Defining a Technology Strategy to Support Product Development

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EXECUTIVE OVERVIEW

Over the past three decades companies have made remarkable gains in manufacturing productivity and efficiency. For instance, the U.S. Department of Labor estimates that since 1987 the typical manufacturing company has experienced just over 3 percent annual gains in labor output per year. This is not surprising given that productivity gains in manufacturing are often realized by optimizing a repetitive sequence of events. In other words, the process to optimize is well-defined with a small degree of variation that can be anticipated.

At the same time, some companies have struggled to duplicate their manufacturing productivity gains during product development. Consider that a typical engineer’s day conservatively includes at least 30-40 percent of non-value added time when his or her expertise is not applied towards innovation. One could conclude that product innovation is too random in nature to ever expect productivity improvements similar to manufacturing and the status quo should just be accepted. Yet, we see every year that successful companies are shortening the amount of time to development and launch a product. Further, these new products have more features that customers desire and achieve ever-higher levels of quality. Clearly, these companies have found a way to augment the innovation process with a strategy that enables greater productivity. This strategy often is strongly supported by executing leadership choosing the right technology tools and systems to support product development.

So, if a technology strategy is paramount to achieving productivity gains during product development, what should a company consider when embarking on its technology roadmap? The first step is to define what challenges during product development need to be addressed. The product development process can simply be defined with the following process flow:
Step 4 is often dominated by ERP and MES software systems, which typically do not directly impact product development productivity. For steps 1 through 3, there are many sub-processes performed by different roles in a company. Further, there are some common technologies that support all 3 of these steps. Some of the major sub-processes and technologies for these pre-manufacturing steps are represented in the diagram below:

Most companies - whether OEMs or suppliers - do all or most of steps 1 through 3. The sub-processes and supporting technologies are also common across many different industry classes – discrete manufacturing, process manufacturing, engineering/service providers, etc. – but with slightly different terminologies that suggest larger differences than really exist. As such, the basic approaches for applying a technology strategy to product development benefits a broad range of industries and business models.

Many companies address the complexity of the above figure by pursuing a broad mix of product development software tools and systems to address different sub-processes and underlying technologies. The lure of this approach is that addressing the overall process seems overwhelming, so teams pursue independent “fixes” without a coherent strategy. While this mix of tools can potentially optimize the contributions of a specific function, the overall process productivity still suffers due to the complexity of data and process exchange.

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Today’s most successful companies have realized that an appropriate strategy for achieving significant product development productivity gains is to choose a software solution that not only delivers most or all of the capabilities described in this diagram, but allows these capabilities to be phased in over time. Broadly speaking, this class of software solution is referred to as Product Lifecycle Management (PLM).

As the appeal of PLM grows, other software providers such as Enterprise Content Management (ECM) and ERP have started to position their offerings to cover some of the capabilities of PLM. Even amongst the traditional PLM software vendors, there are significant differences in the breadth and depth of process and technology. All of these solutions positioning themselves to address the same problems make it more difficult to choose the right PLM approach. Therefore, to successfully set the correct strategy for product development, the company’s selection team must:

1. Gain an understanding of product development sub-processes and determine which ones are applicable to their company’s business model.
2. Understand how these sub-processes must work together seamlessly to achieve optimal results.
3. Assess the supporting technology and be confident that the chosen solution will be able to satisfy their company’s needs not just today, but 20 years from now.

ASSESSING SUPPORTING TECHNOLOGIES

“Commodity” Technologies

The supporting technologies are often where companies make a critical mistake when choosing their strategy for product development. Of the six technologies listed in the previous diagram, three are basically commodities now:

- Document Management
- Collaboration/Workflow
- Cloud and Mobility

Every enterprise class of software on the market today provides some form of these three underlying technologies and some do it at very low cost. In addition, nearly every employee in the company can benefit from these capabilities in some form. This is why so many IT departments pursue corporate-wide Microsoft SharePoint deployments or slightly more capable ECM solutions. They believe they are adding some benefits to the most people at the lowest possible cost.

However, do these solutions really help product development efficiency? The answer is often a resounding “no” and it is easy to understand. While many of the documents managed in ECM are “product related”, the ECM software does not handle the higher-end engineering data that is created during product development. The result is the company has immediately created a barrier between engineers and non-engineers. The ECM technology does not unify the different roles in the company. Instead it becomes a barrier:
Some companies go a different direction and choose to extend their ERP system’s document management capabilities to include engineers in product development. This approach is slightly less short-sighted than applying ECM technology because leading ERP vendors do have CAD integrations to address some engineering processes. However, CAD is often the extent of their product development process coverage. The ERP vendors fail miserably at other product development processes such as systems engineering, simulating the design as it matures, design for manufacturing, and design for environment. So, if your company requires these broader product development approaches now or in the future, then the ERP system will not deliver.

When all of this is considered, it becomes clear that the commodity technologies of document management and workflow should be delivered on a platform that is appropriate for all users, but can also accommodate the more complex needs of engineers.

Change Management

The “change management” sub-process is claimed by nearly every solution too, but again, there are wide ranges of what is delivered. On the low-end, basic revision and version control is provided. Slightly more advanced solutions provide the concept of “maturity”, which means the data or file goes through multiple stages before it is complete. Each stage may require workflows or electronic
signatures to get from one stage to the next.

The most advanced solutions though offer purpose-built change management processes that:

- **Identify** the items to change and explain why they need to change the items.
- **Assess** the business impact of making the proposed change and determine all items that require update.
- **Assign** new item revisions to the individuals responsible for making the updates.
- **Review** the new changes.
- **Coordinate** their release to operations with appropriate effectivity.

Nearly every ECM vendor fails to deliver a change management process such as this. At best, the company will be required to create a workflow to at least allow people to review the proposed changes and the updates. The ERP vendors often have a change management process, but they fall short on the impact assessment given their offerings do not manage the full scope of product development data.

*Project Management*

Similar to ECM, there are many niche solutions for executing project management. Most are excellent methodologies such as defining a schedule, assigning resources to tasks in the schedule, tracking effort, leveling resources, etc. They truly do a great job at automating the project management function. Yet, product development still suffers and fails to meet its goals. This is due to the project management system being disconnected from the work being created, which is often done by engineers. As such, despite all of this great automation for doing their jobs, project managers are often at the mercy of the project team members to accurately communicate the status of their assigned tasks. However, how often do project team members have the same assessment of their progress or the quality of the work done? Of course, this hardly ever happens. It is human nature for most people to say they are further along on a job with higher levels of quality than is really the case. So, the project manager’s roll-up of overall project progress has much uncertainty in it.

An ideal solution eliminates manually communicated updates between a “doer” and a “manager” and the project task status is updated automatically as work is completed with full traceability to the work performed. For instance, a designer’s task may be based upon the completion of a CAD model. The assigned task is not “done” until the CAD model is vaulted and promoted through its lifecycle with peer reviews. As we established in the previous section, only the most advanced PLM tools can manage all content delivered during product development. Therefore, for project management automation to really have an impact on product development efficiency, it must be embedded in a PLM system instead of being a standalone niche solution.

*IP Protection (ITAR/EARS)*

Most IT staffs understand the need to provide some sort of security layer to their managed data and files (or Intelection Property [IP]). However, the security models that are applied are often traditional role-based schemes. If the chosen system understands the concept of data maturity, then its role-
based security model probably adjusts as the data progresses from stage to stage.

However, an additional security consideration is starting to affect more and more companies. ITAR (International Traffic in Arms Regulations) and EAR (Export Administration Regulations) are export control regulations that were defined many years ago to ensure that United States defense-related technology does not get into the hands of potential enemies. Companies in Aerospace and Defense are quite familiar with the need to protect their data based upon end user citizenship, the physical location of the person accessing the data, and even the location of the user’s employing company. All of these factors contribute to whether the data is potentially being exposed to a potential enemy.

With the convergence of mechatronics in product design, many companies not previously affected by ITAR and EAR now find their products have technologies that are covered by these regulations. As a result, these companies require ways to augment their current system’s security models with additional technologies. Of course, one way to avoid this added complexity is to choose a system that already has a security model that complies with ITAR and EAR.

UNDERSTANDING PRODUCT DEVELOPMENT SUB-PROCESSES AND INTERFACES

Each of the product development steps discussed in this section can have their own dedicated paper for deeper understanding. The goal of this section is to just introduce the concept and then close with some key considerations when determining the corresponding technology strategy. All of the concepts covered in this section are considered part of the PLM domain. If your company is evaluating a PLM solution that does not cover the full breadth of this section, then your business challenges will eventually exceed their solution.

Determine Customer Needs
Customer needs are defined from many sources depending on the company’s business model. For companies that build-to-market, there is often an ideation process and some sort of market research that eventually results in formal product requirements. For an engineer-to-order business model, the customer needs are usually communicated via a contract. For configure-to-order, there is often a blend of standard technologies that must be provided and unique extensions that the customer needs. For these companies, traditional ideation and requirements management combined with some sort of contract fulfillment methodology may be required. The challenge most companies face is that as product specialization has increased, there really is not a single business model that applies. Therefore, their chosen system to capture customer needs should be able to handle all three models.

After determining the customer needs, how does a company make sure it is possible to deliver the product? This often requires the start of early conceptual design (step 2 of the process) to start doing virtual prototypes and simulations. With the advent of 3D Printers, it is now even possible to cheaply validate concepts with physical prototypes. This conceptual design work begins the important concept of providing traceability for how the customer needs are actually being fulfilled. Recall the earlier section on change management and assessing change impact. Proper assessment of change impact
requires this traceability to be established. For instance, traceability enables engineers to understand if a proposed design change will impact whether the customer need will still be met. From the product planning perspective, traceability allows an assessment of whether a new market or contract requirement will cause completed designs to be re-worked and add costs and time to the product launch.

Lastly, understanding customer needs are only effective if it is then possible for customers to choose a product that meets these needs. This often requires processes to transform the customer needs to the product features that can be configured for an end product. These product configuration rules are then exposed to sales engineering staffs, dealers, and potential direct customers, in order to place an order.

**KEY QUESTIONS TO CONSIDER**

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<thead>
<tr>
<th>Does your chosen technology to determine customer needs ...</th>
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<tr>
<td>... capture new product ideas in an informal manner (ideation)?</td>
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<tr>
<td>... manage contracts and the line items that must be delivered for payment?</td>
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<tr>
<td>... define requirements whether originating from ideation or contracts?</td>
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<tr>
<td>... allow conceptual design to validate that the requirements can be met?</td>
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<tr>
<td>... establish traceability between the requirements and the designs that fulfill them?</td>
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<tr>
<td>... define rules for configuring the product features that deliver the customer need?</td>
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**Design the Product**

Twenty years ago, when companies thought about product design, the conversation focused mostly on its mechanical form and fit. With the advent of mechatronic products, the design process though now considers mechanical engineering, electrical engineering, computer control, and data communications. So clearly, at a minimum, the variety of design inputs has become broader.

The mechatronic product revolution also requires companies to carefully define how the overall system will function. This requires systems engineering and simulation models of the overall product behavior. Without it, a product may have appealing form and fit, but fail miserably at delivering the expected functions.

In addition to ensuring that the design function is met, it is obviously critical to make sure the design can be manufactured in such a way that cost margins are realized. Designers must be able to evaluate the manufacturability of their designs as it progresses.

Likewise, many countries have regulations that try to minimize the environmental impact of products that are sold in their markets. These regulations influence the design by controlling factors such as recyclability and hazardous material and chemical content. If a product does not comply with these regulations, it cannot be sold in these markets.

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environmental regulations, it will not be possible to sell it in all target markets regardless if it meets consumer expectations.

**KEY QUESTIONS TO CONSIDER**

Does your chosen technology to design the product...

... manage the full breadth of design inputs required with mechatronic products?

... model the product’s overall function in addition to its form and fit?

... simulate the product’s function to validate that the design is really meeting customer needs?

... validate that the design can be manufactured in a cost-effective manner?

... ensure that the design will comply with each target market’s environmental regulations?

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**Prepare for Manufacturing and Service**

The final step to consider is how the design inputs discussed in the previous section get communicated to the rest of the enterprise. This is done through the engineering bill-of-material (EBOM). The best EBOM solutions aggregate the different forms of design intent in a single coherent definition and then extend the design intent with information to prepare for manufacture and service. Examples of this include a component management strategy that identifies which alternative (or substitute) parts can be used at specific plants to provide the same form, fit, and function of the primary part. The component management strategy includes both parts that are defined internally and those that are provided by suppliers. As such, the “supplier parts management” strategy must coordinate the efforts of Purchasing and Engineering staffs.

The best technology strategies also extend this step to include the definition of manufacturing routings or work instructions in order to provide traceability between the design intent and how the product will be manufactured. This provides the foundation for “design for manufacturability” discussed in the previous section. Likewise, companies often choose to manage the as-delivered product bill-of-material with traceability to the EBOM. By establishing this traceability, future engineering changes can be proactively delivered to customers through spare part kits and maintenance bulletins.

Lastly, once a product enters manufacturing and service, addressing quality issues and non-conformances becomes paramount. When these are investigated, a corrective action process of some sort is often launched and it determines that an engineering change of some sort may be required. Being able to establish traceability between the in-service or manufacturing issue with the eventual engineering resolution provides companies with a “closed loop” quality methodology.
KEY QUESTIONS TO CONSIDER

Does your chosen technology to prepare for manufacture and service...
...aggregate the full range of design inputs created for mechatronic products?
...define a component and supplier part management strategy?
...provide traceability to how the product is being manufactured?
...enable proactive product updates to customers already using the product?
...resolve in-service and manufacturing quality issues holistically with product engineering?

Figure 7 – Key Questions for Choosing Technology for “Prepare for Manufacturing and Service”

CONCLUSION

Productivity gains in product development are achievable if the correct technology strategy is chosen to support it. Many commercial software solution providers have offerings positioned for product development. However, only PLM systems really address all of the product development challenges that most companies have. ECM and ERP vendors can address some of the challenges, but companies soon outgrow the solution. Even within the PLM space, there is a large range of offerings. Most software vendors that describe themselves as “PLM” provide less than half of the concepts that have been described in this paper.

Therefore, in order to define a winning technology strategy, companies must assess the full breadth of their product development challenges – not just what is required today, but also what is anticipated in the future. Failure to do so will result in a heterogeneous technology landscape that introduces data and process friction, which will always limit potential productivity improvements.