# Next Generation Machining & Modeling Technology

Presentation NDIA Guns & Missiles 2011


TECHNOLOGY DRIVEN. WARFIGHTER FOCUSED.

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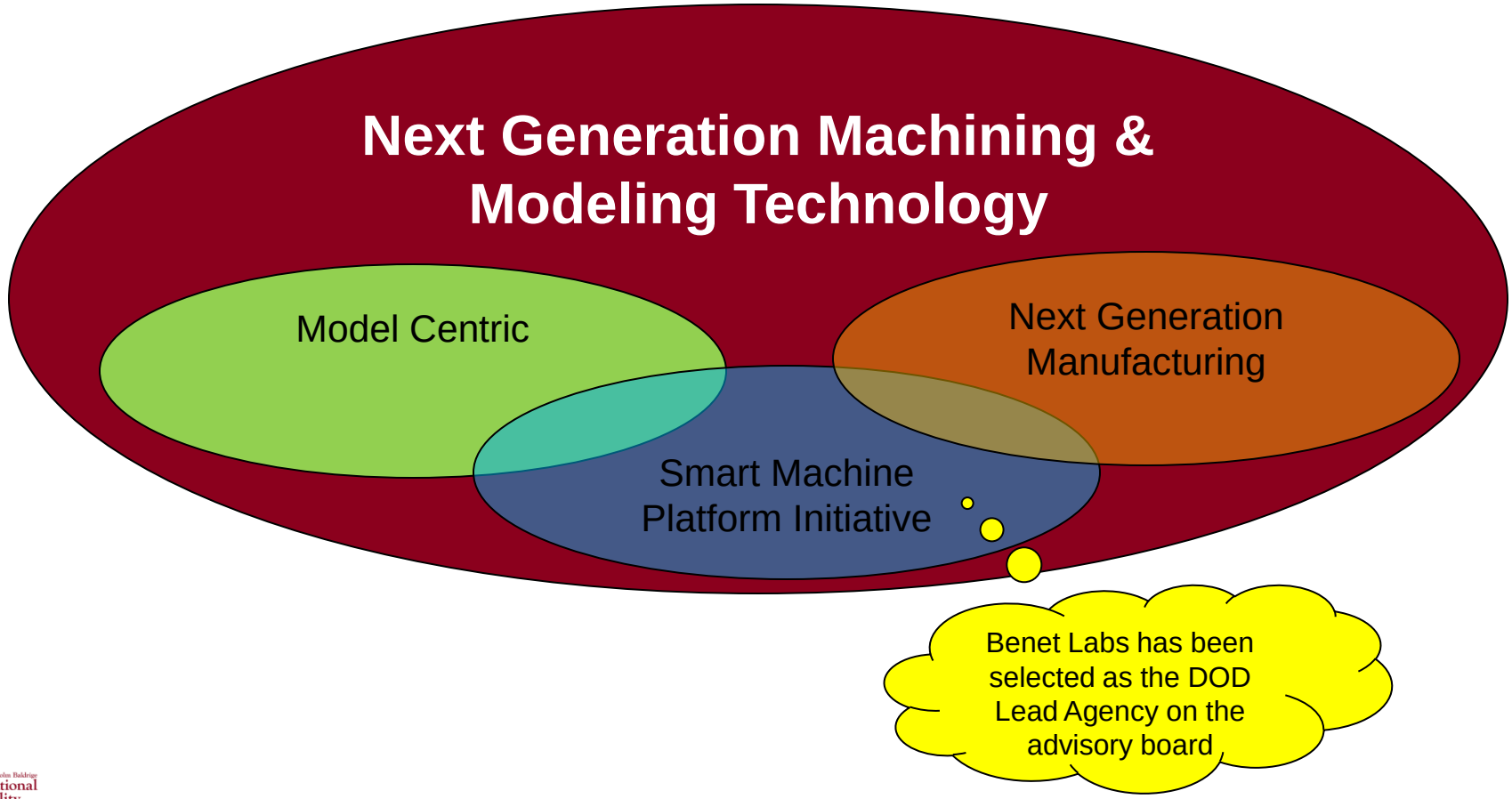
- Objective: To provide an overview of the US Army Benet Laboratories strategy to advance the state-of-the-art in defining product data, acquiring products in a timely, cost effective manner, and to update and maintain the techniques used to model products, maintain and improve the data, and to fabricate the end items. Further to serve as a model for the Department Of Defense agencies in the modernization of design, fabrication, acquisition capabilities



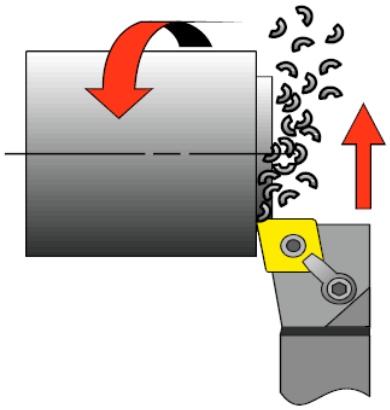


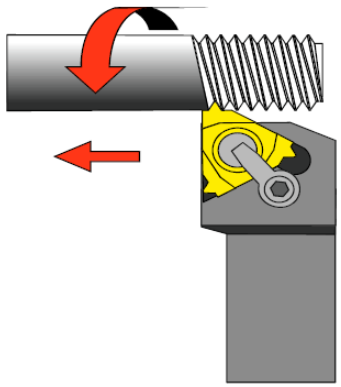
- Facts:
  - Government Technical Data Packages (TDPs) contain design information but no information about manufacturing
  - 85% of companies surveyed indicate that they use 2D drawings as their baseline, even when solid models are available. (1) The US DOD still uses 2D drawings as the legal documentation for acquisition and database
  - Studies by industry and DoD have demonstrated that the use of 3D modeling during design can reduce development cycle time by 30%+ (1).
  - Studies by industry indicate that the use of 3D modeling during design can reduce non-conformances by 35%+ (1, 2).

- Next Generation Machining and Modeling Technology is not a single element program but a strategy that looks at the:
  - Design process
  - Fabrication process
  - Management of these elements

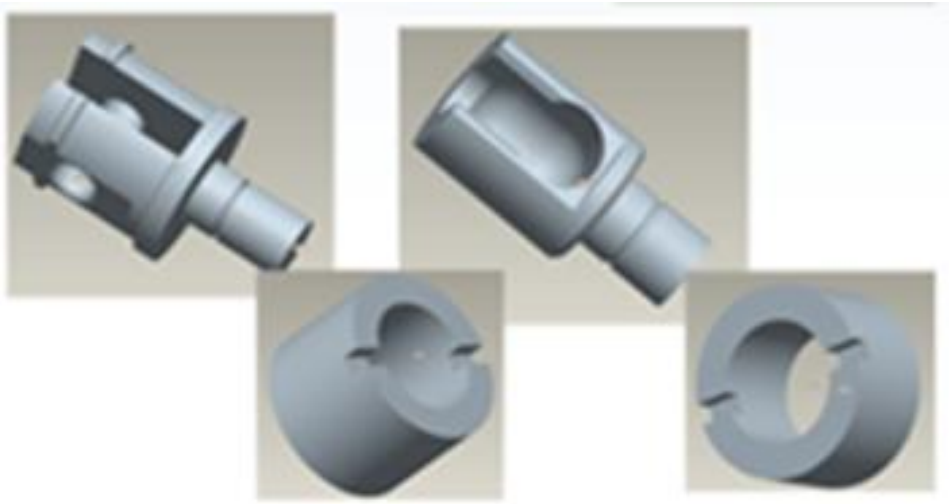

Next Generation Machining & Modeling Technology
Model Centric
Next Generation Manufacturing
Smart Machine Platform Initiative
Benet Labs has been selected as the DOD Lead Agency on the advisory board

- Model Centric Approach:
  - Actually comprised of 3 separate elements
    - Model Centric Design
    - Model Check
    - Model Based Environment
  - Not a project or a program, but a new strategy in how parts are concepted and designed
  - Not just the design information and intent, but all information necessary to support manufacturing the part to it's design intent





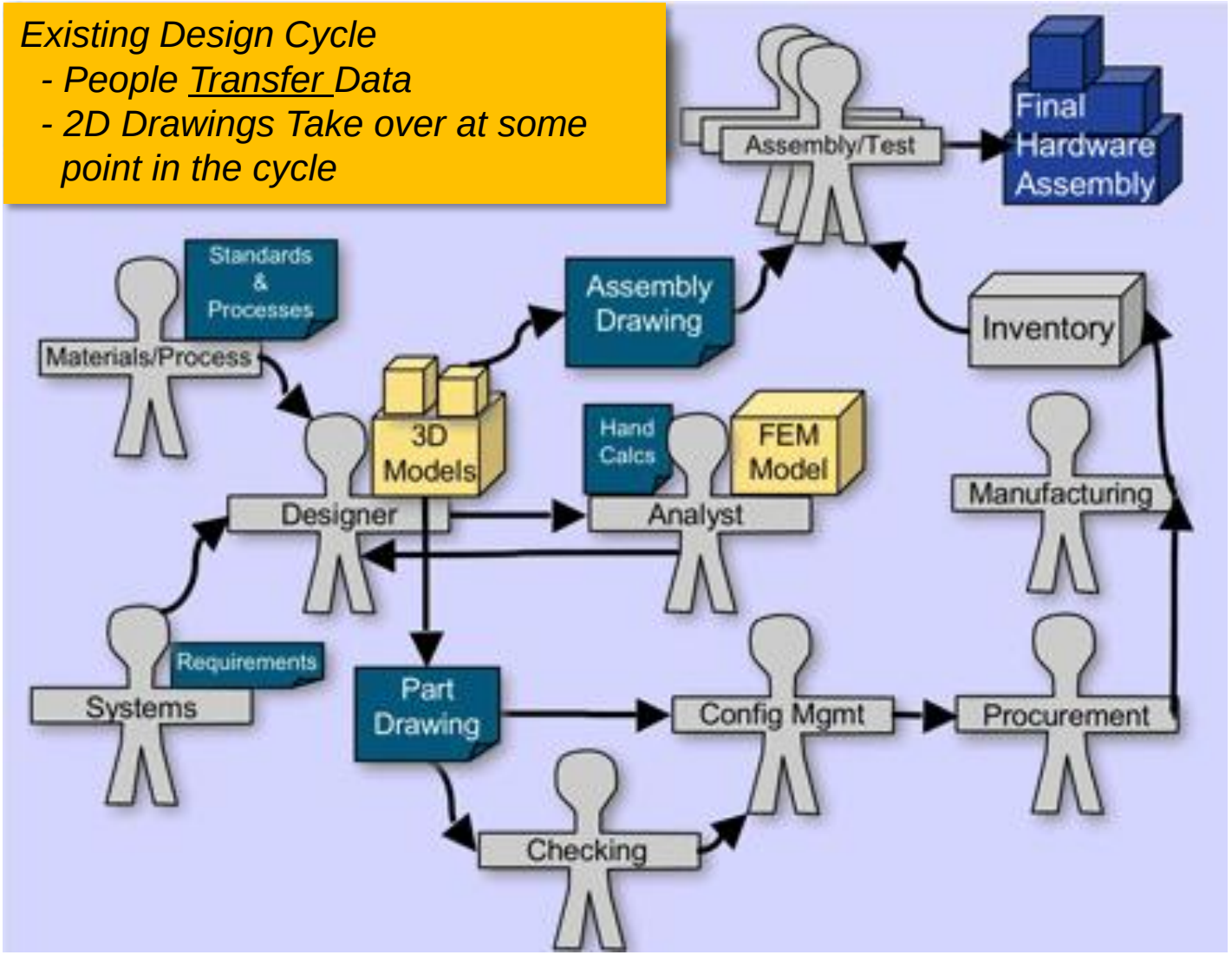
- Model Centric Design:
  - Defined as ". . a Model-based (or -centric) design is an approach that puts 3D models at the center of the design (1)."
  - The 3-Dimensional model serves as the basis of information for all design, analysis, fabrication, inspection, maintenance, repair, re-work, etc
  - Detailed data or characteristics is contained in the solid model files including
    - Physical geometry
    - Tolerances
    - Material characteristics
    - Coating/Finishing
    - Manufacturing Data *
  - Allows re-use of solid data across the enterprise
    - in other designs
    - in other software tools
    - for other purposes



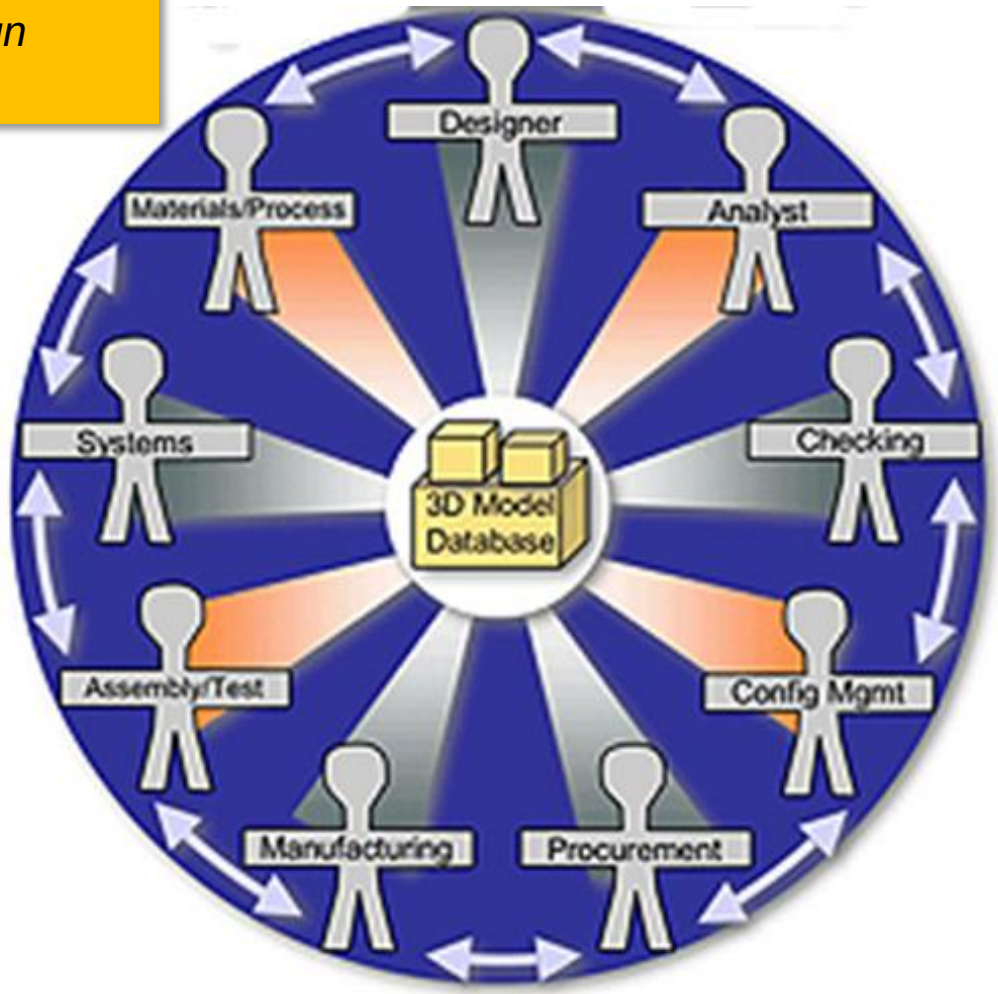
- Model Check:
  - Is a process that compares the solid geometry and tolerancing to an established set of standards to validate the *design.*
    - Can utilize a mix of automated software tools
    - Should include independent review by other individuals
  - Model Check can be tailored
    - To review only tolerancing
    - To address producibility
    - To assess model geometry for stability

- Model Based Environment:
  - A fully integrated and collaborative environment founded on 3D product definition detailed and shared across the enterprise; to enable rapid, seamless, and affordable deployment of products from concept to disposal.
  - An approach to maintain all data in a common data base to serve as the basis for all:
    - Design – Analysis
    - Interface to Enterprise Resource Planning: Raw material orders, Fabrication
    - Re-Use of data
  - May utilize native CAD formats or neutral file formats

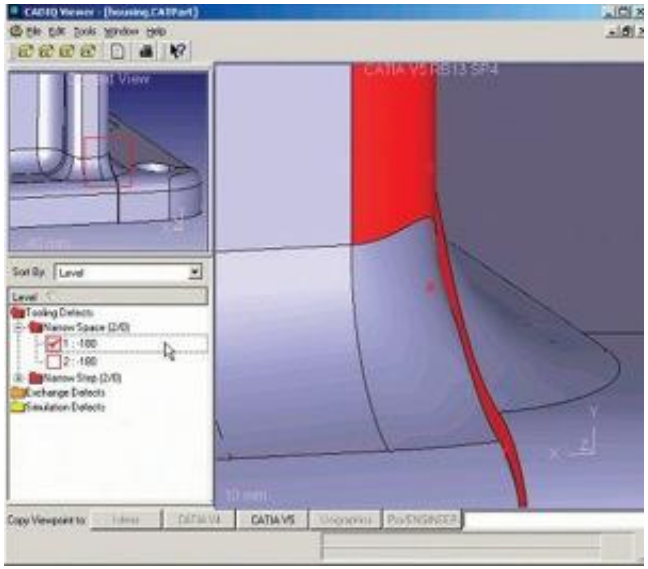
*Existing Design Cycle*
- *People Transfer Data*
- *2D Drawings Take over at some point in the cycle*

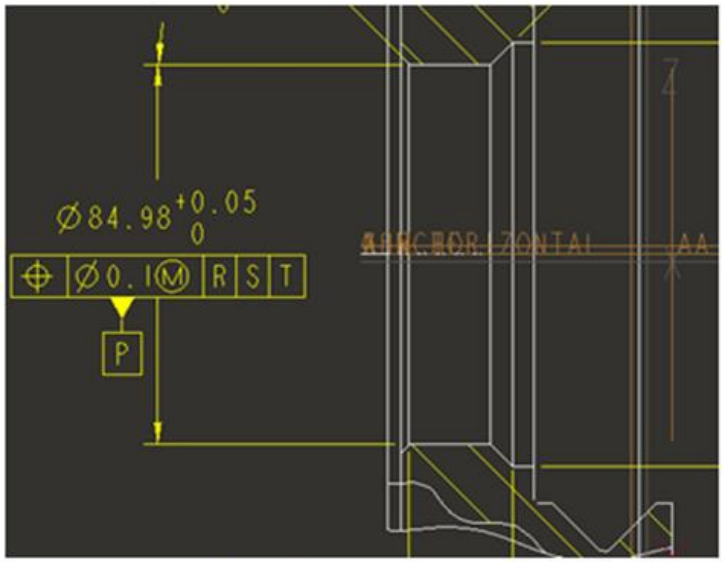


*In a Model Based Environment*
- *People Access Data*
- *3 D Models contain all design information*



- Challenges to realize Model Centric within DOD (organic design & manufacturing)
  - Not all design details can be accurately modeled in CAD Packages
  - Not all CAD packages generate solid data that will:
    - Translate accurately into neutral formats
    - Translate accurately into Manufacturing Software
  - 3D models not transferable into other platforms
  - 3D file format changes can render old formats obsolete
  - Information Technology structure are at odds with government security protocols
  - Units translation needs additional user modification

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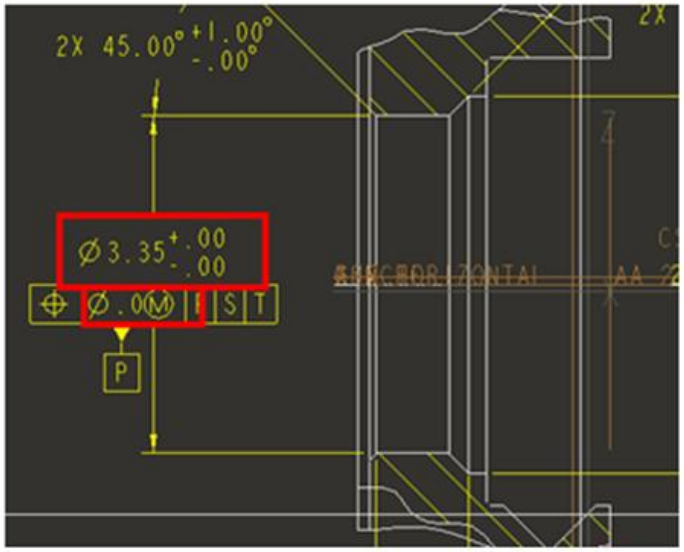
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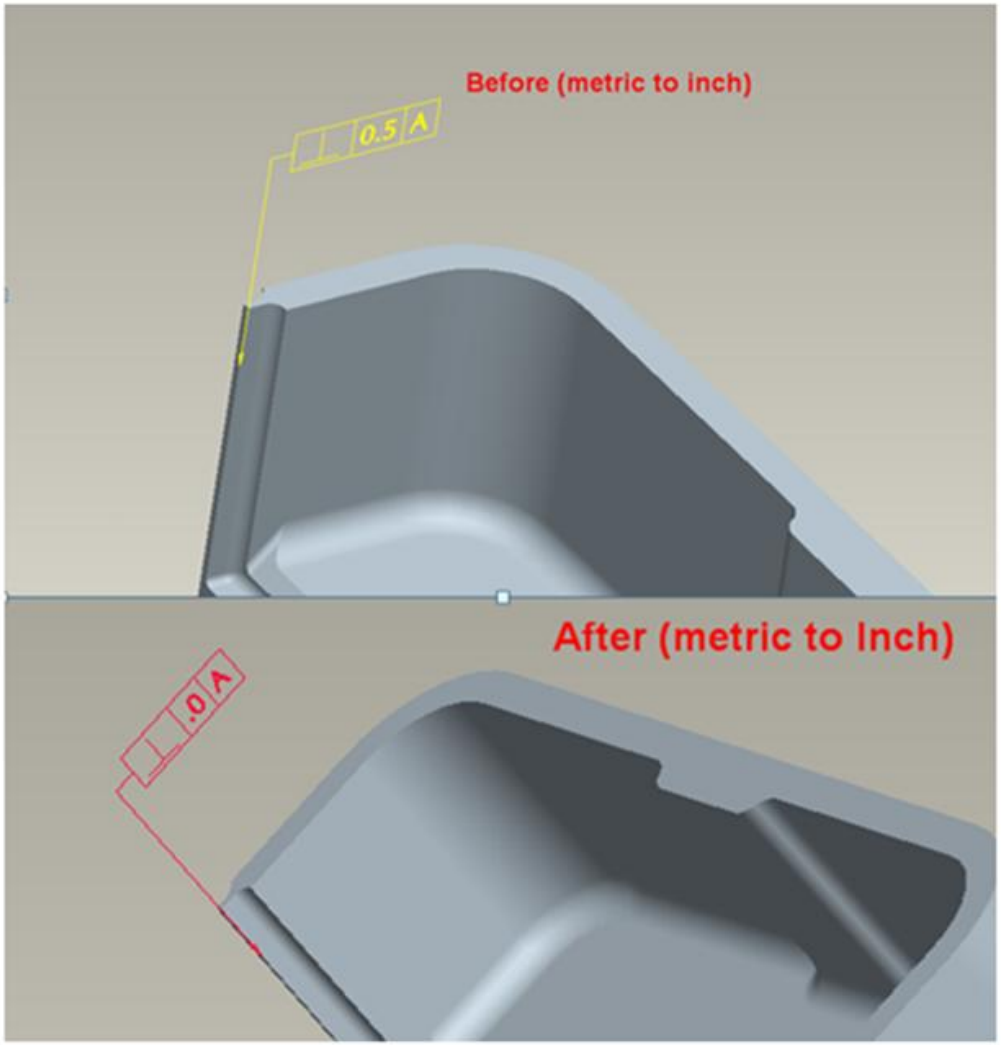
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After (metric to Inch)
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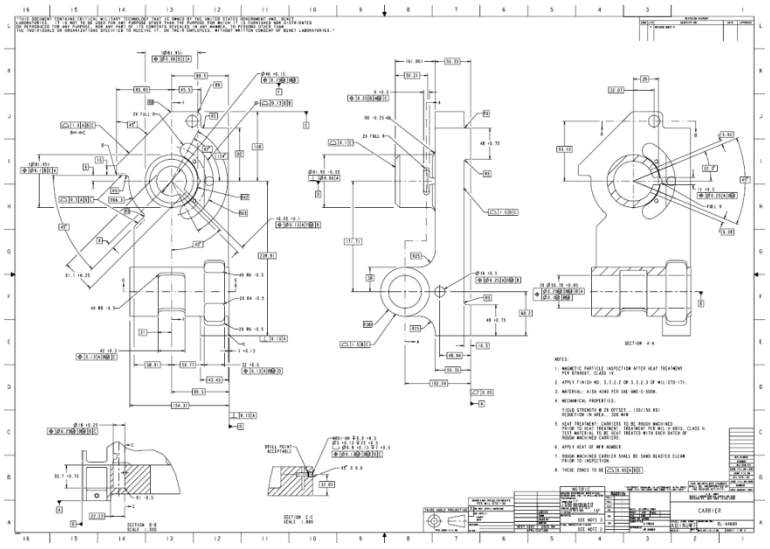
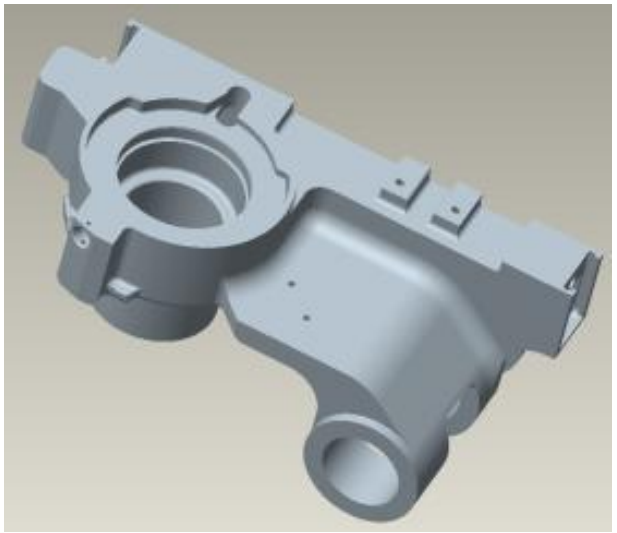
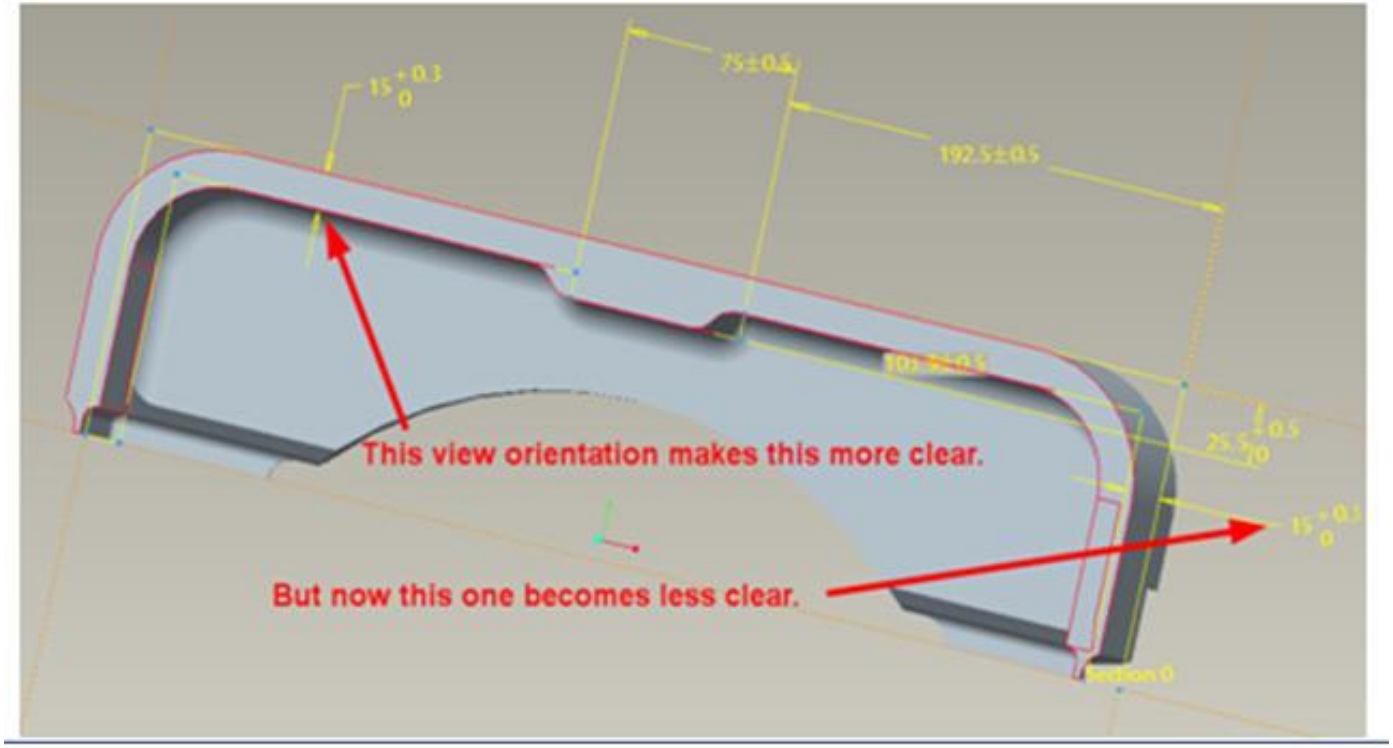
- Challenges to realize Model Centric outside DOD
  - Substantial amounts of legacy data exist in 2 D records only:
    - 2D PDF and C4: Current Army Document of Record
    - Investments in modeling these products must be driven by an economic model
  - Intellectual Property protections not well defined in 3D models
  - Optimal design for 1 vendor/process may be suboptimal for another vendor/process
  - Use of 3D data can create barriers to smaller vendors unable to make 3D capability investments





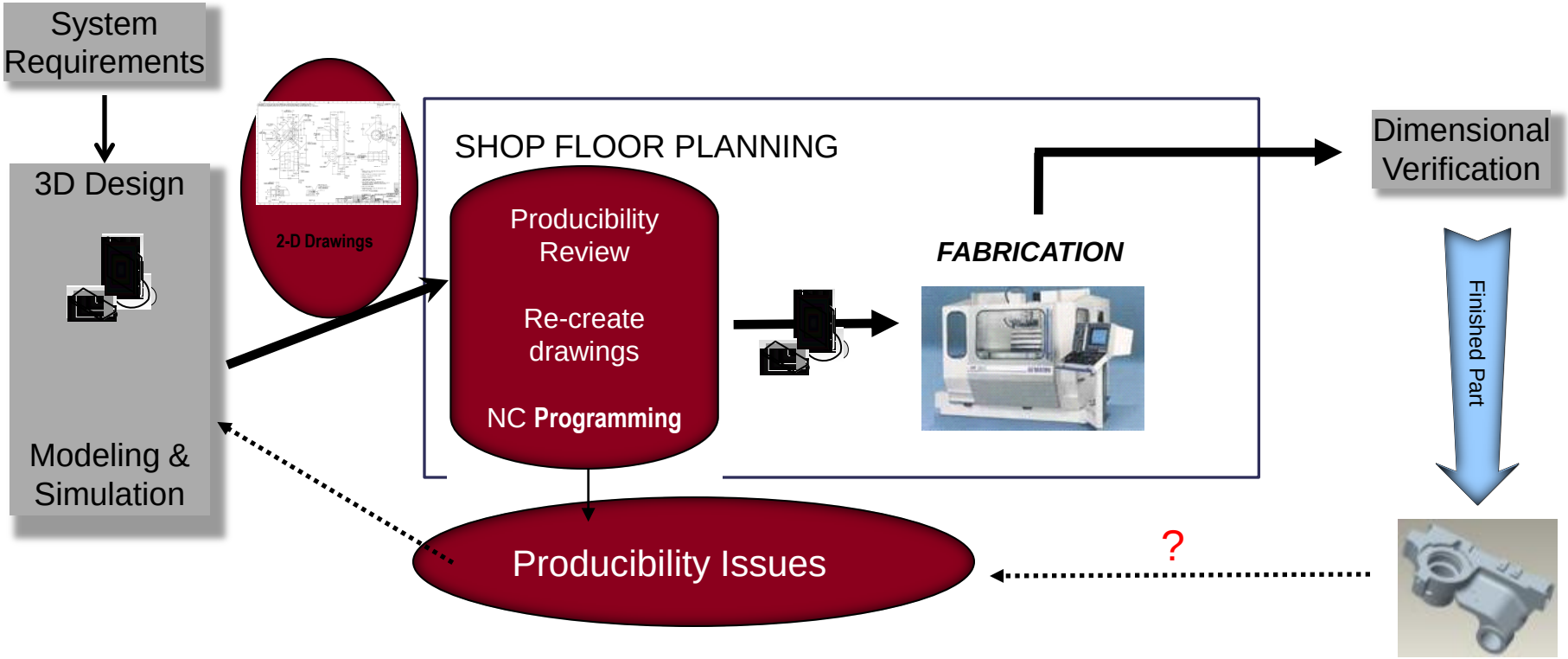
- Challenges to realize Model Centric outside DOD
  - Visualization of data



- Smart Machine Platform Initiative
  - A framework for the identification, development and transition of technologies that recognize the goal of ‘First Part Correct’ Manufacturing
  - Demonstrate technologies identified to produce the first and every subsequent part and part feature to specification without unscheduled delays or significant human intervention.
  - Transition program through organic DoD facilities and DoD contractors
  - Bottom line:  Timely and cost effective acquisition of DoD components
  - Issues Addressed
    - Rapid production and cost reductions required
    - Costly tooling for low volume production
    - Producibility issues / Rework and scrap rates
    - Knowledge retention / Aging workforce
    - Diminishing supplier base

- Thrust Areas:
  - Intelligent Process Planning
    - Feature Recognition – semi automatic programming: 120 mins → 15 mins
    - High Performance Machining Optimization - saves 30% - 50% of machining time
    - Tool Data Management - Integrated with ESPRIT (CAM)
    - Virtual Machining - Reduced cutting errors
  - Machine Tool Health & Maintenance
    - Increased Tool Life & Availability
    - Reduced Turnaround time
      - Correction of minor problems, preventing catastrophic ones
      - Plan for maintainance during downtime
  - Tool Condition Monitoring
    - Reduced Costs & Scrap; Fewer Process Interruptions
    - On-Machine Vision
  - Intelligent Machining Network
    - Allows storage & organization of CNC programming
    - Communication of objective, real-time process data

- How is it done today?

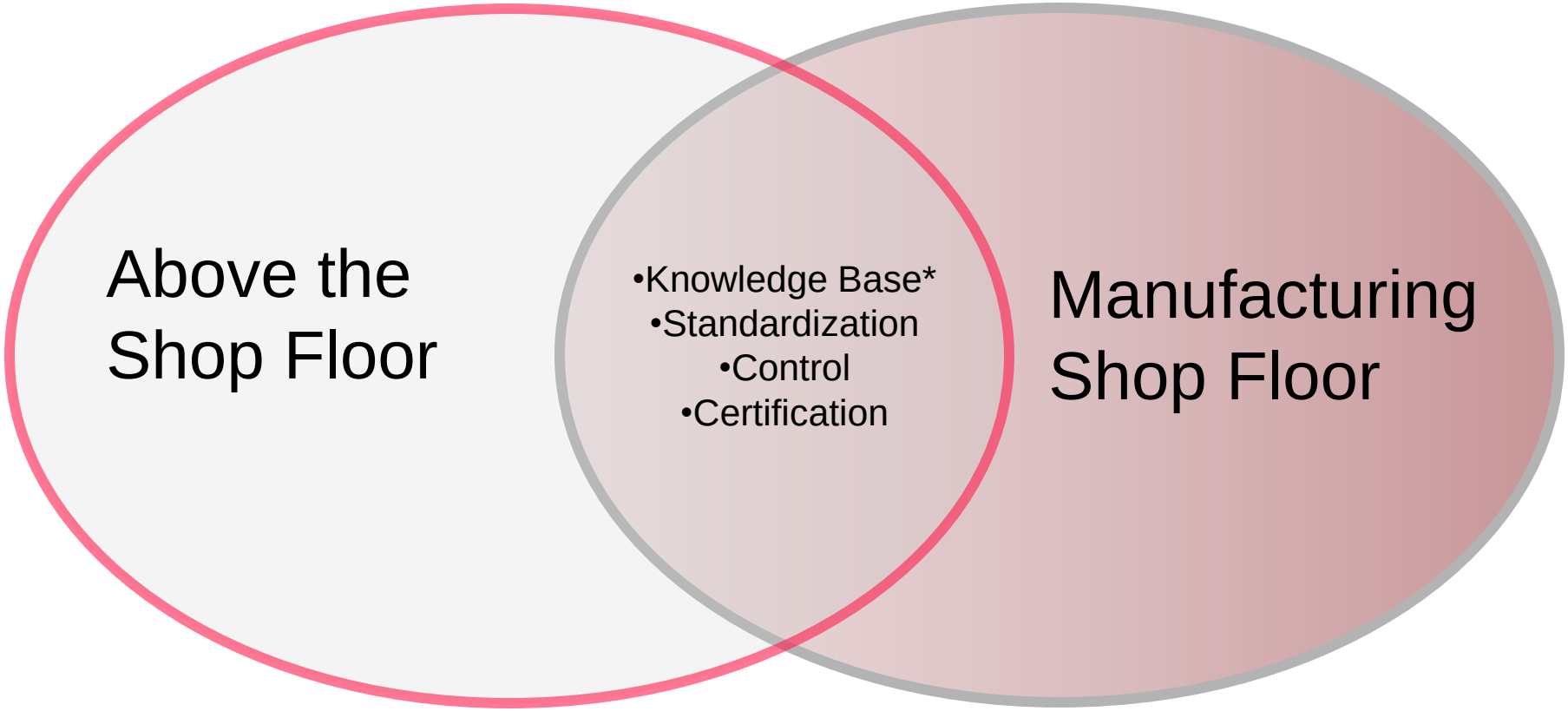



**Limitations:**

- 2-D TDP as "master" / Regeneration of 3-D Model
- Lack of lessons learned / feedback
- Limited in-process verification
- Ineffective producibilty review

- How are we approaching the Smart Machine Platform Initiative?
  - Identify / Develop, Validate and Demonstrate enabling technologies:
  - Create demonstration test beds for enabling (Smart Machine) Technologies
    - Assess the Capabilities and Limitation of the technologies
    - Assess & Validate each Technology to “First Part Correct”
      - Focus: Return on Investment
    - Determine the Inter-relationships between technologies
    - Identify Technology Gaps
  - Provide the introduction of technology to industry & DoD
    - Demonstrate technologies in in-house (Benet) shops
    - Demonstrate/Transition technologies to organic (DOD) facilities
    - Involve private vendors through SMPI Umbrella
- Interaction with Logistics Modernization Plan

Benét Process Vision and Theme
Knowledge Driven Manufacturing




* Knowledge Base = Intellectual IP

# Next Generation Machining & Modeling Technology



*"ABOVE THE SHOP FLOOR" ACTIVITIES*

*"SHOP FLOOR" ACTIVITIES*

**KDMS**

Best Practice / Process Knowledge
Databases: Engineering Knowledge
Cutting Tool / Machine
Feature Recognition

MODEL CENTRIC

**3-D Model-Centric Design**

Model Centric Standards
Fully Annotated Models
Model Based Environment

**Modeling & Simulation**

**Producibility Review**

**Producibility Issues**

**Intelligent Process Planning**

NC Programming
Cycle Time
Production Costs
Tolerance Capability

**SMART MACHINE PLATFORM INITIATIVE (SMPI)**

**Tool Condition Monitoring**

**Dimensional Verification**

**Machine Metrology**

**Intelligent Maintenance**

**System Requirements**

**First Part Correct**

Malcolm Baldrige National Quality Award 2007 Award Recipient

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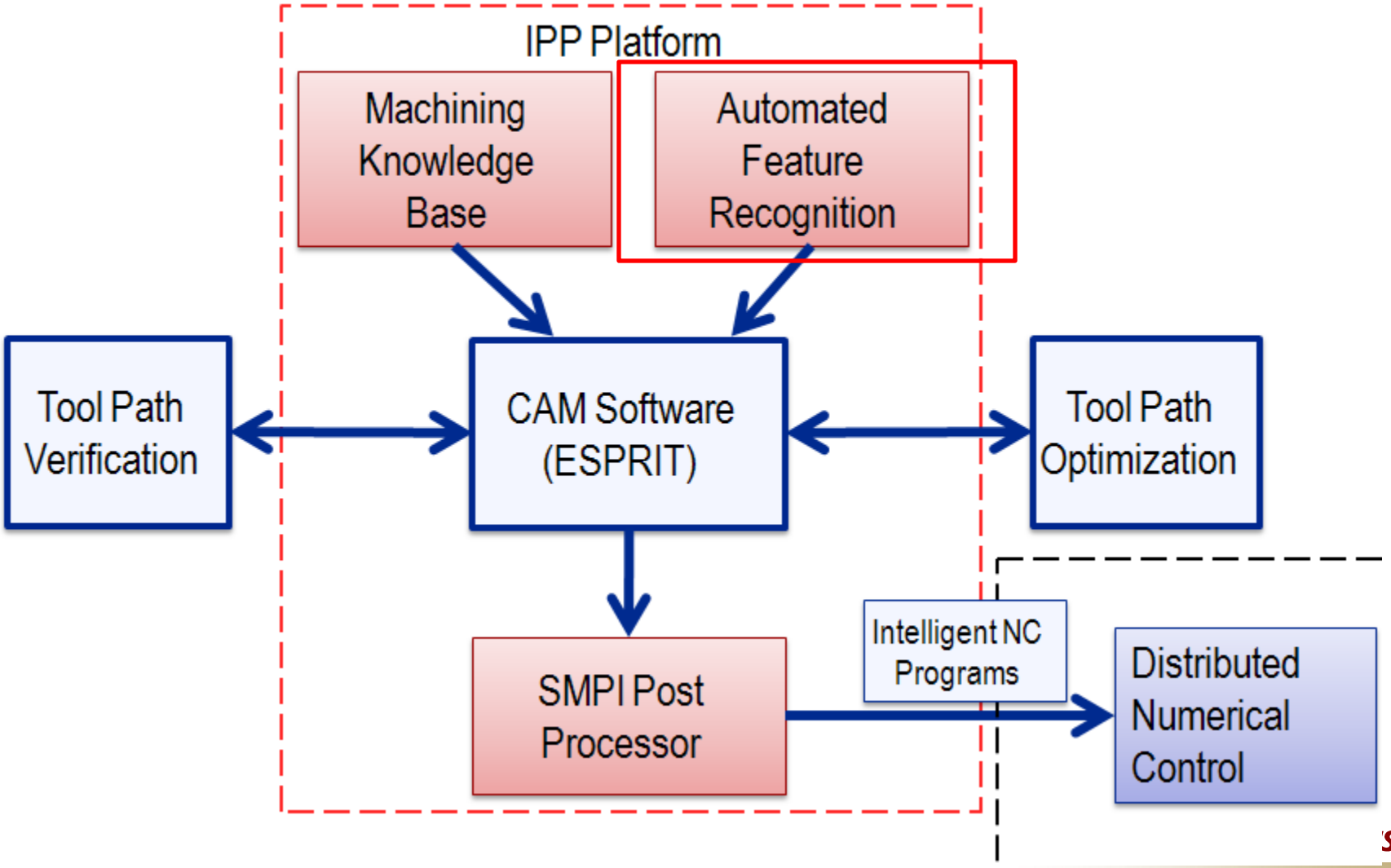
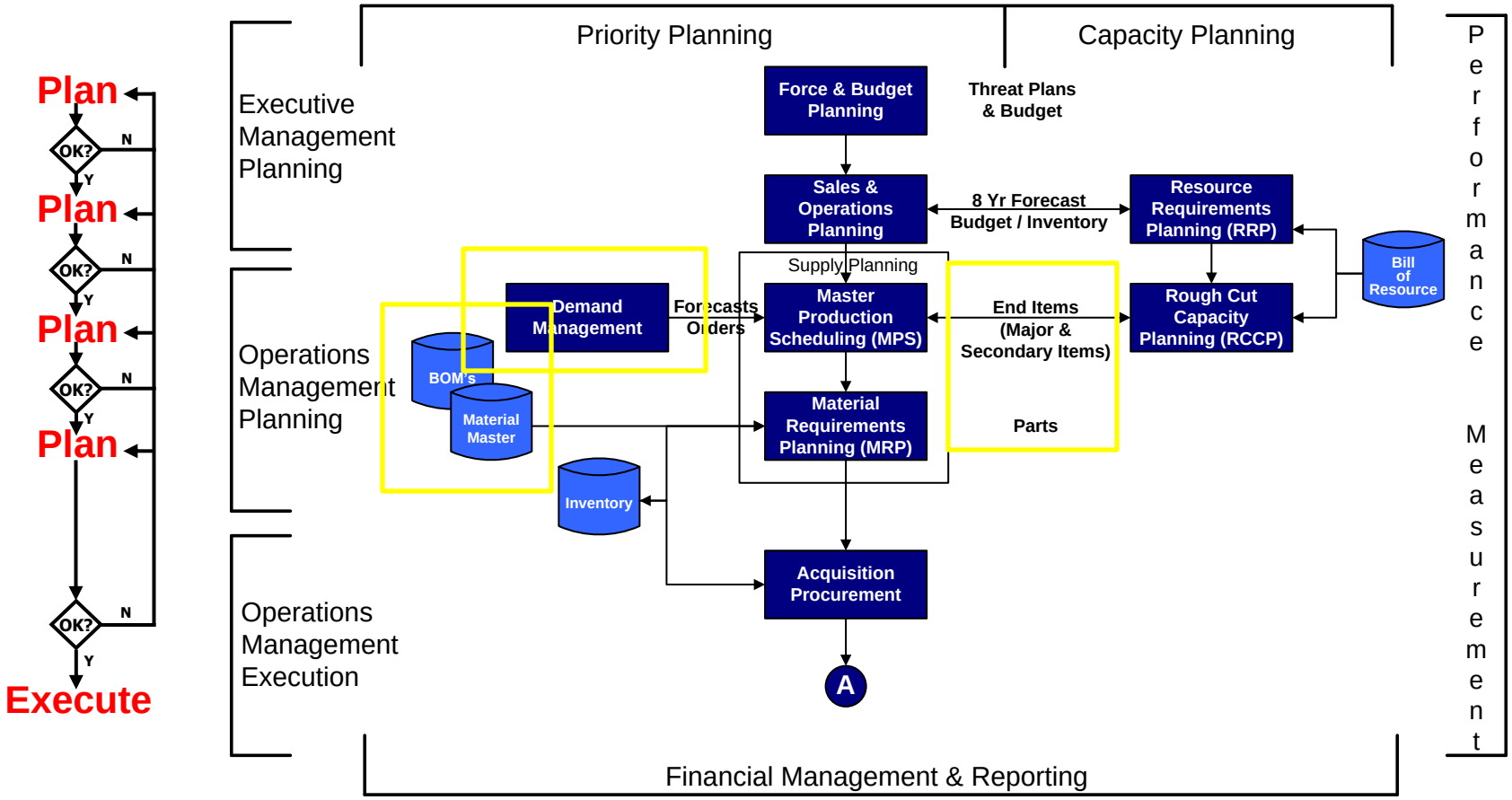
## Intelligent Process Planning



- Logistics Modernization Plan
  - An Army wide Enterprise Resource Planning system being implemented now.
  - Dovetails with SMPI by:
    - providing a smart network to distribute information
    - Extending planning into materials, tooling, acquisition
    - Addressing user demand/needs
    - Creating a database for evaluation

# ERP Business Process Overview

## *High Level ERP Closed-Loop Business Process Model - LCMC View*




## *Customer / Partner / Supplier Integration*

## Advisory Group (Est. 2006)

## Smart Machine Platform Initiative (SMPI)

Future Intelligent Integrated Machining Technologies

(FITMaT)

### Government Advisory Group

- U.S. Army ARDEC Benét Labs – **DoD Lead**
- U.S. Army Research Laboratory
- U.S. Air Force – ManTech
- Defense Logistics Agency
- NIST – Manufacturing Engineering Lab
- NNSA Y-12 National Nuclear Complex

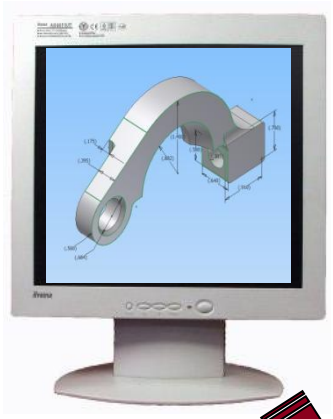
### Industrial Advisory Group

- BAE Systems
- The Boeing Company
- Caterpillar, Inc.
- Cincinnati Machine
- Delphi Automotive
- Ex One
- Ford Motor Company
- GE Aviation
- GD Land Systems
- GD Ordinance & Tactical Systems
- Hurco Companies, Inc.
- Lockheed Martin
- Pratt & Whitney
- Remmele Engineering
- Rolls Royce
- Sikorsky Aircraft Corporation
- Vought Aircraft

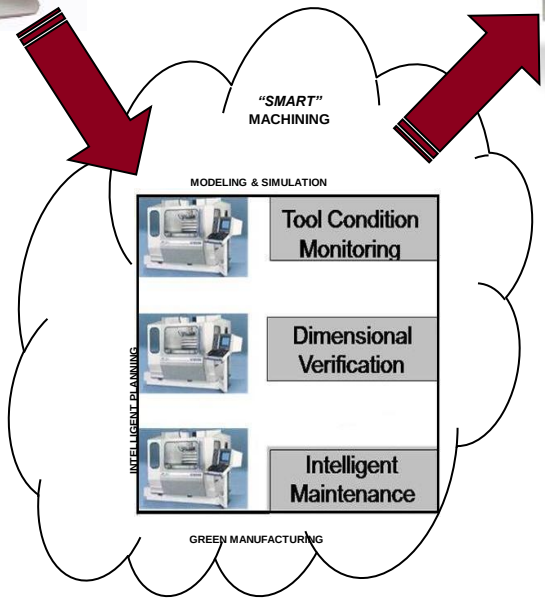
- Challenges to implementing Smart Machine Platform Initiatives within organic manufacturing *or using other vendors*
  - Disparate file formats, databases, optimization approaches create communication barriers.
  - Low demand quantity environment makes it difficult to identify large scale cost savings to justify investment, implementation
  - Established workforce sees increasing ‘knowledge based’ tools as a threat
  - Outside the organic manufacturing base, many unique, small vendors lack the resources, communications links, skill levels to implement some of the SMPI elements

- Why does Smart Machining Platform make more sense for DOD than many other industries
  - Low demand level, wide variety of parts needed on high priority basis
    - Allows very flexible manufacturing approach
    - Allows lessons learned to be retained outside of organic (human) skill base

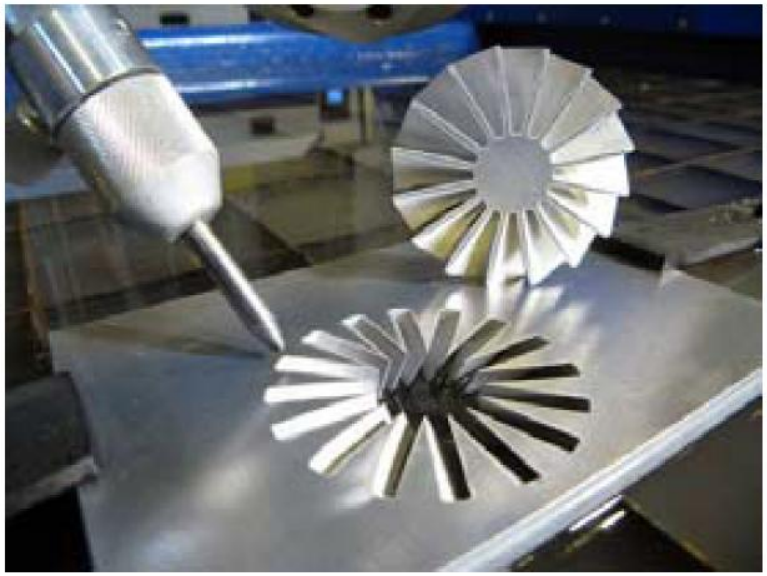
- Next Generation Manufacturing:
  - A series of initiatives to explore advanced manufacturing techniques to reduce costs and to bring new capabilities into DOD Products
  - Focus on “Additive Manufacturing Processes” to exploit the digital models available through the Model Centric approach and reduce waste materials
    - Laser Enhanced Net Shaping (LENS) System – an additive system approach
    - StereoLithograPhy (SLA) generation of near net shape parts in polymers
  - Other approaches include the integration of new techniques with existing processes to focus on net-shape or near-net-shape results
    - Use of SLA with castings
    - Direct tool path generation for waterjet cutting machines
  - Utilizes features of SMPI to enhance routing, material processing
  - Provides cost effective fabrication of low production runs on unique parts
  - Provides new capabilities




OPTOMEC
LENS Model 850-R


"SMART"
MACHINING
MODELING & SIMULATION
Tool Condition Monitoring
Dimensional Verification
Intelligent Maintenance
INTELLIGENT PLANNING
GREEN MANUFACTURING

- Challenges to implementing Next Generation Manufacturing
  - Modeling of parts for new processes may require new design approaches and optimization
- Why does Next Generation Manufacturing make sense
  - Focus on additive manufacturing processes leads to less waste
  - Focus on additive manufacturing processes means lower investment in raw materials
  - New processes can yield new materials that increase performance of equipment



Questions?

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