Maturity Assessment of Digital Manufacturing Initiative

A step towards collaborative integrated Engineering & Manufacturing environment
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Introduction

Globalization is creating competitive pressure on industries to bring innovative products and reduce product development cycle time. In today’s rapidly growing and increasingly competitive industry, more and more companies are turning to an interesting mix of technologies and processes. Adoption of lean philosophy, agile manufacturing, just-in-time manufacturing, and DFx (Design for Manufacturability, Design for Assembly etc) initiatives have become part of the manufacturing strategy.

Digital Manufacturing solutions support these strategies by bridging the gap between “what to manufacture” (product development) and “when-where-how much to manufacture” (production) and answering the “how to manufacture” (process). Digital Manufacturing solution creates a logical relation between “As-Designed” and “As-Built” product by providing “As-Planned” definition.

The Digital Manufacturing portfolio comprises of multiple solution components such as process planning, process simulation and manufacturing process management solution framework for data management, change management, web enabled collaboration etc. So the challenge lies in identifying and integrating the areas to meet the objectives of Digital Manufacturing initiatives with corporate PLM/IT initiatives. This can be achieved through a systematic assessment of business needs and the current maturity level of implementation of each identified solution component. Such assessment also helps in building the business case for investment decision and in defining right implementation roadmap.

This paper outlines the framework and methodology that can be used for assessing the maturity of Digital Manufacturing solution implementation.

Digital Manufacturing - A Perspective

Digital Manufacturing has become an integral part of product lifecycle management solution. Process planning definition to finalization by digital validation has become the key function in reducing of product deployment time in the lifecycle and addresses several critical business challenges faced by today’s global manufacturers, including the need to:

- Accelerate new product introductions (NPI)
- Shorten time-to-volume
- Optimize production execution
- Decrease operating costs
- Ensure overall product and process quality

Facilitate collaboration amongst design, manufacturing engineers and shop floor personnel
Typical components of Digital Manufacturing solution include:

- Manufacturing process planning providing means to do computer aided process planning (CAPP) in a systematic manner which includes component and assembly manufacturing
- Manufacturing process documentation
  Manufacturing data management (MDM) which manages information about manufacturing resources, process plans, plant data, quality documents, work instructions etc. and provides the necessary backbone for access control, change management etc
  Integration with upstream and downstream software applications such as CAD/CAM, PDM, MES, ERP etc
  Environment for visualization and collaboration enabling effective communication and data sharing within the organization and with the extended enterprise as well
- Manufacturing change management
  Manufacturing simulation and analysis which supports assembly simulation, work cell simulation, robotic simulation and OLP, plant layout design and optimization, throughput simulation, and ergonomic simulation etc
- Computer aided manufacturing for machining code generation and verification for CNC machines

Figure 2 depicts the Digital Manufacturing space in the extended PLM environment inclusive of manufacturing execution and interfaces with enterprise resource planning.
Digital Manufacturing Initiative - Industry Scenario

When we analyze the current industrial environment, we observe the below scenarios as regards to the Digital Manufacturing initiative.

Greenfield – This pertains to a completely new setup. It is characterized by sporadic use of Digital Manufacturing point solutions.

Brownfield – This is most common scenario today. It is characterized by the following salient points:-

- Some of the Digital Manufacturing point solutions in use
- Operating in silos
  Each functional group may have different solutions from different software vendors depending on the specific requirements
  Awareness of the benefits of having an integrated engineering & manufacturing environment, but yet to reach the milestone

Concept

For successful selection and deployment of Digital Manufacturing solutions, it is important to :-

- Identify and prioritize the business needs
- Assess the current maturity level
- Prioritize and build the required capabilities

Awareness forms the foundation for improvement. Assessment of the present state creates the awareness which leads to the identification of improvement areas to achieve the desired state. Maturity as regards to a technology initiative can be described as a composite of predictability, effectiveness, consistency and scalability.
Predictability refers to the capability to achieve the estimated results as per the schedule and milestones. Effectiveness is the ability to achieve the precise and right outcome as planned in an efficient manner adhering to the quality, cost and time norms. Consistency refers to the ability to achieve the goals over and over again with minimal deviation. Scalability is the ability to extend the existing technology framework and accommodate the varied industry needs over a period of time.

The mark of mature organization is not do different things but do things differently with the commonly available technologies. They have systematic and documented processes of doing things. Determining the criteria for maturity assessment is very critical and various aspects needs to be considered such as :-

- Concept of progress maturity as applied to Digital Manufacturing initiative
- Digital Manufacturing technology usage in the organization
- Alignment with organizational processes

**Maturity assessment framework**

There can be several approaches for the maturity assessment framework :-

- Basic framework with Digital Manufacturing technology implementation maturity
- Integrated framework with Digital Manufacturing technology implementation maturity and business alignment

The proposed Digital Manufacturing maturity framework provides a high level understanding of various factors an organization can assess to develop and extend Digital Manufacturing initiative as an integral part of the corporate PLM drive.

This conceptual framework has been proposed based on insights from Capability Maturity model integration (CMMI) and business/IT alignment model.

Geometric’s Digital Manufacturing initiative maturity model proposes the maturity assessment framework for Digital Manufacturing technology implementation maturity and business alignment. The representative assessment areas for Digital Manufacturing technology implementation and business alignment are provided in the table shown in Figure 4 and Figure 5 respectively.
## Maturity Assessment of Digital Manufacturing technology implementation

<table>
<thead>
<tr>
<th>Maturity Level</th>
<th>DMfg Technology</th>
<th>Business Dimension</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maturity Level 1</td>
<td>Ad-Hoc / undefined Over the wall</td>
<td>Organization and Process</td>
</tr>
<tr>
<td>Maturity Level 2</td>
<td>Repeatable Independent Silos</td>
<td>Strategy and Policy</td>
</tr>
<tr>
<td>Maturity Level 3</td>
<td>Defined Process Driven</td>
<td>People and Culture</td>
</tr>
<tr>
<td>Maturity Level 4</td>
<td>Managed Interfaced Functions</td>
<td>Monitoring and Control</td>
</tr>
<tr>
<td>Maturity Level 5</td>
<td>Optimized Collaborative Manufacturing Environment</td>
<td>Manufacturing technology &amp; Infrastructure</td>
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**Figure 4 - Maturity assessment of Digital Manufacturing technology implementation**

## Maturity assessment of Digital Manufacturing business alignment

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</table>

**Figure 5 - Maturity assessment of Digital Manufacturing business alignment**
These provide the metrics for maturity assessment of Digital Manufacturing initiative based on the blended concept of CMMI progress maturity and business alignment.

The assessment can be represented on radar charts for easy understanding. Figure 6 shows sample output of one such assessment of an organization operating in the automotive domain.

**Figure 6 – Digital Manufacturing maturity assessment – radar chart representation**

The salient characteristics of this organization were:

- Document driven/legacy system with limited access to 3D design data for manufacturing process planning
- CAM solution with integrated CAD & PDM environment
- Point solutions for Manufacturing simulation available with some customization
- Automated report generation process for manufacturing process documentation but the managed environment is missing
- Manufacturing data being stored in central file system with no control on revisions
- Isolated document driven manufacturing change management
- No proven integration with upstream and downstream engineering and enterprise applications
- Some point solution available for visualization and collaboration amongst engineering and manufacturing teams
- Procedures to support Digital Manufacturing related activities are defined and made available to the concerned.
- Strategy for Digital Manufacturing solution deployment is defined and communicated.
• There is general awareness about Digital Manufacturing initiative and technology.
• No standard mechanism in place to monitor Digital Manufacturing related activities and measure performance.
• Project based investment plan for Digital Manufacturing technology and related infrastructure.

Such assessment helped to identify some of the improvement areas in terms of Digital Manufacturing technology implementation and the required business alignment.

**Key Approach**

Following is the recommended stepped approach for maturity assessment of the Digital Manufacturing initiative:

• Identify business drivers and key processes for corporate wide manufacturing initiatives
• Identify and assess existing processes and system to document limitations and pain areas
• Root cause analysis and prioritization of business needs.
• Identify the areas where Digital Manufacturing technologies can support these initiatives.
• Conduct research to analyze trends in Digital Manufacturing technologies and services market.
• Identify required Digital Manufacturing technology components to address the business needs.
• Assess the As-Is maturity level of Digital Manufacturing solution implementation using the assessment framework
• Define the To-Be maturity level vis-à-vis industry best practices and in alignment with the business objectives.
• Prepare plans to build/ enhance the capabilities, and processes based on the identified gaps.
• Implement the plans for capability and process enhancements.

**Conclusion**

• The proposed assessment framework for Digital Manufacturing technology usage provides a means for assessing the maturity of Digital Manufacturing initiative in an organization
• An Integrated maturity assessment framework with Digital Manufacturing technology capability and business alignment will provide more scientific and quantitative results
• Such framework helps to assess the current maturity level and benchmark against industry best practices to develop capability improvement plan for Digital Manufacturing. It also helps in phase wise assessment of maturity levels during Digital Manufacturing technology implementation
This enables the organization to progress towards collaborative integrated engineering and manufacturing environment.

Such an assessment supports the business case for investment decision for Digital Manufacturing and provide input for strategy formulation and roadmap for organization wide PLM initiative.

About the Author

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Yogesh Modak has been working in the area of product lifecycle management, Digital Manufacturing and CAx for over 10 years. Currently he is leading the Digital Manufacturing practice at Geometric Ltd.
About Geometric

Geometric is a specialist in the domain of engineering solutions, services and technologies. Its portfolio of Global Engineering services and Digital Technology solutions for Product Lifecycle Management (PLM), enables companies to formulate, implement, and execute global engineering and manufacturing strategies aimed at achieving greater efficiencies in the product realization lifecycle.

Geometric was incorporated in 1994 and is headquartered in Mumbai, India. It is listed on the Bombay Stock Exchange (BSE: 532312) and the National Stock Exchange (NSE: GEOMETRIC) in India. For its consolidated operations for the year ending March 2007, the company recorded revenues of 3.95 Billion Rupees (85 Million US Dollars), with market capitalization of 6.2 Billion Rupees (142 Million US Dollars) as on 31 March 2007.


Geometric employs over 3000 people delivering solutions from 10 global delivery locations in the US, France, Romania, India, and China. The company is assessed at SEI CMMI Level 5 for its software services and the engineering operations are ISO 9001:2000 certified.

Geometric has a joint venture with Dassault Systèmes, 3D PLM Software Solutions Ltd., which was set up in 2002 with an equity participation of 70% and 30% respectively.

For further details about Geometric, please visit www.geometricglobal.com