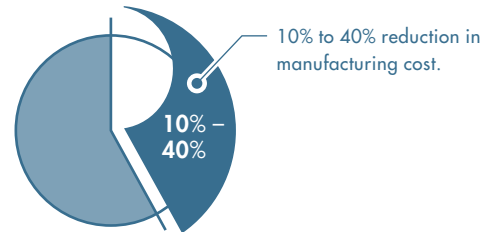


# Manufacturing Process Management

DEFINING AND MANAGING THE PROCESSES USED TO FABRICATE PARTS, ASSEMBLE FINAL PRODUCTS, AND PERFORM INSPECTION

In today's increasingly competitive environment, companies are under constant pressure to not only design new products faster, but also to ramp up production of them with minimal time-to-market, predictable cost, and required quality. Improving the MPM business process is essential to hitting these challenging cost, time, and quality targets.



Possible Cost Reduction

Effective manufacturing process management can have a significant positive profitability impact.

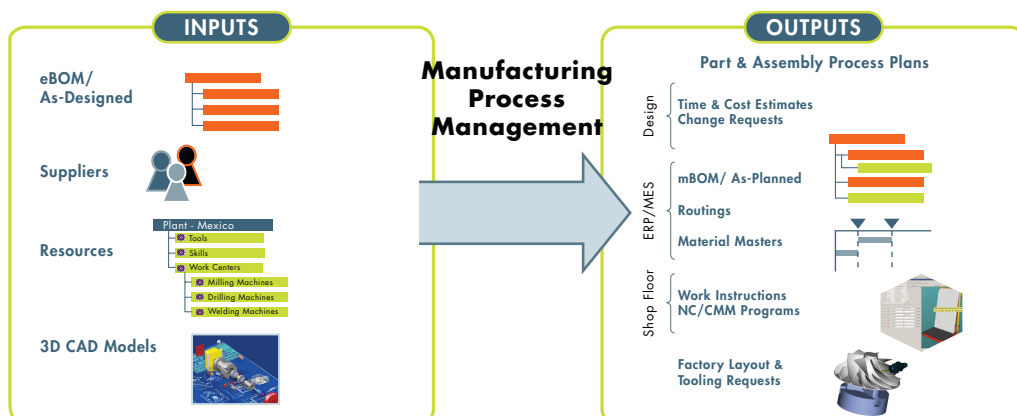
Source: DARPA RaDEO Project

## Definition of Manufacturing Process Management (MPM)

Whereas the focus of many engineering-centric processes is on "what" product to produce, manufacturing process management defines how a product is to be produced. MPM receives the digital product definition from engineering, considers the capabilities and capacities of internal plants and external suppliers, and delivers the set of manufacturing plans required to produce the product.

MPM also entails giving early feedback from manufacturing to engineering based on preliminary versions of the manufacturing processes. Additionally, the MPM process communicates with production systems (ERP/MES), delivering optimized routings, and manufacturing bills of materials (MBOMs) and work instructions, including all supporting documents needed by production operators to build the product.

## Process of defining and managing the manufacturing processes to be used to fabricate parts, to assemble final products, and to perform inspection



## Understanding the Need for Manufacturing Process Management

Optimizing the MPM process is becoming increasingly important to companies. Unfortunately, the process itself is also becoming more difficult to streamline. Products, while becoming more complex, must remain configurable to meet market needs. At the same time, production volume, cost, and time-to-market targets are shrinking. Manufacturing organizations must adapt their manufacturing environment to ramp-up new designs with higher productivity, flexibility and quality.

There are four key areas where companies can typically improve their MPM process.

**1. Define the Manufacturing Process During the Product Design Phase.** Generally, designers “throw the design over the wall” to manufacturing engineers. However, if manufacturing engineers have direct access to the ever-evolving design information, they can define the manufacturing process in parallel with product design. Furthermore, with this information, manufacturing becomes better equipped to handle concurrent product development and is able to adapt to in-process engineering changes.

**2. Provide Manufacturing Engineers with Access to Engineering Data.** Accurate manufacturing process definition requires that manufacturing engineers be able to directly reuse engineering data, including parts, classification, 3D mockups, and manufacturing requirements, such as GD&T information. Yet, typically, manufacturing engineers lack direct access to this information.

**3. Eliminate Manual Processes.** Today, most process plans are defined using a spreadsheet program, and work instructions are created using a word processor. This use of manual tools leads to a variety of issues: slow execution of the process, data duplication and inaccuracy, and chaos whenever a change occurs to the engineering definition of the product.

**4. Improve enterprise collaboration.** Since manufacturing environments typically span multiple plants and time zones, and with manufacturers seeking to implement “design anywhere, build anywhere” strategies, it’s difficult for manufacturing engineers to capture and share their knowledge, and ensure consistency across the enterprise.

## Benefits of an Optimized Process for Manufacturing Process Management

Typical benefits from improving the MPM process include:

### **Improved Efficiency of Manufacturing Engineers**

- Enables direct reuse and manipulation of engineering information in process plans, to avoid data duplication
- Enables reuse of standardized and normalized processes and resources
- Reduces time required to create and update work instructions through their dynamic generation

### **Improved Production Ramp-up and Productivity**

- Reduces training time and learning curve with accurate and meaningful 3D work instructions
- Reduces production trial and error method of optimizing of the manufacturing processes with digital validation

### **Reduced Cost of Changes**

- Identifies required design changes earlier in the design, with timely feedback from manufacturing
- Streamlines change impact identification and propagation
- Increases engineering visibility to the potential manufacturing impact of a change, to facilitate cost effective design decisions
- Provides an integral change management system, which supports both engineering and manufacturing needs

### **Reduce Scrap and Rework**

- Reduces the risk of producing incorrect product configurations by eliminating discrepancies between the latest process definition and the work instructions used on the shop floor

Unless manufacturing processes can be planned, designed, modeled, and ramped up, there is no scalable business potential.

– AMR, January 2004

## The Solution – PTC’s Product Development System

The MPM process is generally characterized by the following steps:

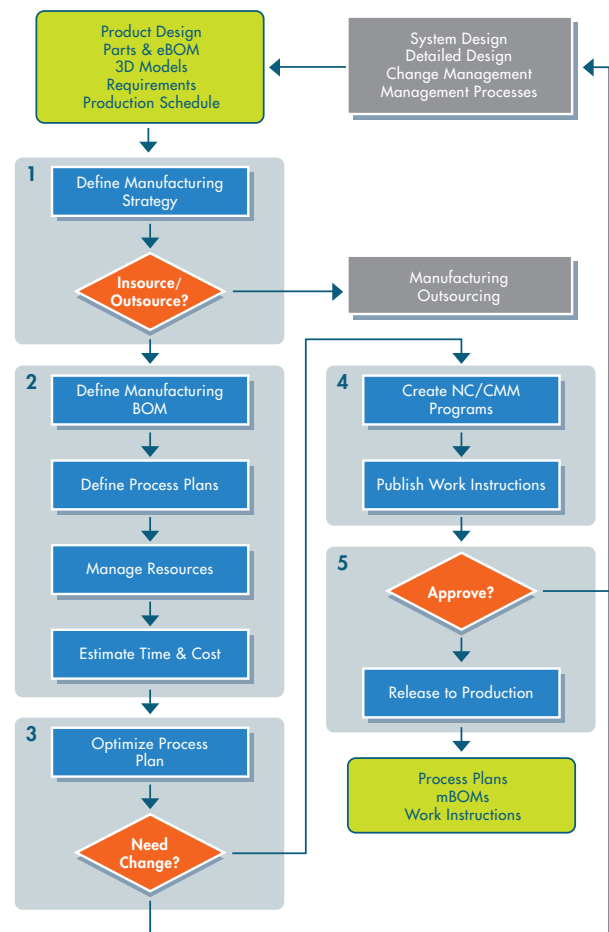
**1. Define Manufacturing Strategy.** In this step, manufacturing engineers evaluate both the design requirements and the manufacturing capabilities and capacities necessary to support the manufacturing strategy. They identify which partners will be required, and any long lead items that will need immediate attention.

**2. Advanced Manufacturing Planning.** (“Advanced”, in this context, means early) In this step, manufacturing engineers work concurrently with engineering, as early as possible in the design process, using preliminary design information. Together, they create preliminary versions of the manufacturing bill of material (mBOM) and process plans, initiate new tooling requests, and produce time and cost estimates. Factual feedback or requests for change are also provided to engineering in the early stages of product design to improve manufacturability.

**3. Optimize Process Plan.** In this step, manufacturing engineers create several manufacturing process alternatives to compare and optimize the manufacturing process. Manufacturing process alternatives can represent either different alternatives in one plant, alternatives between different plants, or make-versus-buy options. Optimization methods typically include line balancing, but can also involve more specialized types of simulation, such as work center simulation or whole factory discrete event simulation.

**4. Document Process Plan.** Once the process plan and product design are mature, the manufacturing engineer must detail and document the manufacturing processes that have been selected from the previous optimization step. PTC’s Pro/ENGINEER® or other 3D CAD/CAM tools are used to define NC (numerical control) tool paths or CMM (coordinate measuring machine) inspection programs. Work instructions are produced for the operator, and typically include images of the product which are dynamically generated from the process definition with Windchill MPMLink. These images can be associatively defined using Pro/ENGINEER or PTC’s ProductView® visualization solution, so that they may easily be kept up-to-date.

**5. Pre-Production and Production.** In this step, the manufacturing process definition is electronically released to production systems (ERP/MES). Work instructions are made available to the shop floor in either printed or electronic format. Electronic work instructions can also be used to collect feedback from the actual execution of the process, including results of inspections, deviations, and as-built BOMs.

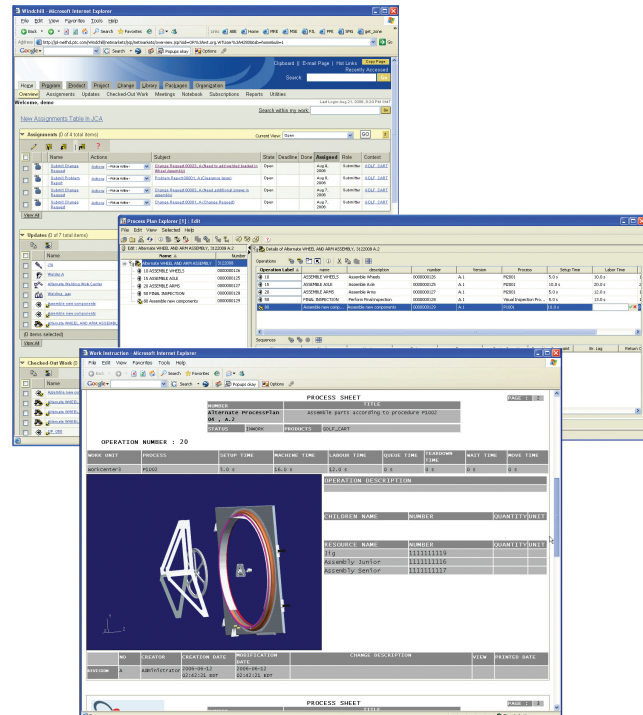


MPM Process Flow

## Critical Capabilities

With the release of Windchill® MPMLink, PTC's Product Development System will support the MPM process with an integral solution which includes the following capabilities:

- **Integral Product, Process, and Resource object model:**  
The industry's only integral PLM (Product Lifecycle Management) solution where both product definition and process definition data are managed in a single system, without any data duplication.
- **Integral change and configuration management covering both engineering and manufacturing impact**
- **Associative eBOM-mBOM transformation with the ability to transform engineering bill of materials (eBOM) into multiple manufacturing bill of materials (mBOM), while keeping associativity with traceability links**
- **eBOM-mBOM reconciliation with visual indicators**
- **Embedded 3D environment (provided by included ProductView capabilities) enabling the ability to:**
  - Visualize engineering designs
  - Select parts from 3D to create mBOM and to allocate part to process plan operations
  - Dynamically generate 3D representations of the mBOM, process plan and operations
  - Include 3D annotations and markups
- **Process plans which allow the definition of plant-specific processes with alternate and parallel sequences of operations and sub-operations**
- **Ability to completely define process plan operations with parts, resources, standard procedure, documents, and time breakdown**
- **Ability to manage resource libraries (Plant, Work Center, Tooling, Process Materials, Skills)**
- **Ability to manage manufacturing capability libraries composed of standard procedures and standard process plans**
- **Dynamically generated work instructions**
- **An available framework for ERP and other integrations**



Windchill MPMLink enables accurate process plans and dynamically created work instructions.

## PTC – Uniquely Qualified

An automated and optimized MPM process not only requires superior technology, it also requires companies to streamline their day-to-day processes. Just as important, companies need to ensure that everyone across the organization understands and adopts the new processes and technology.

After 20 years of deploying process and technology improvements across thousands of customer sites, PTC Global Services understands all the components required for companies to achieve their product development goals. We offer solutions that include the right blend of process consulting, system implementation, and education services so customers realize the most value from their PDS investment. We implement industry best practices that fully leverage PTC technology, so companies take advantage of the technology's potential while avoiding costly customizations. Plus, each of our solutions incorporates a unique training approach that accelerates the adoption of new technology and processes.

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