Transforming the Enterprise through Model-based Engineering

National Nuclear Security Administration
PRIDE
Product Realization Integrated Digital Enterprise
SAND2009-3186C

NASA and DOD Modeling & Simulation Technology Program

New Orleans, Louisiana

May 2009

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PRIDE
Product Realization Integrated Digital Enterprise

PRIDE is Transforming the Enterprise through Model-based Engineering

Product Realization Integrated Digital Enterprise (PRIDE)

May 2009

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Nuclear Security Enterprise (NSE)

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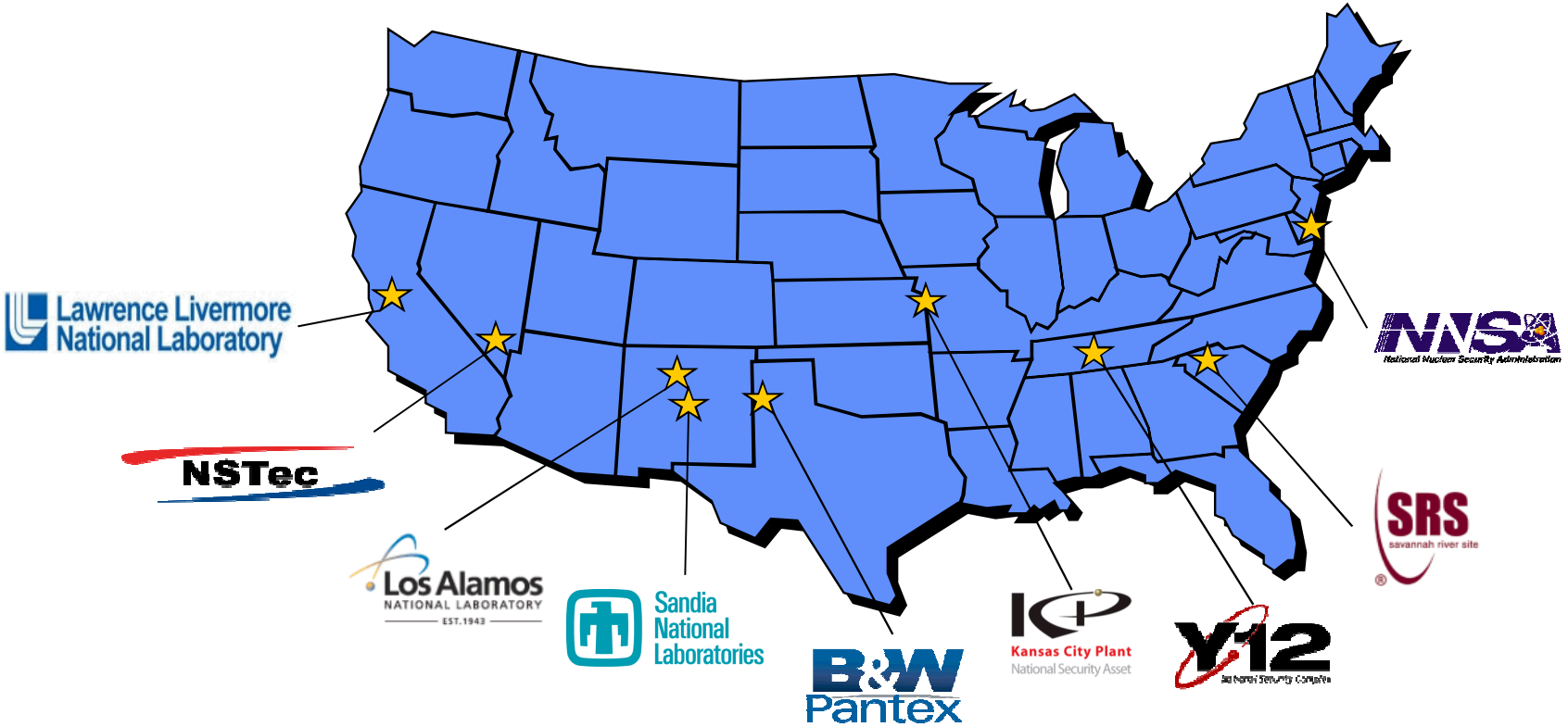
- PRIDE Program Management Team (PMT) manages engineering information systems across NSE M&O contractors



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PRIDE Applications
The Information Backbone for Product Realization at all NSE Sites

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Manufacturing & Inspection
(PCS, E Matrix, ROA, NWC Hub, NGDAS, EAWeb)

Design & Analysis
(PDMLink, Pro/Engineer, EBOM,NWC Hub)

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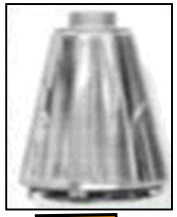

Maintenance & Surveillance
(JNWPS, CASTLE, QERTS, ISIS, SFI, WAVE)

Dismantlement
(SDDB)

Inventory, Tracking and Reporting
(MNS, WIS)

Defense Program

Designs & Manufactures Complex Products

- Design organizations across the Nuclear Security Enterprise directly support the Nuclear Weapons Programs by providing model-based design, manufacturing and inspection services to define, build, maintain and dismantle weapon systems and sub-systems that make up the stockpile.
- Model-based business impact varies within and between Design Agencies (DA) and Production Agencies (PA)

Transforming the NSE requires prioritized focus on DA investment and PA investment

Role of Mechanical Models in Product Life Cycle - Design

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- 2D Drawings continue as basis for official design & inspection definition
- 3D Pro/Engineer high fidelity models routinely used
  - Accelerated iterations of component and system designs
  - Supplement testing in product characterization
  - 3D Rapid prototype part creation
  - Analysis model creation from 3D models saves time
  - Prototypes built directly from 3D Pro/Engineer model via NC machining
  - Drawings for manufacture/inspection are created faster from models
  - System level models have enhanced system engineering activities

Transforming to a modernized and cost effective physical and business infrastructure where we move from
Design-Test-Build →Design-Analyze/Test-Build

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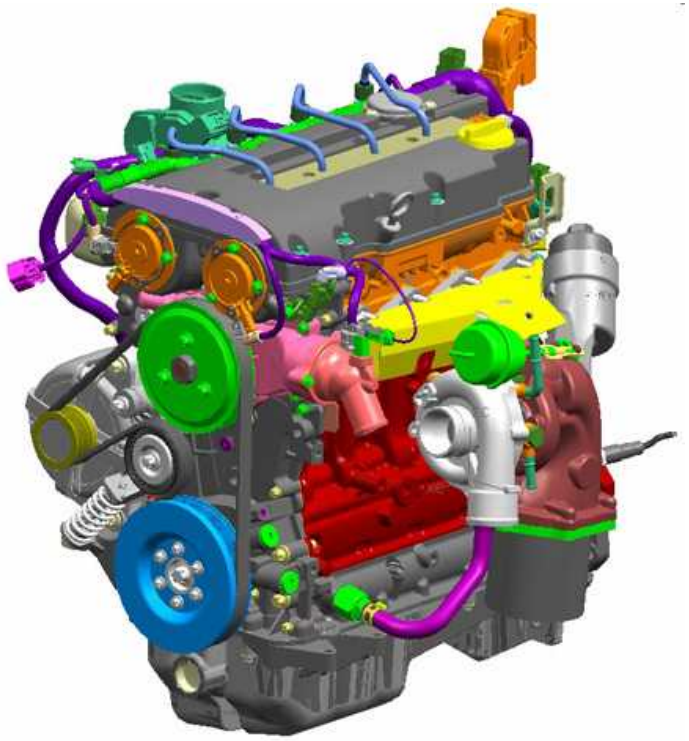
Weapon Components are Complicated Design Quality is Enhanced using 3D Mechanical Models

- Consideration of many design options
- Interface Checks
- Mass Properties
- Dynamic Balancing



System mass properties including part balancing allows for many more design options to be considered and characterized in time available

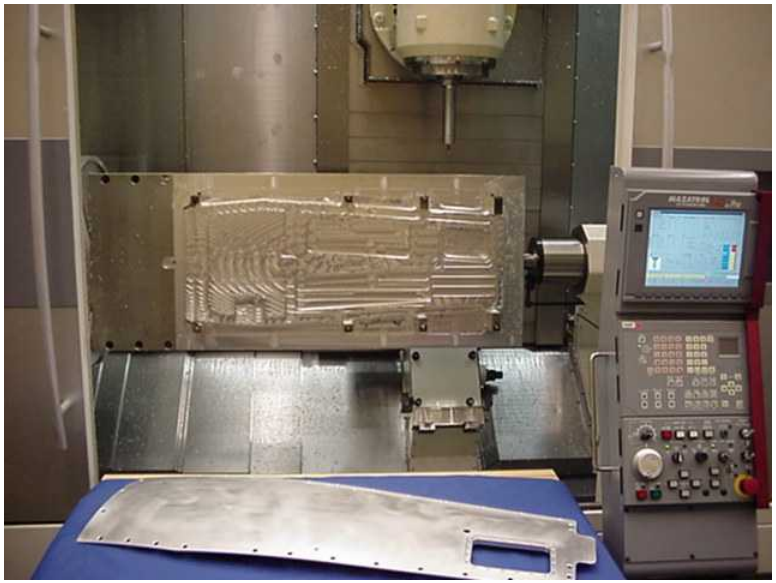
Hardware must be built fast and accurate
3D Models are foundational

Model Use

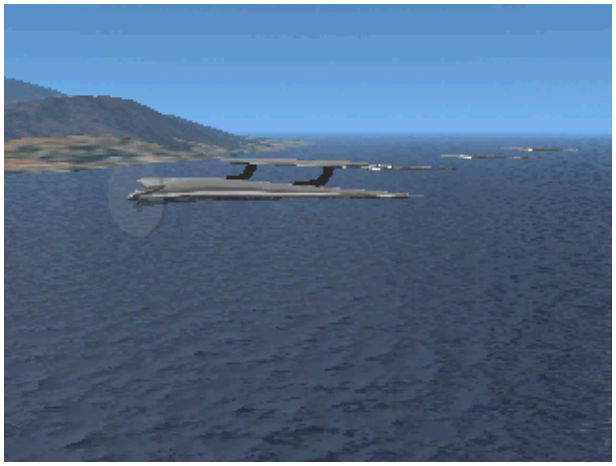
- Local shop used extensively
  - Models required
- Outsourced work used
  - Models rarely used

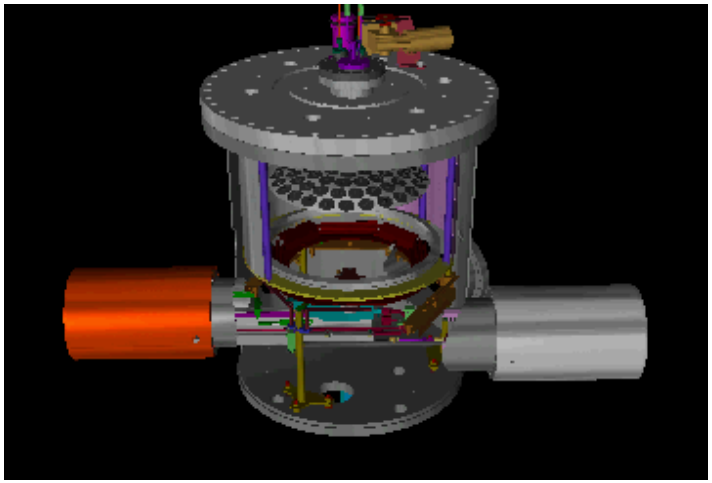
Challenges

- Compatibility of Pro/Engineer with manufacturing equipment
- "Neutral" Manufacturing support model format



Models help Visualize Designs and communicate ideas





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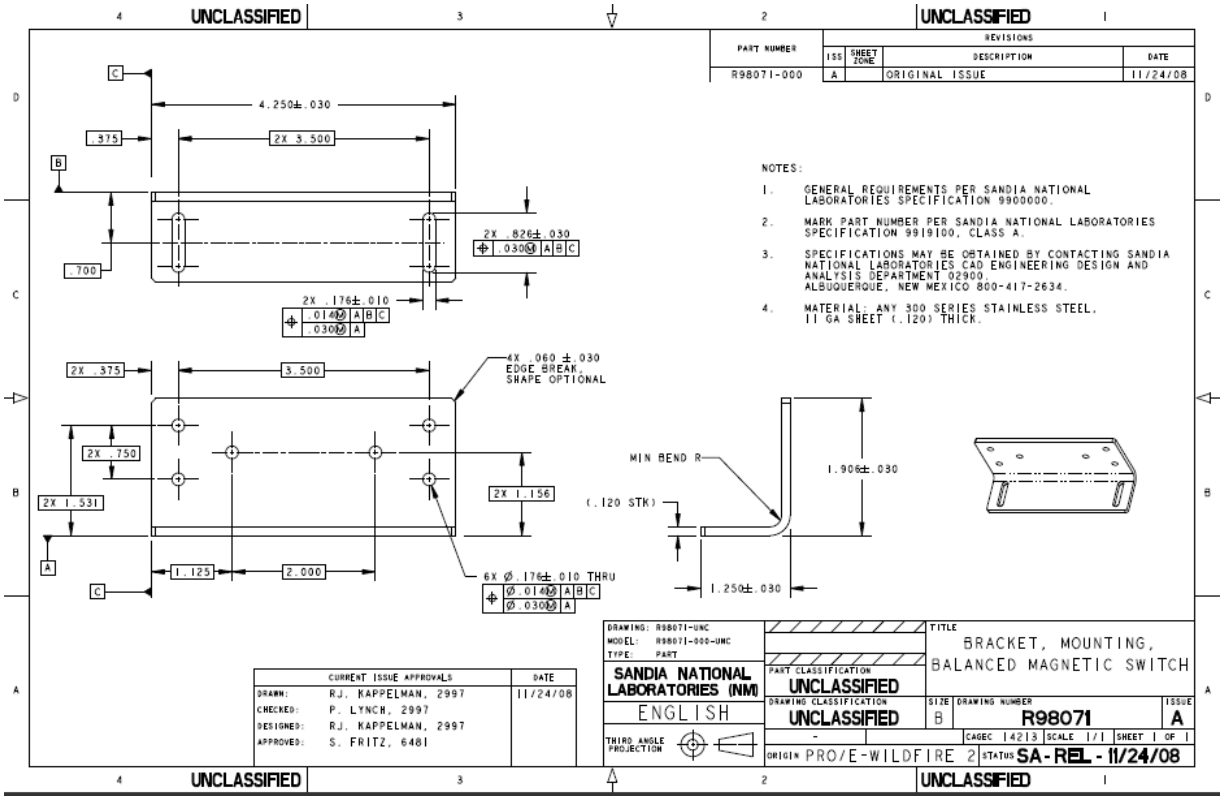
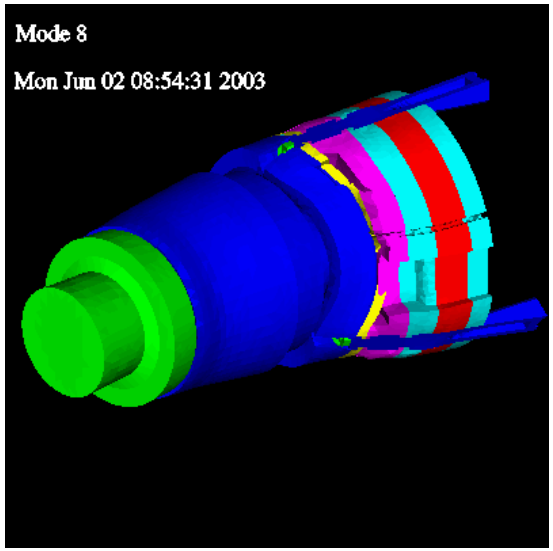
Detailed Drawings are produced from Models

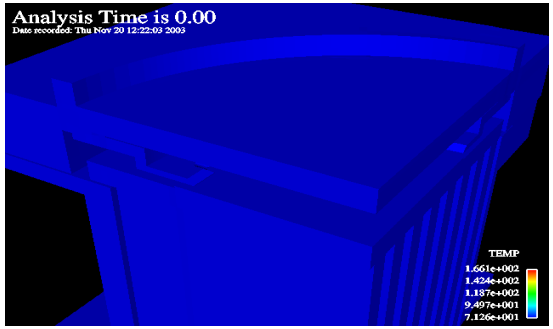


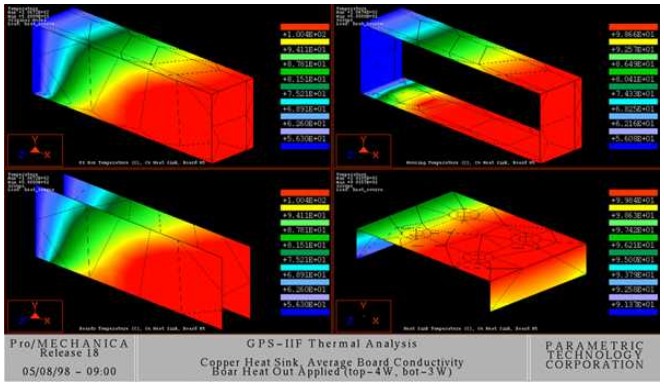
We are establishing the infrastructure needed to move from Drawings-based business to Drawing w/Supporting models business (design set)

3D Models are Leveraged to Predict Product Behavior

- High fidelity analysis meshes come from 3D Models
- Structural, thermal and other analyses predict product performance and help select from design options
- Models typically represent nominal condition - analysis results do not account for tolerance or other imperfection (burrs etc.) issues







Many design options can be characterized and considered

Role of Mechanical Models in Product Life Cycle - Manufacturing

- 2D Drawings continue as basis for official manufacturing & inspection definition
- 3D Pro/Engineer high fidelity models routinely used
  - Concurrent engineering: Design for Manufacturability & Inspectability
  - Manufacturing “dry run” in software avoids costly errors
  - Outsourced parts costs reduced as much as 50% when models are provided
  - TBD

Transforming to a modernized and cost effective physical and business infrastructure where costs are reduced

Mechanical Models
Used and Reused throughout our Business

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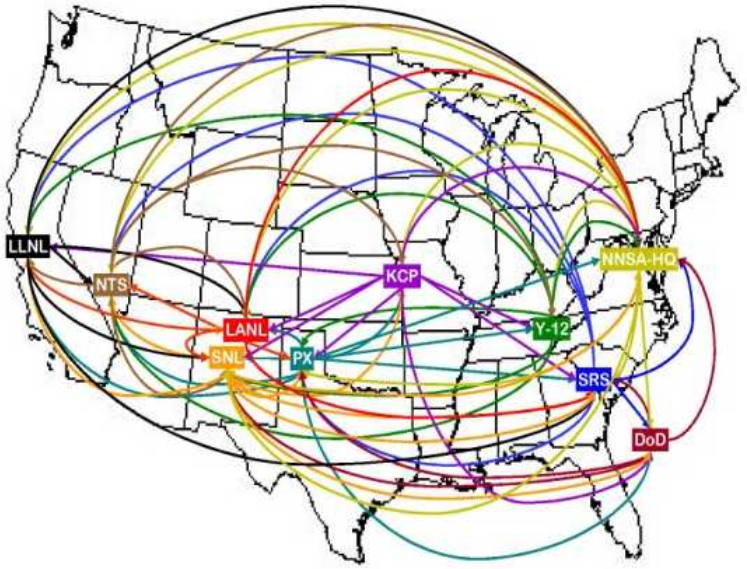
Site	Estimated Model Volume per year
SNL	7320
LLNL	762
LANL	1100
KCP	7192
Pantex	350
Savannah River	186

PRIDE is Delivering Information to Engineers across the NSE



Transformation is enabled through a fully integrated and interdependent Complex

PRIDE MCAD Project

Transforming Design to Manufacture

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Challenge: Models-based Release and Exchange

- MCAD Release and Exchange Process does not include models
- Systems & business processes do not yet support model exchange

Solution/Impact : FY08-09 MCAD Model Management & Sharing

- Complex-wide infrastructure √
- Four model management and sharing evaluations √
- Process documentation for RMI MOCA
- 3D models officially included in product definition
- 3D models included in release & exchange process
- MCAD model/drawing complex-wide sharing refined
- NTK practices applied to MCAD – common approach
- ESN services used to enhance sharing & simplify “system”

Complex-wide common capability, processes & infrastructure to manage and share mechanical CAD product definition will improve quality & reduce design cycle times leading to reduced total cost

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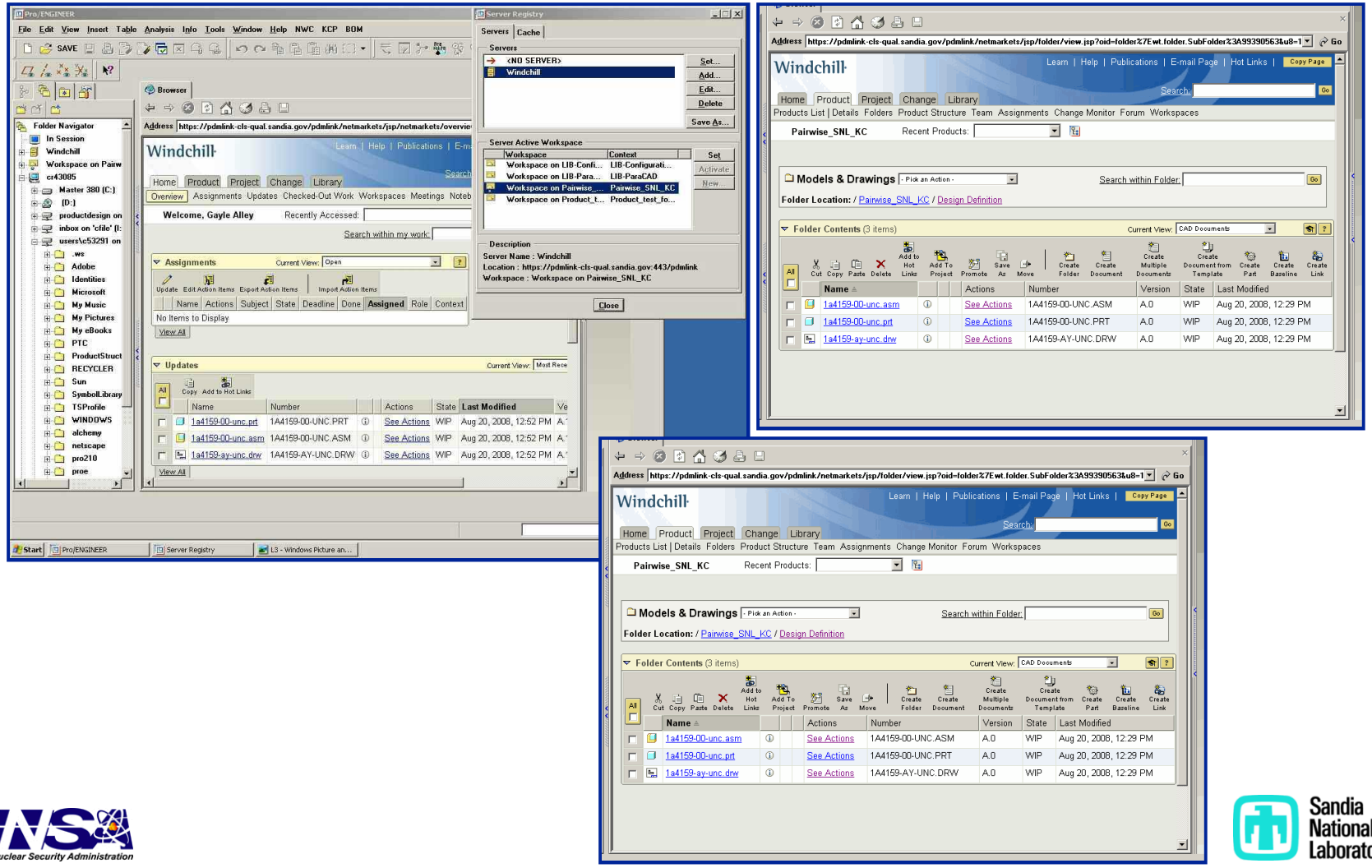
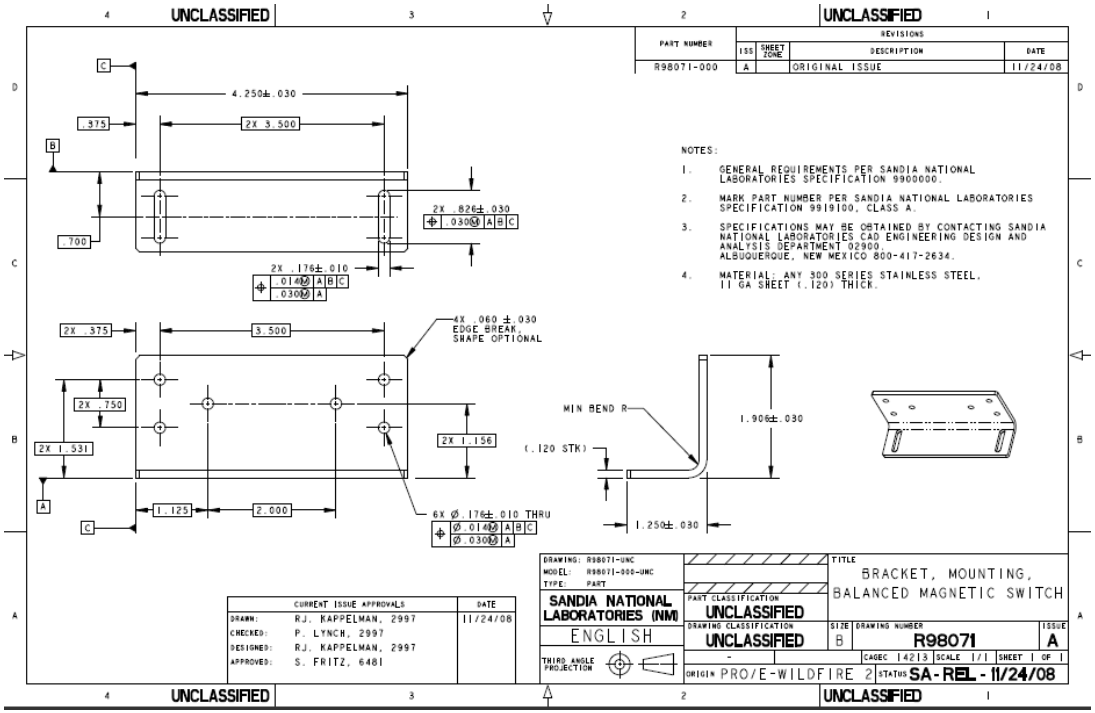
One Sharing Scenario

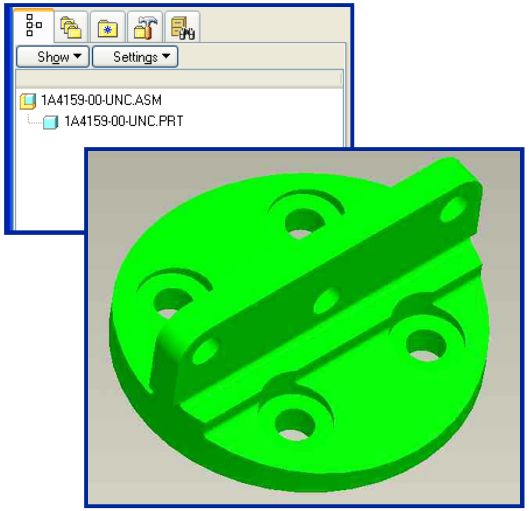
Retrieve test drawing and assembly (via KCP)



One Sharing Scenario

- **Test Data**
  - **Drawing XYZ with accompanying assembly and part models**
  - **Comprised of a piece part and 3 library parts (suppressed)**
  - **Real production data, designed at SNL and manufactured at KCP**





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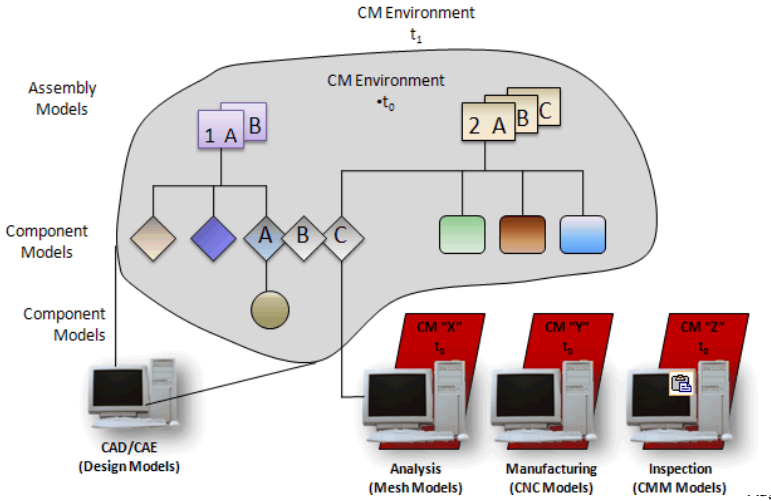
Many challenges remain

- Business Processes
  - Some business processes do not yet include models
- Models are perfect – physical parts are not
  - Many characteristics that cause parts/assemblies to fail are not included in nominal models – many opportunities for modeling software to include realistic scenarios (tolerance, MMC, LMC, burrs etc.)
- Design Archiving requires drawings

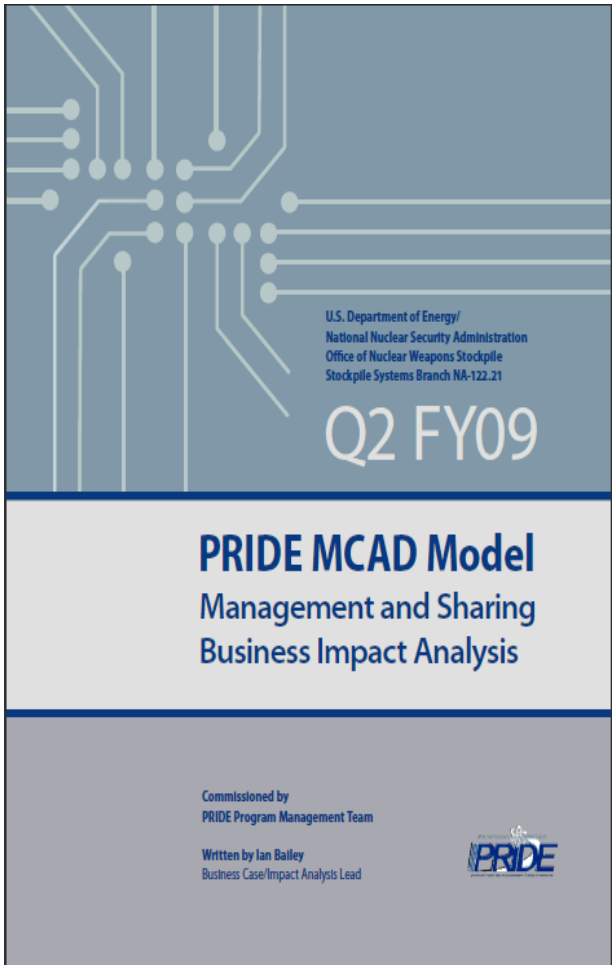
Information must be managed and traceability must be assured

Many challenges remain

- Traceability must be assured
  - Design to analysis, design to prototype, test to analysis, etc.
- PLM System
  - Artifact management has become much more complex
  - Engineering change has become more explicitly complex
  - Demands of staff have increased
    - Staff must be experts in design, Pro/E & PLM
- Theoretical traceability can be daunting – wisdom required to establish "interface" points



Business Benefit from models Realized



- PRIDE business analysis predicts dramatic time and costs savings from increased use of models
- Business benefits have been spectacular – design options, characterization, cost savings
- Configuration management of product definition set remains a major challenge between business units