

**Implementation of a Manufacturing Process Platform**

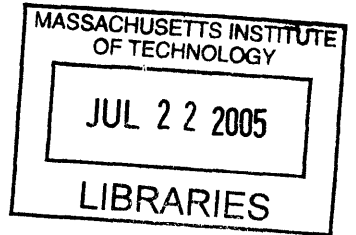
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Submitted to the Sloan School of Management and the  
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And  
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## **ABSTRACT**

As companies grow and innovate, they offer an increasing number of products. Product proliferation must be managed through a product development process, which is supported by key competencies of the company in the form of platforms. Product and technology platforms have been essential to the success of innovative companies. By leveraging core abilities, companies are able to bring products to market faster and at a lower cost for quality. In this research I present the concept of a manufacturing process platform and a framework for identifying and institutionalizing the platform. I present a case study of a manufacturing group in Eastman Kodak Company which has performed analysis of manufacturing processes and is attempting to implement a manufacturing process platform.

Research for this thesis was conducted during a six and a half month internship with Eastman Kodak Company's High Performance Imaging Systems Manufacturing group in Rochester, NY. The internship was affiliated with the Massachusetts Institute of Technology's Leaders for Manufacturing Program.

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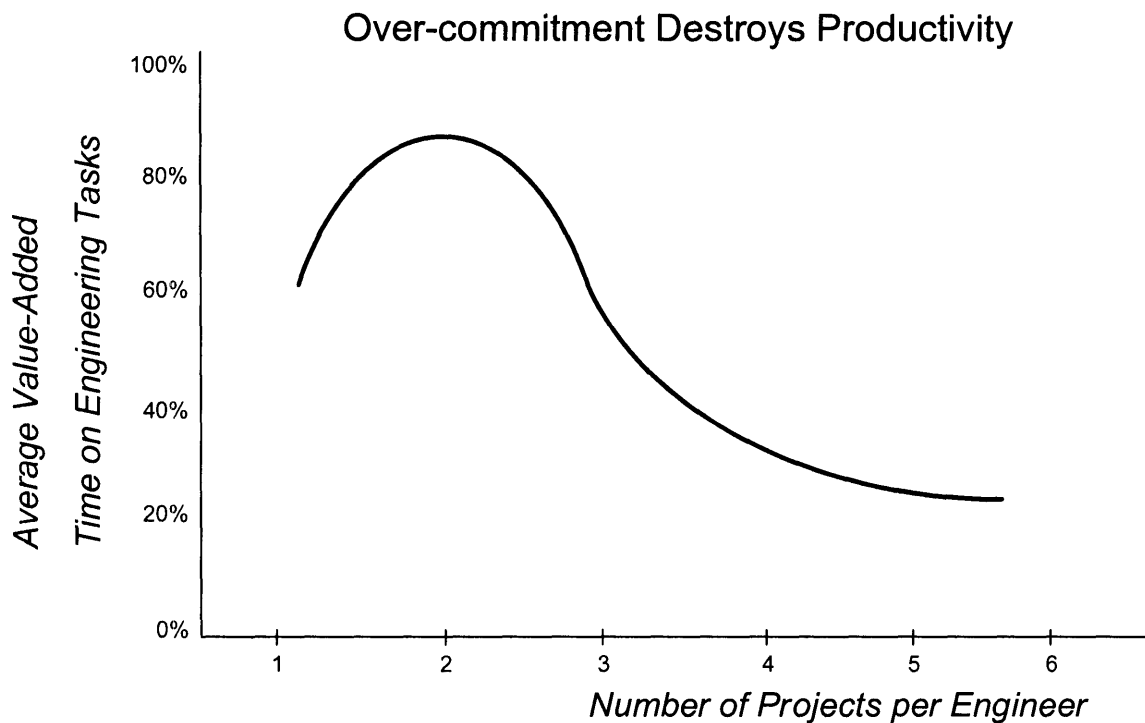
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## 1. Chapter 1 - Introduction

### 1.1 Project Motivation

As companies mature from an entrepreneurial firm focused on a single product into a stable firm focused on a variety of innovations, their product development process must be adapted to the organizational change. Companies which fail to have a process appropriate to the scale of the organization will suffer from high costs, delayed releases, and poor quality. Formalized processes must be implemented in order to transition new products smoothly through the product development pipeline and to compete strategically in the marketplace.



Source: R. Henderson, *Technology Strategy Lecture*

Figure 1 – Productivity as a Function of Projects – As the number of projects to which engineers are assigned increases, the productivity of each engineer decreases. Companies need to select projects strategically to ensure sufficient resources are available.

Growing companies often experience an expansion of their product lines enabled by new innovations. As the number of product development projects increases, though, resources get stretched so thin, as shown in Figure 1, that projects are finished late and at a cost much higher than anticipated. This leads to uncompetitiveness and a downward spiral of poor morale and more late and costly projects. Furthermore, the expansion of products may also lead to a lack of strategic focus for addressing the market. Companies may lose sight of exactly what problems they are trying to solve and what unique competencies they offer. [1]

In large organizations, the proliferation of products may also lead to separation of the organization. Business units are formed which serve to divide employees into separate allegiances and drive the organization to form insulated silos. Silos in an organization prevent communication and cause behavior which optimizes performance locally, but does not necessarily optimize the benefits for the organization as a whole. Poor communication and separate organizations cause a great deal of redundancy in infrastructure and resources. People in one business unit do not benefit from any lessons learned by people in another business unit because of the organizational barriers [2,3].

A solution to the problems of unmanaged product proliferation and separation of an organization is to implement a standard procedure for developing products in the company. By establishing a standard way of developing products, which strategically considers projects and resources, an organizational structure can be formed which ensures that the right people are involved with projects at the right time, and that products can be delivered on time and within the allotted budget. The exact process will depend on the strategic and cultural fit with the company. However some general characteristics are

fairly universal, such as strategic selection of projects for development, contractual agreements between different functional groups, and clear metrics to ensure optimal performance.

Many product companies have found that including “platforms” in their product development procedure has been successful. Platforms are conceptual frameworks which serve to encapsulate core knowledge and form a foundation for derivative products or methods. Technology platforms, for example, group together core technologies in a company and can focus innovation on particular intellectual property which the company owns or is developing. Product platforms can establish a basic architecture on which the company can derive many products. Marketing platforms can establish a standard way to address particular customer groups to ensure that customers’ needs are met. Platforms enable organizations to operate more efficiently and achieve higher quality, faster delivery, and lower cost.

In this thesis I propose a new kind of platform, similar to a technology, product, or marketing platform, which focuses on manufacturing competency. This new platform, a manufacturing process platform, can provide a way for large organizations to share knowledge and experience across silos, select projects which strategically leverage manufacturing competencies, and reduce cost and delivery time while increasing quality. Successful implementation of manufacturing process platforms involves deciding whether a platform is appropriate for an organization, choosing the right processes for platforming, and institutionalizing the platform through organizational and process changes.

## **1.2 Thesis Organization**

In section one, I introduce the concept of manufacturing process platforms and discuss the many possible benefits attainable through their use. I go on to describe how process platforms might fit into the product development process and the types of companies for which platforms are appropriate. Finally I discuss the procedure for identifying which processes would be good candidates for platforming.

In section two, I present a case study of Kodak's HPISM group which has performed much of the analysis discussed in section one and is preparing to implement a manufacturing process platform. I show how the group identified processes of strategic importance through value analysis, process mapping, and financial analysis. Finally I present some examples of how the group saved time and money by having a de facto process platform in place.

In section three I discuss how manufacturing process platforms can be implemented and integrated into the product development process. I discuss changes in organizational structure, product development process, and management involvement. Finally I present a strategic, political and cultural analysis of Kodak in a discussion of the challenges associated with introducing manufacturing process platforms within Kodak.

## **2 Chapter 2 – Manufacturing Process Platforms**

### **2.1 The Concept**

Simply put, a manufacturing process platform is a set of specific manufacturing skills, knowledge, and experience which a company can use as a foundational basis for manufacturing a product. Manufacturing process knowledge can often be a strategic advantage and as such it is important for a company to focus on both maintaining its knowledge and improving upon it. A manufacturing process platform is a way to gather together the essential pieces of manufacturing knowledge, organize them in ways which match the company's general product roadmap, and ensure that sufficient focus is given to continual development of the knowledge.

A manufacturing process platform is analogous to a product platform. Product platforms are used by many companies to bring to market many derivative products based off a common architecture. Some familiar examples include HP, which used a common ink jet subsystem to derive a large number of printers aimed at different market segments, and Black and Decker, which based a variety of power tools on a common motor subsystem [4]. A closer examination of product platforms can bring insight into the possible benefits of a manufacturing process platform.

At its heart, a product platform is a set of subsystems and interfaces which define an architecture which can be used to derive multiple products. Each product derived from the product platform is slightly modified to address different market segments. For example, the Toyota Camry has a single Camry platform, but multiple "trims" can be added to address different customers' desires for luxury. The market can be thought of as different segments in terms of application spaces and in terms of level of perceived

quality and features. The Camry addresses only a single “automotive” market segment, but with all of its trims, plays in the “good, better, best” categories. By using the Camry platform as the basis for the Lexus ES300 model, Toyota extended the spectrum of quality levels even further. An example of a company whose products span different market segments would be Bose. The same waveguide platform is used to derive products for consumers, industrial applications, and professional musicians [5].

The product platform is constructed using a company’s abilities to understand customer needs, apply unique technology and manufacturing processes, and organize effectively to guide the product development process [4]. These building blocks, as seen in Figure 2, are the foundational elements of many possible product platforms in a company. A successful company is able to discover their customers latent needs to provide valuable products. A company also brings to the market unique technologies related to product or process design. Furthermore, a well run company chooses an organizational design to best match their product development and marketing goals. A company can achieve the most success by leveraging these core capabilities across multiple product platforms which address multiple market segments.

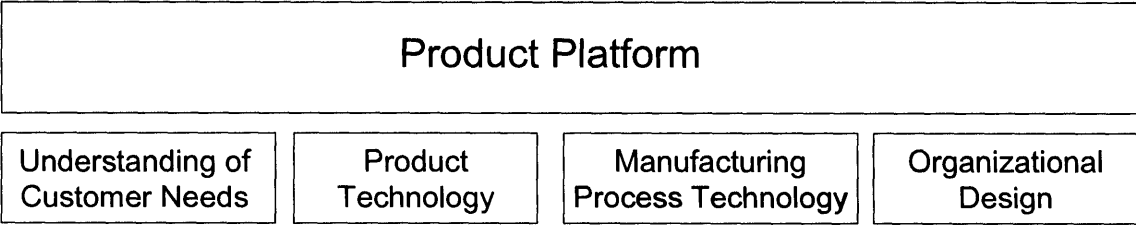


Figure 2 – Product Platform Building Blocks – A successful product platform is built on a company’s ability to discover the latent needs of their customers, develop product and process technologies, and design their organization to effectively approach the market.

The benefits of a product platform are numerous. The most valuable benefit is leverage. By using a common architecture for many products, parts can be shared among the products [6]. By using the same parts, economies of scale can be more easily achieved, supply chain logistics are simplified, and technological innovation related to the part can be shared across all of the products [7,8]. There is also leverage of the platform as a whole. Since the expense associated with designing the platform is sunk, each successive product derived from the platform need only cost an incremental amount. Furthermore, significant development time is saved [9]. Another benefit of product platforms is improved communication between various portions of the business. With focused attention on the idea of what comprises the core of the product, marketing can understand the basic product platform and think how it can be modified to address new market segments. Meanwhile researchers can focus on renewing the product platform to ensure that the latest technologies are incorporated. Product development engineers can share knowledge across particular products and need not waste time reinventing solutions to problems that have been solved in other parts of the company [10]. Other benefits include design elegance due to modular design, increased ability to discover latent customer needs due to the change in perspective of modifying the core product instead of creating a new product from scratch, and organizational clarity during market discontinuities resulting from a clearly defined approach to the market [11].

Manufacturing process platforms can be thought of in a similar way as product platforms. In this case, the process is the platform. A way to do a particular manufacturing step becomes the modular component and the way of putting the process steps together forms the interconnect between the modules. For example, a

semiconductor company might have unique knowledge around several coating steps which together make up a resist making process. The resist making process is the platform. Likewise, a company that invents a process to slice vegetables lengthwise has a process which is a platform for deriving processes to slice cucumbers for sandwich stacker pickles or potatoes for extra large chips.

## **2.2 Benefits of a Process Platform**

The power of process platforms is not just in increasing manufacturing volume or capacity. The real benefit is in the technological advancements which can be applied to the process to create a strategic advantage for the company. A company that retains and continuously improves its knowledge around particular processes creates for itself an ability to compete on things like lower operating costs or unique products, depending on the particular process. By bringing organizational focus upon particular processes, a company can ensure that decisions regarding manufacturing sourcing, product commercialization and technology development are made strategically.

Manufacturing process platforms can improve quality, cost and delivery time. Quality is achieved through a combination of experience with the process and focused attention on improving the process. By leveraging the process across many products, many lessons are learned about the process. Successively more experience with a process increases the company's ability to refine the process, remove variation in output, and tighten specifications. Furthermore, corporate visibility of the importance of a process ensures that sufficient resources are assigned to maintaining and improving upon a process.



Cost savings are achieved through manufacturing process platforms in multiple ways. First, the initial investment into developing the process and training personnel is spent only once, despite the process being used for a variety of products. The initial cost can be considered sunk at the initiation of new projects, and thus the cost to develop a new product is reduced. Learning curve effects due to the common usage of the process also lead to cost savings. As more products go through the manufacturing process, knowledge of how to do the process more efficiently increases, and the cost of the process for successive products decreases. The more the process can be leveraged across products, the lower costs can go. The steepness of the learning curve will determine the amount of cost benefit a process platform could achieve. Economies of scale, which can be achieved when there is significant reuse of processes, are another source of cost savings.

Delivery time is improved through manufacturing process platforms, as well. Development time can be shortened by designing a product around the process. With the process already known, certain design decisions can be made quickly without having to consider all possible ways to manufacturing a product. Furthermore, design engineers can focus more attention on ensuring that the product meets customer needs, rather than on inventing new ways to manufacture the product. Sourcing decisions can be made more quickly, as well. A manufacturing process platform would include a clear understanding of which manufacturing steps need to be done internally to maintain competitive advantage, and which manufacturing steps can be outsourced for cost advantage. This clear understanding reduces the number of manufacturing strategies that need to be considered. Also, supply chain components related to the process platform

would already be established. Experience around a manufacturing process would also yield faster delivery time. Experience allows manufacturing engineers to more quickly and effectively adapt designs to the manufacturing process and to execute the process with fewer issues needing to be resolved.

A manufacturing process platform provides a way for a company to leverage manufacturing knowledge across multiple products and across multiple business units. Product development engineers in a particular business unit may not interact with their counterparts in another business unit, but nevertheless they will mutually benefit each other's experience. The knowledge gained from one project regarding how to adapt the process, what quality of parts are necessary, and what things can go wrong, is captured by the keepers of the manufacturing process platform and applied to each new project. Thus the platform becomes the repository of manufacturing knowledge for the benefit of the entire company, rather than a single project team or business unit.

The benefits of a manufacturing process platform are both strategically and operationally important. The platform ensures that the best technology is applied to a process, that sourcing decisions are made to retain competitive advantage, and that knowledge is shared across the company. The platform also provides lower costs to commercialize new products, higher quality products, and faster time to market.

A manufacturing process platform is not without its drawbacks. Processes which are developed to be common among several different product lines have the potential to be overly constraining on product design. If products are required to fit within certain parameters, engineers may be forced to make certain tradeoffs which affect overall performance. Furthermore, the product and design creativity may be stifled by a strong

manufacturing focus. Another potential drawback is the risk of stagnation due to an overdependence on the existing platforms. A company must continually seek to embrace new technologies to surpass previous performance.

### **2.3 Fit with the Product Development Process**

For a manufacturing process platform to work effectively in an organization, it must be integrated into the company's product development process. For products to transition smoothly from design to production, there must be a clear understanding of what steps should occur, which groups need to communicate, and how the process is managed. When a company is flexible in its ability to adapt its commercialization process, manufacturing process platforms can be more easily implemented [12].

The consulting company, PRTM, has a model for the product commercialization process that is representative of the process used by many companies. As seen in Figure 3, the core of the process is the idea of a project funnel and pipeline, which represents the stage-gated development path of projects. The front end of the process involves the technological, marketing, and product platforms in which the company's competencies are harnessed. Overseeing the pipeline is a layer of management, responsible for coordinating the process in a strategic way. Finally, metrics are applied to projects to ensure that projects in the pipeline are performing as expected.

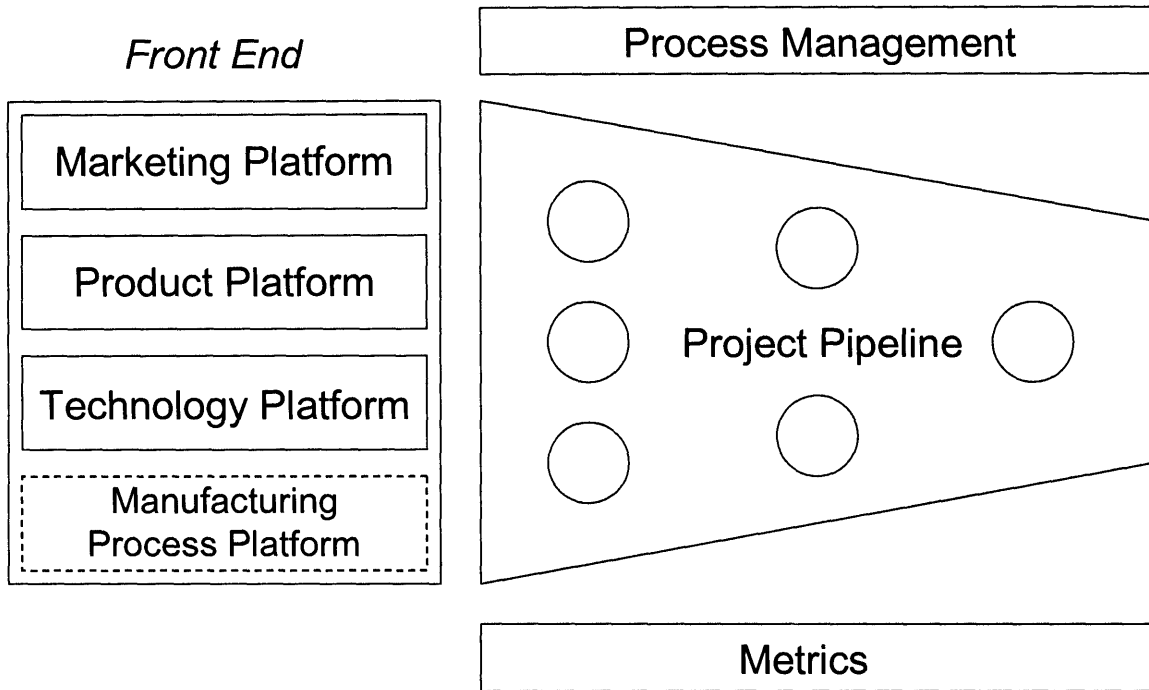


Figure 3 – PRTM Product Commercialization Model – The model involves platforms on the front end which feed projects into the pipeline. Management oversight chooses projects and ensures strategic fit as the projects mature. Metrics guide project managers. Manufacturing process platforms are a natural fit into the front end of the model.

Manufacturing process platforms are a natural fit in the commercialization front end of PRTM’s model. Since manufacturing process platforms comprise specific, strategic manufacturing capabilities, they are useful, just like product platforms, in determining which projects should enter the product pipeline. Of course, a project’s fit with manufacturing competencies is not necessarily a requirement for a project to proceed. Management must choose based on a number of factors including which markets the company wished to enter and what other competencies exist in the company. By strategically determining which projects make the best use of the company’s competencies, projects will have a greater chance of success. Success is defined by the metrics which address the time it takes to develop the product, the time it takes for the product to become profitable, and whether the project was carried out according to

schedule. Choosing projects wisely also reduces the chance of overextending product development resources so that the pipeline becomes a bottleneck. Case studies demonstrate how overutilization of product development resources leads to a downward spiral of late product launches, unprofitable products, and frustrated staff [13]. Clear definition of manufacturing competencies through process platforms helps management to choose projects wisely.

Manufacturing process platforms mesh well with the other components of the commercialization front end and supplement the kinds of knowledge each provides. The marketing platform addresses ways the company can interpret customer needs and provides a way of approaching the customer base. The technology platform addresses how unique innovations of the company can be harnessed to become the foundation for products and product families. The product platforms are more specific architectures for deriving a group of related products. The process platform addresses how the company can use technologically unique abilities in manufacturing to create the products contained in the platforms to meet customer needs. In this way, the manufacturing process platform involves a bit of each of the other front end components as well as unique manufacturing knowledge. Use of this platform increases the chances of successful product commercialization.

#### **2.4 Business Appropriateness**

Although, in general, manufacturing process platforms can provide numerous benefits to the product commercialization process of a company, platforms may be more beneficial to some companies than others. Financially, the companies for which platforms provide significant advantages in terms of cost, quality, and delivery have the

most to gain. Strategically, companies who will benefit most from process platforms are those which either have products for which manufacturing techniques are critical to creating the product or have products for which the manufacturing technique provides competitive advantage. For example, a company that makes chemicals is heavily dependent on the manufacturing processes which it uses to create its products. Likewise, many companies have manufacturing technologies which allow the company to produce their product at a lower cost than competitors. Some companies even have techniques which allow them to make products no other company can. These kinds of companies can benefit from taking a strategic approach to manufacturing processes. Manufacturing process platforms would allow the company to fully leverage their unique manufacturing technology.

Large companies with many product lines can benefit from manufacturing process platforms depending on the similarities between their product lines. If the different product lines could share common manufacturing techniques or sets of experiential knowledge, there is a good chance that a process platform will provide the benefits discussed earlier, specifically, cost, time, and quality savings due to leveraged learning. In fact, the more sharing of a common process that occurs, the greater the potential benefit of establishing a shared process architecture. Furthermore, technological innovations aimed at improving the process will benefit the entire portfolio of products which share the common process.

Some companies which may not benefit greatly from manufacturing process platforms are those for which manufacturing techniques are well known and easily obtained outside the company. As the importance of manufacturing process to a product

decreases, the ability of a manufacturing process platform to provide any useful strategic information also decreases. When deciding whether to proceed with a project, a company will not be able to choose between two projects based on commonality of manufacturing processes, if there is no additional cost or time savings derived from choosing one way over another. If having another project share manufacturing processes does not provide any additional cost savings from the added experience, or if no unique processing knowledge is used, then the process platform would not be a useful construct. A company in this case is better off focusing energy on developing unique designs for product platforms and seeking ways to better understand their customers.

## **2.5 Identifying Valuable Process Platforms**

If a company believes it can benefit from manufacturing process platforms, there are some initial steps it can take to identify which processes might make valuable platforms. These steps, in summary, are to review the subsystems of the company's products and identify which systems are most important to the functionality the product offers, to map out the processes by which these subsystems can be manufactured, and to seek out processes which are common across subsystems of different products. The following sections review these stages in more depth.

### **2.5.1 Value Analysis**

It is possible that many of a company's manufacturing processes could be considered essential to the company's competitive advantage or strategic to the company's product portfolio. More likely, however, only particular processes are truly able to provide the benefits of a manufacturing process platform. A company hoping to

discover which processes are most strategic for their business could do so in a number of ways. Intuition or historical precedent could be sufficient, but careful analysis might yield better results. Value analysis is one method that could be used to determine where a company should focus.

The value analysis method is a ranked pair comparison of the various subsystems in a product. This method is used in engineering as a way to rank various design choices and is similar to conjoint analysis [14]. To use this method, the subsystems of a product are listed on both the first row and first column of a table. Each subsystem is compared to every other subsystem. In each comparison, the relative importance of the subsystem to the intended functionality of the product determines which subsystem, out of the pair, is more important. Every subsystem is likely to be necessary to the product functioning, but certain subsystems are more critical for determining the products capabilities. For example, on a laptop computer, the processor may be ranked higher than the keyboard, since the computer's intended function is to compute.

Comparisons like these may be difficult to make and are not likely to be mutually agreed upon. However, the discussions about the comparisons can be very valuable in and of themselves. The discussions are likely to reinforce in people's minds what the company's strategy is or what it should be. If our company makes drills and we compete on quality, should we focus more on our ability to make a plastic shell or a durable bit?

The relative importance of each of the subsystems can be plotted against the relative cost of the subsystem. This chart not only points out where the company's strategy should focus, but also what types of trade-offs might need to be made. If the



plastic shell for the drill is very expensive compared to the bit, there might be an opportunity to seek a cheaper alternative for the shell.

The ranked comparison can be performed on all of a company's products, and any patterns that emerge will likely point to the common essential subsystem. If the company finds that the drill bit subsystem on the drill is most important and the saw blade subsystem of the saw is most important, then the more abstract "cutting" subsystem may be where the company should focus attention. It is possible that more than one subsystem is important or even critical. This is fine, as multiple subsystems can be analyzed further. For this discussion, we will focus on just a single important subsystem. Also, there may be several layers of subsystems in a product. The ranked comparison can be performed at each of these layers until the company is comfortable with a level at which they are likely to make an impact on manufacturing strategy.

The goal of the value analysis is to focus the company's attention on what is most important to the product's functionality. When the important subsystem has been determined, further analysis can be performed to understand the manufacturing steps involved in creating the subsystem.

### **2.5.2 Process Mapping**

For each of the products in a company's product line, the important subsystem will have been determined. The manufacturing steps involved in creating each of these subsystems should be mapped out. By mapping out the various manufacturing steps, the company can determine which manufacturing processes are shared. Of the shared processes, many are likely to be simple operations, such as moving or identifying something. Some, however, can be more careful processes or processes which involve

unique technologies or capabilities of the company. These are the processes which should be looked at as candidates for a manufacturing process platform.

Laying out the process steps can be valuable for more than just establishing a manufacturing process platform. A process map can serve as a foundation for a value stream map which can be used for lean initiatives. Understanding the flow of the product through manufacturing can highlight potential gains in operational efficiency.

Figure 4 shows the important subsystem from each of several different products along with the manufacturing processes involved in creating the subsystems. The number of shared processes is readily apparent, but the shared processes which are useful for a platform depends on the goals and competencies of the company. If the company excels in Process C, then Process C may be a good choice for creating a process platform. The degree to which a process provides competitive advantage might be a good selection criterion. The contribution to total product cost might be another.

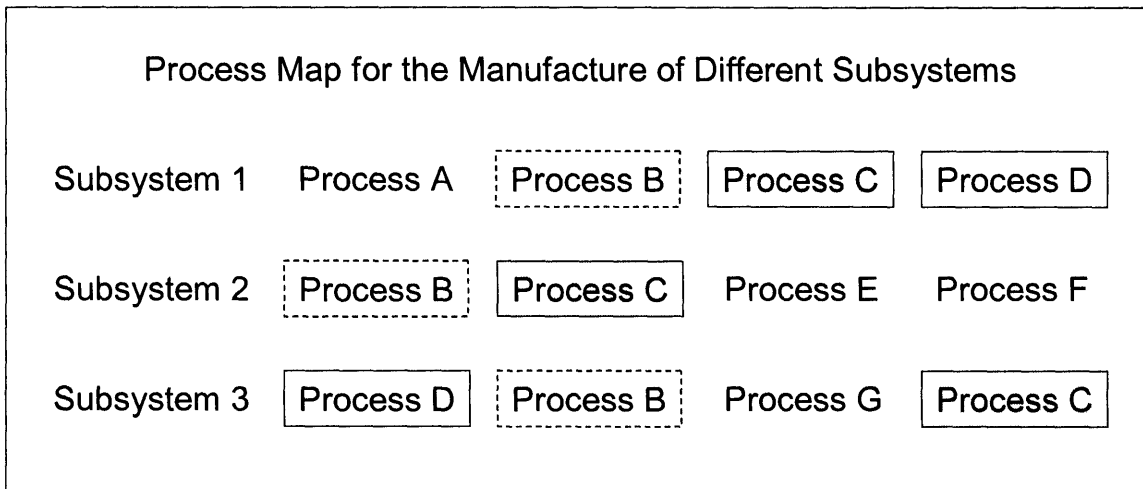


Figure 4 – Process Map for the Manufacture of Different Subsystems – Although subsystems may share several processes, only certain processes may be considered strategic or give the company strategic advantage. Processes B, C, and D are shared between subsystems, but it might be that the company uniquely excels at process C, making it a potential candidate for a process platform.

When the common, important processes have been identified, a company can begin to formulate plans for building a platform. The plans will involve ways to focus company attention on the process so that it can be appropriately valued when the company makes strategic decisions regarding research, development, and manufacturing. The implementation of a process platform is discussed later.

## **2.6 Implementation**

If a manufacturing process platform seems appropriate for one's organization and a particular process has been identified as a worthy candidate, then the next step is to implement the platform. The exact procedure for implementing a manufacturing process platform will vary a great deal depending on a number of factors including the size of the organization, the current product development and manufacturing procedures, and the political landscape of the organization. Change in an organization is always a challenge and should be considered carefully.

Generally, there are three aspects to implementing the platform: the organizational structure, the commercialization process structure, and management involvement.

### **2.6.1 Organizational Structure**

The concept of a manufacturing process platform may seem like just a mental or design construct, but in actuality, it requires people who can ensure that the platform is maintained and utilized appropriately. The number of people involved and how they report into the larger organization must be determined for each company on its own. There are many ways to organize a company's resources all of which may be successful.

The key element for manufacturing process platforms is to have a repository for knowledge and experienced gained from a variety of projects which utilize the process. This might mean that manufacturing engineers within a company's internal manufacturing group are responsible for the process. Alternatively, a company which outsources its manufacturing might choose to have a group of process experts. Proctor and Gamble is one such company which has expertise groups, called communities of practice which focus on particular technologies and manufacturing processes [15]. If a product development group is working on a project which involves mixing, they will work with an expert from the mixing group to ensure that the knowledge gained from all previous products that involved mixing is brought to bear on the new product. The mixing expertise group is responsible for both sharing their knowledge with project groups and for researching new technologies relevant to mixing.

Another important aspect of organizational design is to ensure that the keepers of the platform have sufficient visibility. In some organizations, there is a potential problem with having manufacturing personnel in charge of the platform. While they may be the most knowledgeable about manufacturing processes, they may not have enough power or visibility to ensure that sufficient funding or corporate attention is given to the platform. The platform organization should be visible across the enterprise to ensure that every potential product be considered in light of the company's process competencies.

### **2.6.2 Integration with the Commercialization Process**

How well the manufacturing process platform operates within the company is as important as the structure of the manufacturing organization. To be effective, the manufacturing process platform must function as an integral part of the

commercialization process. The goal is to have products flow through the development process into manufacturing with a smooth transition resulting from designs which leverage process knowledge and capabilities. To achieve this goal, product development must make use of the resources established by the platform group and the research group must be involved with discovering new ways to improve upon process capability.

This may be one of the most difficult aspects of organizational change since existing product development procedures may be deeply ingrained. If the procedural change can be minimized, the transition to making use of the platform may be smoother. Furthermore, it may be necessary to win over a few project managers by demonstrating the benefits and rely on word of mouth for more gradual acceptance into regular business practice.

In addition to direct involvement with design of new product, the platform group should be a participant in project pipeline oversight. When considering potential projects, the managers of the product development pipeline need to evaluate the impact of process compatibility. To do this, the managers need to be well informed of the significant processes.

### **2.6.3 Management Involvement**

Successful implementation will require high level sponsorship and participation. The manufacturing process platform affects so many aspects of the organization that senior managers must buy into the concept and facilitate its acceptance. Management first needs to acknowledge the financial and strategic benefits of a process platform. As a believer in manufacturing process platforms, management needs to do two key things:

establish incentives for proper utilization of the process platform, and clearly communicate to the organization the strategic significance of the process platform.

In some organizations, a significant amount of autonomy is given to individual project managers. This autonomy can be beneficial by providing flexibility and agility. However, the same autonomy can result in highly customized manufacturing processes which do not leverage existing capabilities. By giving these project managers the right incentives, they can still decide what actions to take, but with the proper awareness of potential process choices. Incentives can drive the acceptance of manufacturing process platforms even without direct instructions to do so. Furthermore, incentives to work in cross functional teams can contribute to a smooth adoption of process platforms.

The same evidence which convinces management to adopt manufacturing process platforms can be very convincing to project managers. It is therefore important for management to make the project managers aware of the potential. In large organizations, a significant amount of evangelizing may be required to spread the concept through the many business units and project teams. Assuming process platforms are adopted and well integrated, further evangelism may be directed outside the company. Mastery of certain manufacturing processes could be useful for marketing and advertising purposes.

## **2.7 Summary**

Manufacturing process platforms can be a powerful addition to a company's product commercialization process. Platforms can benefit an organization both financially and strategically. Financially, platforms can provide cost savings by sharing parts among products, increasing the company's economies of scale, and accelerating

learning curve effects. Platforms can provide quality savings through better process definition and increased communications across business functions. Platforms can increase delivery time through better utilization of engineering resources and faster product development. Strategically, platforms can provide a company with a stronger approach to the market with a wider variety of products and with stronger leverage of manufacturing technologies.

A company's commercialization process can be adapted to include manufacturing process platforms in the front end. Platforms can be used as input toward project selection decisions and can serve to smooth the transition of products from design into manufacturing. The manufacturing platform also supplements other platforms in the front end through natural synergies, such as manufacturing technology development.

The process of adopting manufacturing process platforms involves identifying appropriate manufacturing process and implementing the platform. Identification can be performed through ranked pair comparison and process mapping. Implementation involves choosing an organizational structure, integrating that structure into the commercialization process, and getting management sufficiently involved.

In the next chapter, a case study of how Kodak has begun to implement manufacturing process platforms is presented.

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### **3 Chapter 3 - Case Study**

The concept of manufacturing process platforms described in the previous chapter was developed during a six month internship at Eastman Kodak Company. This chapter introduces Kodak and one of its manufacturing groups in which the implementation of manufacturing process platforms has begun to take place.

#### **3.1 Background**

##### **3.1.1 Eastman Kodak Company**

Kodak is a technology leader in imaging products, focused on helping people to take pictures for information, entertainment, and memories. Kodak had \$13.5B in sales in 2004 in four main business categories: Health Imaging, Graphic Communications, Digital and Film Imaging Systems, and Display and Components. As imaging technologies progress, Kodak has been transitioning its business from film based imaging to digitally based imaging. The transition has involved a number of internal activities to improve performance as well as an aggressive acquisition strategy to position the company for growth in the digital imaging world.

##### **3.1.2 High Performance Imaging Systems Manufacturing**

The High Performance Imaging Systems Manufacturing (HPISM) group is set up as a cost center that performs manufacturing operations solely for various groups within Kodak. Business units have development teams who design and engineer products and then bring their plans to HPISM to be manufactured. HPISM takes the plans and determines how the product can be manufactured. The engineers in HPISM are responsible for determining the manufacturing feasibility of a design, developing manufacturing processes and methods to create the design, for handling the supply of

parts to manufacture the product, and for delivering finished product. These processes involve careful analysis of the parts involved, how those parts can be obtained, and the processes by which the parts will be assembled. When parts are determined to be difficult or impossible to manufacture, HPISM works with the development group to modify the plans to make the product manufacturable. HPISM then takes responsibility for ensuring that the product is manufactured according to a particular schedule and with consistent quality. As a cost center, HPISM charges all real costs to the business unit and makes no profit from the operation.

### **3.1.3 Business Need**

HPISM had been noticing a decline in business over the past few years. As the number of projects declined, the utilization of the resources in the group, particularly manufacturing engineers with specialization in image engine manufacturing, was falling as well. As utilization declined, employees were being let go, as the group could no longer justify the cost to keep them. They decided that it was necessary to analyze the business and determine what might be done to increase the number of projects within HPISM so that key staff would remain with the group and that expertise essential to Kodak's business would not be lost.

### **3.1.4 Manufacturing Process Platform Foundation**

A dedicated group of engineers in HPISM have spent several years laying the groundwork for a manufacturing process platform. The competencies of HPISM developed gradually, determined mainly by the types of products commonly manufactured by the division. These competencies related to "image engines". An image engine is either the light capture or light output subsystem in an imaging product.

While the group intuitively sensed that processes related to image engines were the group's specialty, they felt it wise to more carefully analyze their processes and communicate their findings to the rest of Kodak to improve the success of future imaging products. This section describes the steps this group took to discover the important manufacturing processes involved in making a variety of imaging products for business units of Kodak.

### **3.2 Value Analysis**

The first step toward developing a manufacturing process platform was to identify the competitive strategy of Kodak. This was easy for the group, as Kodak has always been known for being the producer of high quality imaging equipment. Clearly identifying the company's marketplace strategy helped the group make decisions and tradeoffs throughout the process. Since high quality was important to Kodak products, subsystems which contributed to high quality imaging were identified as important.

The group performed a value analysis as described earlier, using ranked pair comparisons to determine which product subsystems were relatively more important than others. Ideally, Kodak's entire product portfolio would be analyzed to maximize the possible benefits of shared processes. However, HPISM's analysis of just the products already being manufactured within HPISM provided a good sampling of the full Kodak portfolio. Figure 5 illustrates the results of the comparison for a typical Kodak product. This comparison for a special printer showed that the image engine was the most important subsystem in the printer. Comparisons were performed for all of the products manufactured by HPISM. While the image engine was not always the cheapest

component of all the subsystems, it was always number one or two in importance for contributing to high quality imaging.

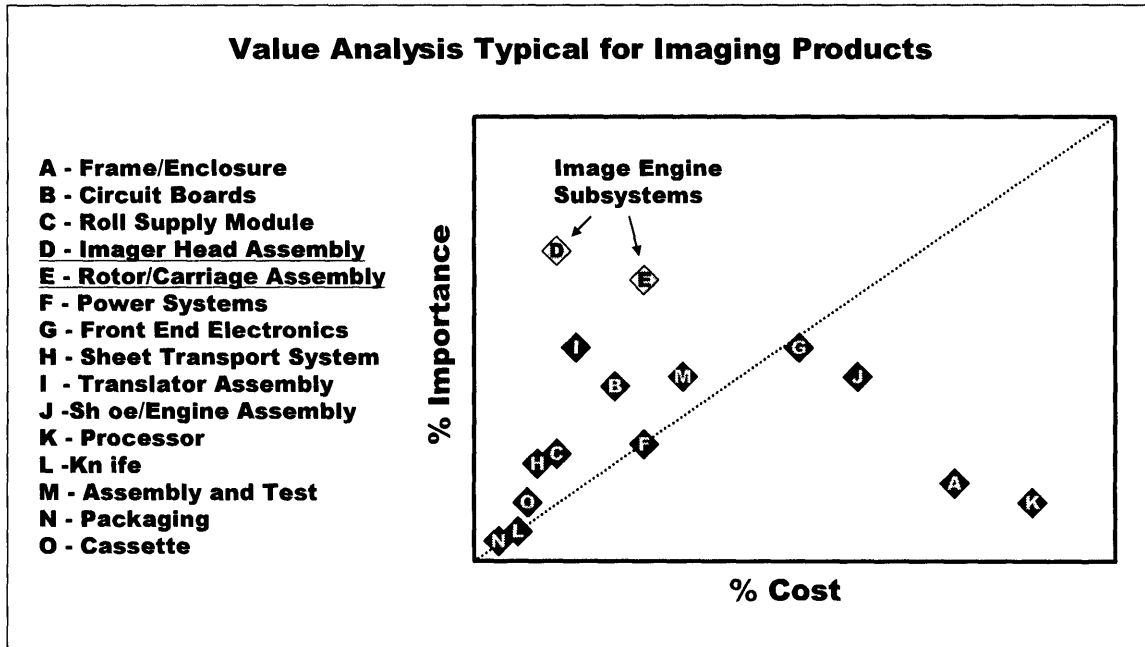


Figure 5 – Value Analysis for a Typical Imaging Product – All of the subsystems of a product can be compared to each other and plotted according to relative importance and relative cost. HPISM found that Image Engine subsystems were always first or second in importance to the products intended function, although not always least expensive.

### 3.3 Process Mapping

With image engines identified as the important subsystem, the next step was to look at the manufacturing processes involved in creating the image engines for the various products manufactured by the group. Laying out the process steps was valuable in identifying not only the processes which were shared by the different products, but also the processes which could be considered strategic to Kodak products due to their intellectual property and experience content. Finding these processes for which HPISM had unique capabilities gave the group focus for further study.

Figure 6 shows the process map the group developed for several Kodak products. Although there were several processes that affected most of the products, only a few were identified as strategically significant. Strategic significance was determined through discussion of which processes were considered competencies and which processes provided Kodak with competitive advantage. These processes included precision alignment, precision UV adhesive characterization, image quality optimization, and metrology. In the detailed study of 11 products, 9 products involved precision alignment, 8 involved precision UV adhesive, and 8 involved image quality optimization and metrology.

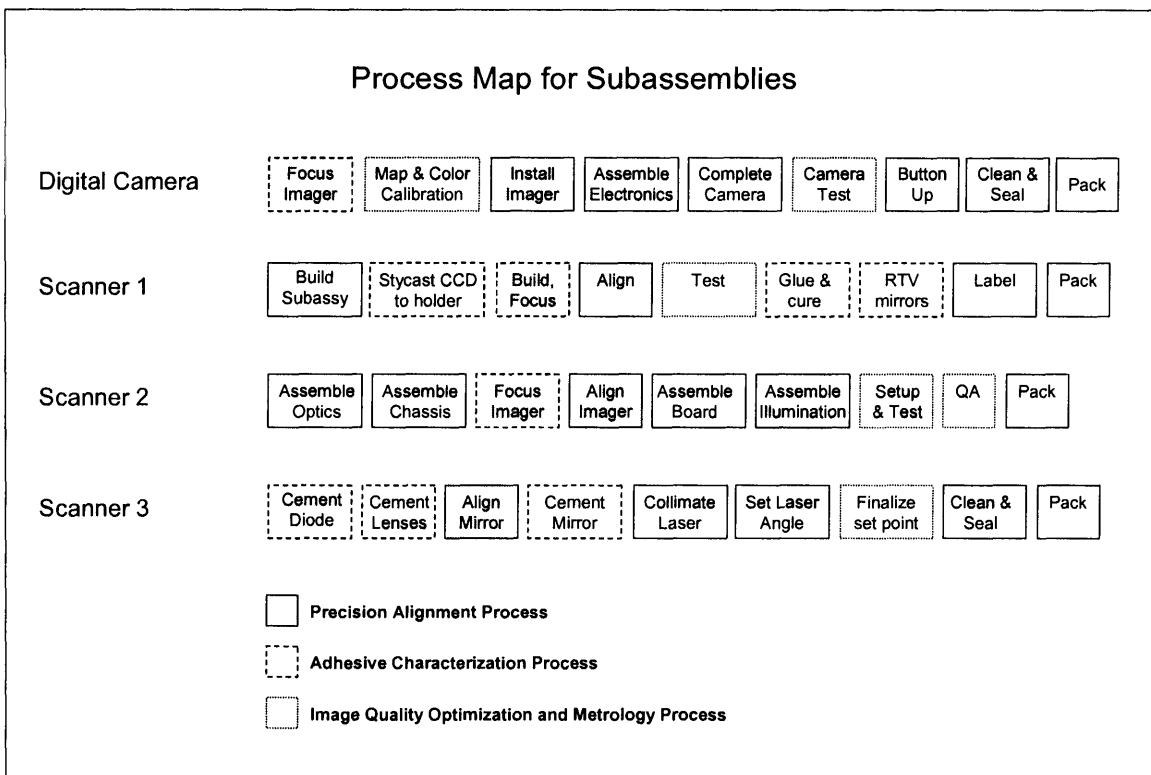


Figure 6 – Process Map for HPISM Subassemblies – Several processes were shared among different subassemblies, but only certain processes seemed to offer competitive advantage. Shaded boxes indicate a precision alignment process, boxes with a dashed line indicate precision UV adhesive processes, and boxes with dotted lines indicate image quality optimization and metrology processes.

### **3.4 Identifying Important Processes**

Precision alignment is a process for bonding a lens assembly to an imager at a specific distance and tilt. For a high quality image, the lens must be at the proper focal length and must be perpendicular to the imager. HPISM accomplished precision alignment through equipment and techniques which were developed over several projects through direct research and experience. Equipment was constructed which controlled the motion of both the imager and lens assemblies. The equipment was controlled by proprietary algorithms designed to optimize the final image quality which the product would deliver.

Once the lens and imager assemblies were aligned, it was necessary to hold the pieces in place permanently. A two stage process was employed by HPISM, using a UV curable adhesive for temporarily holding the pieces in alignment, and a slow setting stycast epoxy for permanent hold. HPISM had developed special techniques for handling and characterizing the UV adhesive and for making precise adjustments in the alignment to account for adhesive variability.

With the lens and imager set in place, the overall subassembly would be measured for fit in the final product using a variety of metrology techniques. Metrology involved both the decision regarding which variables were important to ensuring that each subassembly was being consistently manufactured, and developing equipment and techniques for performing the measurements. An example of one such piece of equipment used by HPISM was a final product fixture. A “socket” carefully calibrated to replicate the final product was employed at the final test and measurement for a certain

subassembly. By measuring the performance of the subassembly while fitted into the socket, overall product performance could be accurately predicted.

Knowing what constituted good performance was another aspect of metrology about which HPISM had experience. Despite changes from analog to digital imaging equipment, the critical factors that determined what constituted quality remained unchanged. Factors such as focus at the edges, color properties, and distortion were all measured and corrected for. HPISM often consulted for other manufacturing groups to advise them on which factors to measure and how to measure them to ensure high quality images.

### **3.5 Financial Analysis**

Having identified the important processes, the group could identify the financial impact of these processes. This could both highlight the relative importance of particular processes and identify particular products which do not use these processes. Products not using the important processes could be considered for outsourcing or elimination as the manufacturing group would seemingly not be adding any value.

Table 1 shows a chart of the products under analysis. For each product, the relative contribution of each process was determined subjectively by engineers on a 0 to 1 scale. This weight was applied to the overall cost of each product, multiplied by the number of products of each type which had been shipped in the previous year. In this way, the total financial impact of each process could be determined. The processes could then be ranked according to their financial impact. The high impact processes were likely candidates for a manufacturing process platform. For HPISM, this turned out to be

precision alignment which impacted 100% of the products being manufactured by the group, along with precision UV adhesive characterization and image quality optimization, which impacted 82% and 96% respectively. The low impact processes were informative as well. With only a single product using the LED placement process, the group could ask the question about whether this particular product was representative of the direction Kodak wanted to go with future products or whether this product should be phased out because of poor fit. Strategic questions could be raised because of the visibility that the ranking process provided.



	Unit Cost	Yearly Quantity	Total Product Value	Alignment		Adhesive Characterization		Image Quality Optimization		Fiber Optic Characterization		LED Placement/Solder	
				Rank	Value	Rank	Value	Rank	Value	Rank	Value	Rank	Value
Digital Camera 1	\$1,500	5000	\$7,500,000	1	\$7,500,000	1	\$7,500,000	1	\$7,500,000				
Digital Camera 2	\$3,500	5000	\$17,500,000	1	\$17,500,000	1	\$17,500,000	1	\$17,500,000				
Scanner Camera 1	\$500	1000	\$500,000	1	\$500,000	1	\$500,000	1	\$500,000				
Scanner Camera 2	\$1,000	2000	\$2,000,000	1	\$2,000,000	1	\$2,000,000	1	\$2,000,000				
Laser Source 1	\$8,000	300	\$2,400,000	1	\$2,400,000	0.2	\$480,000	1	\$2,400,000	1	\$2,400,000		
Laser Source 2	\$8,000	300	\$2,400,000	1	\$2,400,000	0.2	\$480,000	1	\$2,400,000	1	\$2,400,000		
Printer Subsystem	\$5,000	50	\$250,000	1	\$250,000	0.2	\$50,000	0.8	\$200,000	1	\$250,000	1	\$250,000
Scanner Source	\$2,000	1500	\$3,000,000	1	\$3,000,000	0.2	\$600,000	0.5	\$1,500,000				
Lens System	\$20,000	10	\$200,000	1	\$200,000	1	\$200,000	1	\$200,000				
<b>Total Product Value</b>			<b>\$35,750,000</b>		<b>\$35,750,000</b>		<b>\$29,310,000</b>		<b>\$34,200,000</b>		<b>\$5,050,000</b>		<b>\$250,000</b>
<b>Percentage of Process Impact on Product Value</b>					<b>100.0%</b>		<b>82.0%</b>		<b>95.7%</b>		<b>14.1%</b>		<b>0.7%</b>

Table 1 – Financial Impact of Processes – For each product, a rank between 0 and 1 was assigned to major processes to describe the contribution of that process to image quality, the key metric of the final product. Each process was considered independently. Then the total product value was multiplied by the rank to find the impact of each process on total product value. It became clear that Alignment, Adhesive Characterization, and Image Quality Optimization were of particular importance. Although LED Placement affected only a single product, there might be strategic reasons for maintaining process capabilities.

*Note: Product names, quantities, and values have been altered to protect confidentiality*

### **3.6 Strategic Considerations**

Company strategy was significantly important to the choice of a process for platforming. While the group's analysis focused on existing products in manufacturing, the truly valuable analysis would look forward to products which would be in development in the next five years. By looking at the roadmap of products for different business units and by talking with engineers associated with the product lines, it was possible to get a sense of the types of processes which would likely be needed to manufacture the future products. This aspect of the study was challenging due to the sensitive nature of product roadmap information. Business units were reluctant to discuss product details and reveal too much information. Nevertheless, it seemed fairly clear that precision alignment, having been almost universally required for imaging subsystems, would continue to be an important manufacturing process in the future.

With precision alignment identified as a particularly important process, a manufacturing process platform could be put in place. The actual implementation required buy-in from a number of stakeholders and was a challenging venture. Additional discussion on the implementation is discussed later.

### **3.7 Early Platform Benefits**

Without formally implementing a platform around key processes, HPISM had put into place many of the elements of a manufacturing process platform. Precision alignment had focus from both the operational view of HPISM as well as the technological view from a research team called PSET. Equipment was updated with increasingly precise motor controllers and the latest software refinements. Furthermore, the group marketed their precision alignment capabilities to business units in Kodak to

attract projects which could benefit from the process knowledge held in HPISM. These efforts revealed several of the benefits which can be obtained through manufacturing process platforms.

One of the most obvious benefits of a manufacturing process platform is the ability to leverage the wealth of knowledge and experience gained through using similar processes on multiple projects. HPISM had numerous examples of how experience provided savings of both time and money.

### **3.7.1 Tooling Development**

To accomplish the process of precision alignment, the group had developed an optomechatronic system called a FRAM (Flexible Robotic Assembly Metrology), which had two major components: a universal base structure which could perform the optical and mechanical actions and tooling specific to each project which could be easily attached or detached from the base structure as needed. Because the investment for the base structure had already been made, the cost of any additional project was only for the specific tooling which would need to be developed. This savings was significant since the tooling was only about 1/10<sup>th</sup> the cost of the base structure. The cost to develop new tooling was further reduced by more than one half by adopting standardized parts and vendors. The time to develop new tooling was also cut in half through experience, and the number of engineers who needed to be involved was reduced by more than 60%. Overall, new projects cost roughly \$500M less than new projects in the past due to experience with tooling development.

### **3.7.2 Training**

Experience in HPISM extended beyond the engineers to the actual operators on the floor who performed the manufacturing processes. Because new projects used a similar process for precision alignment, the operators needed far less training than previously. Training was necessary only to address project specific issues, rather than how to operate the equipment. Training time in some cases was cut from two weeks to two days.

### **3.7.3 Component Selection**

Since HPISM was concerned with meeting manufacturing specifications, it was also very aware of product performance specifications. With experience in manufacturing imaging products, their knowledge was particularly useful in achieving the desired specifications at the lowest cost. For example, by leveraging knowledge from previous products, HPISM was able to recommend an alternative lens from what the product designers had specified which would meet the desired performance specifications, but cost only one tenth as much. Such intervention also highlights the advantage of cross enterprise knowledge sharing which can occur with a manufacturing process platform.

### **3.7.4 Product sharing**

An extreme example of the benefits of having cross-enterprise knowledge sharing was illustrated by the convergence of two separate projects. Two development groups were working on separate products, but each used a subsystem which performed a similar function. Because both groups chose to manufacture within HPISM, it became clear that with some small design concessions, a single, common subsystem could serve both

products, saving a large amount in development and manufacturing costs. A manufacturing process platform allows for such sharing of designs since the commonality lies in the processes used to create the designs. The platform becomes the magnet for disparate pieces of the organization.

### **3.8 Implementation at Kodak**

The Eastman Kodak Company has recognized that the world of imaging is changing rapidly from film to digital media and is trying to adapt itself to this new environment. As Kodak looks forward to what it should do to be competitive, it has recognized that the old way of running its business is inadequate and that changes are required. To that end, Kodak has done several things to adapt, and could do more. Kodak has reduced headcount significantly, acquired several digital printing and medical imaging companies, and has created a program to make commercialization management a lifelong career position in order to retain product development expertise. Looking forward, Kodak could consider using the analysis performed within HPISM as a foundation for the implementation of manufacturing process platforms to improve the product commercialization process. Manufacturing process platforms could provide numerous benefits to cost, quality, and delivery which would contribute to Kodak's competitiveness in the new digital environment.

#### **3.8.1 Three Perspectives on Organizational Change**

This section will explore Kodak's current environment and will describe how my effort to implement a manufacturing process platform fits into Kodak's desire to bring about change. As an analysis tool, I use a three-lens concept of looking at the organization change from different perspectives: strategically, politically, and culturally.

The strategic view looks at how the change to the organization affects the functional ability to achieve the goal and how groups are placed within the organizational structure. The political view considers how alliances and relationships affect the ability to bring about change. The cultural view considers how company and group traditions and attitudes would affect the potential change.

#### **3.8.1.1 Strategic Design**

A large part of strategic design involves analysis of the company's strategy and how the processes fit with that strategy. Kodak's overall strategy in equipment manufacturing is to be the producer of high quality imaging products. Kodak has deep experience in what comprises a high quality image and understands what is necessary to achieve high quality images. As Kodak is transforming itself to be more aggressive in digital imaging, it is also concerned with cost. Kodak is highly concerned with taking cost out of products and therefore establishes policies to save money. For example, Kodak has established that one of the metrics by which commercialization managers are judged is the dollar amount of inventory that exists in the manufacturing operation.

Each business unit has a portfolio of products and has product managers in charge of commercializing each product or product line. The business unit is responsible for the success of products in the market and the product commercialization managers are responsible for the on time delivery of the product, product quality, and the cost to commercialize the product. The role of the manufacturing organization, HPISM, is to assist the business units and commercialization managers in providing high quality products in a timely fashion, at low cost.

The business units, increasingly concerned with saving money, follow a bidding process to determine what organization will manufacture their products. By asking both the internal manufacturer, HPISM, as well as external manufacturers to propose a manufacturing plan, the business unit hopes to achieve the lowest possible cost for their product. HPISM, with the interests of the company in mind, would like to be the manufacturer of choice for the business units as they feel they have experience which competitors lack and which would be directly relevant to the imaging products being manufactured. HPISM could provide the high quality manufacturing to manufacture high quality imaging equipment.

Manufacturing process platforms have the potential to serve the needs of both the business units and HPISM. Both organizations want to see continuous improvement and are interested in how that can be achieved. However, the decision to implement process platforms and the consideration of strategic design must be made by senior management. Therefore, for change to occur, it is necessary for upper level management to buy into the idea of process platforms, as they alone are in a position to affect the processes by which the business units and HPISM interact.

Process platforms, while conceived with the notion of making as little an impact on the current process as possible, would need buy in from both high level management and the organizations affected by the change. The change in structure I propose is to add expertise groups into the commercialization process. These resource groups do not currently exist, and thus would need to be created and positioned into the company in such a way that they can and will be utilized during commercialization. Getting buy-in is difficult since the proposed change in process will involve taking away some freedom

from business units. While in the past, business units could choose to act in whichever way seemed best, the new process would involve consultation with an expertise group.

#### **3.8.1.2 Political Considerations**

The key stakeholders involved in the implementation of process platforms are the business units and their commercialization managers of imaging products who are responsible for the overall success of the products they make, the manufacturing organization, HPISM, which turns designs into real products, and senior level managers responsible for bringing Kodak into the digital age. From a high up perspective, each of these stakeholders has much to gain from process platforms. Implementation of manufacturing process platforms would increase the speed of getting products to market, improve the quality of products, and reduce the overall cost of commercializing products. On an individual basis, business units would gain access to the manufacturing expertise of the company, which includes lessons learned by other business units with respect to manufacturing competencies. HPISM would see better utilization of the expertise retained by the group. Senior managers would see products being commercialized faster, cheaper, and with better quality and thus success in digital imaging.

However, each of the stakeholders has something to lose as well. Business units, having to consult with an expertise group must give up some autonomy in the commercialization process. Having to utilize experts could be felt as an impediment to speed. Furthermore, the business unit may be subject to design or process changes as recommended by the expertise group. The manufacturing group, HPISM, would potentially need to change its structure to accommodate the creation of expertise groups. The expertise group would likely include several key employees from HPISM. Also, as



the key value which HPISM provides is identified, it may become clear that HPISM is not necessarily competitive on every service it provides to the business units. Senior managers would potentially face difficulty in adjusting the organizational structure to accommodate expertise groups. It may be challenging to develop the right incentives and structural career path for individuals comprising the manufacturing process platform.

Senior managers have the power to bring about a change to the commercialization process, but of course they would be pushing against the history of the processes followed in the past as well as the needs of the business units to feel ownership of projects. Business units therefore have a fairly large amount of power in what processes they will follow. Being free to make individual decisions helps the business units stay nimble in a fast paced market and also instills a certain amount of responsibility into the group. That feeling of responsibility encourages that project performance metrics be consistently met. Process platforms would only eat away at the business units' perceived freedoms, despite that fact that the business unit would be gaining information and assistance which would likely increase their ability to meet their performance goals. The manufacturing group has the least amount of power to move towards a process change. HPISM does not have the ability to insist on business units using the expertise they maintain nor are they structured financially to be a manufacturer of choice for the business units.

As business units have a choice in manufacturers, they also have historical knowledge of what their experience with each manufacturer was like. The memory of projects which did not go as planned or did not meet cost expectations weighs heavily on future manufacturing sourcing decisions. Business units are increasingly disposed to

starting fresh with a new manufacturer to avoid problems experienced in the past, hoping not to encounter new risks. Problems from the past could result in finger pointing about which organization was to blame, but since the business unit is ultimately responsible for the project, they take the hit from the company's perspective. Therefore the business unit will be increasingly wary about their manufacturing choices. The manufacturing organization may have their own ideas about where the process broke down and can feel insulted when they are passed over for future projects.

Business units are more inclined to develop their own expertise, specific to the types of products they manufacture. It is not likely to be immediately obvious to the business unit that knowledge learned from working on projects in other groups translates directly to the types of processes the business unit handles. The senior level managers should be the most inclined to recognize cross-business unit synergies in manufacturing processes and encourage sharing knowledge. The manufacturing group, which currently maintains the cross-business unit process knowledge, is very clear on the benefits afforded by process platforms. It is incumbent upon the manufacturing group to communicate the need for process platforms to senior managers.

### **3.8.1.3 Cultural Considerations**

Successful implementation of a manufacturing process platform would symbolically give credence to the message that the manufacturing group has been trying to convey to the larger Kodak organization for a while: manufacturing performs a valuable service to Kodak and has experience which continues to be critical to Kodak's business. As the utilization of internal manufacturing has declined, it has been a challenge to appear cost competitive with outside vendors and to retain key experts in the

group. The new plan would indicate that the manufacturing group is strategically important and should not need to compete on the basis of cost alone. To the Kodak organization as a whole, process platforms could indicate another step towards a modern organization which is continuously improving its commercialization processes.

There is a perception in the organization that manufacturing is simply providing a service to the business units and offers something that can be obtained outside of the organization just as easily. The new process would recognize the importance of manufacturing knowledge in the commercialization process and would highlight strategic manufacturing process knowledge. This change would elevate the relative power of manufacturing in the commercialization process and could cause the business units to feel more restricted.

The project to institute manufacturing process platforms is being presented to successively higher management levels to get buy in and support. When buy in has been obtained at a high enough level, official process changes can begin to take shape. Presenting directly to business units is tricky in the sense that credibility is difficult to establish as the plan comes directly out of the manufacturing organization. The plan can easily be interpreted as self-interested tactic by manufacturing to justify its own existence. Therefore, identifying the clear benefits to the business units is a key element of getting any support for the proposal.

In Kodak, the importance of relationships within the large organization is clear. To get acceptance among organizations, it is critical to get key, influential people to support the plan. Relationships appear to be much stronger than organizational boundaries. Furthermore, people are very respectful of the hierarchy of leadership and

seem willing to follow. Kodak people are all very dedicated to the success of Kodak and are willing to entertain ideas about how to make Kodak better. However, not everyone is able to agree on what course of action will lead to success.

### **3.8.2 Future Plans**

The plan to implement manufacturing process platforms was delivered to a senior level executive who had the authority to bring about structural change in the organization. This executive had his own thoughts on the benefits of platforms and was open minded about the potential for instituting change. Of course, change does not happen quickly in an organization like Kodak, but it was clear that the concept of process platforms would be addressed.

#### **4 Chapter 4 - Conclusion**

A manufacturing process platform has the potential to deliver strategic and operational benefits to a company's product development process. A company interested in exploring those benefits should undertake an analysis of the manufacturing processes involved with the manufacture of their products. The company should look for processes which leverage manufacturing knowledge and experience gained from past and concurrent projects. Having identified process competencies, a platform should be implemented. Implementation involves consideration of the organizational, political, and cultural landscape within the company. It is critical to have high level management support to implement this change in product development process.

Successful implementation will yield a number of positive results for the company. Communication across business units will be improved as process knowledge is shared between silos. The cost to develop new products which use similar projects will be reduced along with the time it takes to deliver finished product. Because of experience with the manufacturing product, quality is likely to improve as well. Overall, the product pipeline will move more efficiently with strategic selection of projects and efficient use of resources. Manufacturing process platforms can ensure that the talents of the company are well utilized and appreciated.

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