The Effects of Product Platform Topologies and Market Realities on Front-End-Loaded Product Development Processes

by

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MS Electrical Engineering, Rochester Institute of Technology, 1993
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Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for the Degree of

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Abstract

The product development community has adopted new processes in an attempt to deliver to the market products that customers want, on time and on budget. The early 1990s saw the introduction of formal processes, usually of a phase/gate format, to commercialization activities. During the middle of the decade, firms adopted additional processes aimed at bringing new technologies to a commercialization-ready state to prevent technology development during product development. While firms began to improve some metrics, like time-to-market, other metrics, such as development costs and sales volumes, continued to be hard to predict. As a result, the end of the decade saw firms adopting a new front end to their product development processes (PDP), whose purpose was to integrate many of the individual best practices that were in use, in order to deliver products with predictable profits (development costs, manufacturing costs, and sales volumes are predictable). This new Integrated Product Strategy (IPS) would also allow senior managers to manage at a higher level because of the structure imposed on the PDP. This structure would also enable firms to offer a stream of products with customer-pleasing features that gave the firm a sustainable competitive advantage.

IPS relies heavily on a concept called Product Platforms to maximize the performance of a firm's product development process. Platforms foster the reuse of technology and, therefore, lower the risk of new product development. However, the environments that firms face when bringing products to market vary widely. Is it reasonable to believe that Product Platforms are a universal solution that will enable the benefits of IPS, regardless of the environment that the firm is facing? This paper will define a framework that will categorize the environments that firms face, based on the type of platform (topology), the method chosen to execute the platform, and the market environment into which the firm is trying to insert a new product. The end result will be a matrix with 12 different Topology/Method/Market domains and a rating system, based on data from real product development activities, as well as engineering intuition, that rates each domain in the array for its ability to enable the benefits of IPS.

Thesis Advisor:
Dr. Daniel E. Whitney
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# Table of Contents

Abstract ................................................................................................................. 3  
Acknowledgements ........................................................................................ 5  

Chapter 1 – Introduction .................................................................................. 9  
1.1 History of Product Development at Kodak .................................................. 9  
1.2 Product Success Remains Elusive ............................................................... 10  
1.3 Thesis Goals ............................................................................................... 12  
1.4 Thesis Outline .............................................................................................. 13  

Chapter 2 – Integrated Product Strategy .......................................................... 16  
2.1 Introduction ................................................................................................. 16  
2.2 The Core Strategic Vision ......................................................................... 16  
2.3 Market Attack Plans .................................................................................. 18  
2.4 Product Platforms ...................................................................................... 21  
2.5 Mapping Product Platform Benefits to IPS Benefits ............................... 24  
2.6 Summary ..................................................................................................... 28  

Chapter 3 – Product Platform Methodologies ................................................ 30  
3.1 Introduction ................................................................................................ 30  
3.2 Strategic-based Platforms ....................................................................... 30  
3.3 Options-based Platforms .......................................................................... 35  
3.4 Important Differences Between Strategic- and Options-based Platforms .... 39  
3.5 Issues around Technology Readiness ......................................................... 40  
3.6 Financial Issues .......................................................................................... 42  
3.7 Summary ..................................................................................................... 43  

Chapter 4 – Market Realities .......................................................................... 45  
4.1 Introduction ................................................................................................ 45  
4.2 The Market Variety/Rapid Platform Framework ....................................... 45  
4.3 Summary ..................................................................................................... 52  

Chapter 5 – Product Platform Topologies ...................................................... 54  
5.1 Introduction ................................................................................................ 54  
5.2 Component-based Platform Topology ....................................................... 54  
5.3 Component-based Platforms Interface with Market and Platform Method .... 56  
5.4 Manufacturing-based Platform Topology .................................................. 58  
5.5 Manufacturing-based Platforms Interface with Market and Platform Method .. 61  
5.6 Systems-based Platforms ......................................................................... 63  
5.7 Systems-based Platforms Interface with Market and Platform Method ........ 65  
5.8 Knowledge-based Platforms ..................................................................... 66  
5.9 Summary ..................................................................................................... 68  

Chapter 6 – Project Performance .................................................................. 70  
6.1 Introduction ................................................................................................ 70  
6.2 Project Performance Data ......................................................................... 71  
6.3 Summary ..................................................................................................... 76  

(continued)
# Table of Contents (continued)

Chapter 7 – Delivering on Better Revenue Forecasts .................................................... 77  
  7.1 Introduction ............................................................................................................ 77  
  7.2 The Correlation Matrix for the Cost Side of Forecasting Revenue .................. 78  
  7.3 Results from the Correlation Matrices ............................................................... 81  
  7.4 Cost Side of Forecasting Revenue and the Topology/Method/Market Array ... 83  
  7.5 Summary ............................................................................................................. 84  

Chapter 8 – Managing the Vital Few and Vectors of Differentiation ......................... 85  
  8.1 Introduction ........................................................................................................... 85  
  8.2 Managing the Vital Few ....................................................................................... 85  
  8.3 Vectors of Differentiation .................................................................................... 88  

Chapter 9 – Conclusions .............................................................................................. 92  
  9.1 Introduction ........................................................................................................... 92  
  9.2 Analysis of the Completed Topology/Method/Market Array ......................... 92  
  9.3 Remarks About the Data Sets ............................................................................ 94  
  9.4 Getting Better Data ............................................................................................... 97  
  9.5 IPS, RTDP, and KECP ......................................................................................... 100
Chapter 1 – Introduction

“You may never know what results come from your action.
But if you do nothing, there will be no result.” - Gandhi

1.1 History of Product Development Processes at Kodak

During the 1980s, U.S. and European firms were competitively challenged in many industries by Asian firms. Effective, incremental innovation and dramatic improvements in operating efficiencies were the two keys to the success of the Asian firms. In response, U.S. firms increased their competencies in managing the product development process with emphasis on cost competitiveness and quality improvements. There was a variety of prescriptions for success for the American firms including: six sigma quality in manufacturing, concurrent engineering, reduced cycle time, TQM, just-in-time inventory management, and phase-gate product development systems.

Eastman Kodak Company is an example of one of those American firms that faced the onslaught from Asia. In response, it implemented many of the prescriptions listed above. In the early 1990s, it introduced KECP, the Kodak Equipment Commercialization Process, to its equipment development organizations. This process had six phases/gates to shipping approval for new or incrementally-modified equipment and was designed to achieve three major goals: cutting product development cycle time in half, getting twice the number of products from the same R&D investment, and significantly increasing the number of global market successes. The media side of the business that sells the photographic film and paper, for which Kodak is most famous, rolled out KMCP, the Kodak Media Commercialization Process, shortly after KECP was introduced. The differences in the two processes reflect that the manufacturing side of the media business is very capital intensive and requires different timing for its gates.
While KECP and KMCP were successful at getting the firm to talk the same language of product development across many business units (in place of the ad hoc methodologies that were previously used), it was weak in the area of portfolio management and it did nothing to make sure that the firm was not duplicating efforts across its many Strategic Business Units (SBUs). In 1995, Kodak introduced a second process to act as a front-end to KECP and KMCP. RTDP, the Robust Technology Development Process, is a four phases/gates process that aims to ensure that the technology being developed and delivered to product programs (those under KECP and KMCP) is robust enough to enter the commercialization process. This was in direct response to many programs getting stuck in Phase 2 of development. At Gate 2 (at the end of Phase 2), the development team needs to commit to schedules for the completion of the design. This is achievable when “no further invention is required” and the problem was that the new technologies being utilized were not yet robust enough for product implementation. Depending on the criticality of the technology in question - whether it was the core-enabling technology or if it was supporting or component technology - RTDP would overlap KECP in phase 0, 1, or 2.

RTDP is far enough ahead of manufacturing processes in order for the same phases and gates to be used for media, hardware, and algorithm technology development groups.

1.2 Product Success Remains Elusive

Since the introduction of RTDP, product development performance has improved relative to the Phase 2 metric; and, since its implementation, Kodak has seen a reduction in schedule overruns from Gate 2 to Gate 6. Yet, even though Kodak was statistically on par with other world-class organizations in product development cycle time, problems remained. Products that were developed on time, some even within budget, were just as unsuccessful in the marketplace as those that were delivered late and more costly to develop than expected. Could it be that the
popular lament of “missing the market window” was not the only thing wrong with the products Kodak was bringing to the market? What else could be done to get Kodak out of the LARD syndrome? LARD stands for Launch And Ramp Down – the process of launching a product that doesn’t enjoy an immediate market success and then killing the program.

The first phase of RTDP is Opportunity Identification and Assessment (OIA). The inputs to OIA are traditionally Technology Roadmaps (where the industry is going), Product Family Plans (how the company’s technology and capabilities can be used to attack different market segments) and Customer Needs and Preferences (what can be sold). The inability of firm’s to properly identify these inputs has led to calling this activity the “fuzzy front-end” of the product development process.1

When considering the data collected for OIA, particularly for opportunities that depart from the incremental improvements, senior managers often mention gut instincts as the method of evaluation.2 In an attempt to put in place a process that can help clarify the “fuzzy front-end,” many firms are adopting an integrated approach in which cross-functional teams are trying to bridge the critical gap between the strategic vision of the firm and the methodologies used to capture the data for OIA. This process has been labeled as the Integrated Product Strategy (IPS) by McGrath of the consulting firm PRTM and has been called the integrated Product Development Process (iPDP) at Kodak. The process consists of a collection of industry best practices such as Core Strategic Vision, Product Platform Plans, Market Attack Plans, and Vectors of Differentiation. McGrath claims that Product Strategy is a management process and that the better the process, the better the strategy. He states further that if the process is executed properly, it can replace the standard portfolio management approach to product strategy with an

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1 Leifer et al. (2000, p. 41).
enterprise-wide process that will integrate all OIA information and provide consolidated revenue and profit forecasts for all products under development, as well as many other benefits. Many sources have claimed that the institutionalization of an integrated approach to product development will be a strategic core competency in the next decade.3

1.3 Thesis Goal

The “fuzzy front-end” lacks clarity for a reason – there is always uncertainty when trying to predict the future. In fact, in their book Design Rules,4 Baldwin and Clark describe the space of product development in the following way:

“With (economic) value as the force propelling change, ... the design of a complex artifact (product) could evolve in unplanned but nonetheless coordinated ways. The result was a “complex adaptive system”, whose elements were constantly being modified, giving rise in turn to modifications of other elements.”

However, the main promise of IPS, being able to predict the return on products in the market and under development, is close to the Holy Grail of management. McGrath states that product development forecast will be integrated with financial plans – “forecasted revenue from new products was one of the most critical elements of financial plans. But this forecast was rarely based on what was currently in development since the information was simply too difficult to get and usually inconsistent.”5 It must be worth an attempt to find the means of controlling this “complex adaptive system” if the reward is so great.

2 Ibid.
There are two other main deliverables from the IPS process beyond better revenue and profit forecasts for products in the market and under development. The first deliverable is the management of the “vital few.” This is a means for upper management to take a more global perspective of product development. The second deliverable is the establishment of Vectors of Differentiation that will allow products to have a sustained advantage in the marketplace. All three of these deliverables count on great planning, which is embodied in the Market Attack Plan (MAPs) of the IPS, and on great execution in delivering products to market. McGrath relies heavily on a concept called Product Platforms to maximize the performance of a firm’s product development process. The product development process is used to bring products to market and, therefore, Product Platforms are the crucial concept in optimizing a firm’s execution.

The environments that firms face when bringing products to market vary widely. Is it reasonable to believe that Product Platforms are a universal solution that will enable the three benefits of IPS, regardless of the environment that the firm is facing? This paper will define a framework that will categorize the environments that firms face, based on the type of platform (topology), the method chosen to execute the platform, and the market environment into which the firm is trying to insert a new product. The end result will be a matrix with 12 different Topology/Method/Market domains and a rating system, based on data from real product development activities, as well as engineering intuition, that rates each domain in the array for its ability to enable the three IPS benefits.

1.4 Thesis Outline

The stage has been set. Even though Kodak had become world class from a process perspective, in their product commercialization efforts, they still were not enjoying the kind of success they expected in the marketplace. Will another process lead the company to product
development nirvana? While it would be a worthy undertaking to come up with substantial heuristics that would allow the planning (MAP) process to be more fruitful, the battle with the complex adaptive system that is the marketplace will have to wait for another day. This thesis focuses on Product Platforms and the execution side of IPS. In order to build the framework that leads to the Topology/Method/Market Array and, finally, to a set of heuristics that will help product developers assess their environment, as well as decide if Product Platforms will help realize the promises of IPS, the following path will be taken:

Chapter 2 - Discussion of IPS and its core processes – MAP and Product Platform. How do product platforms help realize the three IPS benefits?

Chapter 3 – Product Platform Methodologies – How are platforms implemented in the product development cycle?

Chapter 4 – Market Realities – What are the market dynamics that play a role in determining if a platform strategy will be successful?

Chapter 5 – Firms can have platforms based on component, manufacturing, or system technologies. How does the choice of what type of technology interact with the method in which the platform is implemented and the market realities that it will see?

Chapter 6 – Schedule overrun is the main cause of projects not meeting the cost side of the revenue picture because of the extra development dollars spent and the lost opportunity of not having the product in the market. Industry data will be presented that show why projects are late.

Chapter 7 – The industry data presented in Chapter 6 is analyzed using a correlation matrix-like methodology to show in which environments platforms are good at predicting the cost side of the revenue picture.
Chapter 8 – Industry examples and engineering experience is used to analyze in which environments platforms are able to deliver the other two benefits of IPS, managing the vital few, and sustainable vectors of differentiation.

Chapter 9 – Conclusions and recommendations.
Chapter 2 – Integrated Product Strategy

"Don’t ask the barber whether you need a haircut.” – Daniel Greenberg

2.1 Introduction

This chapter is intended to provide background on the IPS process. While the Core Strategic Vision and Market Attack Plan topics are discussed only in this chapter, their inclusion helps the reader understand the overall process. Product Platforms are introduced in this chapter and the roles they play in IPS are analyzed.

2.2 The Core Strategic Vision

The consulting firm, PRTM, with Michael McGrath as one of the principals, claims to have unequalled expertise in the high-technology sector, accumulated through engagements with over 1200 firms. The Integrated Product Strategy (IPS), as laid out by McGrath in his book “Product Strategy for High-Technology Companies,” starts with generating a Core Strategic Vision (CSV) for a firm. While the ramifications of the CSV are far-reaching, the process used to establish one is quite simple – just ask three simple questions:

1. Where do we want the company to go?
2. How will we get there?
3. Why will we be successful?

Another consulting firm, Waverly Technology Associates, claims that you need five questions answered to develop a successful technology strategy:

1. What future do we face?
2. Which technologies should we exploit and why?
3. Are our technology objectives aligned with our business objectives?

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6 PRTM web site.
7 Waverly Technology web site.
4. What skills and organization do we need?
5. How do we implement our technology programs?

While Waverly may seem overly concerned with technology for technology’s sake, there is really very little difference between the two lists. Waverly focuses on technology as the means of moving a business forward. Choosing technologies to exploit is the answer to “How will we get there?” and aligning technology to strategy and training the organization in those technologies addresses why the firm will be successful.

The purpose of these questions is to generate a vision that can be used to guide the firm. Just like human vision, corporate vision is susceptible to tunnel vision, blindness, shortsightedness, and hallucination. The vision that you want leading your company needs all positive attributes. It needs to be 20/20 with good peripheral vision and a touch of foresightedness. It must be able to see things in focus so that the picture you see is complete and has great clarity. The vision attributes make sure that a firm’s vision is realizable. It would be shortsighted or downright hallucinatory for Kodak to simply say that it will continue to make great photographic film that people will want to buy and that this strategy will provide it with 15% growth rates in the future. The market reality is that competition is driving prices down and digital cameras are starting to eat into volume, further reducing profits. Kodak’s new vision, if it is going to grow at rates that will please Wall Street, is difficult to formulate under such trying circumstances.

After the vision is established it must be aligned with the firm’s capabilities and strategies. McGrath talks about the CSV as having six boundaries that must be adjusted in order for the alignment to take place. They are:

1. Core competencies (value chain) 4. Technology trends/strategy
2. Financial plan (economic model) 5. Product strategy
Financial plan alignment takes place when CSV targets the firm’s financial goals, usually expressed in terms of revenue growth, profitability, and investment. Aligning to market trends allows the vision to track the changing aspects of most high-tech markets such as size, customer needs, buying behavior, and retention, as well as elements of the supply chain. Technology trend alignment is accomplished via roadmapping future key technologies, emerging technologies that could affect the vision, as well as unrelated technologies that could possibly create substitute products. Alignment of product strategy occurs when the planned product stream will satisfy the firm’s existing markets, as well as expanding into the new markets required to make the CSV a reality. For example, Kodak could use its film manufacturing infrastructure to produce membranes for fuel cell applications. The business charter comes into alignment when the firm’s mission, culture, and values don’t interfere with or leave gaps in the path to successfully implementing the CSV. Finally, core competency alignment occurs when the things that the firm does best match the needs of the CSV. Most of the time that means that the firm needs to acquire new skills; but, occasionally, it is a directive for the firm to stop doing something it has been doing well for years.

2.3 Market Attack Plans

The output of the alignment activities will be an all-encompassing plan that will guide the firm. The Market Attack Plan (MAP) is the cornerstone of organizing actions to create and sustain a competitive advantage in the marketplace that will allow the firm to realize its CSV. This requires a thorough analysis of and complete response to current and future opportunities in the market. The MAP links customers to products and to the entire value delivery system.

One view of the MAP elements is shown in Figure 2.1. While this view of the MAP is strong in its linking of the customer (market) to the planning process, it shows a straightforward
process of the analysis required to generate a MAP. Figure 2.2 shows a much more complete view of the decision process required.

As the figures show, MAPs are highly complex planning activities that are much richer in their context than the old method of using product roadmaps to govern market engagement activities. Kodak sees such value in the MAP part of the IPS that MAP activities interface with business unit general managers. When MAP teams are formed, there is a Roles and Responsibilities document in which most of the factors shown in Figure 2.2 are assigned. There is also a MAP team template that is used to prod the MAP team to document the analysis done on each of the factors. The integrated approach to understanding the markets, customers, competitors, technology, and other environment trends has other benefits as well.

As McGrath points out, “Another development that has made strategic integration approach increasingly important is that many high-technology companies are, in a sense, the victims of their own gains in executing individual processes and activities. Inevitably, their process
execution skills start to outpace their strategy-setting capabilities. In other words, their ability to do begins to outstrip their ability to figure out what to do next."\(^8\) The MAP helps with the what.

\[\text{Figure 2.2: Complex view of the MAP}\]

2.4 Product Platforms

A product platform can be thought of as the technical, design, or knowledge “basis” for several products that are derived from it through reuse and leverage. Sanderson\(^9\) defines platform projects as “flexible, adaptable designs that can be easily changed to follow market shifts.” In their seminal book on Product Platforms, Meyer and Lehnerd\(^10\) define a product platform as “a set of subsystems and interfaces that form a common structure from which a stream of derivative products can be efficiently developed and produced.” And finally, McGrath\(^11\) offers “a product platform is not a product. It is a collection of the common elements, especially the underlying defining technology, implemented across a range of products. In general, a platform is the lowest common denominator of relevant technology in a set of products or a product line.”

These three definitions offer an expanding view of a platform. Sanderson focuses on following market shifts, Meyer on subsystems and interfaces, and McGrath calls out the lowest common denominator of relevant technology. The range of these definitions is best discussed while referencing a Market Segmentation Grid, a construct from Meyer and Lehnerd, which is shown in Figure 3.1. A product platform is powerful because it provides the means of populating many squares in the Market Segmentation Grid efficiently. For a practitioner of IPS, this efficiency will enable the three benefits mentioned in Chapter 1 (better revenue and profit forecasts for products in the market and under development; the management of the “vital few;” and sustainable Vectors of Differentiation).

In the Segmentation Grid, Sanderson’s definition seems to be more focused on providing a Vertical Strategy. Meyer uses the term “derivative products” to describe how he sees horizontal movements in the array, and definition of “derivative” can put distance between his and McGrath’s definition. McGrath sees greater value in a horizontal strategy where there is significant distinction in the market segments being served. In fact, McGrath describes platforms in a manner that would cause one to redraw the segmentation grid to align platforms more closely with IPS. MAPs can be viewed as “vertical” constructs – they are detailed, complete responses to opportunities in a single market. Product platforms are “horizontal” constructs – they embody the core competencies of the firm (from a technological standpoint) that can be applied across multiple markets and, thus, multiple MAPs. This relationship is shown in Figure 2.4. There is a strong interaction between MAPs and product platforms – the MAP provides the strategic direction for the development and evolution of product platforms while the firm’s core competencies, embodied in the product platform, influence the choice of which markets to enter and how to compete in them.
As the basis for offering product variants to fill all of the tiers within a market segment, platforms still need to fill the more mundane role, as the definitions of Sanderson and Meyer suggest. However, the MAP must make sure that the firm doesn’t stagnate on the product variant theme. Both Foster\textsuperscript{12} and Leifer\textsuperscript{13} warn of the technological health of the firm when it relies too heavily on product variants. The MAP must plan for successive generation of product platforms so that, while incremental product variants are addressing the ever-changing needs of current customers and keeping the firm’s cash flow healthy, new platforms will emerge that will supply the firm with periodic infusions of innovation and allow the firm to capture new markets and customers.

A simple view of product platforms and IPS shows that product platforms are used to deal with the increased complexity of a MAP-based strategic planning activity. By reusing or leveraging platform components, firms usually find reduced time-to-market for their products as well as improved operating efficiencies in areas like engineering headcount, material cost

\textsuperscript{12} Foster (1986) p. 216.
savings and supply chain costs. Platforms also encourage a longer-term view of product strategy because it is the platform that gets managed over many product cycles.

2.5 Mapping Product Platform Benefits to IPS Benefits

The power of product platforms has received much press since the mid-1990s. The best compilation of how leverage and reuse benefits a firm found in the literature is repeated, in spirit, in Figure 2.5 (the original version was software-specific, it has been generalized in its content to cover all product platforms).

While the benefits of platforms are varied and far-reaching, this paper will zero in on the three benefits of IPS that were mentioned in the first chapter – improved profit and revenue forecast for products in the market and under development; managing the “vital few;” and having products with sustainable vectors of differentiation. These benefits are important because they are unique claims of IPS and make it much more than just another planning activity.

Aggregating across Figure 2.5, the improved profit and revenue forecast for products in the market and under development benefit stems from:

1. Greatly improved time-to-market – shorter development programs are more predictable in their cost; getting to market quicker means it has less chance to change
2. Sustained growth and market presence – having a string of products in process not only grows the market but also allows some percentage of flops without greatly impacting your bottom line.
3. Ability to capture a market niche economically / Known costs for unique requirements – this reflects the fact that large portions of platformed products are reused and, therefore, only a small portion of the design/cost of a new product carries any risk.
4. Increased predictability / Predictable delivery / Predictable cost – as more of the process of product development becomes predictable, the outcome becomes more reliable.

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13 Leifer et al. (2000) p. 3.
<table>
<thead>
<tr>
<th>Stakeholder</th>
<th>Benefits</th>
</tr>
</thead>
</table>
| CEO                          | • Large productivity gains  
  • Greatly improved time-to-market  
  • Sustained growth and market presence  
  • Ability to capture a market niche economically |
| COO                          | • Efficient use of work force  
  • Ability to explore new markets and new technology  
  • Fluid personnel pool |
| Technical Manager            | • Increased predictability  
  • Well-established roles and responsibilities  
  • Efficient production |
| Product Developer            | • Higher morale / Greater job satisfaction  
  • Can focus on truly unique aspects of products  
  • Easier integration  
  • Fewer schedule delays  
  • Part of a team building products with an established quality record and reputation |
| Platform/Product Architect   | • Greater challenge  
  • Work has more impact  
  • Prestige within the organization  
  • As marketable as the product line |
| Marketer                     | • Predictable high-quality products  
  • Predictable delivery  
  • Can sell products with a pedigree |
| Customer                     | • Higher quality products  
  • Predictable delivery date  
  • Predictable cost  
  • Known costs for unique requirements  
  • Well-tested training materials and documentation  
  • Shared maintenance costs  
  • Potential to participate in user’s groups |
| End User                     | • Fewer defects  
  • Better training materials and documentation  
  • A network of other users |

**Figure 2.5: Product Platform Stakeholder Benefits**

According to McGrath, a platform approach to products leads to the management of the "vital few" benefit by allowing management to focus on key platform decisions instead of
individual product decisions. Platforms also encourage a long-term view of product strategy because a platform will have a longer life than individual products. These two benefits could be added to the CEO and Technical Manager boxes in Figure 2.5 to make it more complete; otherwise, it is difficult to pick up “managing the vital few” benefits in Figure 2.5. The concept of managing at the product platform level, rather than the product level, reducing the entities being managed, by an order of magnitude in some cases, is shown in Figure 2.6.

Figure 2.6: Managing the “vital few” with platforms

The final benefit of sustained vectors of differentiation is also difficult to find in Figure 2.5 because the data therein is more of a snapshot of the benefits at a particular time, rather than a view of product platforms in action. Differentiation is used to segment a market and to position a firm’s offerings within the market. The role of differentiation changes as a product moves through its S-curve – in “ferment” there are many differentiating features amongst the product
offerings and customers begin to express their preferences, determining which features, and, sometimes, which companies, are the winners and losers. As the market grows and enters “take off,” products become more clearly differentiated and market share starts to correlate to the relative importance, as seen by the customers, of the vectors of differentiation. Depending on the appropriateness of the different vectors, minimum product requirements increase because non-appropriated features that customers prefer become standard on all models. Finally, as the market reaches maturity, products are relatively undifferentiated (a cumulative effect from non-appropriated features) and the market switches to “soft differentiators,” such as price and service.

Once a market matures, it will either start to decline or it will become redifferentiated by a firm that establishes new differentiation vectors that are important to the customer. This is why it is important to think of differentiation as vectors and not just as points in space. A point implies that it alone is sufficient and that competitors won’t catch up – there is either no need or no opportunity to continue improving that differentiation and the next offering will be based on

**Figure 2.7: Vector of Differentiation Value vs. Time Graph**
another differentiated feature. A vector provides a path for continuous improvement of the differentiating feature; and, if the feature is the one most valued by the consumers and the firm can improve along that vector faster than the competition, the firm has a winning product.

McGrath\textsuperscript{15} uses a value vs. time graph to show the concept of VoDs that is worth including here. In Figure 2.7, the value of the “Ease of Use” attribute for Apple’s Mac is plotted against that of the Wintel architecture.

The length and slope of the vectors supply strategic information. The length denotes how long the feature can be improved for a given platform. For example, Microsoft improved Windows just so many times before it became technically and financially required to introduce Windows 95. The slope of the vector tells how rapidly the differentiating feature is improving — Windows 95, with support of the PCI bus and its plug-and-play features, allowed users to add many new accessories to their PC without installation problems. One needs to remember that as the market matures, the value of existing VoDs tend to lessen and that redifferentiation (new vectors) of the market is required to keep a firm’s participation profitable.

\textbf{2.6 Summary}

In summary, examine Meyer and Lehnerd’s famous example of the Black & Decker (B&D) universal motor platform within the IPS context. B&D designed a scaleable motor that could be manufactured on a single production line and this motor facilitated the redesign of B&D’s entire power hand tool product line. The motor design and the efficiencies it offered in manufacturing gave B&D \textit{a sustainable advantage in cost leadership}. Management could concentrate on the extensibility of the motor platform instead of each individual product. Finally, both product development costs (motor development would normally be a large portion of the product

\textsuperscript{15} McGrath (2001) pp. 166-167.
development) and product Unit Manufacturing Costs (the motor is a big UMC contributor) become more predictable which in turn allows for better revenue and profit forecasts for products under development, at least from the cost side of the equation.

When examining this example with the Segmentation Grid, the scalability of the motor allowed for the vertical strategy within a market segment. The fixed motor diameter and the scalable power output allowed it to move horizontally with ease between market segments (drills to saws to sanders, etc.). However, if one takes a broader view of the definition of “segment” – should the segment be each variety of hand tool (such as drills, sanders, saws, etc.) or should power hand tools itself be a segment – it can be seen that if B&D had a MAP, which pushed the motor platform into other market segments such as handheld kitchen tools and/or outdoor garden tools, the firm would have enjoyed even greater success. This definition of market segment is more closely aligned with McGrath’s definition of platform in which the lowest common denominator of relevant technology (the universal motor) is used across a lot of products.

The IPS process has been defined and the role of platforms in attaining the three IPS benefits has been demonstrated. In the next chapter, the methods that firms use to generate platforms will be explored.
Chapter 3 – Product Platform Methodologies

"We think in generalities, but we live in details." – Alfred North Whitehead

3.1 Introduction

This chapter will define the two methods by which a firm can choose to do its product platforming. The two methods are:

1. Strategic-based platforms
2. Options-based platforms

The choice that a firm makes will affect organizational decisions, investment decisions, the firm’s time-to-market, and, eventually, the firm’s bottom line.

3.2 Strategic-based Platforms

Strategic platforms use parallel development activities to allow a MAP to attack multiple market segments simultaneously. They require meticulous planning to determine which segments to attack and which technologies to use. The technologies or platform elements chosen are very important because they are the keys to moving a platform efficiently in the market segmentation grid. Both vertically and horizontally, movements may be necessary to enable products into all segments identified by the MAP.

An organizational element, usually an engineering team, needs to be in place to condition the technologies for use in the platform environment. This conditioning usually is beyond normal technology development activities (i.e., RTDP at Kodak) and usually involves modularizing the technology so that becomes platform elements that can be used in multiple products at different levels of performance without requiring the commercialization team to reinvent the wheel.

Meyer\textsuperscript{16} talks about the “Silicon Valley Model” of a firm’s organization in which there is a clean

separation between centralized general purpose functions (such as the platform developments discussed in his book) and decentralized or special purpose functions (such as specific derivative products) so that the individual technologies, components, or products can be interchanged without the need to redo everything. Meyer uses Microsoft as an example where there are “different groups within those business units working on new platform developments.”

Organizationally, a structure such as this would look like the one in Figure 3.1. The product platform organization takes direction from the MAP and seeks out new technologies that it feels will best provide the firm with vectors of differentiation as defined by the MAP. The product platform organization (sometimes referred to as Advanced Development) is responsible to develop these elements to the point where their incorporation into a product has little risk associated with it. The firm, or more likely a business unit within the firm, will match market opportunities with the stream of differentiation-creating platforms to pick which technologies to use in a parallel commercialization effort that would involve a number of products.

![Figure 3.1: Strategic-based Platform]
A firm would choose a strategic approach for many reasons. If the firm were engaged in a market where the pace of technology development is very rapid, the firm might need to plan and execute a number of products in parallel, in order to make the most of the present technology before developing the next platform. In contrast, if the firm is engaged in a technology-stable market where niches and competitors are easy to predict, the firm may want to use strategic platforms to lower the commercialization costs because doing multiple products in parallel would allow redundancies to be eliminated. Finally, a firm may need to attack strategically in order to justify an ancillary investment, such as a capital expenditure for a manufacturing capability. The business case on a single product might not pass and it is only when multiple products are executed does the business case become positive.

When planning a strategic platform, resources limit the number of parallel efforts that can be undertaken. There may be the traditional resource limits of money or people. For some markets, time may enter the limiting equation. Particular market windows need to be hit and that situation limits the number of parallel efforts that can be successfully undertaken. The final limit is ideas. This limit can be thought of as the inability to see how the platform can be moved around the market segmentation grid. The market may be changing too fast to allow for a good analysis of possible niches or some potential uses may not become evident until the product is in the customer’s hands.

In order to deal with these limiting factors, it is important that platform teams clearly understand the MAP in order to make correct platform decisions. Craig,\(^\text{17}\) when evaluating copier platforms at Xerox, used a product-family, pruning process to determine which features are best kept within a platform. This is done by prioritizing the markets in which the platform is

\(^{17}\)Craig (2001) pp. 45-49.
to be used and looking at which features compromise, in terms of performance and cost, the platform in the most important markets. The result is usually a scale back in features of the platform to make sure it addresses the needs of the most important markets. Craig also uses an NPV decision tree to analyze alternative platforms. This method could be extended to decide which products should be included during the parallel commercialization effort. Both of these techniques are very important to help optimize the product offerings when doing platforms strategically.

An example of strategic-based platforming is the way in which Kodak develops digital cameras. This market has two traits that are listed above that make strategic platforms successful – technology is moving very fast so platforms become obsolete quickly and the market is well segmented (customers looking for cameras at different price points). There are also certain time pressures in the market (Christmas season) that will limit a team from doing everything they may want to do. The main platform element, or “defining technology” (McGrath’s terminology), for a digital camera is the microprocessor/memory subsystem. Dominant design features associated with this subsystem have been established and include in-camera processing of images and removable image storage memory (compact flash cards). Even though Kodak does not make either the processor or memory, significant work is done to select and optimize the design of the microprocessor/memory subsystem and its associated firmware (embedded code), prior to letting the design teams actually start designing a family of cameras. This pre-work includes benchmarking image processing performance; meeting low noise and low power requirements; and having the capabilities to meet all interface requirements (for example, USB has become the computer connection of choice, therefore, camera design is advantaged if the microprocessor has a built-in USB feature). Beyond the processor/memory element, the platforming group is
looking at other technologies as well. These might include new image-processing algorithms or auto-focusing mechanisms/algorithms that will be implemented in future cameras. The platforming group needs to develop these technologies in a manner that will allow for widespread usage across all present and future camera platforms. A plot of Kodak’s digital camera families based on processor/memory platforms is shown in Figure 3.2.

![Kodak's Line of Digital Cameras Highlighting Processor/Memory Families](image)

Figure 3.2: Kodak’s Line of Digital Cameras Highlighting Processor/Memory Families

and each platform family has a fairly short life. Direction comes from the MAP as to which market segments and what vector of differentiation the new family of cameras is to target. The platform team decides what set of components/technologies, which it has already designed and evaluated, will best serve the product family’s needs. The product teams will take these technologies and start the commercialization process, which will integrate the platformed
components with the other parts of the camera. While this approach is fully implemented for the physical subsystems of the camera, having the same level of process efficiency for the software section of the design is still in the future. However, one aspect where the software has been well managed is the user interface of the camera – one of Kodak’s VoDs. The same easy-to-use user interface has been in use since 1998, which means it has been implemented across six different microprocessor/memory subsystems.

3.3 Options-based Platforms

Options-based platform methodology is based upon the “real-options” methods presently being used to make technology valuations. This new method of evaluating the potential of new technology is blamed for the extraordinary valuations accorded to some technology investments in the recent past.\textsuperscript{18} The basic theory is based on the financial call option where an investor pays a small cost today for the right to purchase a stock at a given price in the future. If the stock’s value exceeds the given price in the future, the investor will make a second investment to purchase the stock at the given price. If the stock’s value does not exceed the given price, the investor abandons the option at no additional cost. The investor’s maximum loss is the cost of the option to purchase the stock.

When “Real Options” are used to value technology, the cost of the option is the cost to acquire, through R&D or perhaps through an outright purchase, the technology. If down the road the technology is desirable, then the second investment will be the commercialization costs of the technology, which are usually much higher than the development costs. Again, just like in financial options, if the technology is not successful, the firm only loses the technology acquisition costs.

The theory changes a bit when applying it to product platforms. In this scenario, a product team is going through commercialization with a product that the MAP has determined to be desirable. During planning and development phases, the team makes small “investment” decisions as to the architecture of the product, particularly concerning its modularity and the robustness of its interfaces, which will enable the team to bring additional products to market. If the first product is successful in the market and the need for variants is clear, the team can extend the platform by “cashing in” the options in the form of much lower development costs and a faster cycle time to bring a second product to market. If no future products are developed, the team has lost only the small “investments” that they made during planning and development. Therefore, the difference between real options for technology and platform options is that platform options require a substantial initial investment to commercialize the first product; whereas, options for technology require only a modest investment that allows you to “play” in the technology. Exercising the options in technology means a substantial secondary investment to commercialize the technology, while in an option-based platform exercising the option means that additional products can be offered with lower development costs and faster cycle times.

The organizational structure of a company that does options-based platforming is shown in Figure 3.3. The important distinctions between options-based and strategic-based platforming are the focus of a corporation on getting one product to market as fast as possible and an organization that would lack looking into moving its basic technology into a platform-ready state. Individual products are initially developed based on their own merits. Decisions are made during commercialization to invest in and enhance the product so that it can be used as a platform in the future. These investments in modularity and robust interfaces not only cost money (both in product development dollars and in Unit Manufacturing Cost (UMC) of the
product) but may also increase the complexity of the product. Increased complexity is an undesired result and acts, along with the increased costs, as a brake on adding too many enhancements. Once the product gets into the market, the decision to “cash in” the options will be made and follow-on products will enjoy the benefits of lower development costs and faster time to market.

An example of options-based platforms in action was the development of Kodak’s mid-volume production scanner. The original Kodak Digital Science scanner 3500, shown in Figure 3.4, was developed to be a discontinuous improvement for its customers, such as hospitals and insurance companies, that used mid-volume production scanners to convert large amounts of analog documents into computer-readable forms. The introduction of the scanner 3500 moved Kodak from a bit player in the industry to the industry leader and forced some participants out of the market. Investments were made during the development of the scanner 3500 to ensure that it
was modular in design, in both the hardware and software aspects. While looking at how next to
attack the market, the product development team had the option to add color to the scanner 3500,
which would require a change in the image sensor and the control software, even though market
research showed that customers had a low interest in color, the development team realized there
was only a small dollar risk in commercializing a color version. This was possible due to the
work that was already done for the scanner 3500. It turned out that color scanning was a latent
need in the market and the Kodak Digital Science color scanner 3590C, also shown in Figure
3.4, was a hit. It has changed the market so much that color-capable scanning is now a
requirement for mid- and high-volume document scanners.

![Figure 3.4: Kodak’s Mid-Volume Production Scanners](image)

While financial options analysis is concerned with valuation, the options framework related
to platforms goes beyond valuing decisions – it represents a different process for structuring and
managing product development decisions. In emerging technology investments, real options
include the flexibility to defer, expand or contract, terminate, or otherwise modify projects. 19

The benefits of such options are operational in nature, relying on active, on-going project management. Attempts to systematically value real technology options have met with little success and, therefore, the process of “playing” the options still involves a great deal of management discretion and time. And, like financial options, the payoffs are highly asymmetric and increase as the uncertainty of the decision increases.

3.4 Important Differences Between Strategic- and Options-based Platforms

Using definitions from Reinertsen’s book, Developing Products in Half the Time,²⁰ strategic platforms are classified as “megaprojects.” These megaprojects would be used by a firm that plans to meet all facets of a MAP in one product development effort that is formidable. The effort would involve large teams, large budgets, and long schedules. As mentioned earlier, there are some markets where, due to the rapid pace of technology change, a firm only has one shot at releasing a small number of products, based on a platform created earlier, by updating the technologies in the platform for the next release. In other markets, a firm may decide to do a strategic platform in order to save commercialization and marketing money by using all products and releasing them at the same time. Conversely, an options-based platform would be classified as “incremental innovation” which delivers the first product to the market quickly and allows the firm to examine the customer’s response to that first product and to develop additional desired products. That is the important distinction – options-based platforms deliver the first product to market fast and inexpensively and allows for accelerated learning from the market.

There are risks involved with both approaches. For example, if a firm tried to attack the digital camera market today with an options-based approach, it would pick a processor/memory configuration and develop a 2-megapixel camera (the nominal resolution of today’s market). If

²⁰ Reinertsen and Smith (1998).
the camera is successful, it would aim to move up and down market by developing products based on that processor/memory platform. Two problems would probably arise with this strategy. One, the processor/memory choice may not allow the firm to move efficiently in a market direction (not powerful enough to move up market, not cheap enough to move down market). Two, the processor/memory platform cycle is only eight months. By the time the firm produced its variants, the competition would have introduced its new platforms. Therefore, when using options-based platforms, a firm runs the risk of either “not being able to perform the next step efficiently” or “not being able to perform the next step fast enough.”

Firms using strategic platforms have a different risk with which to contend. The length and complexity of these product platforms, combined with the addition of the platform groups that are evaluating technology, leave technology decisions further away from the market. This increases the risk that the firm will “do the wrong platform”. For example, if another firm had tried to attack the production scanner market using a strategic platform, it would have gone out and talked with customers and decided that black and white is all that was required. During development, the firm could make architectural decisions that didn’t treat the image sensor modularly. While the other firm’s new scanner enjoys initial success, Kodak discovers the latent need for color and introduces the color scanner 3590C, effectively killing all non-color-capable platforms.

3.5 Issues around Technology Readiness

There are two common misperceptions people have when they compare the strategic- to options-based platforming, which concern the technology readiness of the components/subsystems that product development teams get to use. The first misperception is that strategic teams use components/subsystems that are proven to be fully functional. This is
usually not the case. Any time new technology is introduced, the product development team experiences increased risk. NASA has a systematic metric\(^{21}\) that they use to evaluate the technology readiness of spacecraft components/subsystems. Their metric runs from TRL0 (Technology Readiness Level 0), meaning the basic principles have been observed and reported, to TRL9, which means the component/subsystem has functioned \textit{in situ}. The important takeaway from the NASA metric is that proof-of-concept models are down at TRL3 and component validation in relevant (not laboratory) environments is at TRL5. These are readiness levels that most product development teams experience. Usually TRL3 is where the team is dealing with a breadboard that has proven that the technology "works." If the team is fortunate, they will actually have component/subsystem of new technology that is in its final form and manufactured on process. These thoughts demonstrate the rigor that needs to be applied by the platform teams to the technology they’re developing, moving as close to TRL9 as possible, in order for the strategic platform method to be successful.

The second misperception is that options-based platforms will be slowed down by having to use unproven components/subsystems in their second or third loops through the product development cycle. This is usually not the case because the first product has embodied in it the “defining technology” that makes the platform. The second or third trips through are enhancing the platform with proven technology. In the product scanner example, the enhancement from the scanner 3500 to the color scanner 3590C was a color image sensor – a component of proven technology. If the product development team needed to develop a color sensor, there would be a large delay that some would expect, but that is usually not the case. For the most part, the

additional loops through the product development cycle for options-based platforms are done with high-TRL components as the enhancements.

### 3.6 Financial Issues

When trying to attain the IPS benefit of better revenue and profit forecasts for products in the market and under development, the two platform methodologies (strategic- and options-based) have different strengths. In relatively stable markets with well-established technologies and well-understood applications, confident projections are possible and discounted cash flow (NPV) approaches offer a conceptually sound and analytically elegant evaluation of future potential of strategic platforms. This domain, stable markets, and established technologies, is where strategic platforms would seem to shine. However, NPV limitations become more problematic in the highly uncertain, rapidly changing environments associated with emerging technologies. Craig\textsuperscript{22} eloquently outlines these problems and limitations when he ties a product’s NPV analysis with the probability that it will go to market. Craig asserts that this methodology has some value, even if the team is “only making best guesses,” and could be used to give “some clear direction” between different strategies. As a last resort, the use of NPV and probability would at least force a firm to think of tradeoffs “that otherwise might be glossed over.”

The rapidly changing environments associated with emerging technologies is where the flexibility of options-based financial analysis has its greatest power. The same is true for options-based platforms. The problem with planning this way is that you don’t see the whole picture; you only see a slice of the product under development at a time. But, the point is that the whole picture in rapidly changing environments is so out of focus as to be nearly worthless and, therefore, the firm is better off taking one small, clear view at a time. This approach should

\textsuperscript{22} Craig (2001) p. 49.
guarantee the firm the ability to predict a small success and leave the door open for more success down the road.

3.7 Summary

It is a firm's choice as to what type of platform methodology to follow. It is this paper's contention that under differing "environments," one choice will have better results than the other. The financial discussion in Section 3.6 suggests that a component of this "environment" is the type of market environment in which the firm competes. A firm can do little to change this component on its own – what the competitors are doing and what the customers want is a function of the state of the technology. The next chapter will establish a framework for market environments. The second component of the "environment" is the type of platform. These will be discussed in detail in Chapter 5. For now, it is important to state that a firm's control over what type of platform to use is sometimes limited by legacy effects. That is to say, a platform or product development team may not have as clean a sheet of paper at the start of a new design as it would like.

Therefore, over the next two chapters, the paper is going to build a topology/method/market environmental triad with which the platform or product development team will need to contend. The team has total control over the platform method; limited control over the platform type; and no control over the market environment. The advantages of a strategic platform method will become apparent for certain topology/market combinations. There will also be environments where options-based platforms will be the superior method.

One final thought on the differences between strategic- and options-based platforms. It is always possible to take a strategic platform and generate some options-based products from it. The possible disadvantage of this method is that the first product is not in the market as quickly
as if it had been developed using an options-based approach and, therefore, some market learnings or market opportunities may be lost. The reverse is almost never true – options-based platforms lack the meticulous planning, both in the business sense (prioritizing and attacking as many market segments as resources allow) and the technical sense (generating platform components that can be used vertically and horizontally in the market segmentation grid), which strategic platforms require. However, there probably have been instances where a team is partially through an options-based commercialization only to see market niches firm up or market windows materialize that cause them to regroup and attack the market with a strategic platform – of course, saving as much of the options-based approach as possible.
Chapter 4 – Market Realities

“We don’t know a millionth of one percent about anything.” – Thomas Alva Edison

4.1 Introduction

Discussions in Chapter 3 indicate that the success of a platform will be limited by the market environment in which it operates. This chapter establishes a framework for the market environment that will be used. The use of the standard S-curve analysis of a product life cycle was considered, but the framework presented below adds a little color to the market perspective.

4.2 The Market Variety/Rapid Platform Framework

The framework introduced by Sanderson and Uzumeri\(^\text{23}\) defines a relationship between model variety and the rate of change of models. The best illustration to succinctly show their framework is shown in Figure 4.1.

\[^{23}\text{Sanderson and Uzumeri (1997).}\]

![Figure 4.1: Framework of Product-Model Structure](image-url)
From the perspective of platforms, Sanderson’s view of a model is analogous to a platform. Therefore, the axes in Figure 4.1 could be relabeled as the “rate of change of platforms” and the “model variety derived from each platform.” Products from the “simple” quadrant are primarily of the commodity type, which are slow to change and have little variety. The customer characteristics for this group are stable needs over time, high price sensitivity, and no loyalty to product design. The competition in this quadrant is well known and predictable. Economies of scale are very important to commodity products and the manufacturing processes used are usually inflexible. However, all innovation is directed toward manufacturing process activities that yield cost savings or quality improvements. Selling the total capacity of the operation is important. Organizational learning and change is modest and slow.

The “variety intensive” quadrant has relatively stable platforms but serves a fragmented market in which customer needs are diverse. Customers tend to be feature sensitive and are potentially loyal. The competition tends to be well known but can surprise with new products that serve previously unrecognized niche markets. Firms are looking for “economies of scope” in which designs and manufacturing capabilities can be used over many models, maximizing the horizontal play shown in Figure 2.3. Marketing can develop sophisticated models to forecast sales. Decisions to drop old, money-producing models and take on new ones are heart wrenching. Organizational learning tends to be slow.

The “change intensive” quadrant features products that are changing rapidly and customers that are technically knowledgeable. Customers want the latest and best designs and are minimally loyal. The competition is unpredictable and constantly introducing products that threaten to make current offerings obsolete. Manufacturing investments are tempered by the
realization of the short life spans of their platforms. Firms place great stock in shortening the learning curve, investing heavily in design and engineering. Marketing concentrates on selling products as fast as possible and guessing what the competition will do and when they will do it. Organizational learning needs to occur rapidly and must be put to use immediately on the next design generation.

The “dynamic” quadrant is the most difficult in which to compete, requiring a large variety of products whose platforms are changing rapidly with the potential that different segments will require varying rates of change. The customers’ needs are diverse and rapidly changing, with some customers being knowledgeable and some confused. The competition is confused, as well, but is always threatening to surprise the market with new technology. Firms are in search of flexibility on all fronts – core competencies and flexible or lean manufacturing are important. Marketing intently follows the customer to detect changes in needs. Organizational learning is torn between rapid, focused learning to master change and the need to formalize lessons and apply them across related designs.

Sanderson’s main point in her framework is that the rate of technological advances and globalization are pushing most markets into the dynamic quadrant – lots of product variety with the platform that the products are based on, having shorter and shorter life cycles. The problem with this is that a firm has finite resources and will have to decide how it is going to allocate such resources. The competition for resources within the firm suggests the existence of a “constant budget boundary” that represents all possible combinations between model variety and platform rate of change that a firm is able to fund. This concept is shown in Figure 4.2. Firms trying to operate on the far side of the boundary are likely to find costs spiraling out of control. The
impact of this analysis is that a firm will have to choose its mode of operation – it will either be good at rapid platform development or variety proliferation from a platform, but not both.

The two product examples from the last chapter fit nicely into this framework. The production scanner design group invested a large amount of money over several years to produce the scanner 3500, and invested an extra percentage of dollars so that the product could be used as a platform. They had no incentive to push out along the x-axis – requiring them to produce another platform. They wanted to push up into the many variants per platform

![Figure 4.2: Tradeoff between Model Variety and Platform Rate of Change](image)

regime and did so, even though the voice of the customer was not leading them in that direction. Not only has the scanner 3500 been platformed into the color scanner 3590C, but this Kodak
group also offers the Kodak Digital Science scanner 3510 and the Kodak Digital Science scanner 3520 series, which add some important image processing features (accomplished mostly through software enhancements) to the product line, furthering the concept that Kodak wants to be a “many varieties per platform” organization.

The digital camera group, on the other hand, knows that its platforms will be replaced frequently. As Figure 3.2 shows, this Kodak group has used six different microprocessor/memory platforms since 1998 – each platform lasting an average of two-thirds of a year. During this time, the digital camera industry has been in take-off, as validated by the data in Figure 4.3. An industry usually demonstrates take-off by the large number of participants in the industry.

Figure 4.3: Digital Camera Market in Take-Off
Once the industry matures, a number of firms will drop out of the market. The digital camera industry had almost reached maturity once before, only to be redifferentiated by new technology or processes. By January of 1997, most of the major photographic companies (Kodak, Fuji, Polaroid), as well as some of the major electronics firms (Sony, Canon, Casio), had entered the market. Fueled by the “dot-com” era, the ready availability of digital camera components (most importantly CCD image sensors) and knowledge dissemination to Taiwanese manufacturers, the industry went through take-off from January 1997 to April 1999. By this time, the other photographic companies (Agfa, Konica) and electronics firms (HP, Hitachi, Intel, Kyrocera, Panasonic, Samsung, Sanyo, Sharp and Toshiba) and the Japanese 35mm camera manufactures (Minolta, Nikon, Olympus, Pentax, Ricoh, Vivitar and Yashica) had all entered the fray. The industry started to reach maturity in the April – October, 1999, timeframe until it was redifferentiated with the combination of low-cost CMOS image sensors, as well as knowledge dissemination to Chinese manufacturers (much lower cost producers than Taiwanese manufacturers). This led to a glut of firms offering low cost VGA resolution cameras in the year 2000 timeframe. The industry started a strong shakeout at the beginning of 2001 and lost 30% of the manufacturers over that year.

All of this has occurred while the number of units of digital cameras sold has grown to approximately 1.5 million units annually, as shown in Figure 4.4. Whether or not the environment changes from a rapid platform change to a product variety mode, as the industry matures, is yet to be seen. The thinking is that it probably will. Companies are still pushing image sensors to the 4 to 5 megapixel range when 3.3 megapixel is enough for 11 by 14 inch prints. This proves that technology “specs-manship” is still an important part of competition in this industry; but, as the technology matures and the industry becomes more stable, competition
should switch to camera features and the ability to fill as many market niches as economically as possible. This switch would be especially important for a company like Kodak, which is not used to competing in a rapid platform market, particularly because some of its competitors (Sony, for example) thrive in such market.

Sanderson’s belief that most markets are heading towards the dynamic quadrant is difficult to believe after these examples. The existence of the commodity quadrant is a strong indication that not everything is going dynamic because in the scanner business, rapid changes in platforms would put customers off by outdating their purchase too quickly. The same is true for the amount of variety in the marketplace – Kodak canceled
some models of the scanner 3500 series because it did not want to overwhelm the customer with choices. Sanderson defined the desires in the market as a “market preference region” that seemed to interact all along the constant budget curve and also defined a “concentration of preference,” in which “potential customers exhibit similar preference structures”, which interacted with the curve in a limited region. The “concentration of preference” is a more fitting model of the marketplace. Therefore, the framework can be extended beyond limiting firms to only being good at either lots of platforms or lots of variety. It also shows that for most industries, customer preference will also choose between a lot of variety and rapid change of platforms.

This is the market reality that a firm has to deal with – it has a choice to direct its resources to variety or platforms, but it is the consumer who makes the choice of how competition takes place in the market. Even if there is only one competitor, the consumer gets to vote by walking away from a variety of staid products or from sitting on the sidelines waiting for the pace of change to slow. For the production scanner business, the market was sensitive to the size of the investment and decided that variety was the way to go. For the digital camera business, the market is very sensitive to technological innovation and, therefore, rapid platforms were the way to go.

4.3 Summary

The Sanderson framework contains four quadrants. This document will concentrate on just two of them, those labeled Variety-Intensive and Change-Intensive in Figure 4.1. The terms “variety market” and “rapid platform market” will be used throughout the rest of the paper, respectively. In today’s product development environment, particularly for consumer goods where the market is heavily segmented, it would be unusual for a firm to participate in a rapid

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platform market and only bring one product to market. As the digital camera data of Figure 3.2 shows, most firms make an attempt to hit at least a few market segments while introducing a new platform. Therefore, the rapid platform quadrant that this paper will continue to examine should be thought of as having limited variety. The Dynamic quadrant of Figure 4.1 is not examined because Sanderson’s analysis states this is an area in which firms have a very difficult time operating. The Simple quadrant is also ignored because it is an area where the commodity products exist and it is well known that price is the major factor driving consumers in that market.

We will use the concept of the market favoring variety or favoring rapid platforms, as we move to integrate the environments we have discussed so far; but the complete environment has not yet been discussed. Firms have platforms that are different from the digital camera and production scanner examples used in Chapter 3. These different platform types will be presented in the next chapter.
Chapter 5 – Product Platform Topologies

“All cases are unique and very similar to others.” – T. S. Eliot

5.1 Introduction

Chapter 2 defined the role of a platform – to fill as many boxes in the market segmentation grid as efficiently as possible. Chapter 3 examined two methods that a firm can use to implement a platform strategy within its commercialization framework. Chapter 4 introduced the concept that it is impossible for a firm to be all things and, therefore, it needs to align its efforts with the market preference when engaging the market. This chapter introduces the last piece of the framework. When firms make a platforming decision, they are making a choice to invest in “something” that will provide returns over many product variants in the simple case, and over many product segments for a well used platform (strong horizontal play in Figure 2.3).

The author’s research has identified four “somethings”, or platform topologies:

1. Components
2. Manufacturing Capabilities
3. Systems
4. Knowledge

In a series of two-by-twos, this chapter defines each topology and examines how the platform topology interacts with the methodologies of Chapter 3 and the market realities of Chapter 4.

5.2 Component-based Platform Topology

Product families from component-based platforms closely follow the Sanderson and Meyer definitions found in Section 2.3. The key to this type of platform is modularity of the subsystems and the robustness of the interfaces between them. Clark and Baldwin25 state that this requires “an architecture – that allows for both the independence of structure and the
integration of function.” They call out six types of operations that can be performed on a product platform in order to change the design’s parameters: splitting, substitution, augmenting, excluding, inversion, and porting. While all six operations are critically important to consider when architecting a design, substitution, augmenting, and excluding are the operations most closely linked with component-based platforms that allow the designer to take a platform and move it around the market segmentation grid.

Augmenting results in the addition of features in the product. An example of augmenting would be the addition of a flash module to a disposable camera as shown in Figure 5.1.

![Figure 5.1 – Augmenting a Product](image)

While the addition of a seemingly simple, self-contained module may seem easy to the uninitiated, the ability to do so in a platform environment requires prophetic architectural decisions early in the design of disposable camera platform. How does the flash interact with the exposure control circuit? What does the flash do to our power source requirements? What user options (fill flash, etc.) will be provided and how do they affect our ease-of-use Vector of Differentiation? If the platform is going to have success with the augmentation operator, it needs to have an architecture that anticipates these types of questions.

While excluding can be thought of as augmentation in reverse, it is best thought of as producing a product that gains acceptance because its price is closer to its perceived benefits or because the product has become easier to use.

Substitution is used to change the quality/capability of a feature. For example, the Kodak DX3500 digital camera and Kodak Easyshare DX3600 zoom digital camera are exactly the same product (with small industrial design changes) except that the DX3600 camera lens has a 2X optical zoom capability, while the DX3500 camera lens has a fixed focus. If the substitution results in a change in capabilities, it has the same architectural requirements as augmenting/excluding – robust interfaces and modules are required in order to handle the different variants. For example, the DX3600 camera requires a different optical viewfinder, in order to show the user how the picture will change as the zoom is adjusted.

![Kodak DX3500 and DX3600 cameras](image)

**Figure 5.2 – Substitution in a product**

5.3 Component-based Platforms Interface with Market and Platform Method

A two-by-two can be generated to show the interactions between the platform method (strategic- or options-based), the market (variety-based or rapid platform-based), and a firm using a component-based platform. The two-by-two is shown in Figure 5.3. When the market seeks variety, both platform methods can be successful. Strategic platforms benefit because
technology stability means that platform choices are more accurate, even though the platform development cycles are long. Options-based platforms are very successful in seeking out niche markets in a variety market.

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Variety</th>
<th>Market</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strategic</td>
<td></td>
<td>Rapid Platform</td>
</tr>
<tr>
<td>Options-based</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Component-based Platforms**

<table>
<thead>
<tr>
<th></th>
<th>Good</th>
<th>Fair</th>
<th>Poor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benefits from stable technology markets</td>
<td>Planning more difficult, development cycle time critical</td>
<td>Inefficient in stable markets but allows exploration of Niche markets</td>
<td>Platform may not last long enough to exploit options</td>
</tr>
</tbody>
</table>

Figure 5.3: Platforms based on Components

If the market is in a rapid-platform stage, then both platform methodologies suffer. For strategic platforms, predicting the technologies the platform needs in the face of a very turbulent future is a daunting task. The value of the options in an options-based platform may become zero because the technology might have advanced beyond the platform before the firm was able to spin a second product. The digital camera data in Figure 3.2 is an example of what happens in the rapid platform environment. Only two cameras have been used in an options-based way – the Kodak DC260 zoom digital camera was redone with a faster processor upgrade and the Kodak DC280 zoom digital camera was redone with a more sensitive sensor in the Kodak DC3400 zoom digital camera and with a more rugged body in the Kodak DC5000 zoom digital camera. All of the other offerings came from strategic platform development where the platform
teams chose the defining technology (processor/memory configuration) and the supporting components, which would allow them to attack the desired market segments.

5.4 Manufacturing-based Platform Topology

Manufacturing platforms are created when investment is targeted at manufacturing capabilities instead of the product itself. For example, both Meyer\textsuperscript{26} and Craig\textsuperscript{27} point out that consumables, HP inkjet cartridges in Meyer’s case and Canon toner cartridges in Craig’s case, often remain exactly the same throughout many product model and product family changes. Craig claims that this is because multiple units of the consumable will be sold over the lifetime of a single unit of product and, therefore, the consumables have a greater effect on the business case of the product and need to be manufactured as cheaply as possible. Once an investment is made in the “big iron” manufacturing units that churn out the consumables in a cost efficient manner, it is advantageous for a firm to offer a family or families of products that use and interface with that consumable; thereby, maximizing the consumable manufacturing investment before rebuilding or retooling the manufacturing line. For example, HP introduced 19 different inkjet printers that used their original black cartridge.\textsuperscript{28} It was not until HP developed a better performing ink (darker blacks, more vivid colors) that they felt the need to replace the venerable cartridge.

In the photography industry, one would think of platforms as the 35 mm format or the APS format. But these platforms are really controlled by manufacturing capabilities. Improvement in the films usually requires an investment in the machines that coat the emulsions on the Estar base. Once the manufacturing process has been improved to produce a family of films, the

\begin{footnotesize}
\textsuperscript{26} Meyer and Lehnerd (1997) p. 31.
\textsuperscript{27} Craig (2001) p. 33.
\textsuperscript{28} Meyers and Lehnerd (1997) pp. 24-35.
\end{footnotesize}
emulsions themselves are varied in order to make different film grades and types. For example, the underwater film of a particular family will have some of its color emulsions tweaked for the lighting conditions of that environment.

Ford has recently introduced a manufacturing platform into its process. Normally, each assembly line is built to manufacture a single car model. When there is a model year change the line is retooled. Ford has built an assembly line that will not only build multiple model years, but will build multiple car models on the line simultaneously. According to Sudjianto and Otto, Ford’s system consists of common locator points among the three major units of the underbody framing. This enables the assembly line investment, on the order of $600M to $1B, to be shared among several car models and brands. The common locator points act as references to the robotic welding and assembly equipment alongside the line – as long as the underbody moving down the line meets the locator requirements, the robots can be programmed off those references. Taken to the extreme, it would be theoretically possible to build all unibody platforms on the same line, even though they vary dramatically in size and performance. This is in contrast to the way that Volkswagen has worked its platform strategy. VW has more of a component-based platform strategy in which it shares front axles, rear axles, front ends, rear ends, exhaust systems, brakes systems, and numerous other elements among the four major brands it owns (VW, Audi, Skoda and Seat).

The manufacturers of consumer electronic equipment also have programmable manufacturing capabilities that enable them to build widely varying products on the same line. Sony is the most cited company with this capability and has manufacturing lines that switch from building digital camcorders to MP3 players. There are design restrictions, termed “Design for

Assembly” rules, which must be followed by each product to be built on the line. These rules make sure that new products will have accessibility at the correct points so that they can interface with the manufacturing system. The level of restriction, generated by the Design for Assembly rules, is governed by the designers of the manufacturing line, and it takes an increased amount of time in product development to design the products to meet the rules.

This paper will define strategic manufacturing platforms as manufacturing platforms that are designed to be capable of building many products. The Sony lines for consumer electronics products, the new Ford line, and the Kodak film lines all fall under this domain. Semiconductor manufacturing lines, due to their expense, are almost always designed as strategic manufacturing platforms. Mitsubishi is claiming they have designed “flexible fabs”\textsuperscript{30} that will produce both microprocessors and memory on the same line. Mitsubishi lists the benefits as: better product availability, shorter lead times, lower inventory obsolescence costs, better over-all quality, on-demand availability, and lower product costs.

Options-based manufacturing will be defined as building a manufacturing line for a limited number of products. Standard automotive manufacturing meets this definition wherein a line is built for a particular vehicle (for all market segments) and needs to be significantly retooled before the next model can be built. The HP consumables example has some indications that it was options-based. It is not known how the later model printheads were built, but holding onto the same inkjet cartridge design over 19 models may be an indication that HP did not design the manufacturing line with capabilities to handle newer technology printheads.

It is possible for an options-based manufacturing platform to change into a strategic platform over time. This is the path that the, now strategic, film manufacturing platforms at Kodak took:

\textsuperscript{30} Mitsubishi web site.
after many years and many dollars of capital improvements as more and more was learned about coating technology and the products Kodak wanted to build.

The Black & Decker power tool example shows how a design (the universal motor) led the way to a strategic manufacturing investment (the automated production line making the motors) that gave B&D a competitive advantage in a variety market (power tools). The 35 mm film lines at Kodak are also an example of strategic manufacturing investment working in the variety market of 35 mm film (different speed grades). Here, however, it is the manufacturing platform that affects product design. Even though Kodak has a myriad of coating technologies (hopper, slide, curtain, gravure, extrusion, etc.) the design engineer must always be cognizant of how the manufacturing platform limits what he wants to do with his product.

5.5 Manufacturing-based Platforms Interface with Market and Platform Method

In looking at the Method and Market two-by-two for manufacturing platforms, the examples from above indicate that both strategic- and options-based methodologies have worked well in variety markets. For high volume products, the product-specific line of an options-based approach could offer manufacturing cost advantages. The list of Mitsubishi benefits shows that flexible strategic manufacturing can help resource utilization when product volumes don’t require three shifts a day, 365 days a year. Having an options-based methodology in a rapid platform market can be disastrous. There are examples, including a Kodak camera program, where products went through commercialization with the added burden of needing to design the product for robotic assembly so that it could be built competitively in the USA. Money was invested in the production line only to have the product become non-competitive and the line shut down. The line’s design was very streamlined in order to produce cameras for the lowest possible cost, which did not leave it with much flexibility. Even though the facilities (robots,
etc.) could be used on subsequent manufacturing lines, the money spent to put the camera line
together was lost as soon as the product being manufactured on it became undesirable.

This same Kodak camera example would indicate that strategic manufacturing platforms
would work best in a rapid platform world – the investment in the platform can be spread across
many products in many market segments increasing the chance that one or more will be winners.
Strategic manufacturing also enables firms to take chances because the product development
budget doesn't need to have a large capital investment for manufacturing resources. The two-by-
two for manufacturing platforms is shown in Figure 5.4.

<table>
<thead>
<tr>
<th></th>
<th>Manufacturing-based Platforms</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Strategic</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Methodology</strong></td>
<td></td>
</tr>
<tr>
<td>Options-based</td>
<td></td>
</tr>
<tr>
<td><strong>Fair</strong></td>
<td>May not be as efficient as options-based, but allows the combining of many lines into one</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td>Platform flexibility is best way to keep up in this market</td>
</tr>
<tr>
<td><strong>Good</strong></td>
<td>Benefits from stable technology and can be extremely efficient</td>
</tr>
<tr>
<td><strong>Poor</strong></td>
<td>Platform can quickly become obsolete</td>
</tr>
<tr>
<td><strong>Variety</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Market</strong></td>
<td><strong>Rapid Platform</strong></td>
</tr>
</tbody>
</table>

Figure 5.4: Platforms based on Manufacturing Investment
5.6 Systems-based Platforms

Systems-based platforms are a special class of platforms that are not as widely applicable as component or manufacturing platforms, but their unique properties make examination worthwhile. A systems-based platform occurs when a firm produces a product with the intent that when a customer purchases the product, there will be a measure of lock-in that will influence the customer to buy additional system-involved products from the firm in the future. The platform uses a system-entity that allows the coupling between products to take place. This system-entity is an interface that all products in the system share, and it can take the form of hardware, software, or specification.

An example of a systems-based platform is the VersaPak line of tools from Black & Decker. This line uses the same unique batteries as the portable, rechargeable power source for all products. The batteries are an example of a hardware system-entity. The products range from hand tools (saws, drills, etc.) to cleaning tools (Dustbuster and Scumbuster) to garden tools (leaf blower, power sprayer) to flashlights. Once the customer purchases the first tool, there is a strong pull for him to purchase others from the line, as the need arises, because of perceived efficiency in the system (interchanging of the power packs).

The evolution of the cordless power tools industry highlights under what environments a systems-based platform performs best. When the VersaPak was introduced, the battery voltage of 3.6V, scalable to 7.2V by using two batteries, was comparable to the competition and the system enjoyed success for a number of years. In the ensuing years, battery technology took off and competitive products started to have 9V, then 12V, then 15V, etc., and now the top of the line products have 24V batteries. While the battery voltage was changing rapidly, the tools were redesigned, motor power increased to match the battery’s capabilities, but there was no systems-
based platform in which B&D tried to redo VersaPak with a higher voltage battery. Recently B&D has started a new systems-based product line but this time the battery is not the system-entity. Instead, it is the interface to the business end of the tool that has been standardized. In this system a collection of tool ends, which have changed very little over the past years, will now play with a common interface to the motor/battery unit. As technology continues to improve the motor/battery unit, the customer will be able to trade up for more power while keeping the same collection of tool ends. The lesson is that the system-entity works best when targeting the most technically stable components – the original battery system-entity became dated by new technology but the new tool interface system entity should have an indefinite life (as long as man uses his current mode of construction).

Another example of systems-based platforms is the Radiology Information Systems (RIS) that would be sold to healthcare institutions. The RIS has a standard communications interface that is an example of a specification system-entity. Some early hospital information systems, of which RIS is a category, used proprietary interfaces for both the physical layer (the specification of the wiring) and the protocol layer (how the software communicates over the physical layer). Once a healthcare institution went through the expense of installing a firm’s physical layer, the firm was in a strong position to sell products to the institution that interfaced neatly with the installed physical layer.

Evolution in the electronic communication area affected the evolution of hospital information systems. RIS got their start as a Picture Archiving and Communication System (PACS) which allowed radiological images to seen at multiple locations. As computer-to-computer communication improved in other markets, the physical layer in RIS evolved to standard LAN technology and, therefore, the physical layer has lost its system-entity status. In an effort to keep
the same level of lock-in that the proprietary physical layer had, the RIS incorporated other functions. The new functions included appointment booking, billing, patient charting, and management reporting, which serve to tie the RIS in tightly with other hospital information systems.

Systems-based platforms operating in a technology-advanced market like healthcare, need to manage the communications interface system-entity carefully. It is rare that a single company will be able to supply all of the required radiology equipment that a healthcare institution would desire. For example Kodak, which has a strong presence in the standard x-ray portion of the radiology market and is a strong RIS competitor (particularly in Europe), does not manufacture an MRI unit. Therefore, the protocol layer, the remaining system-entity, needs to be able to accommodate industry standards so that the system can interface with products from other manufacturers. For example, the Kodak radiology information system 2010 provides a software conversion program called Broker to enable the RIS 2010 system’s standard interface to communicate with the industry standard Digital Imaging and Communications in Medicine (DICOM) protocol.

5.7 Systems-based Platforms Interface with Market and Platform Method

The Method and Market two-by-two for systems-based platforms is shown in Figure 5.5. When working with strategic platforms, the key is choosing a technically stable component as the system-entity. This is easy to do in a variety market and more difficult in a rapid platform market, as the B&D VersaPak example shows. When battery technology was slow, choosing either the tool end or the battery as the system-entity would have worked. When the batteries went into rapid platform mode, only the tool end system-entity works. For options-based platforming, the question is one of backward-compatible enhancements to the system so that the
investments the customer has already made are not voided. This can be limiting in a variety market and down right impossible in a rapid platform market. The electronics industry is rife with examples of customers being left “in the lurch” because they can no longer get new systems that are able to interface with their legacy products.

<table>
<thead>
<tr>
<th>Methodology</th>
<th>Systems-based Platforms</th>
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</thead>
<tbody>
<tr>
<td>Strategic</td>
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<td></td>
<td>Good</td>
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<td></td>
<td>Fair</td>
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<td></td>
<td>Poor</td>
</tr>
<tr>
<td>Options-based</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good</td>
</tr>
<tr>
<td></td>
<td>Fair</td>
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<tr>
<td></td>
<td>Poor</td>
</tr>
<tr>
<td>Variety</td>
<td>Rapid Platform</td>
</tr>
</tbody>
</table>

**Figure 5.5: Platforms based on Systems Investment**

### 5.8 Knowledge-based Platforms

If a firm is not executing on one of the three platforms we have discussed so far, then it is either bringing products to market blindly or executing a knowledge-based platform. Therefore, in a sense, a knowledge-based platform is really the “anti-platform.” Using a knowledge-based platform is what firms should do when they don’t have a platform strategy. In a knowledge-based platform environment, a firm possesses the knowledge, expertise and/or systems to design and/or manufacture products for a particular industry. Knowledge-based platforms are the mechanisms that keep firms tied to their particular industries. To bring products to market
without at least having the knowledge of the technologies, manufacturing processes, and market
dynamics would be foolhardy. For example, Kodak will not become a successful player in the
automotive industry. Many firms, after the acquisition boom of the late 1980s and early 1990s,
have realized that they need to stick close to their knitting in order to be successful and have
purged themselves of technologies outside their core competencies.

The ultimate in knowledge-based platforms would be the structure of consulting firms. They
don’t produce any products, *per se*; they just study industries and use that knowledge they gather
to solve problems for their clients. For example, McKinsey and Company has 25 “Practices,”
ranging from High Tech to Pulp and Paper, in which they “develop and disseminate our
functional, industry, and other expertise.” Each practice is led by a group of partners and has a
collection of managers and dedicated experts that set out to serve their customers’ needs.

As an example of a company that designs and manufactures physical products, assume there
is an imaging company that is straddling the transition from analog to digital imaging. As the
transition is occurring, the firm designs new systems which write on the old photographic media
and on new thermal media. They design products that will produce prints from “one print every
three minutes” for the home-based printer to products that need to produce three prints per
second for the wholesale photofinishing application.

All of the products have the same subsystems – optics, lasers, precision motion control, color
management, etc. – but they vary so widely in scope and performance that it is high unlikely that
a common physical product platform could be produced to meet all of the needs. In instances
like these, it is best to invest in a knowledge-based platform in which the workforce is trained in
the “practice” of digital imaging and where they develop functional and industry expertise and

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31 McKinsey web site.
are able to disperse that expertise to the product development teams, which are entering commercialization activities. For this example, expertise includes the following:

1. Knowledge of the human visual system – to which image artifacts are most sensitive to the eye.
2. Knowledge of precise motion control – how to design a system that uses translational and rotational servos and not produce image artifacts that the eye can see. How to do so on stop-and-print systems like CRT and LCD printers or on continuous motion printers, such as the flying-spot laser and inkjet printers.
4. How to use noise, such as dithering techniques, to hide artifacts in an image
5. Knowledge of image-compression techniques and the artifacts they create.
6. Knowledge of testing methodologies – how to generate images that will test the weakest links in the product.

Knowledge-based platforms are included here for completeness but because they are the anti-platform and it is difficult to get data on projects that were done using a firm’s core competencies, their analysis will not be carried throughout.

5.9 Summary

The individual two-by-twos are aggregated in Figure 5.6 so that the complete topology/method/market landscape can be seen. The rating in each domain was garnered from industry examples and engineering experience of how well each combination would work. The ratings are given the “Eval =” label to denote that this rating came from this evaluation – each domain will receive additional ratings in the analysis that follows.

The landscape is in complete view and the first evaluations, based on example and experience, are in each domain. The next step is to use real project data to see if platforms are
capable of delivering on the IPS benefit of better revenue and profit forecasts for products under development.

<table>
<thead>
<tr>
<th></th>
<th>Strategic Investment</th>
<th>Variety Market</th>
<th>Rapid Platform Market</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eval = Good</td>
<td>Eval = Good</td>
<td>Eval = Fair</td>
</tr>
<tr>
<td>Strategic Investment</td>
<td>Eval = Fair</td>
<td>Eval = Good</td>
<td>Eval = Good</td>
</tr>
<tr>
<td>Option Investment</td>
<td>Eval = Fair</td>
<td>Eval = Fair</td>
<td>Eval = Good</td>
</tr>
<tr>
<td>Rapid Platform Market</td>
<td>Eval = Poor</td>
<td>Eval = Poor</td>
<td>Eval = Poor</td>
</tr>
<tr>
<td>Option Investment</td>
<td>Eval = Poor</td>
<td>Eval = Poor</td>
<td>Eval = Poor</td>
</tr>
</tbody>
</table>

Component | System | Manufacturing

**Figure 5.6: Topology/Method/Market Array**
Chapter 6 – Project Performance

“Get the facts, or the facts will get you. And when you get ‘em, get ‘em right, or they will get you wrong.” — A. E. Housman

6.1 Introduction

Out of the three benefits of IPS that are under investigation in this paper, the ability to forecast revenues for products under development is the most alluring to management. The reasons why product platforms help the forecast, in a generic sense, were covered in Chapter 2. In this chapter, real project data will be used to see how the generic solutions fit.

Hartmann and Meyers\textsuperscript{32} use a two-by-two that defines the risk involved in the introduction of new innovations (products) as a function of the market and the technology, as shown in Figure 6.1. The solid lines represent constant overall risk and are similar in shape to Sanderson’s constant budget lines. It would be easy to say that strategic platforms in a variety-based market

![Figure 6.1: Quadrants of Risk](image-url)
most closely aligns with the Evolutionary quadrant in Figure 6.1; and because that quadrant has the lowest risk (and therefore is most predictable), strategic-based platforms in a variety market must have the most accurate forecasts of revenue. However, technical and market risks are not the only contributors to overall project risk. For each of the 12 unique domains in the Topology/Method/Market Array defined in Figure 5.6, there will be environmental factors generated by the topology/method/market domain that interface with a firm’s ability to do product development. On occasion, this interface between what a firm is trying to do and the realities of product development will exacerbate the situation, increasing the risk beyond the standard technology/market risks shown in Figure 6.1.

This chapter will introduce three data sets that describe the common problems that product development teams encounter. The first set, from Pugh-Roberts, looks at over 100 large scale projects. The second set, from an industry database, breaks the projects down by their complexity. The third set, from a single company, has a good snapshot of projects that are done using both manufacturing and systems platforms. The third set also has a snapshot of that company’s performance in generic project performance to show that it is on par with the firms from the other two data sets. This data will be used in subsequent chapters to try to rate the performance of firms in each of the Topology/Method/Market Array domains.

6.2 Project Performance Factors

This first set of data used in this analysis comes from a survey of 100 managers conducted by Pugh-Roberts. In this survey, companies from the IT/Software, Banking/Finance/Insurance, Transportation/Utilities, and Aerospace/Electronics industries reported on several hundred projects that were scheduled to take, on average, 24 months to complete at an average cost of $9

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32 Hartmann and Meyers (2000).
million. The survey results showed an average completion time of 33 months (35% overrun) and an average cost of $11.5 million (40% overrun), with a full 84% of the projects having a schedule overrun or budget overrun or both. The survey asked the managers to rank the impacts of 17 factors on productivity. The survey results are in Figure 6.2. The question was asked separately for the design process (defined as phase 1 through 3) and the build process (defined as phase 4 through phase 6) of product development, only the build process results are listed since it

<table>
<thead>
<tr>
<th>Factor</th>
<th>Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Poor clarity/completeness of reqmnts specifications</td>
<td>21%</td>
</tr>
<tr>
<td>2. Low staff experience or skill</td>
<td>21%</td>
</tr>
<tr>
<td>3. Work-scope changes generated externally to project</td>
<td>20%</td>
</tr>
<tr>
<td>4. Work-scope changes generated internally to project</td>
<td>17%</td>
</tr>
<tr>
<td>5. Low availability/experience of supervisors</td>
<td>16%</td>
</tr>
<tr>
<td>6. Overtime and staff fatigue</td>
<td>15%</td>
</tr>
<tr>
<td>7. Low staff morale</td>
<td>15%</td>
</tr>
<tr>
<td>8. Design errors</td>
<td>14%</td>
</tr>
<tr>
<td>9. Late/unavailable design product</td>
<td>14%</td>
</tr>
<tr>
<td>10. Low availability of tools or equipment</td>
<td>13%</td>
</tr>
<tr>
<td>11. Build errors</td>
<td>12%</td>
</tr>
<tr>
<td>12. Excessive schedule pressure</td>
<td>12%</td>
</tr>
<tr>
<td>13. Changing processes</td>
<td>11%</td>
</tr>
<tr>
<td>14. Late/unavailable supplied material</td>
<td>9%</td>
</tr>
<tr>
<td>15. Doing work out of sequence</td>
<td>7%</td>
</tr>
<tr>
<td>16. Changing size of organization</td>
<td>6%</td>
</tr>
<tr>
<td>17. Physical overcrowding</td>
<td>6%</td>
</tr>
</tbody>
</table>

**Figure 6.2: Maximum Impacts on Build Productivity**

33 Cooper (1999).
is the downstream process and, as such, reflects a lot of the design factors. The surveyors generated the list of factors rather than soliciting them; but there is value in the data, nonetheless.

This particular survey concentrated on the “people” issues (low staff experience, experience of supervisors, overtime fatigue, morale, changing organizational size, and overcrowding). While the people issues are important, we are more interested in the factors that can be linked to the methodologies and topologies that have been previously discussed. Thus, from this survey we generate the following list of factors with their associated importance ratings:

1. Poor clarity and completeness of requirements specifications (21%)
2. Work-scope changes generated externally to project (20%)
3. Work-scope changes generated internally to project (17%)
4. Design errors (14%)
5. Late/unavailable design product (14%)
6. Build errors (12%)
7. Changing processes (11%)

The second set of data on factors affecting project performance comes from a database of products from many companies and industries. The projects were classified by their complexity and the data set contains approximately 85 high-complexity, 65 medium-complexity and 35 low-complexity projects. This breakdown by complexity gives an interesting perspective to the data that was not available in the Pugh-Roberts data. For example, when looking at project schedule and cost overruns, the data in Figure 6.3 is extracted, showing a surprising increase in schedule overrun for low-complexity projects.
This data set asked participants to attribute project problems (schedule and cost overruns) to seven factors, which again the surveyors supplied. It is believed that in most instances the program manager filled out the questionnaire after completion of the project. The factors used in this survey provide a different look at the problem. Unlike the Pugh-Roberts factors, only one is people-related. The factors and their ratings are shown in Figure 6.4.

![Figure 6.3: Summary data from Consultant](image)

![Figure 6.4: Project data from Database](image)
The “Best in Class Projects” or BIC data accompanies the average data (All Projects). The BIC data comes from the projects that performed the best with respect to schedule and cost overruns. For example, even though the average cost overrun for the development of a high-complexity product is 22%, the best projects in the survey for that class were completed with an average 6% cost under-run. The BIC data for the “seven factors” listed in the survey track the All Projects data fairly well, except for the low-complexity products. For that class there is a large discrepancy between which factors affected BIC projects and which factors affected the average project. This data set is not broken into platformed vs. non-platformed products. It is known, however, that a 85% of the BIC examples come from companies that have integrated IPS into their product development process to the point that product platforms should have been adopted (the database monitors the IPS maturity level of participating companies)34

The final data set comes from an individual company. It is of interest because it shows one firm’s ability to manage projects across a variety of platform types. This data set uses the same seven factors as the second data set and has been grouped into three categories. The Consumable products, which had 25 samples, were projects that were produced on a manufacturing platform. The Systems products, which had 15 samples, were primarily products designed to interface with the company’s systems platform. There are two instances in that data set where the product is being designed to utilize someone else’s system platform and these two projects make up about half of the subcontractor performance problems. There were 35 projects in the CEE (Computer and Electronic Equipment) category and most of these projects would have benefited from a component platform approach. This firm had yet to adopt a platform strategy for this class of product and, therefore, most of the data comes from the anti-platform classification of

34 PRTM (2001).
knowledge platforms. That means that we have not found a data set that shows the average performance of projects using component-based platforms. The data is shown in Figure 6.5.

<table>
<thead>
<tr>
<th></th>
<th>Consumables Products</th>
<th>CEE Products</th>
<th>Systems Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Schedule Overrun</td>
<td>28%</td>
<td>11%</td>
<td>12%</td>
</tr>
<tr>
<td>1. Unanticipated technical difficulty</td>
<td>57%</td>
<td>36%</td>
<td>16%</td>
</tr>
<tr>
<td>2. Resource shortfall</td>
<td>10%</td>
<td>12%</td>
<td>13%</td>
</tr>
<tr>
<td>3. Late changes to project requirements</td>
<td>3%</td>
<td>8%</td>
<td>29%</td>
</tr>
<tr>
<td>4. Poor project management</td>
<td>2%</td>
<td>3%</td>
<td>0%</td>
</tr>
<tr>
<td>5. Unrealistic initial targets</td>
<td>12%</td>
<td>11%</td>
<td>7%</td>
</tr>
<tr>
<td>6. Subcontractor performance issues</td>
<td>1%</td>
<td>10%</td>
<td>22%</td>
</tr>
<tr>
<td>7. Other</td>
<td>15%</td>
<td>19%</td>
<td>14%</td>
</tr>
</tbody>
</table>

**Figure 6.5: Multi-product Line Company Data**

6.3 Summary

The first two data sets reveal the major problems teams experience during product development activities. Unanticipated technical difficulties and late changes to requirements are the major causes for projects being late. There is an eerie sameness to the data as the complexity of the projects change. The third data set gives a great snapshot of the performance, on the cost side of the equation for manufacturing and systems-based platforms, but not down to the level of detail needed to be able to fill in all four of the method/market domains in each of the topologies. The data for the component platforms will need to be extrapolated. In the next chapter the data sets will be used to predict how each domain in the topology/method/market array will perform with respect to the IPS benefit of better forecasts of products under development.
Chapter 7 – Delivering on Better Revenue Forecasts

“There are no facts, only interpretations.” – Frederick Nietzsche

7.1 Introduction

When trying to provide better revenue forecasts for products under development, the cost of bringing a product to market has two components, which the data from Chapter 6 address – the product development program cost and the opportunity cost that is lost if the product is brought to market later than expected. There are other costs involved, such as the SADA (sales, advertising, distribution and amortization), that are probably not reflected in those numbers to a great extent, but these costs are usually small when compared to the overall product development budget. The data in Chapter 6 only captures a generic project schedule overrun statistic, which this paper will use to estimate how well teams are able to predict the cost side (program cost plus opportunity cost) of their programs. Reinertsen agrees that “development cycle time is worth a quantifiable amount of money”35 and he predicates his book on models based on that assumption. On the profit side, revenues depend on the volume and price of product sold and that will depend on how well the product meets customer needs, as well as how it responds to the competitive pressures in the marketplace through its vectors of differentiation. Predicting the revenue side is beyond the scope of this paper; but using the data from Chapter 6 to analyze the cost side of the equation is a worthy endeavor.

A quantitative analysis would be nice but it would require data sets from product development projects involving platforms that could be broken down into fine detail. To make an estimate of the predictability of the cost side of a platformed project, it would be great to have the generic project overrun data from each of the 12 domains in the Topology/Method/Market...

Array. Our data sets do not carry that level of detail and there is no statistically valid way of combining or decomposing the data to get that information. As a substitute, this paper will use a qualitative analysis similar to what is used in the Correlation Matrix of a QFD analysis. The QFD's main task is to assemble a list of customer requirements (needs) and a list of product attributes (metrics) that will satisfy those requirements. Which requirements are being satisfied by which attributes are sorted out in the Relationship Matrix. The relationships between product attributes are rated in the Correlation matrix. It is important to know if attributes correlate constructively, destructively, or independently, as well as the strength of the correlation.

7.2 The Correlation Matrix for the Cost Side of Forecasting Revenue

The first analysis will show how each of the domains in the Topology/Method/Market Array is affected by the seven factors used in two of the project performance studies. For this analysis the following assumptions are used:

1. Strategic platform / Variety market => Low-Complexity Project
2. Options platform / Variety market => Mid-Complexity Project
3. Options platform / Rapid Platform market => High-Complexity Project
4. Strategic platform / Rapid platform market => High-Complexity Project
5. Component platforms use the CEE data
6. Manufacturing platforms use the Consumables data
7. Systems platforms use the Systems data

The alignment of strategic/variety with low-complexity data set is based on these projects having the technology developed and the markets stable and a good/good/good rating in the Topology/Method/Market array (Figure 5.6). The ok/ok/ok for options/variety aligns it with mid-complexity projects. The ok/poor/ok of strategic/rapid and the poor/good/poor of options/rapid align both of those categories with high complexity projects. The use of the CEE
data is really a stretch because the amount of platform data contained in it is small. The use of the consumables data for manufacturing platforms and of the systems data for systems platforms is right on.

Using the two data sets (industry database and single company data) in Chapter 6 as described above, the average value of schedule overrun was calculated for each of the domain weightings. For example, the Unanticipated Technical Difficulties for Strategic platform / Variety market, which we equate to Low Complexity in Figure 6.4, is 28%. The Unanticipated Technical Difficulties for Component platforms, which we equate to CEE data in Figure 6.5, is 36%. Therefore, the AVERAGE schedule slip for Component/Strategic/Variety (topology/method/market) is 32%. The data was computed for all 12 domains in the Topology/Method/Market Array, and the correlation between the method/market and the topology for each was figured as follows:

1. If AVERAGE < 4%, correlation = 0
2. If 8% < AVERAGE < 5%, correlation = 1
3. If 16% < AVERAGE < 9%, correlation = 2
4. If 31% < AVERAGE < 17%, correlation = 4
5. If AVERAGE > 32%, correlation = 5

A high correlation means that the factor has a strong effect on that particular domain of Topology/Method/Market Array. The results of this analysis are shown in Figure 7.1.

It isn’t possible to use a sum of the rows in Figure 7.1 to compute a value of how good a particular topology/method/market combination does overall because they sum to approximately 15. This occurs because the data sets all total to 100% and, therefore, Figure 7.1 is only good for looking at the relative importance of the factors for a given domain. The table is particularly useful in displaying the consistency of the problems that plague product
development efforts across all topology/method/market combinations. To further enhance the
view, the data for BIC Projects was used in place of the All Projects data to see what happens
when projects go well. The results are shown in Figure 7.2. The lightly shaded areas show
where the correlation decreased for the BIC Projects and the darkly shaded areas show where the
correlation increased.
### Figure 7.2: Correlation Matrix for BIC Projects

<table>
<thead>
<tr>
<th>BIC Project Data (topology/method/market)</th>
<th>Technical difficulties</th>
<th>Resources shortfall</th>
<th>Late changes to requirements</th>
<th>Poor project management</th>
<th>Unrealistic initial targets</th>
<th>Subcontractor perf. issues</th>
<th>other</th>
</tr>
</thead>
<tbody>
<tr>
<td>Component / Strategic / Variety</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Component / Options / Variety</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Component / Strategic / Rapid Platform</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Component / Options / Rapid Platform</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Manufacturing / Strategic / Variety</td>
<td>3</td>
<td>2</td>
<td>4</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Manufacturing / Options / Variety</td>
<td>5</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Manufacturing / Strategic / Rapid Platform</td>
<td>4</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
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<tr>
<td>Manufacturing / Options / Rapid Platform</td>
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<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>Systems / Strategic / Variety</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>0</td>
<td>1</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Systems / Options / Variety</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Systems / Strategic / Rapid Platform</td>
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<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>Systems / Options / Rapid Platform</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>0</td>
<td>2</td>
<td>3</td>
<td>2</td>
</tr>
</tbody>
</table>

#### 7.3 Results from the Correlation Matrices

Figures 7.1 and 7.2 show some surprising results. As a general comment, the data shows that BIC projects, which, for the most part, are on time and under budget and, therefore, take care of the cost side of revenue projection predictability, have lower levels of technical uncertainty, are better staffed, and establish initial targets that can be met. This comes about through the significant change in the performance of low-complexity projects, which are equated to the strategic/variety domains. With technical uncertainty, staffing, and initial targets under better control, the problem that becomes the big hitter is late changes to requirements. This makes
perfect sense because these domains are counting on quick, simple changes to a strategic platform, and it is easy to see how product cycles could be elongated, if the requirements of preplanned variants are changed. If the data in Figure 6.4 had shown similar shifts for the mid- and high-complexity BIC projects, then the deduction could be made that BIC projects show the increase in forecasting accuracy expected by platformed projects. But the mid- and high-complexity projects have the same problems, whether they are on time or late, meaning that the problems were smaller in magnitude across the board.

The data set is surprisingly similar across all 12 domains. There are small nuances that can be expanded upon. The strength of the technical problems when using component-based platforms is surprising because that type of platform is designed to reuse technology at the component level and, therefore, minimize technical difficulty. High technical difficulties in the manufacturing domains indicate that the manufacturing of the parts is a small portion of bringing the product to market and that design plays a much larger role – if a component is designed wrong and manufactured right, it is still wrong. The systems platform’s data showing increased problems with subcontractors is expected because the platform has the role of allowing many individual systems, some of which can be from outside vendors, to connect with the system.

The data in the Correlation matrices is relative and, therefore, can only be used for project teams, once they have identified which topology/method/market domain they are in, to have a heads-up for the standard problems that have previous plagued teams. The similarity of the data across domains does not undermine its usefulness – teams need to realize how prevalent technical difficulties, changing requirements, and resourcing shortfalls are in all product development endeavors. Teams can also look closely at the small nuances noted above to heighten their awareness of problems that are particular to their domain.
7.4 Cost Side of Forecasting Revenue and the Topology/Method/Market Array

The Correlation matrices of Sections 7.2 and 7.3 can be used by product development teams to identify which problems are most likely to occur, given their topology/method/market domain. However, it is desired to have a rating of how each domain will perform relative to the cost side of forecasting revenue (which is being estimated by project schedule overrun).

To do the ratings, the same definitions and methodologies used in the Correlation Matrices will again be employed. The same relationship between method/market and project complexity will be used (from Section 7.2) and is repeated below:

1. Strategic platform / Variety market => Mid-Complexity Project
2. Options platform / Variety market => Low-Complexity Project
3. Options platform / Rapid Platform market => High-Complexity Project
4. Strategic platform / Rapid platform market => High-Complexity Project

Instead of correlating across all of the correlation factors, this time the Average Schedule overruns from Figures 6.4 and 6.5 will be used. For example, the system/strategic/variety domain is equated to the systems average overrun from Figure 6.5 of 12% and the strategic/variety (which is equated to mid-complexity projects in Figure 6.4) overrun of 21%. The two percentages are averaged for a weighting of 17%. When using this method to do the ratings, the output is trimodal with six domains having a rating percentage in the mid-teens, five domains having a ratings percentage in the mid-twenties and a single domain in the low-thirties. This result is driven by the two data points that are outliers – the manufacturing rating of 28% (from Figure 6.5) and the options/variety rating of 35% (from low complexity in Figure 6.4). In adding the revenue forecasting ability for each domain in Figure 7.3, the grouping of domains with the mid-teen ratings were given a Good rating, while the grouping in the mid-twenties were rated Fair and the one domain in the low thirties was rated poor.
7.5 Summary

It turns out that the project data used in this analysis is limited by its sameness. If the Component and Systems data from Figure 6.5 (Multi-product line company data) were not 11% and 12% respectively, and the High-Complexity and Medium-Complexity data from Figure 6.4 (the Consultant’s database) were not 20% and 21% respectively, then there was the possibility the Topology/Method/Market Array would show more interesting results. As mentioned above, with the data as it is, the Array gets swamped by the two factors that are out-of-line – the 35% schedule overrun for low-complexity projects (Strategic/Variety) and the 28% schedule overrun for consumables projects (Manufacturing topology).

This analysis only looked at the first of the three benefits. The remaining two benefits, managing the vital few and sustainable vectors of differentiation, are examined next.
Chapter 8 – Managing the Vital Few and Vectors of Differentiation

“In the field of observation, chance favors the prepared mind.” – Louis Pasteur

8.1 Introduction

This chapter will describe the thought process that was used to determine the ratings for the two other IPS benefits – Managing the Vital Few and Sustainable Vectors of Differentiation.

8.2 Managing the Vital Few

Figure 2.5 is repeated here for convenience. The concept is that Product Platforms are used by the MAP to interface to the individual products. The key concept, as stated by McGrath, is that platform strategies focus management on key decisions at the right time because “Strategic decisions are simplified, because there are fewer platforms than products, and major platform decisions are made every few years, not every few months.” McGrath further claims that with

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platforms, senior management can spend 90% of their time managing the few most critical decisions (platform decisions) that determine 90% of the success of the product line. Managers are cognizant on what they are spending their time. Car parts manufacturer Valeo’s chief executive, Thierry Morin, commented he needs to “fix its money-losing factory or close it” because “it is taking a lot of my time and my teams time.” Therefore, to determine how successful each domain in the Topology/Method/Market Array is at allowing senior managers to manage their business at a more abstract level, one would need to examine what managers are spending their time on, while in a platform environment versus a non-platform environment. Because this data is extremely difficult to obtain, we will reason through each domain by correlating the performance of the combination variables:

**Strategic Method** – Firm plans for first product and the variants that follow. Can manage at an abstract level. Rating = Good.

**Options Method** – Firm develops one product robustly, analyzes response in the market, and plans the next move. If the next move is simple, management can be abstract; if it is complicated, management is involved. Rating = Fair.

**Variety Market** – Customers are happy with technology; firm is trying to fill all niches; or expanding platform to adjacent markets. Management for niche fill can be abstract; for adjacent markets, more work is involved. Rating = Good.

**Rapid Platform Market** – Platform decisions must occur more frequently. Rating = Poor.

**Component Topology** – Supplying up-to-date building blocks for use by product teams. If the technology decisions by the platform team are correct (the right technologies are in the pipeline), this will be very successful. Because the defining technology (the motor in the B&D

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case) makes up a substantial portion of any of the products, most of the hard product decisions are made (again in the B&D example, the motor is surrounded by technology that has not changed in years). Rating = Good.

**Manufacturing Topology** – Platform is removed from the marketplace. In the Ford assembly line example, the manufacturing platform purposely uses common points that do not influence, and, therefore, limit, the design/performance of the vehicle. This means that all product decisions, except where to put the locator holes, need to be made for all vehicles that will use that platform. While not having to build a new assembly line does save a lot of money, it doesn’t reduce the number of decisions that need to be made for each new vehicle. Rating = Poor.

**Systems Topology** – One aspect of the design, how the product will interface with others, is established by a systems platform. In most products, that is a small part of the design tasks. Because this system is not platformed on the defining technology for each product that will be developed, there are few common decisions that can be made. Rating = Poor.

Using these ratings and the same type of correlation thinking used for the analysis of forecasting the cost side of products under development, new ratings are entered into the Topology/Method/Market Array shown in Figure 8.2. The rating order is Good, Fair, and Poor and the correlation for Component/Strategic/Variety was Good/Good/Good which gave it a Good rating. The opposite end of the spectrum was the Manufacturing/Option/Rapid Platform domain whose correlation was Poor/Fair/Poor, giving it a rating of Poor. All other ratings are scaled between those two extremes.
8.3 Vectors of Differentiation

This final IPS benefit is particularly difficult to quantify. McGrath’s assertion is that product platforms will allow a firm to maintain a sustainable Vector of Differentiation. In his book, McGrath has a litany of possible VoDs – unique features; measurable consumer benefits; ease of use; improved productivity; protecting customer’s investment; lower cost of product failure; higher performance; unique fundamental capabilities; design, based on standards; total solutions; total cost of ownership; brand name; convenience – for every market segment there may be multiple VoDs. Trying to pull out VoD data from the data sets of Chapter 7 is an impossible task. To quantify how sustainable the vector was, is even more difficult.

Generating the VoD requires that the firm have some competencies of its own. However, for any firm to make the VoD sustainable, it requires that the firm be faster than the competition in
moving the vector along its technology profile or that the firm establishes barriers to entry that exclude other firms from participating in the market. These barriers can be legal, such as patents, or they can be strategic, such as making a risky investment in capabilities that will give the firm an advantage for a long time. Examples of both these tactics can be found in Kodak’s involvement in Organic Light Emitting Diode (OLED) displays. Kodak has a strong patent position in the fundamental chemicals used to make OLED displays and has licensed other manufacturers to use the technology, controlling whom it wants in the market. Kodak also has a partnership with Sanyo to manufacture OLED displays and has recently announced a $350 million dollar investment in a manufacturing plant. The one hitch is that, at this point in time, OLED sales are limited but, if they take off as expected and the plant can manufacture the displays at an advantage over the competition, the strategic investment in this plant could give the Kodak/Sanyo team a sufficient barrier to block others to compete profitably.

When examining the Topology/Method/Market Array, is it possible to pick out which domains will have an advantage in speed or barriers to entry? The following heuristics were developed to answer that question:

1. In a variety market, an options-based platform will allow a firm to quickly meet changing customer needs by generating derivative products faster.
2. In a rapid platform market, options-based platforms will keep pace better than strategic, but will encounter difficulty in maintaining an advantage over competition.
3. Patenting a critical component is an excellent barrier to entry through capital investment or by using process patents (OLED example).
4. Manufacturing platforms can establish barriers to entry (Kodak’s investment in film manufacturing is an example).
5. Systems platforms, through the lock-in of customers, can provide barriers to entry.
These heuristics can be used to fill in the final piece of the Topology/Method/Market Array, as shown in Figure 8.3.

The VoDs in Figure 8.3 are listed for both their speed and barriers to entry possibilities. As listed, the component/option/variety domain can excel at providing a VoD by being fast or by patenting a component technology. Therefore, this domain has a strong VoD position. By contrast, if a firm is producing products strategically and the customer needs evolve toward a product that the platform can’t accommodate, it doesn’t matter if the firm has barriers to entry (IP or manufacturing benefits) it will still need to redesign its platform to provide a new vector of differentiation. The numbers (and shadings) in Figure 8.3 are simply a summation of each Good = 2 points, each Fair = 1 point, and each Poor = 0 points. It helps to highlight regions where platforms can deliver the benefits predicted by IPS (lighter means better).
### Variety Market

<table>
<thead>
<tr>
<th>Strategic Investment</th>
<th>Eval = Good</th>
<th>$= Good</th>
<th>Few = Good</th>
<th>VoD: Spd = Poor</th>
<th>BTE = Patent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option Investment</td>
<td>Eval = Fair</td>
<td>$= Fair</td>
<td>Few = Good</td>
<td>VoD: Spd = Good</td>
<td>BTE = Patent</td>
</tr>
<tr>
<td></td>
<td>Eval = Good</td>
<td>$= Good</td>
<td>Few = Fair</td>
<td>VoD: Spd = Poor</td>
<td>BTE = Lockin</td>
</tr>
<tr>
<td></td>
<td>Eval = Fair</td>
<td>$= Fair</td>
<td>Few = Fair</td>
<td>VoD: Spd = Good</td>
<td>BTE = Lockin</td>
</tr>
</tbody>
</table>

### Rapid Platform Market

<table>
<thead>
<tr>
<th>Strategic Investment</th>
<th>Eval = Poor</th>
<th>$= Good</th>
<th>Few = Fair</th>
<th>VoD: Spd = Fair</th>
<th>BTE = Patent</th>
</tr>
</thead>
<tbody>
<tr>
<td>Option Investment</td>
<td>Eval = Poor</td>
<td>$= Good</td>
<td>Few = Poor</td>
<td>VoD: Spd = Poor</td>
<td>BTE = Lockin</td>
</tr>
<tr>
<td></td>
<td>Eval = Poor</td>
<td>$= Good</td>
<td>Few = Poor</td>
<td>VoD: Spd = Poor</td>
<td>BTE = Lockin</td>
</tr>
</tbody>
</table>

* Figure 8.3: Topology/Method/Market Array
Chapter 9 – Conclusions

“It does not take much strength to do things, but it requires
great strength to decide what to do.” – Elbert Hubbard

9.1 Introduction

This section will discuss the completed matrix of Figure 8.3 and what it is telling us about
where platforms are the most helpful to the IPS process. It will also discuss the problems with
the data set and what companies can do or are doing to help improve the data to make the array
more meaningful. Finally, the relationship between IPS and Kodak’s other two processes will be
revisited to see if the array adds any new thinking to how platforms should be applied.

9.2 Analysis of the Completed Topology/Method/Market Array

Broad statements about the success of platforms in delivering the IPS can be made by
summing the rating numbers in the domains of Figure 8.3. For example, summing across the top
two rows, which are both variety market domains, results in values of 14 and 10. By
comparison, summing across the bottom two rows, which are the rapid platform domains, results
in values of 10 and 6. Therefore, generally speaking, platforms will be much more successful in
facilitating the IPS benefits if the market is in a variety mode. This should be an intuitive result
because the value of a platform increases the longer it is in use; the stable technology
environment of a variety market allows for long-lived platforms. This analysis also shows a
strong advantage to strategic platforms in both market domains.

When looking across the platform topologies (summing the columns), component-based
platforms sum to 17, systems platforms sum to 13, and manufacturing platforms only sum to 10.
This result means that platforms are most valuable when they are based on the reuse of
components. Reused components’ costs and performance are known. Having a new product or
family of products that are made up of a large percentage of proven components goes a long way toward removing risks on the cost side of product development.

This cannot be said, generically, for the other two platform topologies. For systems-based platforms, the common communication interface of a product that is designed to connect to an RIS-type network for example, is only a small portion of the design of that product. In this case, the system platform does not protect you from the variability in product development cost or performance for a significant portion of the design of each product, which would connect to the system. On the other side of the coin, the new paradigm from B&D, where the tool ends remain constant while the motor/battery pack is allowed to change as technology improves, is a case where a systems-platform has reduced the risks that a product development team sees – they no longer have to worry about the risks associated with a significant portion of the tool design. Therefore, systems platforms by themselves may or may not foster reuse.

Manufacturing platforms suffer from the same dichotomy. Platforms, like the one at Ford, are specifically design to not be restrictive. They want to make sure that the product development teams have the utmost freedom in the design of new product and, therefore, the platform, by itself, does not foster a large amount of reuse. Even though the Facilities & Tooling (F&T) budget can be 25-40% of the total product development budget for a new program, a platformed assembly line won’t bring the F&T budget to zero because there will be new programming, fixtures, and jigs required. In addition, a lot of tradeoffs will still need to be made between what Design wants to do (outside of the Design for Assembly rules that the line has established) and what the line is capable of doing. These decisions, changing the capabilities of the line versus limiting what the designers can do, are usually bitter battles between the Design and Manufacturing communities.
The other side of the coin for manufacturing platforms is using those platforms that severely limit what can be done in new products. These restrictions act as a governor on new ideas and, therefore, foster reuse. An example of this in action can be found in the film manufacturing platforms at Kodak. Designers need to meet a plethora of restrictions – from coating speed to the type of solvents used, to the viscosity and thixotropic properties of the formulation, and, finally, to the clean up time of the line to make sure product switchovers go smoothly. All of these restrictions tend to make designers reuse coating components and methodologies in their designs that have worked before. Therefore, it can be said that restrictive manufacturing platforms usually foster reuse while nonrestrictive manufacturing platforms do not.

9.3 Remarks About the Data Sets

The data sets discussed in Chapter 6 had some surprising values in them, but none more surprising than the 35% schedule overrun for low-complexity projects in Figure 6.4. Even when trying to rationalize that it is a larger percentage of a shorter schedule time and, therefore, not as significant as one might think, when the average overrun is converted into days, the results are 90, 78 and 124 days for low-, mid- and high-complexity projects respectively. Intuitively, one would think that the estimate for low-complexity projects would be more accurate because of the shorter duration and limited number of tasks to complete and that the actual schedule overrun should scale with the complexity of the project. Because the data doesn’t show this, it indicates that there is trouble estimating low-complexity projects, most likely caused by the scheduler believing that he understands all tasks at hand and, therefore, he builds in very little cushion time. When schedulers start to become overwhelmed by the complexity of a project, the response is usually to build in cushion time.
If the data in Figure 6.4 was more representative of what intuition tells us, the low-complexity projects, which we equate to options/variety domains, are better at forecasting the cost side of revenue for products under development, then the completed matrix of Figure 8.3 would only have a slight modification that would not affect the generalizations made in Section 9.2. For example, if the average overrun for low-complexity projects was changed to 21%, about the same level as mid- and high-complexity projects, then the $$ rating for the second row of the array would change from Fair/Fair/Poor to Good/Good/Fair. If low-complexity projects had less schedule overrun than mid- and high-complexity projects, say, 10%, then the top row $$ rating would change to Great/Great/Good. Using these new $$ ratings, the second row overall rating would change to 5/4/4 for a 20% value and 6/5/5 for a 10% value. This would put the option/variety row at least on par with the strategic/variety with a row value of 13 if the 20% value is used value or ahead of strategic/variety with a row value of 16 if the 10% value is used. More importantly, if this adjustment is made, two new observations follow. First, there is little difference between strategic and options-based platforming in a variety market. Second, there is a clear advantage to platforming in variety markets over platforming in rapid platform markets.

There are data points from Figure 6.5 that deserve some discussion as well. The correlation between the CEE projects, which are a collection of non-platformed computer and electrical equipment projects, and the systems projects, which are a collection of products designed to connect to a RIS-like network, should be expected. The system component in each of the RIS-products was only a small component of the total product development effort and, therefore, it is expected that their overrun performance would be similar in scale to the collection of projects in the CEE category. This is consistent with the discussion in the previous section.
When examining the individual factors between the CEE and Systems columns, there are some significant differences. Subcontractor performance issues were to blame in 22% of the Systems projects versus only 10% of the CEE projects. One needs to look into the details of the data set to explain why there is a difference. The cause is that there are two projects in the data set in which the firm was developing a product that was to connect to another firm’s system platform, and these two projects contributed to half of the subcontractor performance issues. If these projects are backed out, then the subcontractor performance issues between the two columns are essentially the same. However, the point that a product development activity destined to connect to another system is risky should not be lost.

A last point about expected benefits of systems platforms that does not show up in the data is their value in rapid platform environments. System platforms not only give a firm an advantage in selling the products it has to its customers, but it can also be used to delay its customers from purchasing a competitor’s product. If the market environment is in rapid platform and a competitor beats a system-platform-owning firm to the punch with new technology, the system-platform-owning firm has a much better chance of selling “vaporware” products to its customers. Even if the firm’s new product doesn’t quite measure up to specification when delivered (which is usually later than promised), the power of the systems platform (service contracts, single point of contact, etc.) can usually smooth over the differences.

The final data set number that deserves some attention is the 23% average schedule overrun for the manufacturing platform products (consumables products) in Figure 6.5. This particular platform would fall under the restrictive type of manufacturing platform, which is expected to foster much reuse in the products that are developed on it. The huge value for unanticipated technical difficulties (57%) for this category would indicate that the product development teams
are pushing the envelope in one of two ways – either by trying to get products to do new things while being restricted in the way the product can be built (the new products are design limited) or by designing the products in such a way that pushes the manufacturing capabilities (the new products are manufacturing limited). In any case, this data is an excellent sample of why manufacturing platforms have problems securing the IPS benefits.

9.4 Getting Better Data

The data sets used to do the analysis contained in this paper were strained to the limit. To truly evaluate platforms, the way the data is collected and classified must be changed. Some data, particularly the market environment (variety or rapid platform), can be evaluated after the fact because it is not under the control of the product development team. There might even be cases where a team thought it was in one environment but realized after the fact that the market was really in the other mode.

Data collection methods are starting to classify projects in three categories – platform projects, major projects, and minor projects. The platform projects category includes both strategic- and options-based platforms, while the other two categories should not contain products with any platform content. It would be better if the projects were classified in the following manner:

1. **Strategic-based platforms** – preplanned execution of the platform components across multiple market segments.

2. **Options-based platforms** – very similar to a non-platform development effort where the team targets an initial segment but also invests in additional capabilities that might be exploited later.

3. **Non-platforms** – products that are created in isolated development efforts.
Which of the three platform types used in each development effort also needs to be tracked. That determination should be easy to make because the platformed projects are now separated.

While the classification of product development efforts requires a small amount of additional work, the rating of the success of each project will be more difficult. Getting any post-shipping approval data on products is sometimes a difficult task. For example, the data set in Figure 6.5 (from the single company) only contains the performance of the product development programs up to gate 6 (shipping approval). There is no data available to see how the projects did in the market, if it was a success, or if it suffered from LARD (Launch And Ramp Down) syndrome. Without product performance data, firms have less than half of the required information needed to make informed decisions indicating how their platform choices performed.

There are many attributes that can be used to rate the successfulness of a project. This paper used the attributes from IPS to rate each domain in the Topology/Method/Market Array and, while improved revenue forecasting and managing the vital few and sustainable vectors of differentiation are important, they are also difficult to measure and may not be high on a firm’s prioritized goal attainment list. Current data collection methods are starting to use nine factors to rate a product’s success in the market:

1. Average unit price
2. Average unit cost
3. Unit volume
4. Performance to specification
5. Manufacturing capacity
6. Product quality
7. Performance to customer needs
8. Customer satisfaction
9. Planned reliability/planned service level

Realizing that not all factors apply equally to all products, the teams get to rank the importance of each factor for their particular development effort and the final Goal Attainment rating is the sum of the weighted ratings for each of the nine factors. This method for rating the
success of a platform is more appropriate than the three IPS benefits used in this paper. However, adding the IPS benefits to the list of nine would allow the data to show if the IPS process is actually producing those benefits. The proposed additions would be:

10. Program financials (Is the program providing the returns predicted at Gate 2?)
11. Management involvement (How much of the program required minimal management involvement?)
12. Product Wow! (Did the product establish or maintain the firm’s leadership position in certain defined product attributes?)

Having a program with this level of detail would make the Topology/Method/Market Array more accurate.

The last topic of discussion from a data standpoint is how to evaluate options-based platforms and their follow-ons. When doing a platform strategically, like the digital camera programs used as examples in this paper, a firm chooses which market segments it wishes to attack. The selection is usually limited by the resource constraints, whether they are time, development funding, intellectual resources, or organizational bandwidth. The firm executes the selected product development activities to bring multiple products to market. For this fixed set of activities, the firm can evaluate itself on the performance of the product development activities, as well as the performance of the products in the market, using the 9-12 factors listed above or by doing a more stringent Return On Investment (ROI) analysis. For an options-based platform, the team brings a single product to market in a development activity that is taxed by the platforming features that are included. Once in the market, the firm discovers niches that should be exploited and those that should be avoided. How is the lost opportunity cost of not having the good niche products ready at the launch of the first product calculated? How are the savings from not producing products for the bad niches calculated? Is it enough to sum all the data for
the first product and its variants and build a database that says, on average, we get a return of X% on our investment when using options-based platforms? To truly evaluate the value of options-based platforms, firms will need a systematic approach to evaluating the total benefits that the approach provides.

9.5 IPS, RTDP, and KECP

Integrated Product Strategy (IPS) is primarily a planning activity with the Market Attack Plan (MAP) as the main output. As described in Chapter 2, MAPs are a much more complete way to examine the markets new products are entering when compared to the technology-driven product roadmap approach of the past. The use of templates to guide teams through the complexity of a MAP evaluation is an absolute requirement; but like the processes that have come before it (KECP and RTDP), IPS will add value because, at a minimum, it will standardize the way a firm thinks about its markets across all business units. This small point should not be lost – a common commercialization language was the first benefit that Kodak saw when KECP was introduced and it allowed Kodak to realize where it was struggling with commercialization, which in turn brought about the RTDP process.

Both RTDP and IPS are designed to take risk out of KECP. RTDP is designed to take the technical risk out of commercialization efforts and move it forward in the process where less money is at stake so that if the technology fails to develop, a lot of ancillary product development dollars aren’t wasted. RTDP doesn’t remove the risk of new technology development but it can give efforts a better chance of succeeding by isolating them from the demands of commercialization.

IPS is designed to take the marketing risk out of commercialization efforts. It counts on product platforms as a means of eliminating a lot of the risk, assuming that the platforms will
provide predictable product development cycles and deliver winning products to the market. The winning product assumption is based on the belief that platforms can repeatedly deliver a collection of products with differentiated features that customers have shown a desire for in the past (sustained Vectors of Differentiation). Mitigating the marketing risk in commercialization is not as clean as removing the technology risk because the market is a “complex adaptive system” described by Baldwin and Clark. MAPs try to move the risk forward by increasing the number of factors examined, when deciding on a strategy; but the rapid pace of some technology markets can make any amount of planning futile. Therefore, while RTDP has significantly improved KECP’s Gate 2 to Gate 6 accuracy, it is difficult to say if IPS will significantly improve the percentage of market successes. IPS is attempting to overcome risks that are much more difficult.

Focusing on platforms as the key to IPS may be a little simplistic. It is the author’s impression that what is really needed in today’s environment is speed – speed in technology development and speed in product development. Shortened horizons would make all of the MAP estimates more accurate. Reinertsen’s book shows the monetary advantages of making a total commitment to a product concept and being in the market first. This is the advantage that firms should be looking for. Platforming may provide a path to speed for some firms in some market environments, but the desire to platform should not interfere with getting products out to the market. In the word’s of Conoco’s recent advertising of their mission statement:

“Think Big. Move Fast.”
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