visualization
Critical Infrastructure
Shop Floor as NMI
Mechanical Metrology
Large Scale Metrology
Surface Metrology
Nano-to-mm Manufacturing
Engineering Metrology
Advanced Optics
Nano Metrology
...Traceable
...Small
manufacturing engineering laboratory • measuring for success

Simulation and Visualization Program Goal

Establish standard interfaces and conformance tests for simulation to support the construction of:

- ***Simulations based upon a neutral data models, transactions, and libraries of components that are adopted by simulation software vendors in future product offerings***
- ***Distributed simulation systems based upon a High Level Architecture (HLA) foundation***

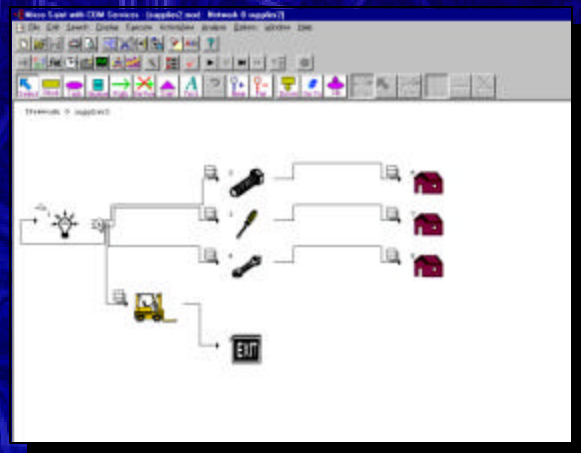


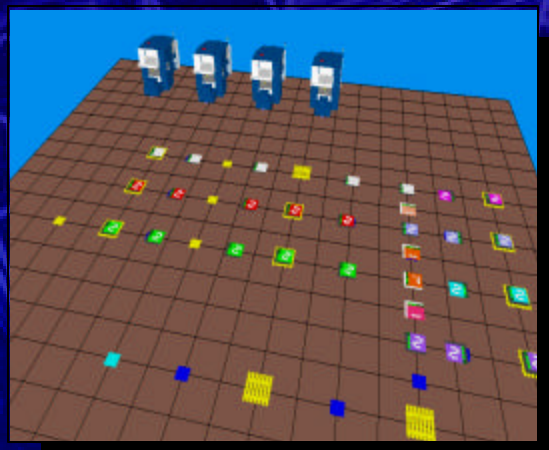

Some examples of our work ...

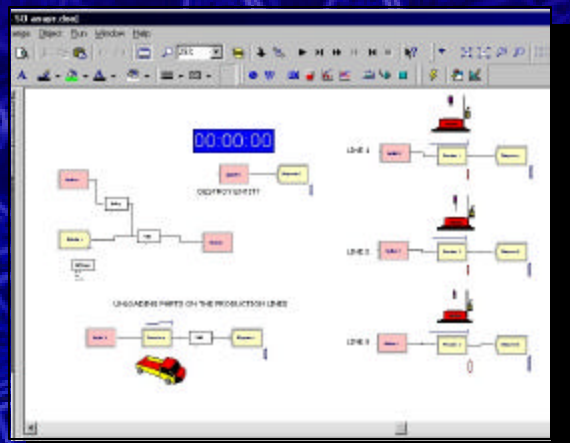
Navy Manufacturing Technology Program

MISSION: Modeling and Simulation Environments for Design, Planning, and Operation of Globally Distributed Enterprises

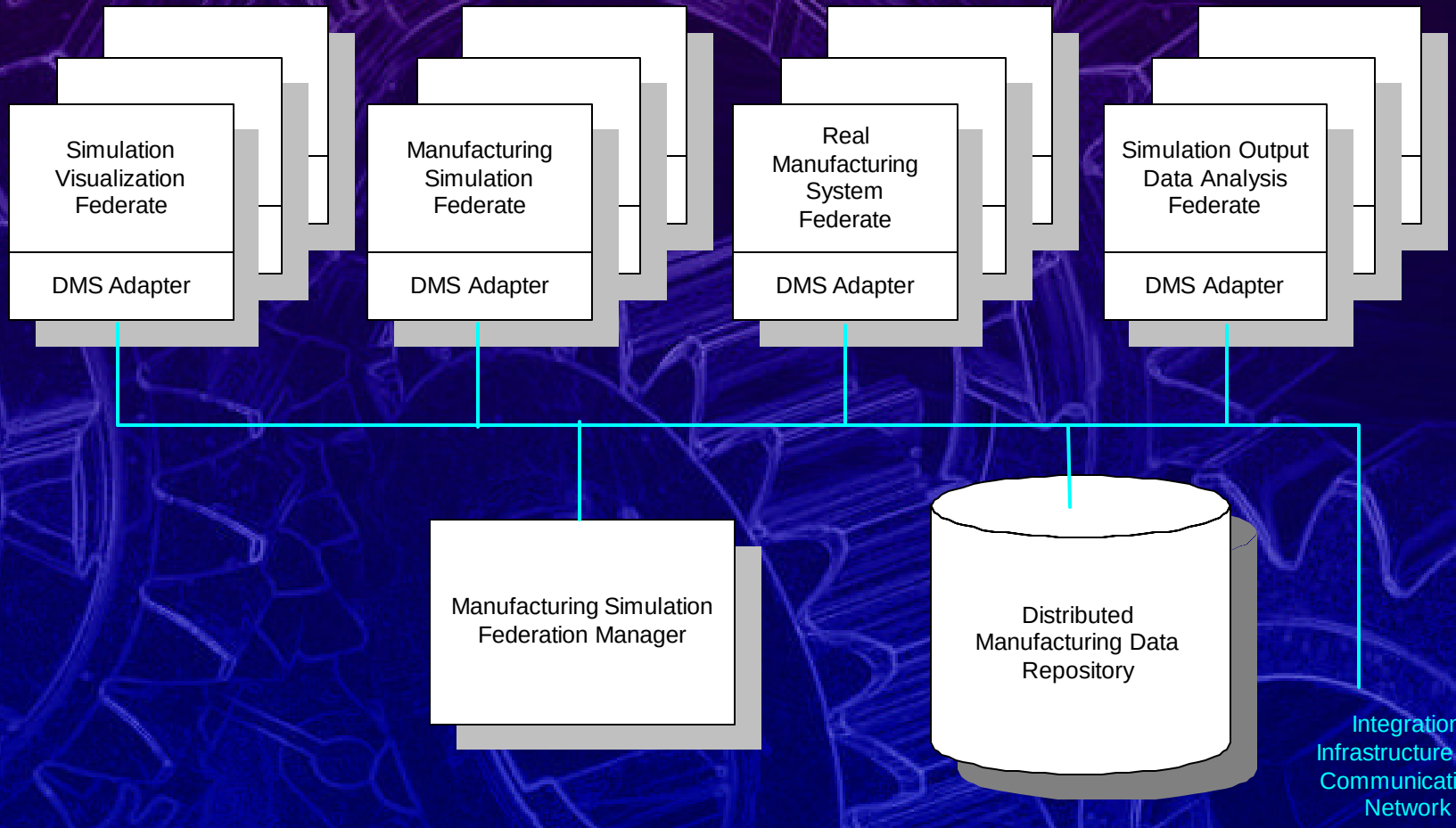
Develop interfaces and mechanisms for integrating COTS manufacturing simulation software to meet the needs of globally distributed enterprise modeling in various enterprise domains



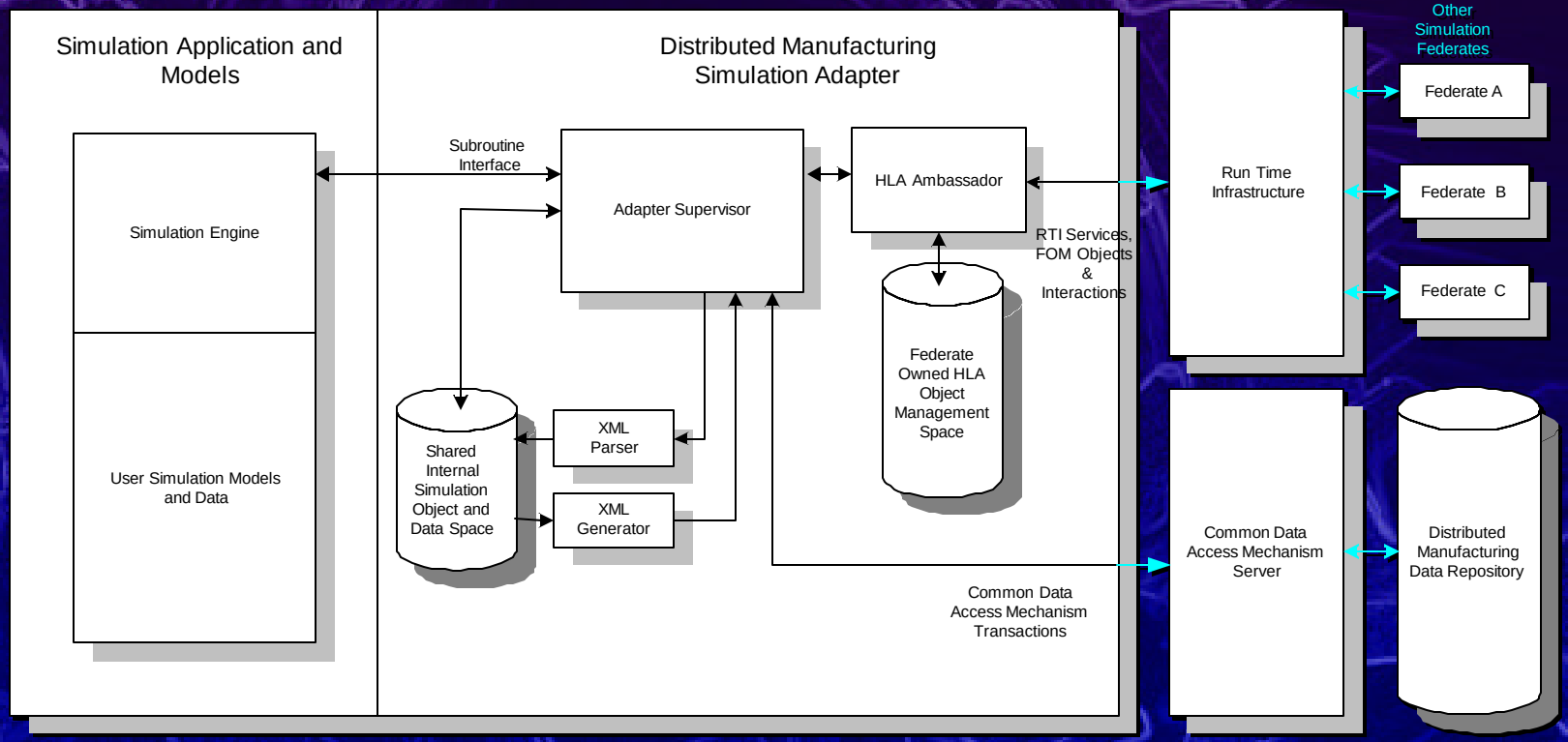




Architecture for Distributed Manufacturing Simulation



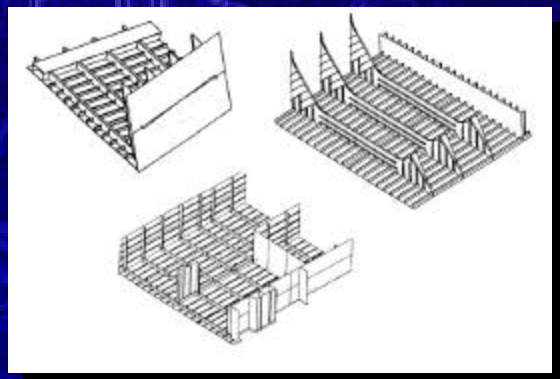
Simulation Federate



Navy Manufacturing Technology Program

NASSCO Advanced Shipbuilding Enterprise

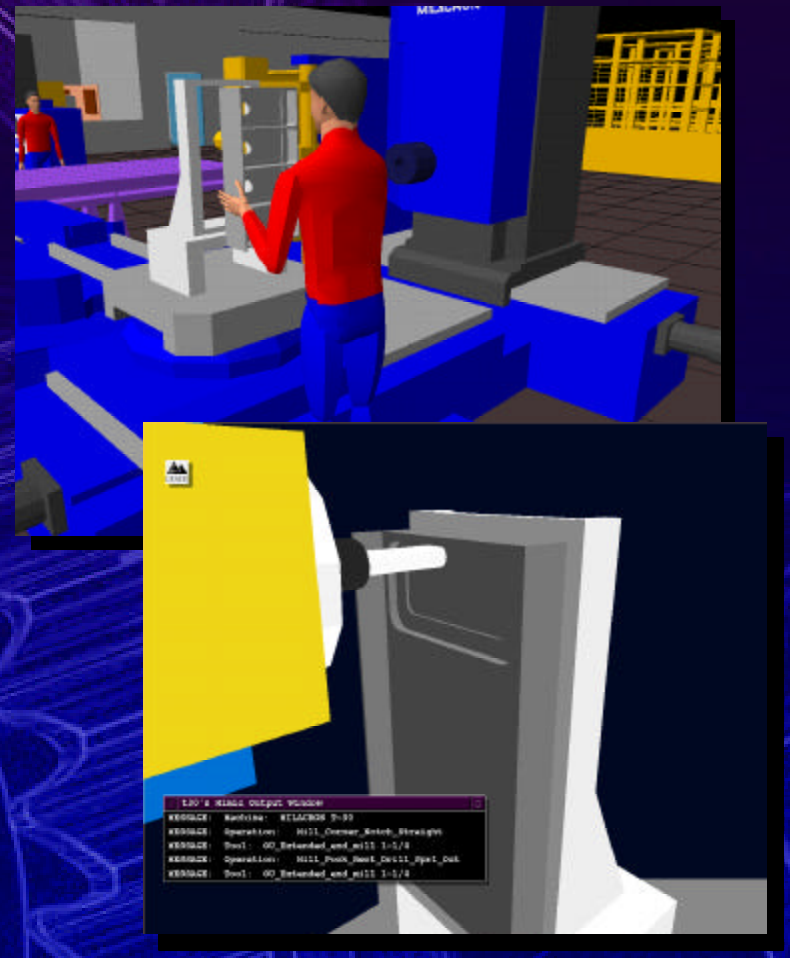
Develop generic model templates and data interfaces for the simulation of the fabrication and assembly processes associated with shipyard block construction



Navy Manufacturing Technology Program

Manufacturing Engineering Tool Kit

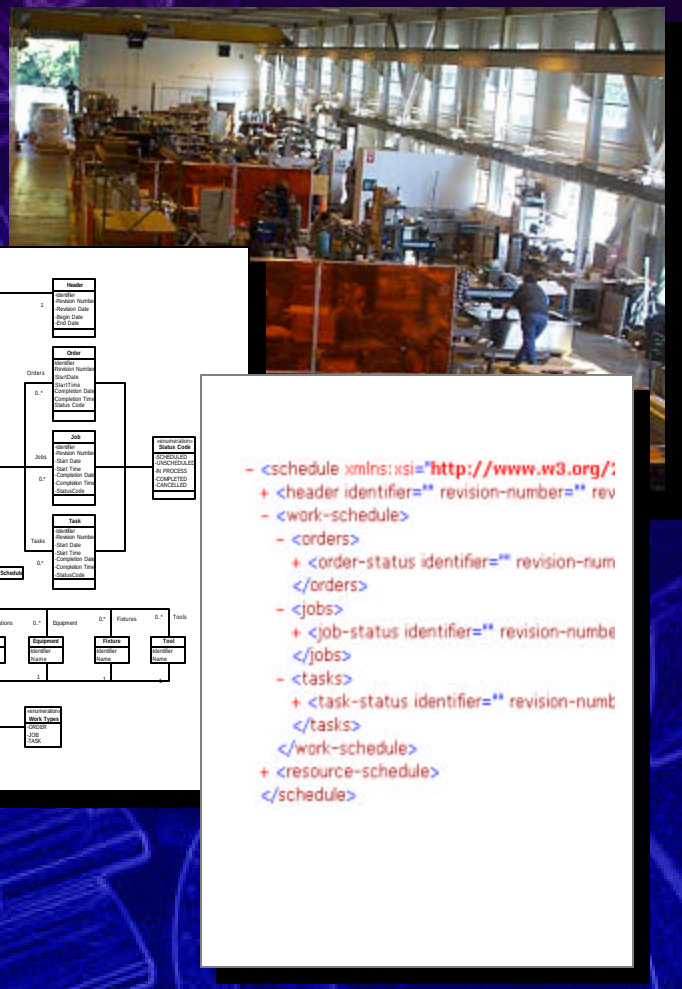
Develop interfaces and demonstrate integration of engineering tools with manufacturing shop floor and machine tool simulators to validate manufacturing plans, programs, and data



SEI Technology Insertion, Demonstration and Evaluation (TIDE) Program:

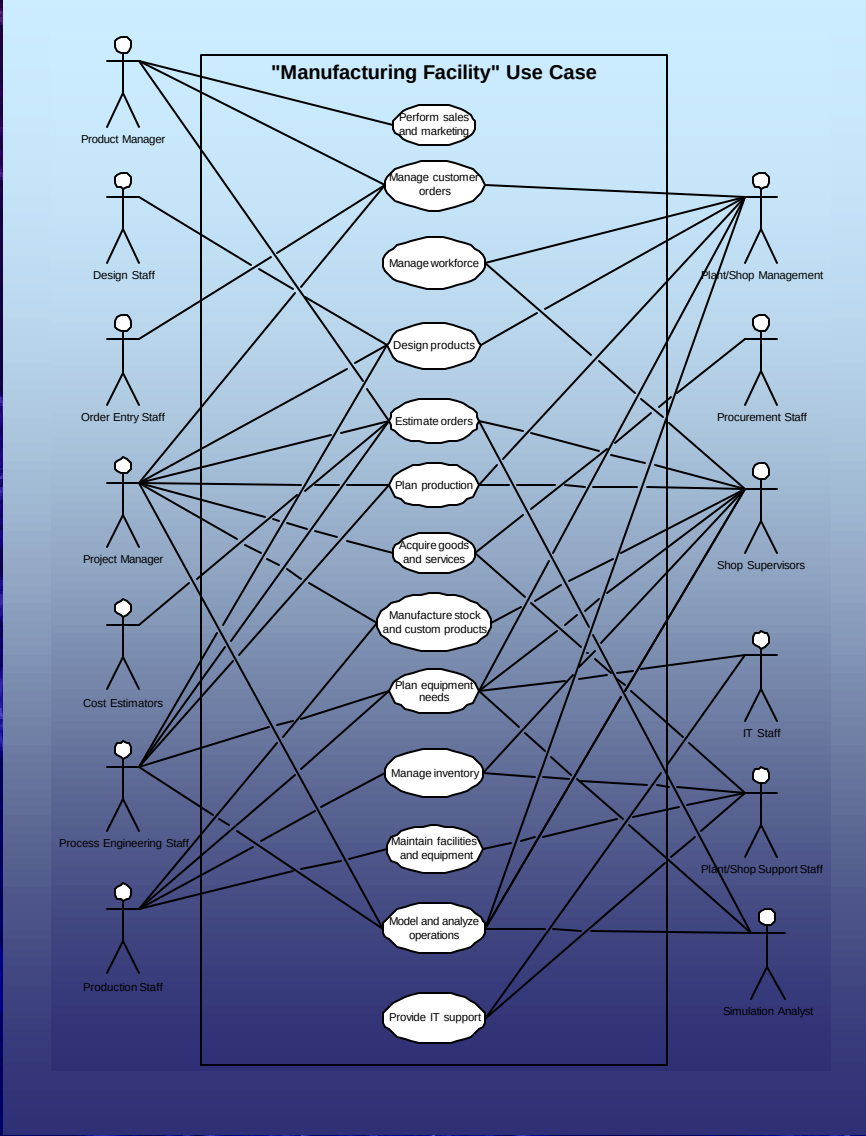
Machine Shop Data Interface Specification

Develop a generic machine shop simulation model and neutral interfaces for integration with scheduling, manufacturing execution system, and other applications in job shop environment



Machine Shop UML Use Cases

- *manage work force*
- *manage customer orders*
- *design products*
- *estimate orders*
- *plan production*
- *acquire goods and services*
- *manufacture products*
- *manage inventory*
- *maintain facilities and equipment*
- *model and analyze operations*
- *define simulation study parameters*



Shop Data Types Specified in UML & XML

Organizations

- Customers & suppliers
- Departments

Product & process specifications

- parts
- bill of materials
- process plans: routing & operation sheets, machine programs

Production operations

- calendars & shifts
- work: orders, jobs, tasks
- time sheets
- procurements

Inventory

Layout

Resource definitions

- stations
- machines & setups
- cranes
- tools & fixtures
- employees

Setup Definitions

Skill Definitions

Operation Definitions

Maintenance Definitions

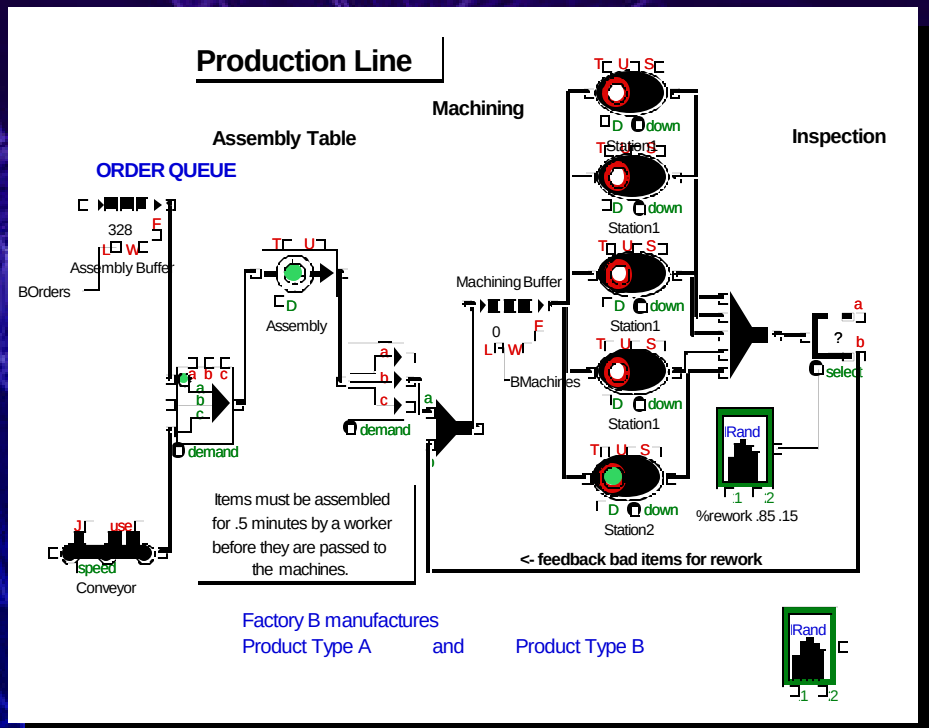
Miscellaneous

- revisions
- references
- units of measurement
- probability distributions

TIDE Phase II - Doyle Center

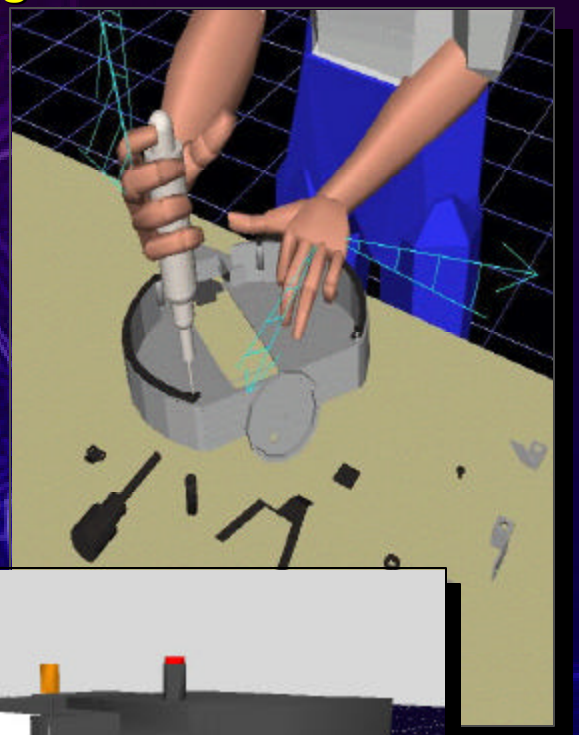
Simulation of Manufacturing Supply Chains

Develop supply chain simulation models and templates and interfaces to evaluate different coordination strategies for manufacturing supply chains

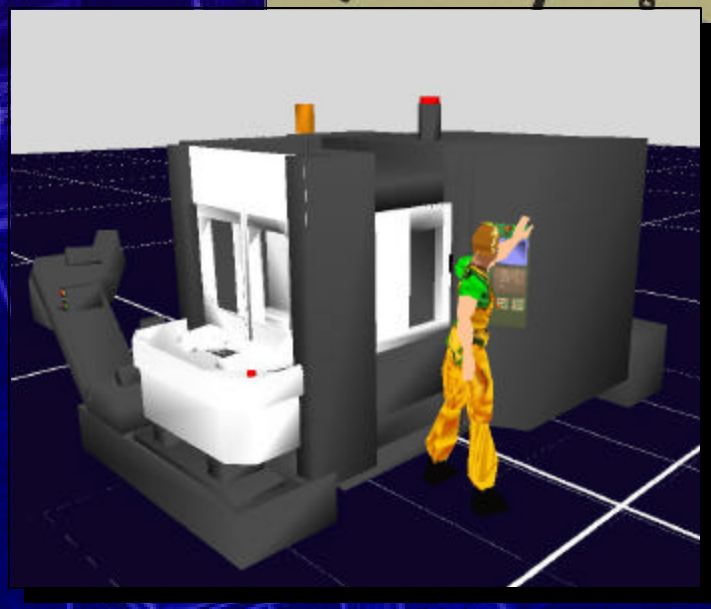


Systems Integration for Manufacturing Applications

Simulation of Manual Manufacturing Operations



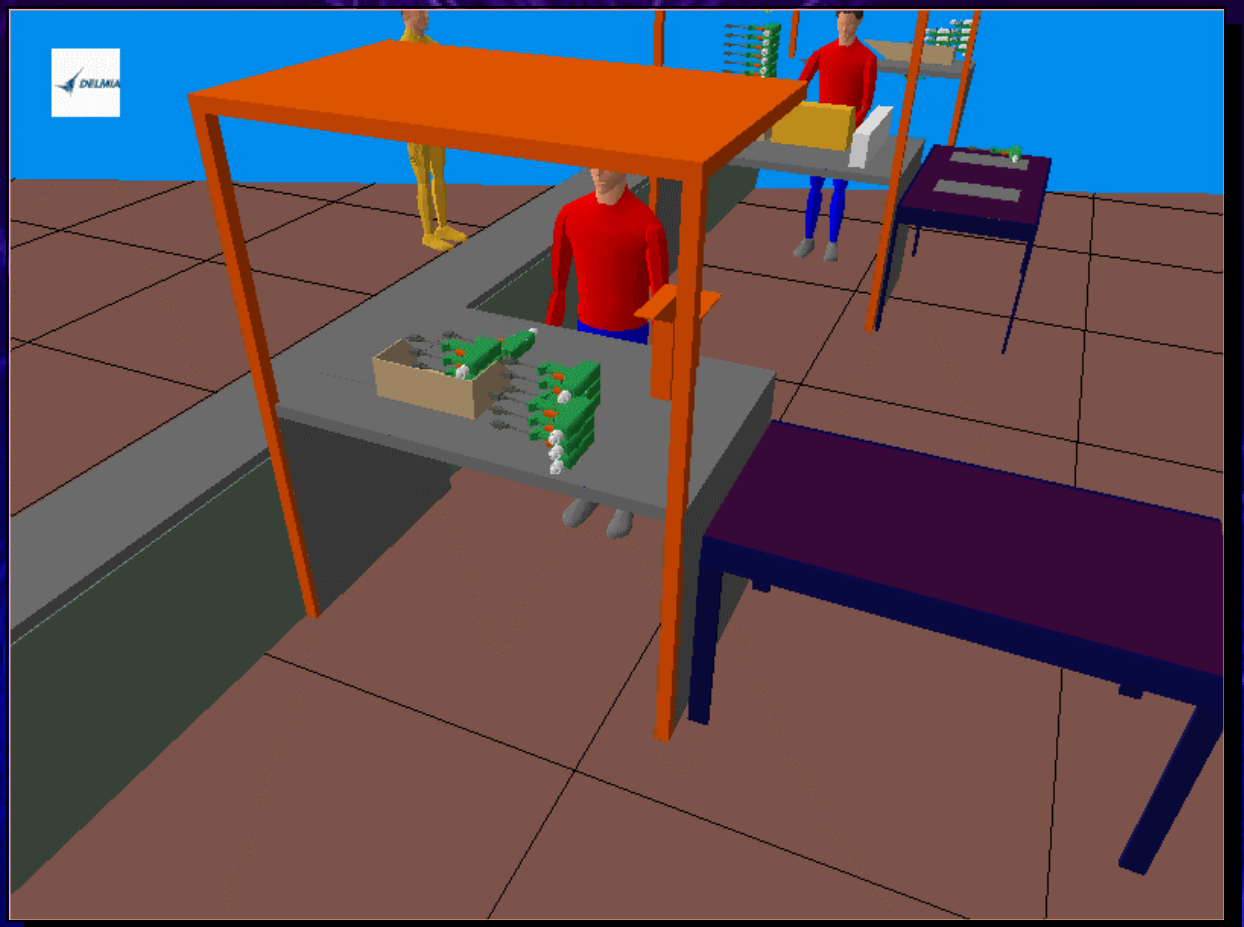
Develop data interfaces to simulate manufacturing assembly operations and behavior of skilled factory workers using hierarchical finite state machines



Systems Integration for Manufacturing Applications

Production System Engineering

Identify simulation modeling and data interface requirements for modeling manufacturing production lines



Naval Education and Training Command

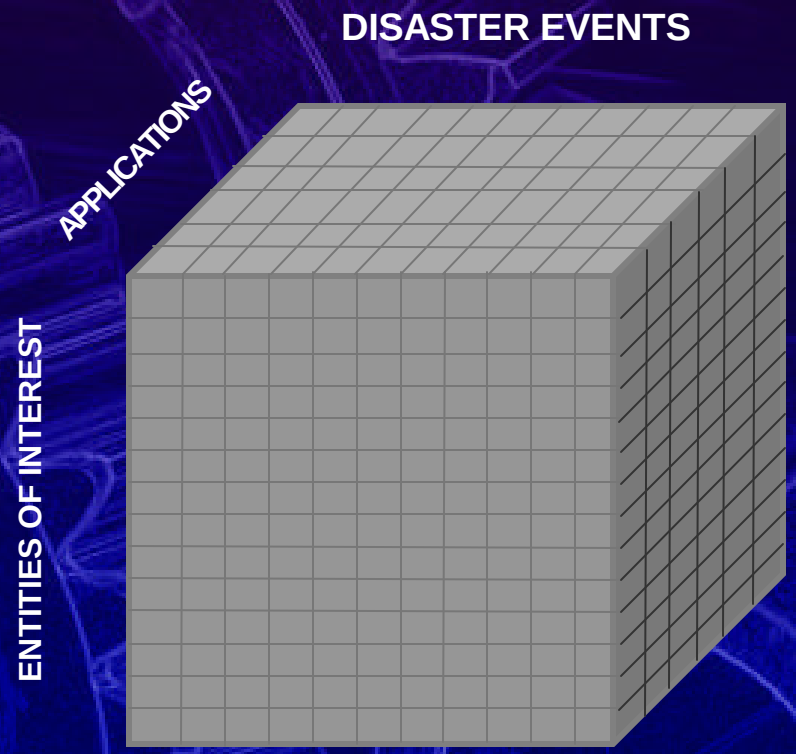
PC Simulation-Based Learning Systems

Develop integration architectures, methods, data interfaces, and testing systems to enable and support PC simulation-based learning systems to meet the Navy's future training needs

NIST Strategic Focus Area - Homeland Security

Modeling and Simulation for Emergency Response

Develop frameworks, system architectures, and data interfaces for integrating emergency response simulations

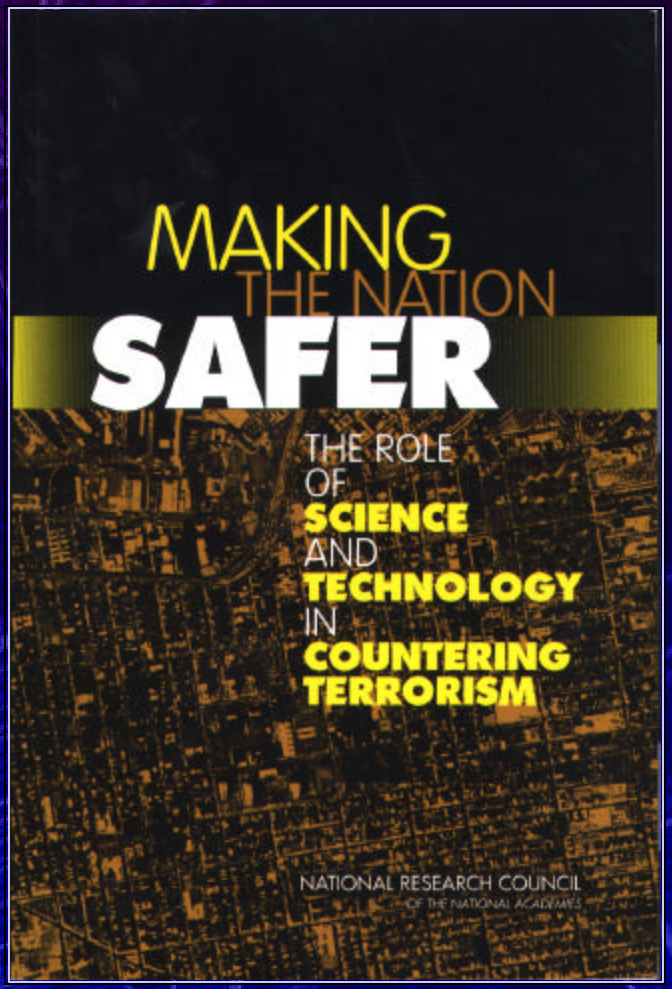


Need Recognized

Need for modeling and simulation for homeland security recognized in 2002 National Research Council report

"*Systems analysis and modeling tools are required for threat assessment; identification of infrastructure vulnerabilities and interdependencies; and planning and decision making (particularly for threat detection, identification and response coordination).*

Modeling and simulation also have great value for training first responders and supporting research on preparing for, and responding to, biological, chemical and other terrorist attacks."



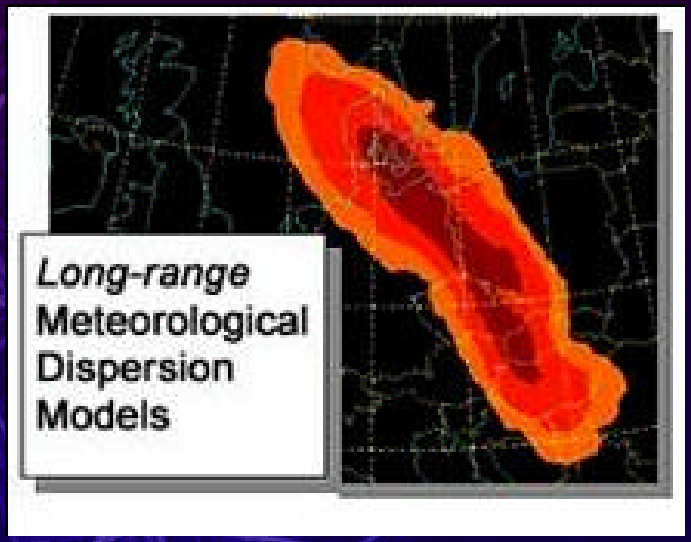
Background

- *Modeling and simulation (M&S) tools highly applicable*
- *Available tools mostly meant for standalone use*
- *Need integrated tools that address all major aspects of emergency response*

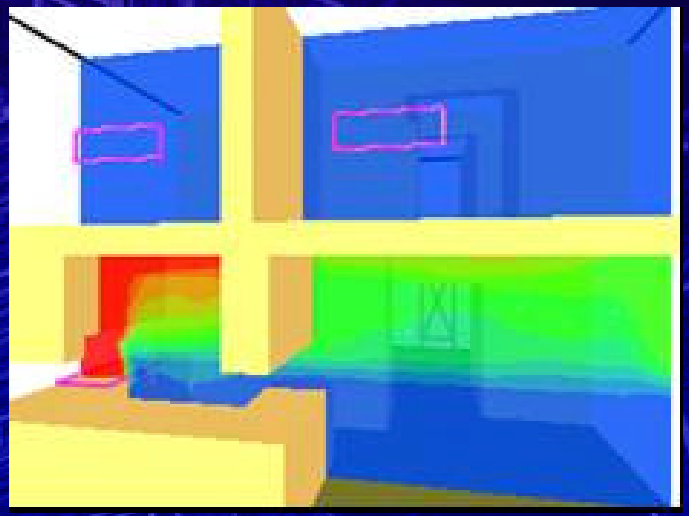
HotSpot for radiological plume simulation – Lawrence Livermore National Lab

Examples of Current Tools

- *Disaster impact modeling tools*
- *Emergency response planning tools*
- *Emergency response training tools*
- *Identification and detection tools*



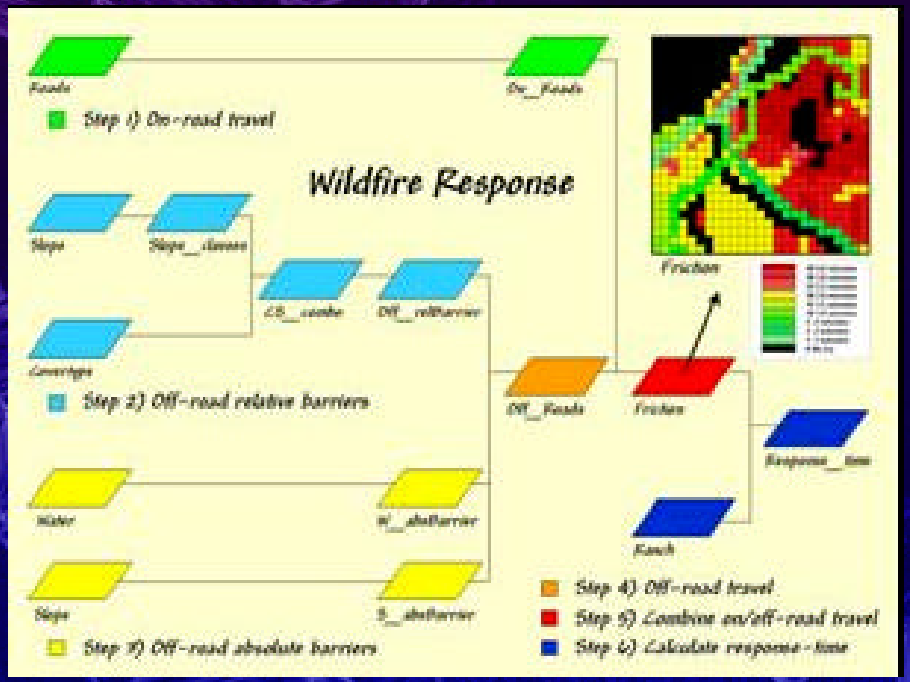
National Atmospheric Release Advisory Center – Lawrence Livermore National Lab



Fire simulation tools - NIST

Examples of Current Tools

- *Disaster impact modeling tools*
- *Emergency response planning tools*
- *Emergency response training tools*
- *Identification and detection tools*



Wild fire response planning tool – Innovative GIS Solutions Inc.

Examples of Current Tools

- *Disaster impact modeling tools*
- *Emergency response planning tools*
- ***Emergency response training tools***
- *Identification and detection tools*

Weapons of Mass Destruction Decision Analysis Center – Sandia National Lab

BioSimMER – Sandia National Lab

Examples of Current Tools

- *Disaster impact modeling tools*
- *Emergency response planning tools*
- *Emergency response training tools*
- *Identification and detection tools*

Warning Decision Support System
- National Oceanic and Atmospheric Administration

Concept for Integrated M&S Tools Environment

Explosion Simulation

Building Fire Simulation

Information flow modeling

Emergency vehicles response simulation

Traffic flow simulation

Hospital system simulation

City Map with Street details, Police, Fire, Hospital Locations

Availability of response personnel

Population density information by time of day

Federal, State, Local authority network spec.

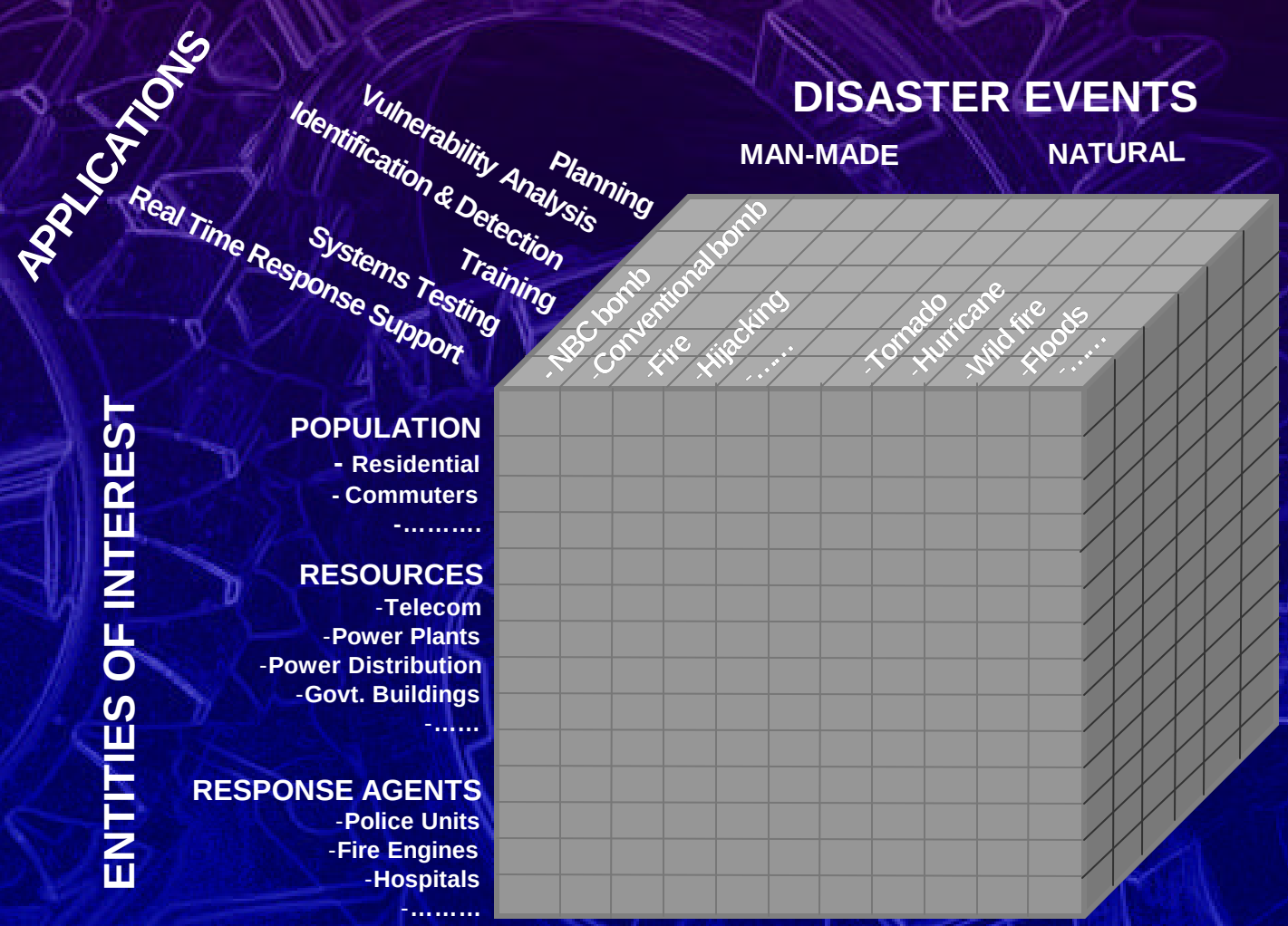
Acknowledgment: The building fire screenshot has been adapted from Sim City 4 website.

How can we make M&S more useful?

- *Create M&S tools that can rapidly configure to a given scenario*
- *Pre-validate tools over a number of scenarios*
- *Make simulations completely data driven using data available in standards formats*
- *Create interoperable tools to allow rapid integration*
- *Establish a common communication and computing infrastructure*

… First step: A framework for integrating M&S tools

Proposed integrated Emergency Response Framework (iERF)



NIST Strategic Focus Area - Homeland Security

Industry Workshop

- Date: March 4-6, 2003
- Location: NIST, Gaithersburg, MD
- Participants:

  Approximately 160 representatives including emergency responders and response planners, simulation software developers and vendors, standards developers
- Purpose:
  - Explore simulation, visualization, and modeling opportunities and requirements for emergency response
  - Understand current simulation state-of-the-practice and its applications for emergency response
  - Explore what is needed to develop, demonstrate, and deploy a framework> to enable simulations to share information for emergency response
  - Identify next steps that result in proposals, redirection of programs, initiating standards' activities, and chartering of work efforts.

Simulation Standards Consortium

- *NIST-led Consortium to address industry manufacturing simulation standards needs*
  - *Educate simulation user and vendor community on standards technology, opportunities, and status*
  - *Identify and prioritize industry interface standards requirements*
  - *Harmonize and integrate relevant existing and evolving specifications and standards*
  - *Ensure vendor commitment to implementation of solutions*
  - *Develop new draft standards specifications and prototype implementations that demonstrate feasibility*
- *Kick-off meeting was held in February 2003*
- *Projects underway with partners*

Simulation Standards Consortium

Government
- Defense Modeling Simulation Office
- Naval Air Warfare Center
- NIST (Coordinator)
- Tinker Air Force Base

Software Vendors
- Brooks Automation - Autosimulation
- Delmia
- EDS
- Knowledge Based Systems Inc.
- Lanner Group
- MicroAnalysis and Design
- ProModel Corporation
- Proplanner
- Rockwell Software - Arena
- Simul8
- Softimage
- Wolverine Software

Industry
- Altarum
- Boeing
- Ford Motor Company
- Forging Industry Association
- General Motors
- John Deere
- Makino Machine Tool

Research Institutions
- Software Engineering Institute

Academia
- Florida International University
- Oklahoma State University
- Virginia Polytechnic Institute
- University of Arizona
- University of Cincinnati

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