PRODUCT DEVELOPMENT PROCESS ASSESSMENT AT COMPANY D

by

Michael M. Vander Wel

Submitted to the Sloan School of Management and the
Department of Civil and Environmental Engineering
in Partial Fulfillment of the Requirements for the Degrees of

Master of Science in Management
and
Master of Science in Civil and Environmental Engineering

in conjunction with the
Leaders for Manufacturing Program

at the
Massachusetts Institute of Technology
June 2001
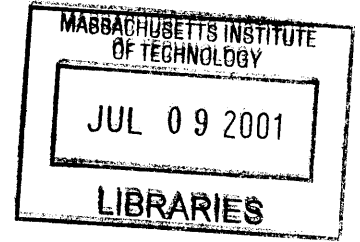
Signature of Author_____

Sloan School of Management
Department of Civil and Environmental Engineering
April 20, 2001

Certified by_____

Professor Nelson Repenning, Thesis Advisor
Sloan School of Management

Certified by_____

Dr. Daniel Whitney, Thesis Advisor
Department of Mechanical Engineering

Certified by_____

Professor Cynthia Barnhart, Thesis Reader
Department of Civil and Environmental Engineering

Accepted by_____

Oral Buyukozturk, Chairman of Committee on Graduate Studies
Department of Civil and Environmental Engineering

Accepted by_____

Margaret Andrews, Executive Director of Master's Program
Sloan School of Management

PRODUCT DEVELOPMENT PROCESS ASSESSMENT AT COMPANY D

by

Michael M. Vander Wel

Abstract

It has long been recognized that product development is the engine of growth for manufacturing companies. Continuously improving the product development process has thus become an imperative in order to compete effectively in today's world. However, few frameworks exist that allow organizations to systematically analyze process performance.

This thesis presents a postmortem assessment process that relates factory product launch data to the entire product development chain at a large consumer product company. A novel interviewing method is used to extract qualitative data from stakeholders in the product development chain. Discoveries from data analysis are presented and compared with previous years' results. The Berkeley Model Competency Ladder is used as a generic template for assessing project management process maturity. The data are also discussed in light of the underlying culture and organizational environment, and process improvement leverage points are identified. A key leverage point identified in this thesis is project timing and product development process timing. The strengths and weaknesses of the utilized assessment process are analyzed and improvement areas are discussed. A framework is presented for improving the product development process based on findings.

Acknowledgements

This work has been a wonderful journey. I want to thank the many people who took a part in this project. Thanks to PW, Ben, Kerry, Frank and Estelle for allowing me to blend into your work group for six months and making me feel as though I were one of your own. I can only hope the scales are even. Thank you Dan and Nelson, for your guidance and support as advisors; also to Cynthia and Nancy Young.

I also need to express gratitude to others that walked with me during the LFM program as well as the internship. Kerry, I could not begin to imagine life without you. Thanks for being my best friend in the world. Thanks to wonderful little Anneka and little Marcus, for putting up with my late nights; our family for their mighty support; Mr. And Mrs. P. for welcoming us to Boston; our LFM classmates and families; the distinguished members of team 8, the Magic 8-ball.

Thanks to the Boeing Company for allowing me this incredible opportunity.

Praise to our Lord and Savior Jesus Christ, through whom all things are made and sustained.

Table of Contents

Table of Exhibits

1.1 Introduction

This thesis analyzes the product development process at "Company D," a manufacturer of popular highly engineered consumer products, with particular focus on Company D's product development process in 2001. It is a continuation of a multi-year effort to assess the state of the development process as it relates to launching product in the factory, and builds on the assessments and What Went Right/What Went Wrong reports of recent years. The first project that used a formal design methodology was launched a few years ago, and the design methodology is continuously being improved; in part, by performing assessments similar to the assessment described in these pages. Company leadership requires a feedback loop effort to assess its current practices in the product development lifecycle from concept into the dealer showroom. It is expected that this exercise will result in process and organizational improvement recommendations based on 2001 Launch results. The Product Development Office (PDO) has been tasked to deliver the results of this project to all stakeholders. Stakeholders include all company work sites, functional groups, and platforms, and suppliers that are involved in the product development process.

The goals of this project include creating a framework from which to identify organizational and process improvements. The intent is to expand the scope of these previous efforts to encompass more of the design delivery process by linking documented process steps and metrics with specific phase exit feedback. More specifically, this effort will provide

- High level trends that can be identified via launch feedback.
- An interpretation of trends in light of the organizational culture.
- Specific leverage points for process and organizational improvements.
- Recommendations to reduce the assessment cycle time and improve feedback data.

The approach to this effort will be to extract phase-based data from project teams to understand variance to methodology in light of specific launch feedback. Assessment methodology and key discoveries from this year's process are presented and discussed in detail. A key part of this effort is to quickly break down the audit into useful chunks of data that can be leveraged into maximal design process improvements. A thrust of this year's assessment was to speed the report-out time to a six-month timeframe and recommend changes to the assessment process itself to provide

continuous, real time feedback. The organization expects to exploit leverage areas to improve the product development process.

1.2   Company and project background

Company D is the established leader in a mature industry. It produces and sells a large and complex electromechanical product. The industry is characterized by slow and stable growth with incremental product improvements. Typically, approximately 2,000 parts need to be designed and integrated into a high quality product. Customers are powerfully drawn to Company D's brand. There is both domestic and foreign appeal for the products. The company currently operates at full capacity and is not able to satisfy current demand.

Continuous improvement via Total Quality Management principles is a well-used concept at Company D. Years ago, a command and control management structure had created a subservient middle and lower management. Workforce morale was terrible, and relations with the unions were strained. Product quality was poor, customers were unhappy, and Company D was losing market share. Engineering groups were viewed with distrust and competency was suspect. The union went on strike and after a damaging shutdown, both sides recognized the destructive nature of what had occurred. That historical event played a key role in the re-shaping of company-union relations as well as the change in corporate culture from command and control to an empowered organization. It was during this time that a new corporate culture emerged, and a key element was an organizational desire to continually improve. Management had turned away from command-and-control to a Hoshin management style, where employees were aligned toward key company goals using indirect influence and enforcement. Many improvements were implemented using TQM principles. As the product development organization grew from a small number of engineers, organizational complexity grew to the point where it became necessary to introduce standardized processes. It was a natural extension of the new culture to continuously improve these processes.

An assessment of Company D's product development process attempts to incorporate the three types of improvements found in the VW model (Shiba). Process control improvement allows you to compare expectations with results and bring a process back into its intended alignment if

necessary. Reactive improvement addresses weak process steps that produce many points outside control limits by changing the process. Proactive improvements are done to anticipate customer needs or leapfrog current process performance.

This is the sixth year Company D has performed a model year assessment. The first three years were an effort by the largest manufacturing plant and termed the "What Went Right/What Went Wrong" report. Interviews have always been conducted without management interference in order to generate candid feedback. The first three years focused on the biggest factory's launch with the intent of discovering dominant themes in the interview data. The first effort at performing an enterprise-wide postmortem assessment took place in 1999. Thirty-five interviews of launch participants across functions and facilities created the interview data for this assessment. The information was analyzed in a modified KJ approach where fact-based feedback was grouped into high-level themes (Shiba). These themes were combined into causal loop diagrams to discover leverage areas and to recommend policy changes. The program management group used the findings of this report to propose policy changes and communicated the findings throughout the organization. The year 2000 and 2001 assessments are expanded to include the entire product development chain and recommend improvements to the product development organization. However, since assessments have been performed once a year, the process improvement cycle is at least one year past the actual event, which raises questions in the minds of some as to the timeliness of any proposed initiatives.

Effectively integrating findings into an improvement process is not an easy task for any organization, and Company D is no exception. Many employees champion improvements and get approval from leadership. An approved activity is documented via a mechanism called an "initiative," which is then tracked until it is completed. In the case of the product development process assessment, the Product Development Office facilitates framing of initiatives proposed from findings. Because the assessment is chartered and sponsored through the PDO, the PDO is expected to facilitate generation of initiatives based on the leverage points of this assessment.

In 1994, the company committed to a product development vision with three key objectives:

- Become predictable.
- Reduce product development cycle time.

- Demonstrate product and process feasibility and establish confidence that targets are achievable before committing to a production date.

While progress has been made toward this vision, management experiences a great deal of dissatisfaction with the current state of this vision because by many measures, the product development organization has not progressed quickly enough toward this goal. For example, projects are not at all predictable as they pass through the phased methodology. Because the organization does not consistently follow its prescribed design methodology, it is impossible to know precisely how to reduce development time. A key goal of assessments is to help move the organization toward the goal of being predictable and quicker to market.

1.3   Thesis Organization

The layout of this thesis naturally follows the development and execution of this project. Chapter 1 has described the project and the basic approach, in addition to providing some necessary background information on both the company and the project. Chapter 2 describes maturity models for both product development and project management and evaluates Company D. Chapter 3 describes how the interview process was arrived at and how the generated data was to be analyzed and presented. Chapter 4 summarizes the top trends that are discovered in the interview data and compared with previous year's results. The company culture and environment is described using System Dynamics, providing context to the interview data. Data driven conclusions that can be drawn from the data are presented and discussed in detail. Chapter 5 examines the performance of the assessment process and suggests a novel path for future assessments. Chapter 6 recommends specific tactical approaches to solve the issues presented in Chapter 4.

2. Product Development Process

2.1   Product development at Company D

A product development process is the sequence of steps undertaken by an enterprise to conceive, design, build, and sell a product. Many of the steps are not physical but rather involve intellectual and organizational effort. In addition, every organization approaches product development in a different way from that of other organizations. Some cannot articulate how their product development works because it is done in an ad hoc fashion. Other organizations define every step and interaction in the development process. A well-defined development process is useful for the following reasons: (1) Quality—a development process passes through approval points along the way and can help assure the quality of the end product, (2) Coordination—a clearly articulated process defines normative behavior for all the involved actors, (3) Planning—development processes naturally contain key milestones that help the organization enforce proper timing of the project, (4) Management—a properly defined process allows managers to assess performance and take corrective actions, and (5) Improvement—The careful documentation of an organization's development process often helps to identify opportunities for improvement. (Ulrich and Eppinger). Many companies place a great deal of emphasis on improving their particular product development process. This is done for many reasons, including strategic advantage reasons, specific continuous quality improvement efforts, or because it is part and parcel of an engrained company culture.

"Timing" is a focal issue in Company D's product development process. Because timing plays a large role in this year's assessment and in the conclusions and recommendations of this thesis, a working definition of timing-related issues is presented here:

- Correct sequencing of methology steps
- Allowing enough time to complete methodology steps
- Making information available when it is needed
- Avoiding lob-ins
- Establishing detailed project schedule with real dates
- Completing project schedule dates on time

As Company D has grown in size, the product development organization has grown significantly. A few years ago, a formal design methodology was introduced in an attempt to systematize product development. Since that time, it has been revised many times to expand its scope and effectiveness. Currently, the phases are defined by fifty-four tasks that engineers are expected to complete to take a design from concept to the dealer showroom, as summarized in Exhibit 1. The key feature of this methodology is that it is a gated system with five key phases: (1) Phase 0 and 1 concept validation, (2) Phase 2 design validation, (3) Phase 3 production process validation, and (4) Phase 4 Product Launch and Production validation. A post mortem assessment (Ulrich) is conducted in Phase 4 as part of a knowledge management exercise to close out projects.

Phase 0	Phase 1	Phase 2	Phase 3	Phase 4
We have an idea!	We can design, make, and sell it.	Confidence we designed it well	Confidence we can build it well.	Build and sell!

Exhibit 1 Product development methodology

Theoretically, projects are allowed to exit to the next phase only after demonstrating completeness to designated approval teams. Approval teams are comprised of different leadership for different phases. For instance, leadership from marketing and strategic management is very interested in the concept phase, while the factory is more involved in the latter phases. Participation from functional groups follows a similar pattern. Exhibit 2 shows how the initial phases receive heavy involvement from certain groups concerned with conceptual issues, while the factory dominates the end of the methodology. There is cross-functional involvement in every step of the methodology.
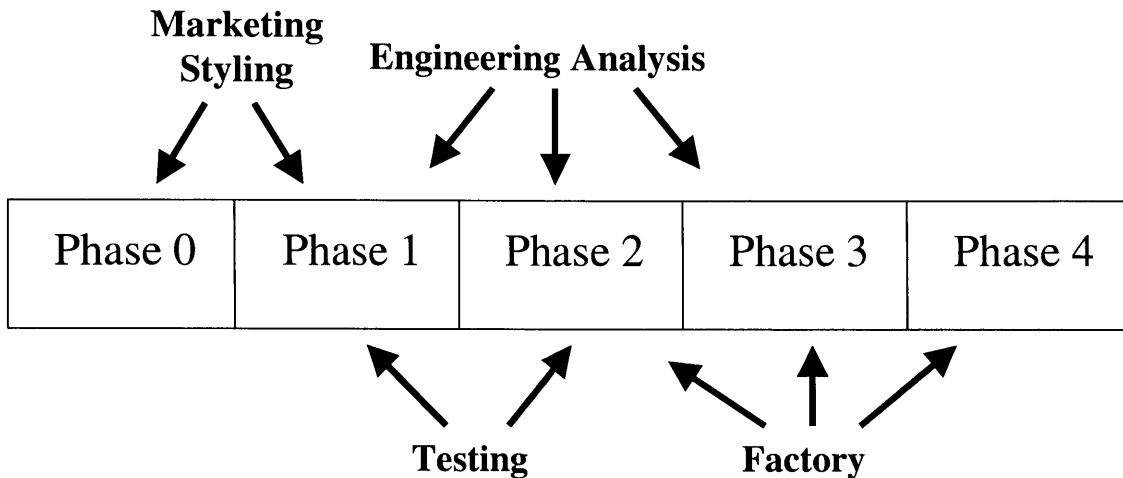
Exhibit 2 Different functional disciplines contribute at different times

By the time a project completes Phase 1, the scope and resource requirements of the project are supposed to be firm. After Phase 1 exit, it is declared an official project and is committed to a schedule. A project's model year is determined by its likelihood to meet the factory launch deadline in Phase 4 of a particular model year. Phase exit deadlines are clocked backward from launch at set dates based on expected time to complete the activities in that phase. All projects are expected to be nearly through Phase 4 by launch. Phase 3 exit is expected for all projects a few months before that, and so on. Because the phase exit schedule is basically fixed from year to year, the chief mechanism (by default) for completing projects on time is by allocating the proper amount of engineering labor to a project. Based on rough resource estimates in the concept phase, it is assigned appropriate launch timing.

For engineering resource analysis, projects are identified with timing requirements and of a defined size. "BIN" definitions are given in Appendix 8.2. This definition is used in an organizational macro analysis to ensure that in any one year, the product development organization is not forced into committing to designs it does not have the resources to complete. Not all projects are forced to follow methodology. Some projects are deemed as too simple to reasonably complete all steps in the methodology, while others do not reasonably fit into the expected formal methodology timing. Projects are tracked internally to product platforms and provide progress reports to the Product Development Office for global progress rollups. Specific metrics include number of changed parts, number of authorized drawings, percent of authorized

parts, and number of tooling changes. In practice, many authorized projects do not follow the timing and technical requirements of the methodology very closely. Projects are often late and require substantial effort to recover them in time for the launch date. When projects are clearly not going to meet the launch date, they usually are slid to a later launch.

2.2   Product development and project management maturity

As noted previously, all companies define their product development process differently. This does not mean that all product development processes are equal in effectiveness. Some companies have more mature or advanced processes than other organizations, resulting in higher efficiencies, more robust designs, or a quicker time to market. There are a number of models that assess product development process maturity. Two product development process models described below are a PRTM model (McGrath) and the software industry's Capability Maturity Model, followed by the Berkley project management maturity model.

Pittiglio Rabin Todd & McGrath (PRTM) recently completed the largest benchmarking study ever conducted on the product development process. This encompassed data from 288 businesses from seven industries including computers and electronic equipment, automotive electronics, medical devices and equipment, semiconductors and telecommunications equipment. Collectively these 288 companies invest more than $40 billion annually in research and development. (U.S. industry as a whole invests approximately $100 billion annually in R&D.)

The study also introduced a product development "process-maturity model" that uses 32 management practices, such as priority setting, decision making and project accountability, to classify the product-development process maturity of each participant. On a scale of 0 to 3, the model measures the capability of a company's product development engine: Stage 0-Informal, Stage 1-Functional, Stage 2-Project Excellence and Stage 3-Portfolio Excellence.

Stage 0 represents the absence of a consistent process for product development. Stage 1 is characteristic of the strong functional organization with barriers between functions. Stage 2 companies empower cross-functional project teams to develop new products and make decisions at clearly defined phases. Stage 3 companies have an integrated management process across all projects and coordinate them with effective product strategy and technology development.

It was found in the study that no companies have achieved Stage 3, and while most are transitioning between Stage 1 and 3, 8% of the companies could not be reliably classified because of hybrid systems. The process maturity classifications correlate quite significantly to revenue growth. Companies with a Stage 2 process grew three times faster than those with a Stage 1 process, showing a 27.6% annual increase in revenue compared to 8.7%. Bringing products to market faster enabled companies to increase revenue from these new products while also improving R&D productivity. A company's product development process is its engine for growth. Those that have been diligent are reaping significant benefits (McGrath).

Company D is clearly out of Stage 0 and is somewhere between Stage 1 and 2 because it works with cross-functional teams and has defined a relatively consistent and clearly defined product development process. However, the company seems to be a long way from achieving Stage 3. According to the model, an integrated management process across all projects characterizes stage 3, and the product development organization of Company D is incapable of analyzing interdependencies between projects. Additional proof of the existence of this issue is comments made by engineers regarding "lob-ins" and the subsequent effects on resource requirements.

It is also instructive to turn to the software industry to examine how it evaluates development practices. The Capability Maturity Model (Paulk) was established in 1991, and describes the progression an organization follows in modeling continuous improvement. Even though a software process model does not translate perfectly to a heavy industries manufacturer, the premise of the model does apply because it focuses on the common principle that continuous improvement can occur only through focused and sustained effort towards building a process infrastructure of effective engineering and management practices.

There are five levels of software process maturity in the CMM model: initial, repeatable, defined, managed and optimizing. In the 'initial' stage, development is seen as ad hoc and chaotic with few defined processes. Being 'repeatable' requires that basic project management practices are established to track cost, schedule and functionality. Process discipline is in place to repeat performance on similar projects. 'Defined' requires both management and engineering activities to be documented, standardized and integrated into a standard software process for the organization. 'Managed' occurs when detailed measures of the process and product quality are

collected in a specific and quantitative way. 'Optimizing' is reached when continuous process improvements are enabled by quantitative feedback from the process and from piloting innovative ideas and technologies.

Although it has characteristics from the top two levels, Company D arguably can be placed between the "repeatable" and "defined" levels. Management and engineering processes are documented across organizational lines, but there are many areas where organizations use their own process, or choose not to use a process. For instance, some factories juggle the effects of three design methodologies that exist within the company. Another example is that not all projects are required to fulfill the requirements specified by the product development methodology.

While process development is an important factor in repeatable product development, it does not necessarily result in good schedule performance. Repeatable and predictable schedule performance can only be achieved by deploying robust project management principles. The Berkeley Project Management Process Maturity Model (Ibbs) is used to gain a better sense of Company D's PM sophistication level. This research developed and applied a five-level PM process maturity model. The objective of developing the Berkeley PM Process Maturity Model was to pinpoint an organization's current PM maturity level. This model illustrates a series of steps to help an organization incrementally improve overall PM effectiveness. Each level of the model subdivides PM processes and practices into the eight knowledge areas and six PM processes. This allows an organization to determine PM strengths and to focus only on the weak areas to achieve higher PM maturity. Exhibit 3 presents an overview of the Model.
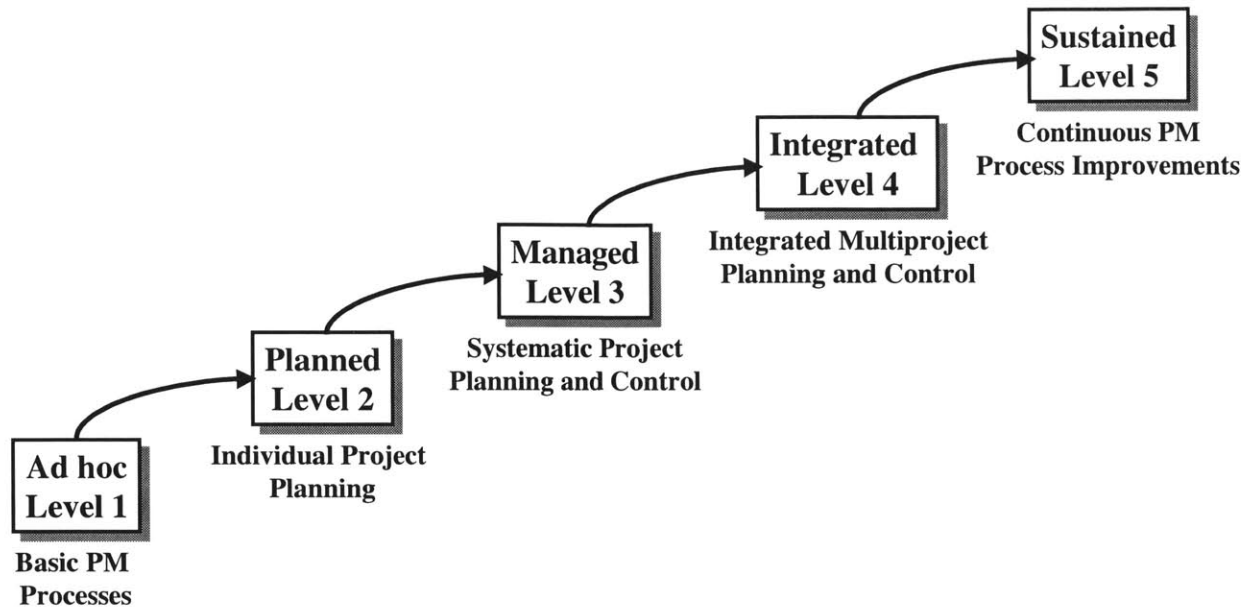
Exhibit 3 The Berkley PM maturity model

The model evolves from a functionally driven organization to a project-driven organization. Use of the model allows determination and positioning of any organization's maturity relative to other organizations in its industry class or otherwise. It consists of major characteristics, factors, and processes. The primary purpose of the Model is for use as a reference point or a yardstick for an organization applying PM processes. It can lead to suggestions about an organization's application expertise and its use of technology, or produce recommendations on how to hire, motivate, and retain competent staff. It can also provide and guide necessary processes and requirements for what is needed to achieve a higher maturity level.

Level 1: Ad-Hoc Stage. At the Ad-Hoc Stage, there are no formal procedures or plans to execute a project. The project activities are poorly defined and cost estimates are inferior. PM-related data collection and analysis are not conducted in a systematic manner. Processes are unpredictable and poorly controlled. There are no formal steps or guidelines to ensure PM processes and practices. As a result, utilization of PM tools and techniques is inconsistent and applied irregularly if at all, even though individual project managers may be very competent.

Level 2: Planned Stage. At the Planned Stage, informal and incomplete processes are used to manage a project. Some of the PM problems are identified, but these problems are not

documented or corrected. PM-- related data collection and analysis are informally conducted but not documented. PM processes are partially recognized and controlled by project managers. Nevertheless, planning and management of projects depend largely on individuals.

An organization at Level 2 is more team oriented than at Level 1. The project team understands the project's basic commitments. This organization possesses strength in doing similar and repeatable work. However, when the organization is presented with new or unfamiliar projects, it confronts major chaos in managing and controlling the project. Level 2 PM processes are efficient for individual project planning, but not for controlling the project or any portfolio of projects.

Level 3: Managed Stage. At the Managed Stage, PM processes become more robust and demonstrate both systematic planning and control characteristics. Most of the problems regarding PM are identified and informally documented for project control purposes. PM-related data are collected across the organization for project planning and control. Various types of analyzed trend data are shared by the project team to help it work together as an integrated unit throughout the duration of the project. This type of organization works hard to integrate cross-functional teams to form a project team.

Level 4: Integrated Stage. At the Integrated Stage, PM processes are formal, with information and processes being documented. The Level 4 organization can plan, manage, integrate, and control multiple projects efficiently. PM processes are well defined, quantitatively measured, understood, and executed. PM process data are standardized, collected, and stored in a database to evaluate and analyze the process effectively. Also, collected data are used to anticipate and prevent adverse productivity or quality impacts. This allows an organization to establish a foundation for fact-based decision-making.

In addition to effectively conducting multiple project planning and control, the organization exhibits a strong sense of teamwork within each project and across projects. PM training is fully planned and is provided to the entire organization, according to the respective role of project team members. Integrated PM processes are fully implemented at this level.

Level 5: Sustained Stage. Companies at the Sustained Stage continuously improve their PM processes using, for instance, formal lessons-learned programs. Problems associated with applying PM are fully understood and addressed on an ongoing basis to ensure project success. PM data are collected automatically to identify the weakest process elements. These data are then rigorously analyzed and evaluated to select and improve the PM processes. Innovative ideas are also vigorously pursued, tested, and organized to improve processes.

Organizations at Level 5 are involved in the continuous improvement of PM processes and practices. Each project team member spends effort to maintain and sustain the project-driven environment. Project teams are dynamic, energetic, and fluid in a Level 5 project-- centric organization.

With the Berkley model, an organization evolves from a less PM-sophisticated organization to a highly project-oriented organization. This does not necessarily mean that at Level N+1, all the characteristics of Level N are fully implemented. Rather, at Level N+1, an organization has the capability to choose the proper and eligible PM practices or tools that are suitable for a given project. For example, assume that scheduling techniques evolve from drawing simple bar charts to developing project network diagrams, to conducting a complex simulation for resource optimization. An organization that has a high PM level does not always have to conduct expensive simulation or resource leveling to find an optimal schedule and resources using highly sophisticated PM tools. At a higher PM level, an organization can apply eligible sets of PM processes and requirements based on the nature or complexity of a project.

It is clear that in comparison with the progress made in the design process arena, the Company D product development organization clearly lags in developing project management skills and can be barely classified at Level 2. Although at higher levels of management it appears that there is integrated project management and control, conversations with ground level engineers indicate that this is not rigorous and project control is performed (often informally) at an individual engineer's level. Exhibit 4 lists the questions from the Berkley model assessing efforts to identify projects' critical path, and for this question the company is clearly in the Level 1 Ad Hoc stage. Other indicators of immature project management skills at Company D include wildly varying schedule metrics, late projects, no real capacity and risk analysis, and disjointed

interfaces between key processes within the product development methodology. Specific details to these symptoms are discussed in relation to the assessment feedback in later sections.

Question #56: How is a Schedule's Critical Path Identified?

No critical path calculation done. Each subproject identifies critical tasks independently and sets work priorities 1
Critical path based on committed milestone dates. No CPM calculation performed, or CPM used on individual subprojects 2
Key critical tasks identified through non-quantifiable means, and used to drive the critical path calculation 3
Critical path calculated through integrated schedules, but only key milestone dates communicated to subprojects 4
All critical tasks identified and indicated on each individual subproject schedule. Critical path determined through an integrated schedule.............5

Exhibit 4 Example of a PM maturity assessment question from the Berkley model.

Much of this project management immaturity can be traced to historical and cultural reasons. Only a few years ago the product development organization was extremely small and had very little budget—at one point there was extreme pressure for every single design that entered the marketplace to be successful. The culture that emerged was one that valued individualistic, heroic effort to get the job done. As the organization has grown (as well as the resulting organizational complexity), this aspect of the culture has emerged as a dominant characteristic. People who could get the job done under any conditions were valued and rewarded. As a result, great engineers were promoted into management positions because of technical skills, not project management skills. Much of new product development is not radical new design, but merely updating technology and tinkering with the successful basic design. As a result, it seems design effort is simple and projects can be accomplished quickly. In summary, the organization as a whole does not yet feel significant urgency to become highly proficient in project management.

2.3 Expected PD Costs by Phase and Design Maturity

The previous section explains that while Company D actively tries to advance its product development capability, it is not developing expertise in project management. An obvious question arises to the *cost* of this lack of knowledge. While a definitive answer is impossible,

this section approximates the cost of not developing project management skills. In the Berkley model, a cost index is defined as

$$CI = (\text{Actual Project Costs} / \text{Original Budget})$$

and a project that meets its original budget has a cost index if 1. The companies benchmarked against the Berkley model were plotted in Exhibit 5, and shows that companies controlling project costs typically generated higher margins on projects. A graph such as this should motivate any company to work toward becoming more proficient at project management. The slopes of the curve in Exhibit 5 indicate that higher levels of PM maturity are associated with better cost and schedule performance on projects. This encourages an ever-increasing projectizing of operations and maturity of PM teams. Even if outlying data points are excluded, a nonlinear downward-sloping curve is still the best fit, thus reaffirming this key point.
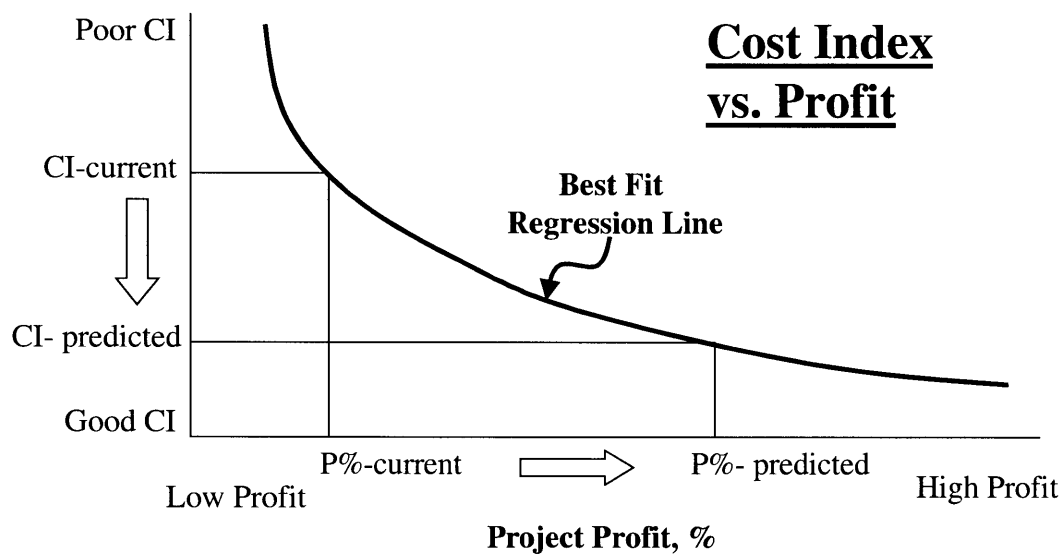
Exhibit 5 Cost control via project management often results in higher margins

It is problematical to apply a CI to Company D because it does not scope projects in detail at the start of a project, and thus the original budget number always is questionable. Actual cost is also difficult to quantify. For example, costly tooling errors from miscommunication or engineering rework are not necessarily tracked to an offending project. Engineers do not clearly track their labor hours specifically to projects. The fact that a CI is difficult to quantify suggests Company D is not near the optimal side of this curve and is losing potential profit to inefficiencies.

3. The Interview Process

3.1   2001 Model Year Product Development Assessment

This chapter describes development and use of the interview process of this year's product development process assessment. The purpose of the interview process is to gather individual and personal feedback (after product launch) that can be related to the entire product development value chain. The feedback was then analyzed to identify key trends and themes that exist in the data. Trends in the data can be used to exploit leverage points in modifying the product development process. Finally, taking a retrospective look at the interview process itself can help to assess the value of expending energy on assessments.

The 2001 interview process evolved from previous year's assessments. Initially, the assessment was a post-mortem of only the launch where problems specific to the launch itself were evaluated. The post-mortem assessments were termed the "What Went Right? / What Went Wrong?" launch reports because the assessment was based on those two open-ended questions. Starting in 1999, the process expanded to encompass the entire value chain of new product development. It was at this point that the interview process began to use TQM techniques to extract fact-based feedback and look for leverage areas in a more systematic way. The 2001 assessment built on this by focusing on speeding up delivery and simplifying the presentation of the final results, as well as to reflectively examine the efficacy of the assessment process and recommend improvements. However, the basic interview process itself has not changed significantly since 1999.

The number of projects that were launched this model year describes the relative scope of interviewing in the model year 2001 assessment. Because Company D does not radically change the product's design each year, the size of projects is similar to those of other years. The previous year was considered a larger than normal launch by a count of the projects, and launch year 2001 was considered a smaller than what is considered typical. The number of projects that made it to the factory launch was forty percent less than the previous year, thus characterizing this year as a "light launch year." Approximately 20 projects of varying scope were launched this

past model year, in part because the product development organization planned it this way, but also because the organization was recovering from the previous year's effort.

3.2   Interview Methodology

Three factors influenced how the interview process was established. The primary factor was time--an interview process was adapted from the 1999 and 2000 assessments because there was very little time between the start of the internship and the beginning of interviews. Second, since participants in the assessment process could not devote large amounts of their time to it, a novel interview methodology needed to be adopted. Third, it was desirable that the interview method permitted the assessment results to be compared with previous years' assessment results.

Since it is too expensive and time consuming to interview everyone involved in developing and launching product, it was imperative to develop an interview process that collects data from a reasonable cross section of participants. For example, if only engineers or only factory workers were interviewed, a biased picture would emerge from interview data. By interviewing a fraction of employees at each company site, a consistent cross-section of feedback was collected from different groups participating in product development. Personnel at varying organizational levels at each site were interviewed as long as they were directly involved in the design development and/or the factory launch in some way. Individual involvement in a specific project widely varies. A design engineer can spend the majority of his/her time on only one project, while a marketing person can be involved with many projects. The total number of people involved in each project is difficult to estimate. However, it would be fair to observe that while many more people would be involved in larger projects than in smaller projects, each function along the product development chain has a responsibility to participate in each project and does in fact do so. Typical interviewees included styling engineers, marketing, design engineers, suppliers, line workers, auditors, inspectors, resident engineers, and procurement engineers.

In addition to getting a proper distribution of product development process participants, another concern is putting enough effort into the interview process to get a statistically relevant size sample of interviewees. Polling data usually settles toward a mean score with only a small sample size. Previous product development process assessments concluded that too much effort

was put into interviewing people and recommended that fewer interviews could produce the same results (Morrison). In the case of the 2001 assessment, noticeable trends in the data in fact began to emerge after only 20 people were interviewed.

Potential interviewees were identified in a number of ways, and selections were made with eye toward a consistent cross section of the launch participants. Management within the formal organizational structure that is involved in product development was contacted to ensure that they were willing to participate and support their organization's involvement in this assessment. A 30+ year senior engineer, who was intimate with the informal network of the company, was able to identify which key people to talk to in most organizations. Other people came forward to volunteer for interviews because they found that participating in assessments was in previous years was an enjoyable experience or a valuable effort. Others were designated by their management as the correct person to interview. A few days before the interview, interviewees were sent a meeting notice and a pre-interview list of questions designed to get them to think in a fact based way about how the launch effort related to particular steps in the product development process. A list of pre-interview questions that interviewees received can be found in Appendix A. The target audience size was three to ten people. However, actual audience size depended on personnel schedules and ranged anywhere between a one-on-one interview to more than twenty people. Interviewees were interviewed by function, by organizational level (management, for example), or by product platform to collect a balanced (total) interview data set. The interview agenda typically included an introduction and an explanation of the process and objective, followed by a feedback brainstorming session, and ending with organizing the feedback into a logical order. Interview length was from twenty minutes to two and a half hours, and typically lasted one hour.

The interview process is best described as a modified and simplified KJ methodology. Japanese anthropologist Jiro Kawakita developed the KJ method in the 1950's (Shiba). The KJ method, identified with Kawakita's initials, helped the anthropologist and his students gather and analyze data. The scope of the KJ method includes four aspects: (1) a problem solving model, specifically the W model; (2) qualitative data formulation and analysis tools; (3) a new type of field research concept and method; and (4) teamwork concepts for creativity. The key steps of the KJ method include agreeing on a topic, writing and understanding the data, grouping similar

data, title the groupings, lay out groups and show relationships, and voting on the most important low-level issues and draw conclusions.

KJ diagrams differ from affinity diagrams in that the feedback is fact based and goes through a highly structured refinement process before a final diagram is created (Burchill). Similarly, Company D personnel were asked open-ended questions about launch as it related to the product development cycle. It was unrealistic to ask busy personnel to spend six to eight hours of intense effort in a meeting to generate complete KJ diagrams or LP (Language Processing) diagrams. The maximum time individuals and organizations were willing to devote to any sort of feedback process was one or two hours. In fact, as functional tasks got closer to the factory assembly line, the less willing were personnel to give of their time, and time came at an even higher premium.

During brainstorming, interviewees were asked open-ended questions like "What went well or poorly with this year's launch?" or questions that related to the performance of a particular phase or product development step. If the brainstorming session began to stall, asking questions from the pre-interview question list that related to the interviewees' job function assisted with prodding new recollections. Individual's feedback was written down on Post-It notes and immediately read to the group. If the thought was unclear or written illegibly, the contributor was asked to add words or re-write the thought altogether. To remain true to KJ principles, efforts were made to ensure that feedback was indeed fact-based, but often interviewees could not recall specifics to the comment. Positive comments were assigned a specific Post-It color, while negative comments were assigned another. Once the feedback was clear and concise as possible, the Post-Its were placed on a wall or table in a random order. The Post-Its were then grouped by commonality in order to write a title (or theme) for each grouping. Whether the group or the meeting facilitator performed the initial grouping, each group of interviewees validated the theme definition. The themes are what is reported on in the results and used to compare to previous years' results. Because a theme is in effect a summary title that groups many comments, some specificity is lost in defining it. As a result, there is some overlap between the group-defined themes. This is a reflection of the fact that different job functions and organizational levels will view and organize open-ended feedback in different ways.

Interviews with personnel from various company sites and job functions commenced in July 2000 and were completed by the end of September 2000. Typically, all manufacturing sites, testing facilities, and the product development location are involved in ushering a project from the conceptual stages through the factory launch. Due to the smaller product launch, one major manufacturing site had minimal change impact and was essentially left out of the assessment. The impact from minimal product change that this particular site experienced was coordinated with engineers from one of the other sites.

Each interview meeting produced approximately three to nine themes. To get a sense of what was uppermost in people's thoughts, and if time permitted, the interview group was asked to vote for their individual top one or two themes, whether they were positive or negative. Once a top theme emerged, the group tried to perform a deeper analysis and find a root cause behind the particular theme by two methods. A fishbone diagram or military style After Action Review (AAR) methods were used to try to find root causes. Voting on themes and performing root cause analysis provided additional insight on what people felt were key issues in the product development process.

A total of sixty-five people were ultimately interviewed in relation to the product development process assessment, producing approximately 600 data points. A data point represents one specific comment that was recorded on a Post-It note during an interview. Each record was inputted in the chronological order in which the interviews were conducted into a Microsoft Excel spreadsheet. Examples of identifiers associated with each record include functional group, site, date, associated theme, and whether the comment was positive or negative. Inputting the data into a spreadsheet allowed for analysis of the data.

This is a list of a few actual quotes gathered during the interview process.

- There was excellent cross-functional communication within engineering groups.
- We deal with 3 different methodologies in this plant.
- The eight day rule was not followed in multiple events in my area.
- Late design changes to _____ caused scrap or shortages in area _____.
- Working to low volumes during the training phase was great because it gave builders a chance to learn the new parts and processes without the pressure of the usual factory pace.

- We were lucky to have a light launch this year to because we are still recovering from last year's design development and launch.

3.3 Data Analysis Methods

The data from the interview process was analyzed in a number of ways. First, the raw interview data was organized by the open-ended themes that the interviewees came up with during the interview process. In order to minimize bias from any one particular function, the data was then normalized. This was accomplished by converting the "number of responses to" into "the number of organizations responding to" a theme and expressing it as a percentage. In Section 4.1, histograms are used to discover trends in the data. Pareto diagrams in particular are useful in identifying dominant themes that dominated peoples' thoughts in relation to launch. Pareto analysis is an analysis method that orders data by frequency, and is often used to find the high impact factors and shows the top 5-10 themes and allows for comparison with previous year's assessments. Section 4.2 presents an historical approach to the data, comparing it to assessments from previous years and explains differences that can be seen between them. Third, system dynamics is used to analyze the interview data in Section 4.4. The feedback must be understood in light of what can be observed from the organizational structure and the company culture in which this product launch occurred, and causal loop analysis is a great tool to explain data in light of these two factors. Goldratt's Current Reality Tree is a similar tool that may also have been used (Dettmer), but Company D has many people who understand system dynamics and find it useful to have such a common language to describe complex phenomena. Finally, the interview feedback is mapped to specific methodology steps in Chapter 6. Doing so allows specific steps of the product development process to be critiqued without making valuable employees feel as though their personal effort is judged to be lacking. It also shows how the current assessment process can be greatly improved over current procedure because it substitutes specificity for the current vagueness and opinion from the results of an assessment.

4. Results and Analysis

4.1 Dominant Themes Found in the Interview Data

In this section a summary of the data gathered during the interviews is presented in graphical form, and each graph's significance is explained. The observable overlap between themes is an artifact of the interview process because interviewees were given latitude to develop and define themes as they wished. Theme definitions are listed in Appendix 8.3, and keywords are listed after each theme to give a general idea of what a particular theme is about.
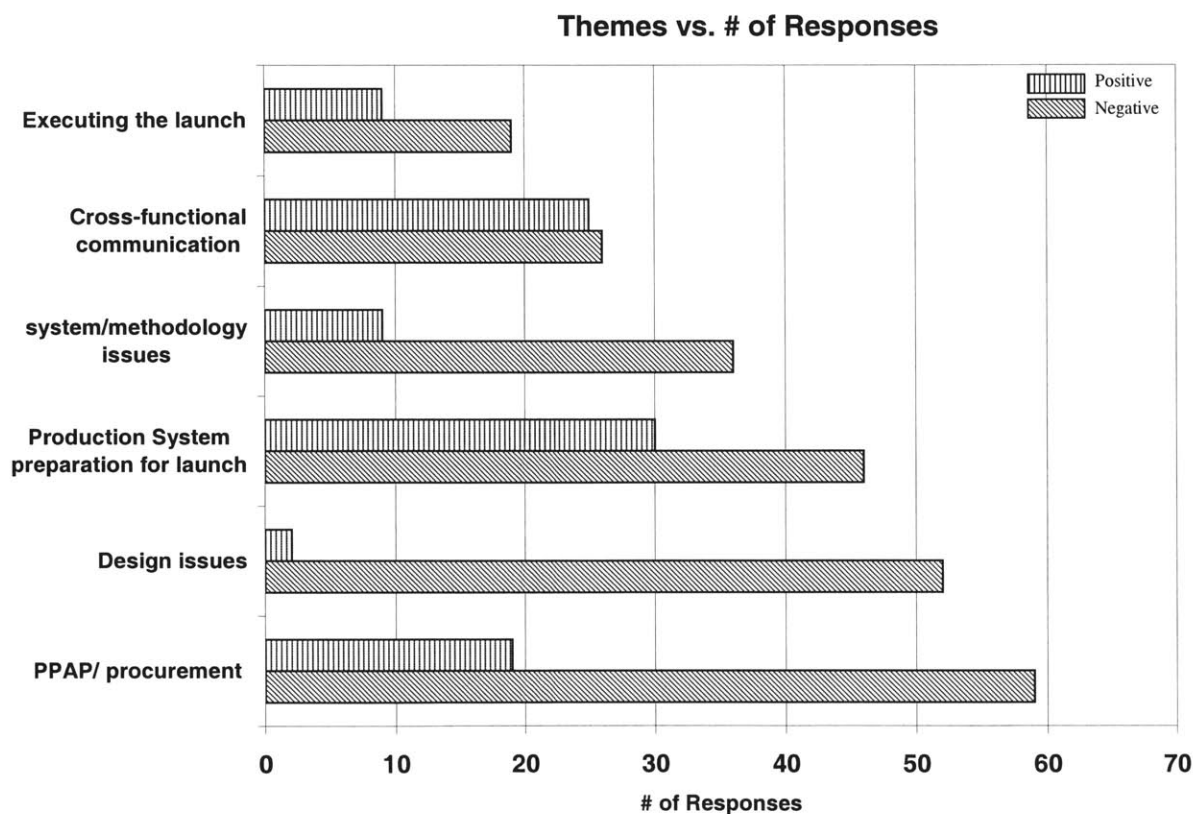
Themes vs. # of Responses

Exhibit 6 General themes Pareto analysis

Exhibit 6 is a Pareto analysis of interview feedback data. The vertical axis lists the interviewee-defined themes while the horizontal axis is a count of the number of responses to that theme. For each theme, the lower bar is a count of negative responses, and adjacent to it is an upper bar counting positive responses. For example, in terms of absolute numbers, the theme "PPAP / procurement" received nearly sixty negative responses. Conversely, the theme with the highest number of positive responses (thirty) was "preparing the production system for launch". The themes in the graph should not surprise anyone because the interviewees were asked specifically what their feelings were about the new product designs immediately after factory launch. The responses center on exactly that—the design issues parts, production processes, and methodology, etc.

However, as discussed previously, this graph does not take into account the possibility that a disproportionate number of people were interviewed from a particular group. If that were the case, the data would be biased toward that group's point of view. In order to account for any skewed input, Exhibit 7 normalizes the data by group, and the Pareto analysis of interview data is re-ordered around the percentage of group's responses to any particular theme.

Exhibit 7 is a normalized summary of the top themes that are observable in the interview data. The raw data was normalized by converting the total number of responses to a particular theme into the percentage of different groups responding to that particular theme. Groups were established by identifying clearly discernable role differences. For instance, factory line workers are clearly a different group than quality auditors. This graph shows that while 79% of the groups surveyed had something negative to say about 'methodology issues,' 29% of groups voiced positive opinions regarding 'methodology issues.' This analysis method is consistent with the previous years' assessments and allows for a year-to-year comparison of interview themes. The top 9 issues are ranked from the most negative to the least negative. It is interesting to note that there were a lot of positive responses around production system readiness and cross-functional communication this year.

Theme vs. Group Response %
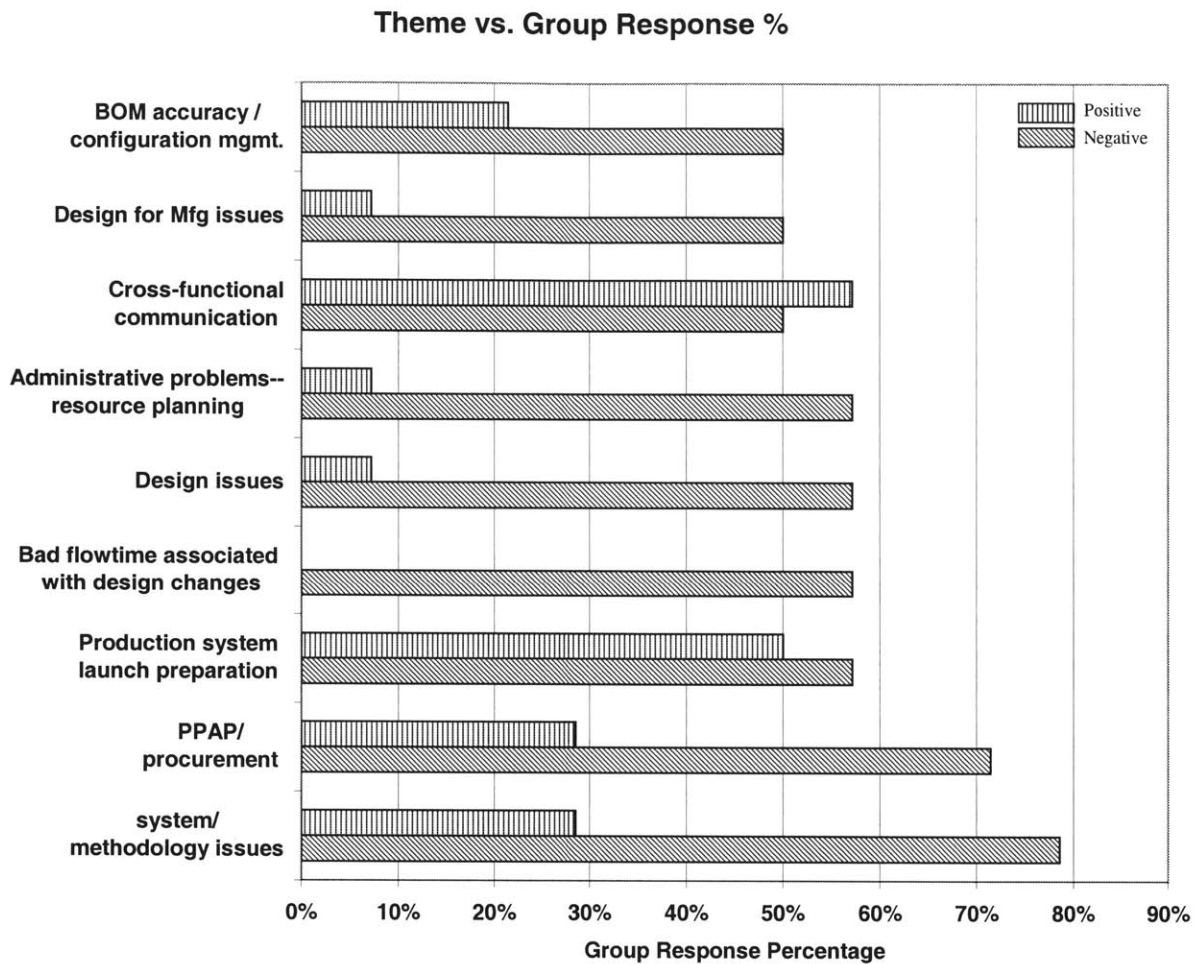
Exhibit 7 Normalized top themes Pareto analysis

The top themes may identify leverage areas to implement process-improvement initiatives. In peoples' minds, design issues and methodology are not living up to expectations. Although the procurement initiative has been implemented, it is clear that employees feel it has both added value as well as needs improvement. Organizational issues and resource planning are a constant worry in every company, and Company D is no exception. One specific area that falls short and is a prime candidate for an initiative is Design for Manufacturing.

4.2   A Historical Comparison with Model Year 2001

Appendix A compares the key trends in the 2001 model year with the themes seen in previous years' assessments. The top themes from 1997 through 1999 that were compared with the 2001

results were found in that year's assessment reports. Following are exhibits that summarize this analysis for the "What Went Wrong" as well as the "What Went Right" top themes from interviews.
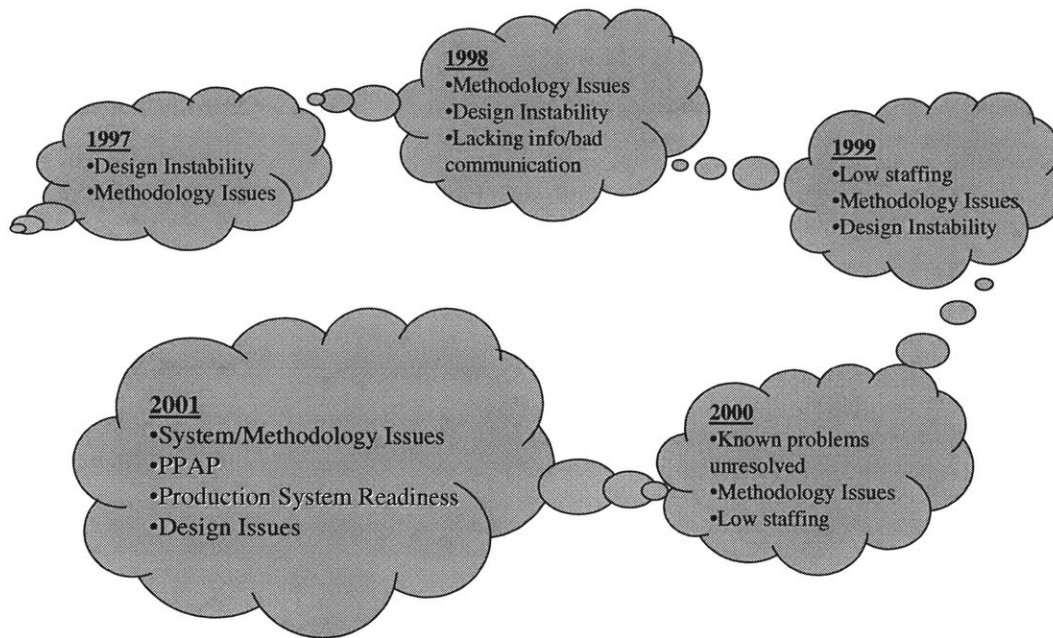
Exhibit 8 1997-2001 What Went Wrong History

Exhibit 8 compares the top issues from the 1997 through 2001 model years. There is a clear trend of repeated concern over methodology and design issues. The reason this is so is that these two issues summarize the activity--assessing the product development process! In the modified KJ interview process, specific feedback is given, but a summary theme is necessarily less specific. One resonating comment commonly heard is that 'we are getting better.' This fit well with the other observation found in this year's interviews--'Low staffing' is becoming less important and 'production system readiness' has appeared as a theme. This is a positive development because it indicates that as Company D become more organized in project design development, the resulting factory fire fighting seen in previous launches is less intense. Although the methodology is clearly far from perfect, there is a feeling of more efficient organizational effort that has allowed the factory to develop needed production processes earlier

and more robustly. Another reason these issues have surfaced when they had not previously is that it was a "light" launch year.
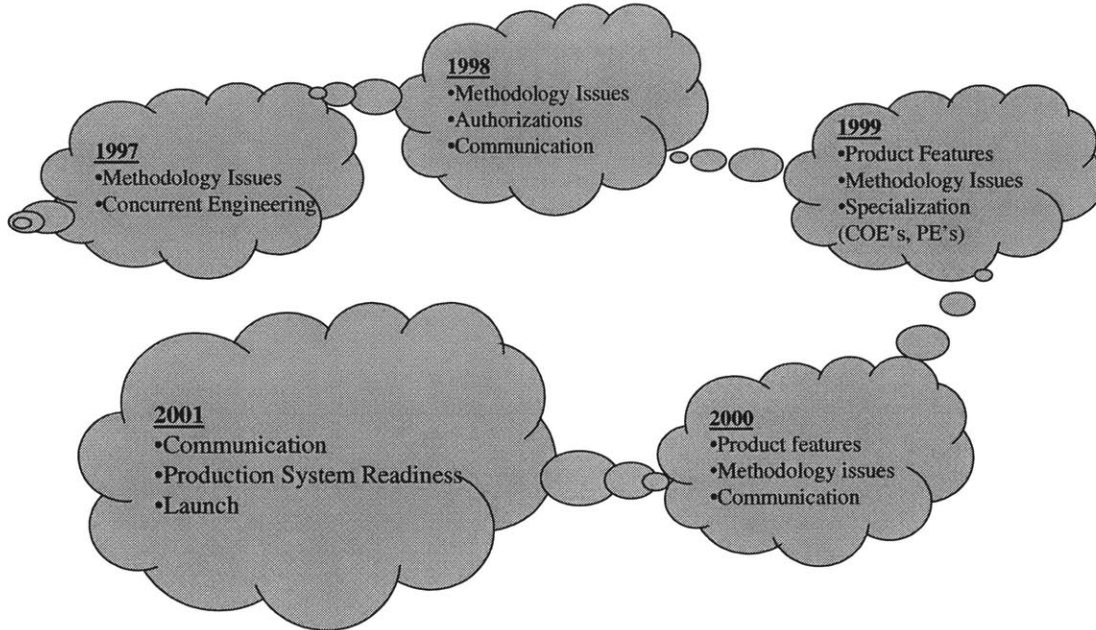
Exhibit 9 What Went Right History, 1997-2001

Exhibit 9 discusses the two or three of the most positive comments offered by interviewees in launch year 1997 through 2001. In 2001, "communication," "production system readiness," and "launch" itself were viewed the most positively. The pride in their product that Company D employees feel is evident in this chart--people get excited about working together to launch a great product. The fact that 'Product Features' dropped out of the top three list is likely a result of having a lighter than normal launch this year. During interview conversations, many comments were made to the pride people felt in "pulling it off" in the previous year despite incredible challenges.

4.3   Causal Loop Introduction

The data gathered by interviewing paints a picture on the complicated backdrop of the product development environment and the larger company culture. Our finite minds have a very difficult

time creating mental models that precisely explain what we can see and observe in the product development process. Causal loop diagrams are a useful tool to overcome this difficulty by explaining effects in this particular system. Their use is expected to improve the 'mental model' that is in our minds. Causal loop diagrams (CLDs) capture the feedback structure of systems, and help communicate the important feedback that are believed to be responsible for a problem. CLDs indicate how the dependent variable(s) change with respect to the independent variable. Loops are either reinforcing (positive) or balancing (negative), and are read as follows:

1. Reinforcing loop explanation--as Birth Rate increases Population increases, and as population increases the birth rate increases. Reinforcing loops are denoted with an R followed by a number.

2. Balancing loop explanation--as death rate increases, population decreases, and as population increases, the death rate increases. B followed by a number denotes balancing loops.
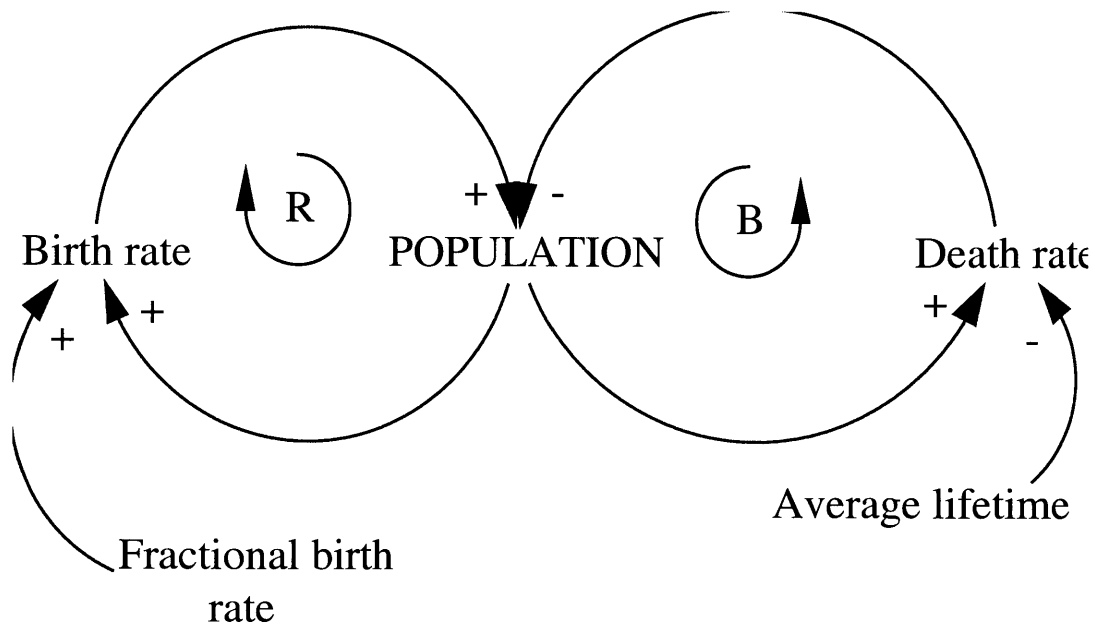

Exhibit 10 Causal Loop Example

source: Business Dynamics, by John Sterman

32

4.4   Connecting the Environment with the Interview Data

Interview data is useless if it cannot be interpreted correctly. Since the company environment in which workers live in influences everyday work and decisions, it is inextricably connected with the interview data. This section explains in causal loop form the systemic and cultural environment of Company D. The interview data alone cannot describe the organizational characteristics that are described in the following causal loop diagrams. Quotes from the interviews are placed in appropriate places to describe how the product development process or the company environment was affecting what interviewees were feeling. A key environmental factor is that Company D values individualistic and heroic effort. In fact, there is an internal debate inside the product development organization on the value of even having a design methodology. Senior employees reason that it was only a few years ago when they did not have a methodology, and launch seemed to happen anyway. In addition, the introduction of a product development methodology hasn't seemed to make the factory launches go more smoothly in their minds. However, the less senior employees, particularly in engineering, appreciate methodology more than heroics because it helps them deal with organizational complexities. A related cultural dynamic at work in this company is that the factory launch is considered the only true deadline for design projects. As a result, the phased design process is allowed to stretch toward launch, often causing huge resource pileups at launch. After a massive and dedicated effort manages to rescue the factory launch, the organization reinforces its belief that heroic effort is a good thing.
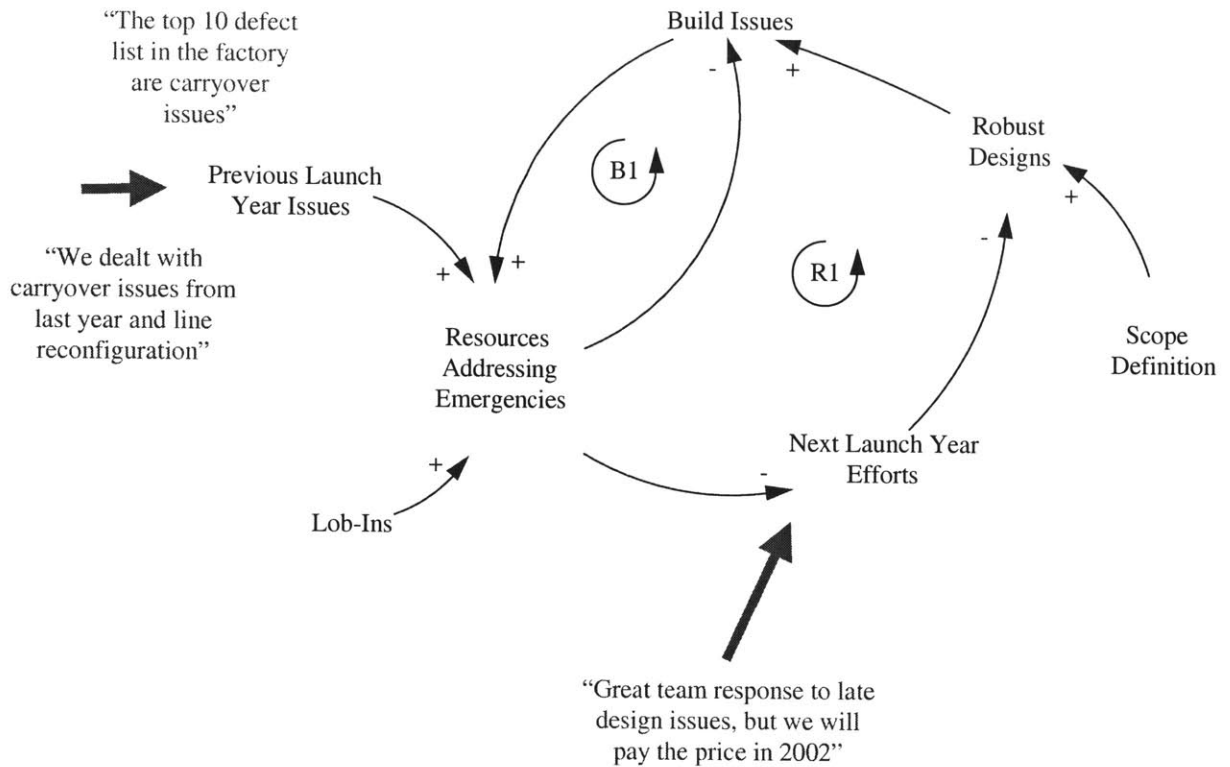
"The top 10 defect
list in the factory
are carryover
issues"

Build Issues

Robust
Designs

Previous Launch
Year Issues

"We dealt with
carryover issues from
last year and line
reconfiguration"

B1

R1

Scope
Definition

Resources
Addressing
Emergencies

Next Launch Year
Efforts

Lob-Ins

"Great team response to late
design issues, but we will
pay the price in 2002"

Exhibit 11 Unbalanced Launch Year Effort causal loop diagram

Exhibit 11 shows how effort in the current model year can affect future launches. This is a negative overall effect because today's fire fighting is unplanned effort and inevitably draws resources away from future designs. As this happens, designs mature more slowly and cause more build issues (resulting in fire fighting). B1 is a loop that shows that as build issues pop up, fire-fighting effort increases, which decreases build issues. However, increased fire fighting decreases efforts on next year's designs, which decreases design robustness and increases build issues. The inserted comments indicate that people recognize that this is not a positive effect to have in a growing organization. To break this cycle, it is important to be certain that future launch projects are not sacrificed for short-term effort.

To understand how fire fighting a launch can impact future effort, read the causal loop descriptions in the following table:

B1: As build issues mount, more resources (people) are assigned to fight fires, which decreases the number of build issues

R1: As more resources fight fires, less attention is paid to next year's designs, which slows project maturation, which results in projects launched that are not fully developed, which increases build issues, requiring even more fire fighters
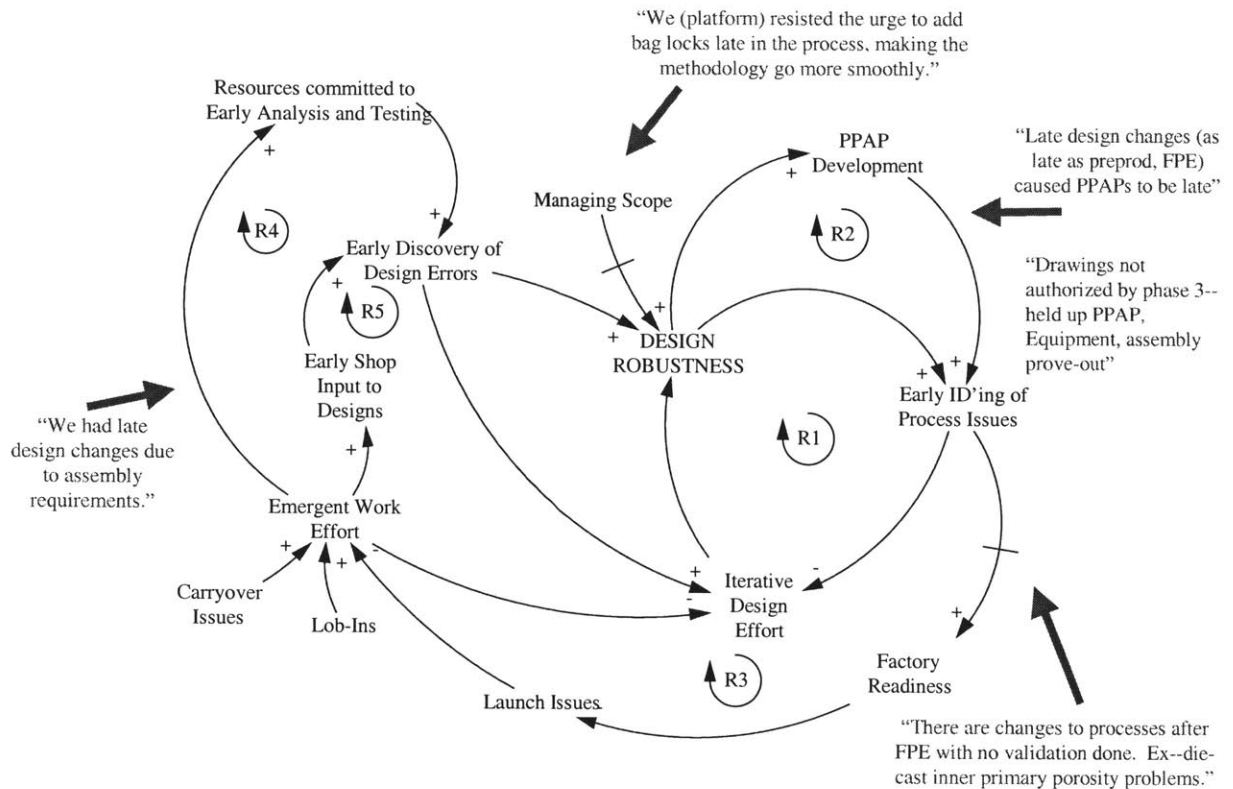
Exhibit 12 Early Robust Designs causal loop diagram

Exhibit 12 explains the valuable and positive effect of producing a robust design as early as possible. The key to achieving this is clearly defining the project, designing out discovered deficiencies, and getting supporting production processes in place. Timely and robust designs spawn many positive effects throughout the organization, most of which decrease fire fighting (labeled 'emergent work effort'). Less emergent work effort allows the product development organization to focus on identifying and fixing design issues earlier, which helps the factory get ready for launch more effectively. This diagram shows how long term success is directly related to managing project scope and proper resource allocation.

The following table explains the key loops that are identified in the diagram.

R1:   DESIGN ROBUSTNESS--Early ID'ing of Process Issues--Iterative Design Effort

R2:   DESIGN ROBUSTNESS--PPAP Development--Early ID'ing of Process Issues--Iterative Design Effort

R3:   DESIGN ROBUSTNESS--Early ID'ing of Process Issues--Factory Readiness--Launch Issues--Emergent Work Effort--Iterative Design Effort

R4:   DESIGN ROBUSTNESS--Early ID'ing of Process Issues--Factory Readiness--Launch Issues--Emergent Work Effort--Resources committed to Early Analysis and Testing--Early Discovery of Design Errors

R5:   DESIGN ROBUSTNESS--Early ID'ing of Process Issues--Factory Readiness--Launch Issues--Emergent Work Effort--Early Shop Input to Designs--Early Discovery of Design Errors
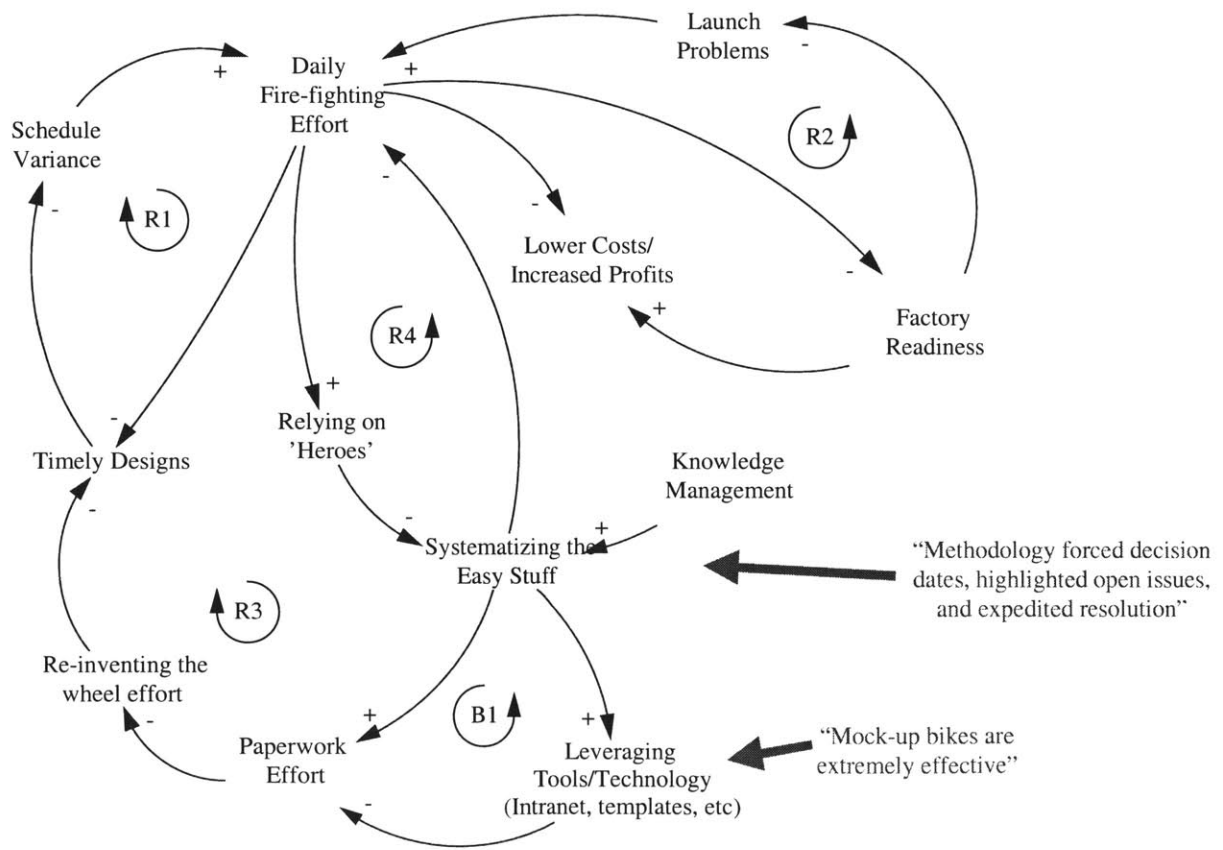

Exhibit 13 Why Methodology is Important and Valuable

Exhibit 13 explains the natural conflict between fire fighting and leveraging processes (systematizing product development). Positive loops R1 and R2 show how fire fighting can result in increasingly poor schedule performance and factory readiness. Reinforcing loop R4 depicts how process development (methodology) can supplant the culture of heroic effort. Engineers that were with the product development organization when it was small, and by seniority drive much of the decision-making, often expect performance to follow a heroic pattern. In contrast, many younger engineers are willing to display heroism only when necessary, but are more vocal about the benefits of following a methodology. Loops B1, R3, and R4 demonstrate the benefit of systematizing repetitive activity (process development). Key leverage points are using methodology where it is activity is indeed repetitive (forces excellent cross-functional communication, frees up resources for creative activity), and being certain to finish robust designs on schedule (proper resources and teaming, project management).

To understand this chart, follow these loops to get a feel for the conflicting forces that influence product development:

R1: Fighting near-term fires reduces the timeliness of designs, which impacts schedule variance that results in more fire fighting.

R2: Fire fighting decrease factory readiness, which increases launch problems, increasing fire-fighting even more.

R3: Systematizing results in additional paperwork but decreases effort in re-inventing the wheel which helps designs finish on time and reduces schedule variance, which in turn reduces fire fighting and reliance on heroes

R4: If we systematize the easy stuff it decreases fire fighting which decreases reliance on heroic effort which encourages us to rely on processes even more than before.

B1: If we use processes we can use technology to do some of the work for us, reducing paperwork, helping timely designs and schedule variances, decreasing our reliance on fire fighting.

4.5 Leverage Points from Causal Loops

The causal loop diagrams in Section 4.4 connect launch year 2001 interview feedback within the context of the environment of the company, and thus can be a vehicle to develop strategies for maximal improvements around leverage points. Leverage areas center around use of engineering resources, developing robust designs as early as possible, and standardization to make work easier and more efficient across different job roles.

Exhibit 11 demonstrates that it may not be constructive to shift resources from following years' design development effort in order to complete this year's effort. This is especially important if the long-term resource requirements are larger than what is forecasted. It is critical to understand the short and long term workload in light of the expected available engineering resource capacity. Exhibit 12 implies that the organization needs to be efficient about how it organizes work. If the product development system is set up to interact in an inefficient manner, product and production process design will suffer from quality issues. The leverage point is paying attention to inter-organizational connections. For example, although there is much communication between the product development center and the main assembly factory, there are only a few unionized shop personnel stationed among the design engineers. Furthermore, the few that are stationed there complain that they do not feel integrated into the design decision-making structure. Exhibit 13 discusses a cultural issue—that is, the value the organization places on standardized work as opposed to heroism. As the product development organization as well as the company continues to expand in the upcoming years, this will become an even bigger leverage point. As the organization grows, it will be imperative for organizations to standardize as the organizational interactions continue to become more complex. The causal loop diagram also discusses the importance of schedule. When designs are late, it cuts into time required to develop the manufacturing processes behind the designs. If production process development time is cut back, quality suffers and build issues will increase.
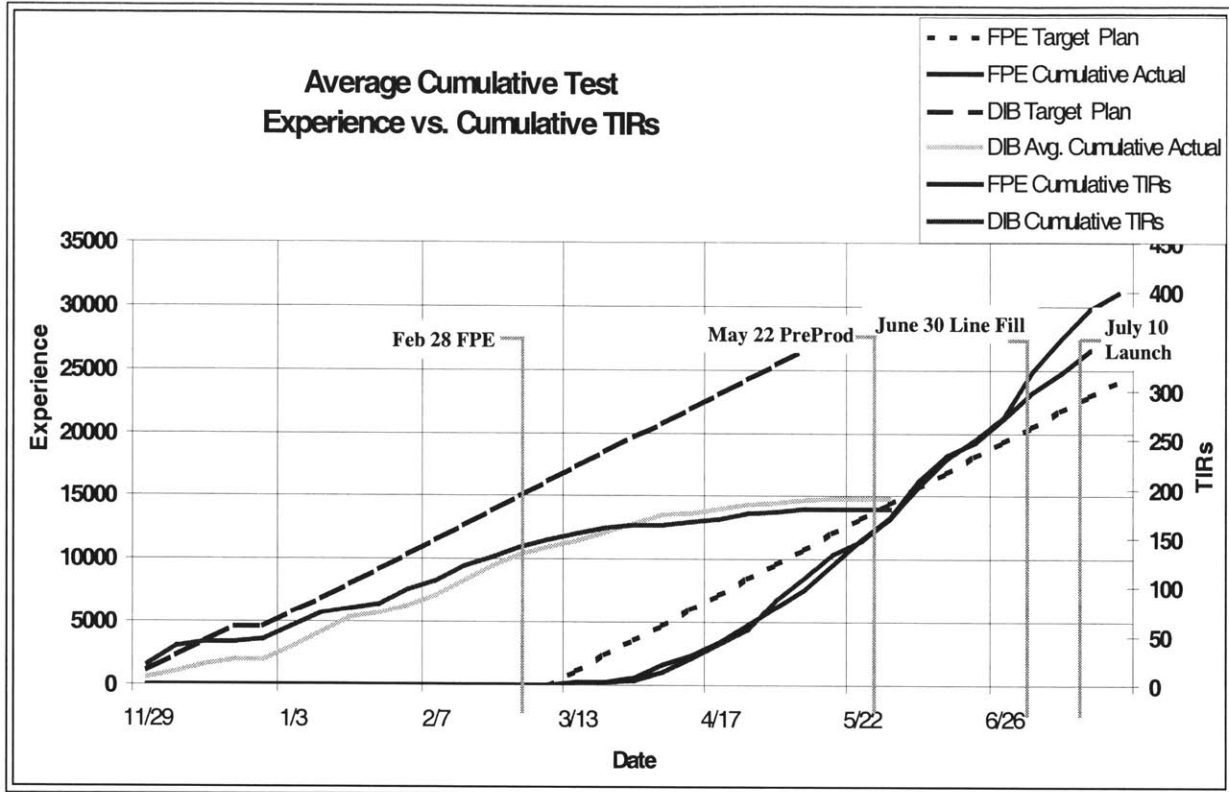
4.6 Discussion

At first glance, the data presented in Section 4.1 indicates that by attacking themes, the organization can solve all its product development process problems. For example, procurement has been an issue focused on for several years, and an official supplier development and validation process initiative (PPAP) was recently implemented with some success. Another reaction from Exhibit 7 may be that we need to implement an initiative to improve the BOM accuracy. Yet another initiative could be suggested to deal with the apparently high level of concern with production system process development, which was the third highest concern in the 2001 assessment. Clearly, the "Design for Manufacturing" theme in light of the fact that a DFM process is *not* in place at Company D suggests that this is an obvious leverage point.

While it is valid that new initiatives can and should be proposed directly from a reading of Exhibit 7, a closer examination of the data suggests that a deeper issue exists. A more fundamental issue that lies beneath the interview data from Company D employees and suppliers can be summed up in two words--POOR TIMING. The interview data suggests that people are generally not happy with the timing of the System, or more specifically, the steps in the design methodology and how the organizations work together in addition to schedule performance. The organization does not explicitly state that timing is an issue, but an analysis of the words spoken by employees uncovers timing as an issue. To detect this, the interview data was categorized into comments that directly or indirectly referred to a timing problem and into comments that did not refer at all to a timing problem. Exhibit 14 shows that 51% of the interviewees directly said or indirectly implied that a key factor in their comment was timing related. ("Directly referred to" was defined as a comment with a time adjective in it—"The design change was *late*." "Indirectly referred to" was defined as not having a time adjective in it but implying the existence of a time or sequencing issue—"The parts are in production before testing sees them."). The comments that did not refer to timing dealt with specific technical issues, a lack of support or resources, and organizational issues, to name a few. Ultimately, if not addressed properly, these issues can also develop into timing related problems.

Directly referred to	Indirectly referred to	Not referred to
29%	22%	49%

Exhibit 14 "Timing" is a key factor behind the interview data

Interviewees sometimes felt uncomfortable with methodology because there was an expectation that the right things would happen at the right time, and this was not always so. PPAP development is a good example. Purchasing engineers felt they did not get information at the right times and could not effectively complete their tasks, while final assembly was upset that parts were not always there in time and at the right location. Also, design issues and late authorizations frequently were cited as a reason for late downstream effort; i.e., blame the engineers! However, design engineers did not feel they had control or visibility on the testing or analysis groups' effort that was vital to completing their design. One result of poor timing is that work piles up in front of launch week every year that should have, in everyone's minds, been completed earlier in the product development process. In fact, a recognized part of the Company D culture is that launch is the only deadline! One possible explanation for this is that the product development system currently has poor timing within and between key processes. The following exhibits demonstrate that there are timing issues in the product development process.

Average Cumulative Test Experience vs. Cumulative TIRs

Legend:
- FPE Target Plan
- FPE Cumulative Actual
- DIB Target Plan
- DIB Avg. Cumulative Actual
- FPE Cumulative TIRs
- DIB Cumulative TIRs

Experience axis (left): 35000, 30000, 25000, 20000, 15000, 10000, 5000, 0

TIRs axis (right): 450, 400, 350, 300, 250, 200, 150, 100, 50, 0

Date axis: 11/29, 1/3, 2/7, 3/13, 4/17, 5/22, 6/26

Annotations: Feb 28 FPE, May 22 PreProd, June 30 Line Fill, July 10 Launch

Source: M. McEvoy

Exhibit 15 Plot of testing versus time

Exhibit 15 summarizes the timing around the testing of product. The accumulated test experience is plotted over time as well as the number of test issues in the form of TIRs. What this chart shows is that a significant amount of testing occurs after FPE (First Production Event). However, methodology defines FPE as a build where the design is supposed to be complete, and production processes are to be completely developed, including tooling and factory training. Nearly every year, significant design changes are discovered at launch, often due to late discoveries from testing. This is not a problem with the testing process itself, but rather a reliance on full product testing to validate the design. If the testing process is timed to allow for post-FPE testing, no one should be surprised to find design flaws and/or manufacturing issues at or after launch. By pushing part and sub-system validation upstream in the development process, Company D could shorten the full product test cycle.
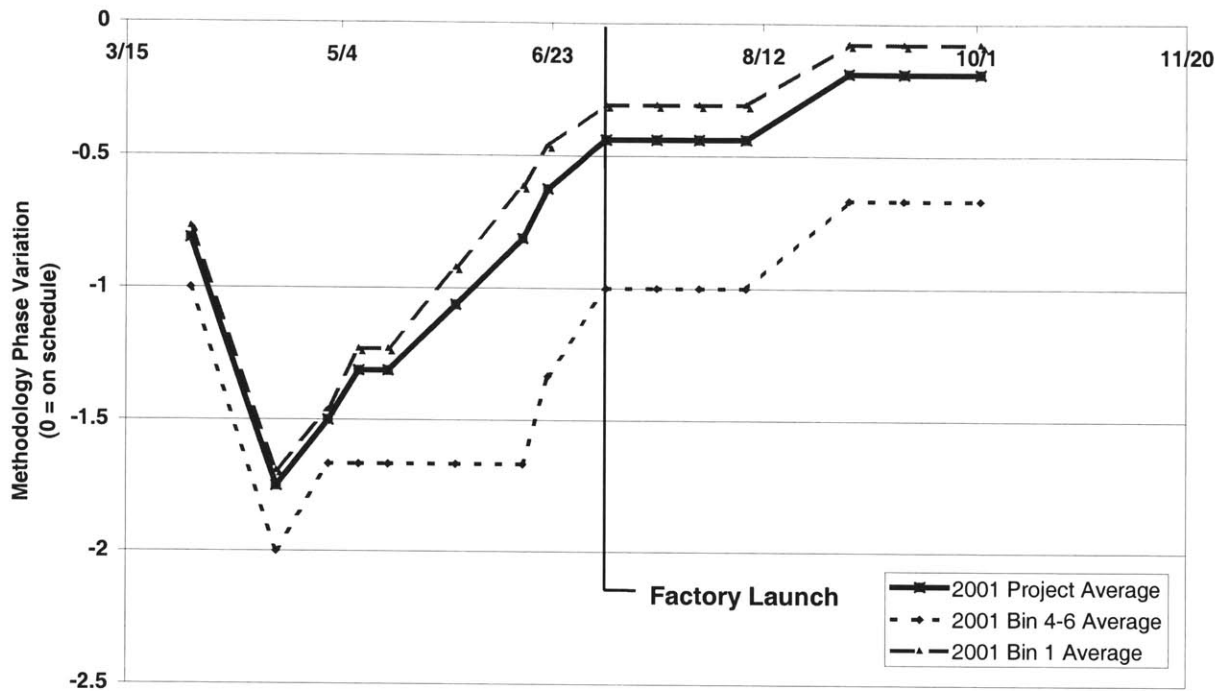
Average Phase Variance in MY2001 Projects

Exhibit 16 Project schedule variance (<u>source</u>: LSC trigger report, PDO)

Exhibit 16 plots average project variance to scheduled methodology phase exit dates. The horizontal axis shows project performance over time. The vertical y-axis plots variance, or deviation, from scheduled phase exit dates. If a project is on time, its y-axis value should remain zero over time. If it is ahead of schedule, the value will go into positive territory, and negative if the project is behind schedule. On this graph, the 2001 average project variance dipped to a low of 1.75. This means that all projects, on average, were 1.75 phase exits behind schedule only two months before factory launch (July)! The fact that there are only five phases in methodology makes this a very significant deviation from expected performance. Generally speaking, smaller projects (Bin 1) perform better than larger projects--the Bin 6 average is the worst on this chart. This graph shows that as the factory launch approaches, development schedule performance improves rapidly, but on average, projects are launched with schedule performance that is not per methodology.

DIB/FPE/Pre-Prod Concerns
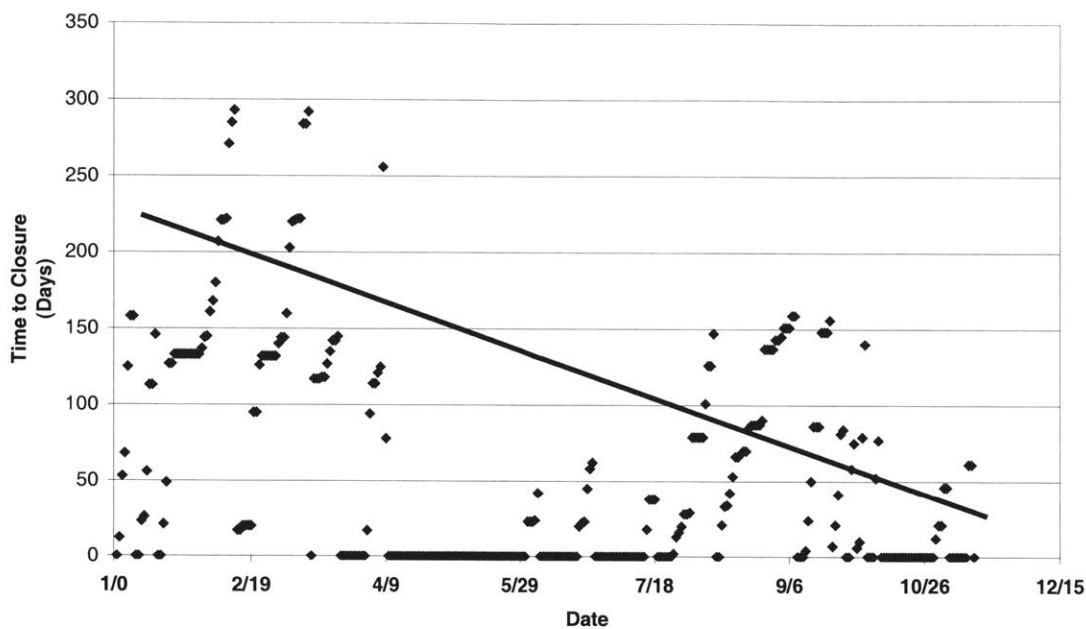Open date vs. Closure

Exhibit 17 Closure time for Concerns, MY 2001   (snapshot of data from October 2000)
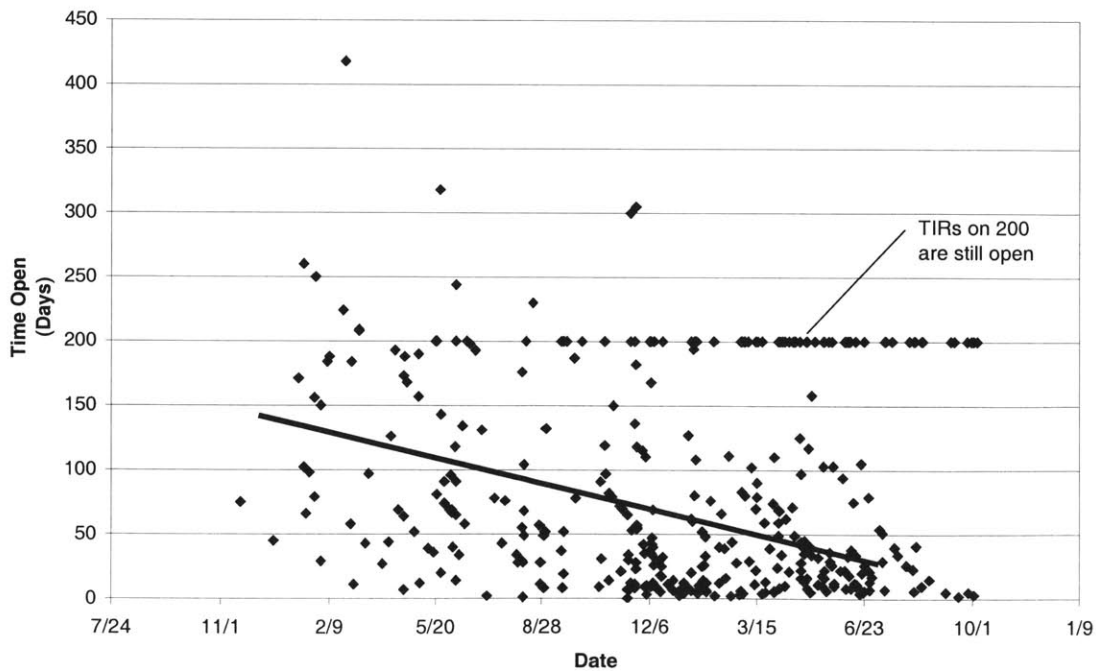
Time until TIRs are Closed
MY2001

Exhibit 18 Closure time for TIRs   (snapshot of data from October 2000)

43

Exhibit 17 and Exhibit 18 plot the time it takes to close Concerns and Test Incidence Reports (TIR) over time. (Concerns are issues that are recorded during product builds before the actual factory launch, and TIRs are the mechanism in which test data is reconciled via design changes.) For example, a data point with a y-value of 150 means that from the date it was recorded (the x-axis value) as a Concern or TIR, it took 150 days to close. A linear regression of the data is plotted for each exhibit and is statistically significant in both t-tests and F-tests. The TIRs that have not been closed were placed on the 200-day line and ignored in the linear regression computation. The conclusion that can be arrived at from Exhibits 17 and 18 is that concerns and TIRs are not closed in a very predictable manner. A second conclusion observable from the data is that the closer we get to the July factory launch, the more quickly concerns and TIRs get resolved.
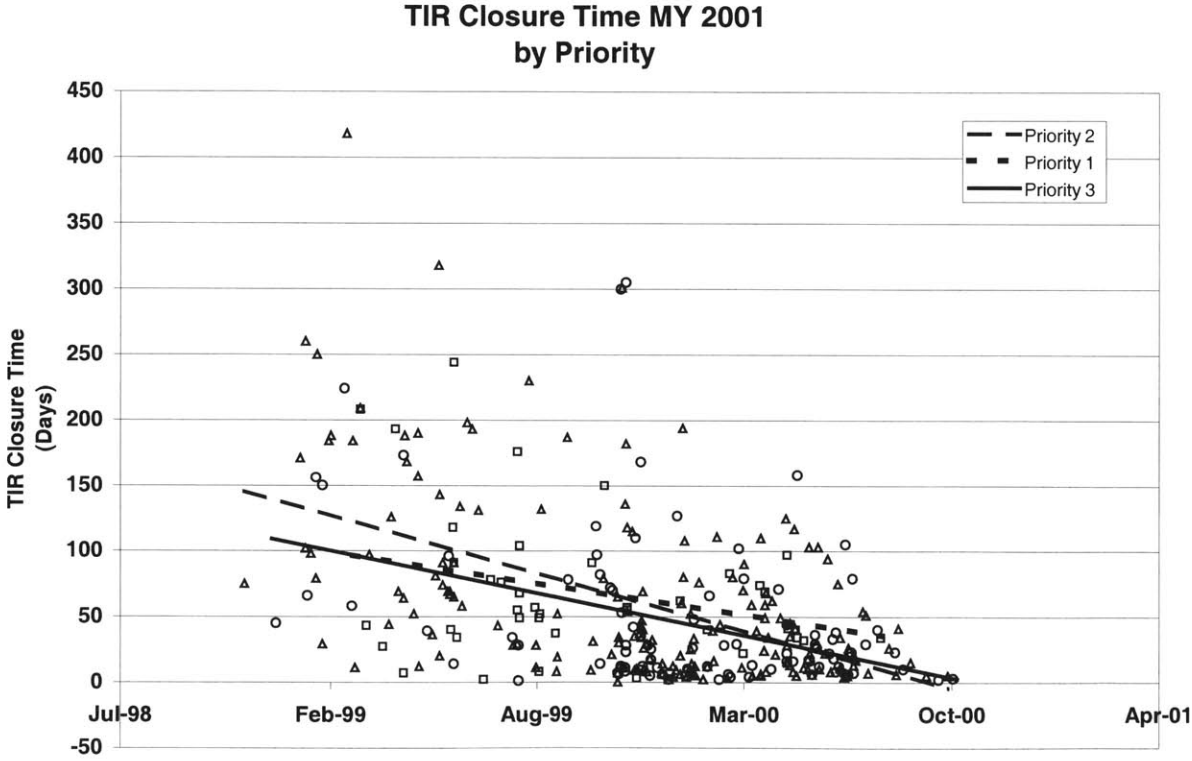

Exhibit 19 TIR closure by priority

(snapshot of data from October 2000)

44

Exhibit 19 takes the data in Exhibit 18 and breaks it down by priority level. Open TIRs are not shown at all on these charts. These plots show that the priority level does not significantly affect how quickly TIRs are closed. It would be expected that the priority 1 (highest priority) would be closed the fastest and Priority 3 the slowest. However, it takes longer for a Priority 2 TIR to close than a Priority 3 TIR. Regardless of priority, closure time improves as launch approaches. It is unknown if this effect is simply from fire fighting, or solving minor rather than major design issues (a rapidly maturing design). This data is consistent with data from the model year 2000 product development process launch assessment (Morrison).

Timing is not the only observation that can be made by digging deeper into the Pareto analysis in Exhibit 7. Other underlying themes that can be sensed from interviews deal with employee morale and the exuberance around launch, feelings on initiatives, and support for the methodology.

Interviewees were generally pleased with efforts to ready the production system for launch as well as cross-functional communication. This positive feedback is likely from two sources. The first is that it can be linked to the lighter than normal launch year. The second, and more likely reason, is that this is an indication that the product development process IS at least partly successful in streamlining early stages of product development AND it is set up to foster good communication. However, there is some frustration with 'too much process' because processes conflict or are viewed as busywork. Examples indicative of this are comments referring to PPAP ("Too much paperwork!") and multiple methodology conflicts.

Also, there is a sense that the effect of management decisions are not well understood or communicated before they are implemented. For instance, interviewees specifically questioned the decisions around outsourcing—it was felt that the decision was based not on logical strategic reasons but a desire to level load resources in a factory. Also, projects are "lobbed" into the product development organization by management without understanding negative ripple effects to resource and schedule requirements.

A constant refrain heard was 'Things are getting better." According to interview data, this could be an indication that certain initiatives are working in a positive way, and particularly ones that define major processes. Comments from interviews suggest that personnel believe this is due to

the structural system improvements that are being put into place by implementing major initiatives. While implementing key process initiatives (such as procurement, communication, and the methodology) has made progress, concerns still remain in the minds of interviewees. One reason is that employees see new processes put in place that either cost them more time with no benefit, or have a sense that things could work even more efficiently. Interview data indicates while many people are very happy with having a methodology to drive product development, others feel as if there is too much of it or would rather do without it.

There is some frustration around Company D's culture that encourages heroic effort. This stems from the survival mindset that developed in the 1980's. While interviewees expressed confidence in their ability to get designs out no matter how late the project, they also voiced appreciation for how key processes have simplified work effort. When dedicated employees get designs out the door no matter what obstacles are in their way, it is a sign of a powerful culture. However, heroic effort has a cost associated with it because it can have wasted effort in it. The causal loop diagram in Exhibit 11 also shows how efforts in getting today's designs launched can adversely affect next year's efforts. In addition, there is an intangible toll on employee's morale by working heavy overtime leading up to and during launch.

5. Assessing the Assessment Process

5.1 Introduction

The 2001 launch assessment was performed while assessing the assessment process itself in order to make it better. This was a activity separate from the assessment that served the purposes of the Product Development Office, the organization overseeing this assessment. The intent of this exercise was to optimize the established assessment norms by questioning key steps and assumptions behind the interviews and analysis. It is clear that there are problems with the assessment process in the way it is currently used. The characteristics that were focused on include feedback specificity, participant's attitudes about the assessment process, and the timeliness of broadcasting and acting upon the results.

5.2 Issues with the Current Methods

Open-ended, personal interviews produce high quality data because interviewees are asked for a complete data dump of anything that comes to mind concerning the product development process and launch. In addition, the fact that the interviews are conducted face-to-face emphasizes that the feedback is wanted and appreciated. The process enjoys high levels of support from senior leadership and management and workers in all the participating organizations. However, there are some unintended negative aspects to the current approach.

First, often comments aren't very specific as is desirable because interviewees cannot remember or know all the specific details that stimulated the thought. This makes it difficult to develop tactical plans to address particular concerns found in the interview data. For example, the average factory worker, who often does not understand all aspects of the design process, often can sense there was an informational breakdown somewhere but cannot specifically describe its source. Exhibit 20 is an attempt to map the model year 2001 data to specific methodology steps. It was created by taking each feedback data point from interviews and mapped by the author to one or more of the 54 steps in the current version of the methodology. The Pareto diagram does not have normalized data because this exhibit only is meant to demonstrate the concept of getting more methodology directed feedback. If the interview process could be directed toward

gathering performance data on each step in the design process, it becomes a powerful tool to fix steps that do not work and learn from the ones that work well.

Top Issues in Methodology Steps
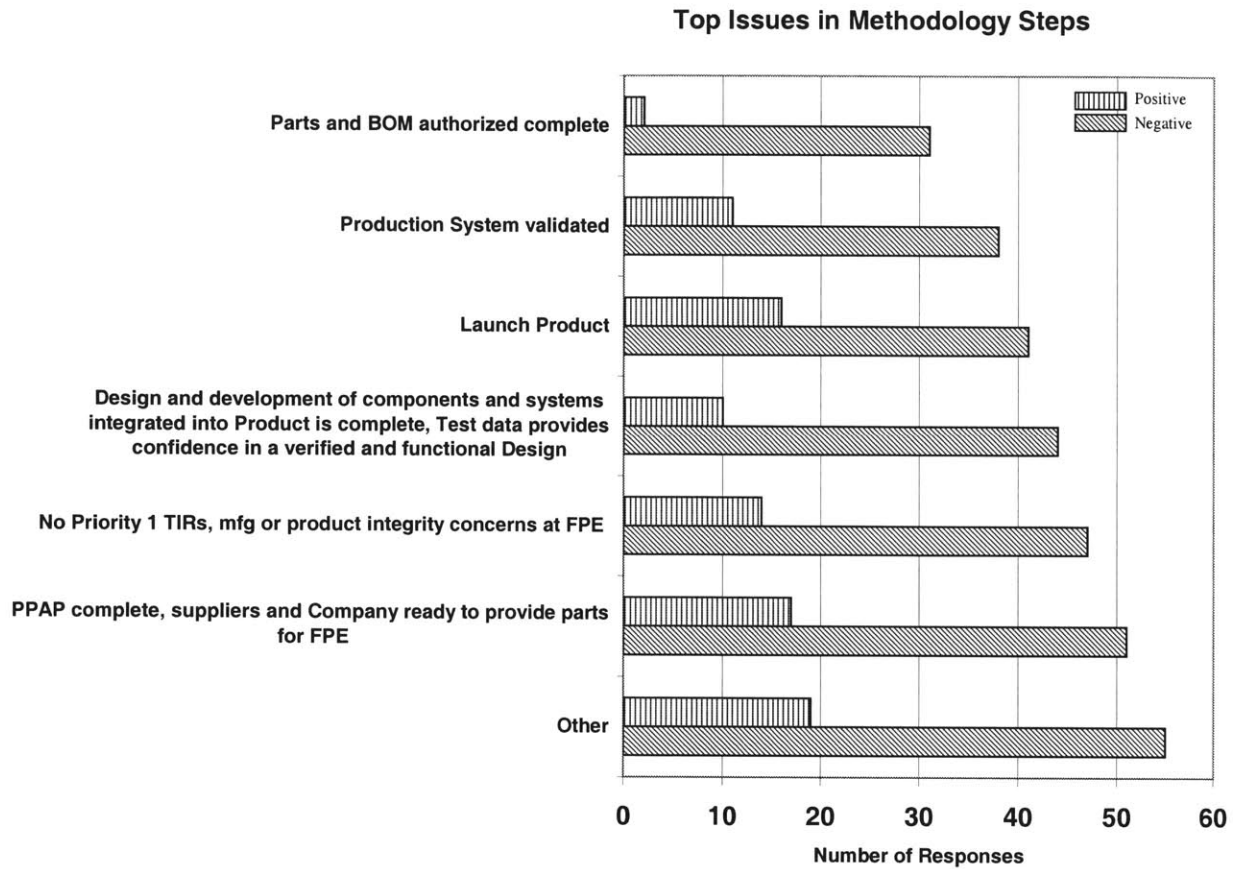
Exhibit 20 Feedback mapped to specific methodology steps

Exhibit 20 further demonstrates the power of mapping of interview data directly to specific steps in the methodology, because it shows that it is valuable to understand performance by phases. If positive or negative feedback can be traced to a process step everyone is supposed to do, it becomes easier to celebrate or attack the System, and not the people who come to work everyday and do the best they can do.

Top Issues in Phase 1

Top Issues in Phase 2

Top Issues in Phase 3

Top Issues in Phase 4

Positive
Negative
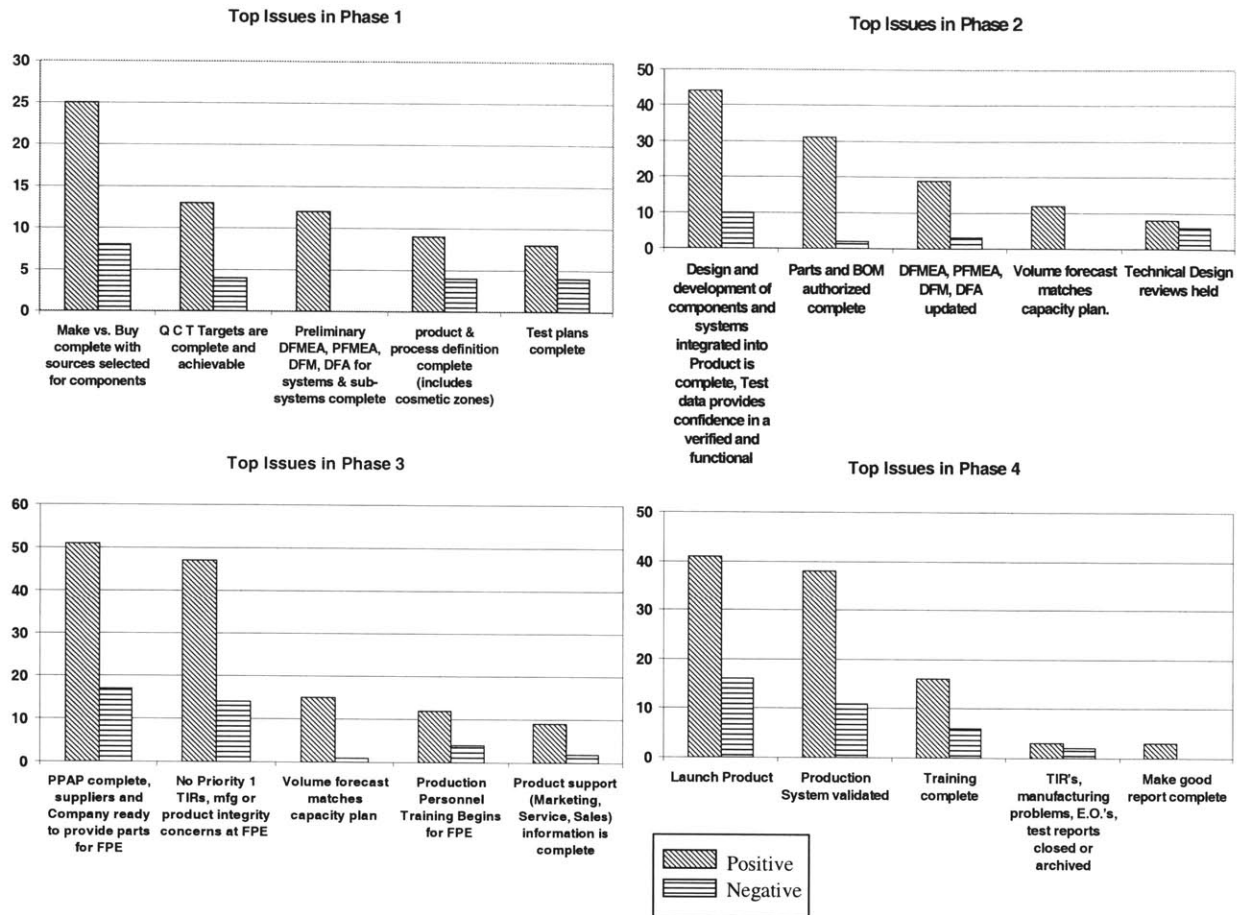
Exhibit 21 Feedback analysis of methodology Phases 1, 2, 3, and 4

Second, as the interviews were being conducted, many comments surfaced that displayed a high degree of cynicism around the assessment process itself. Other comments only imply a belief that he/she gives the same feedback year after year on obvious issues with no apparent reaction. Employees commented that they had given the same input a year ago and nothing has changed. Many others felt it was useless to participate because the assessment did not help them to be more efficient in completing this year's projects. Some people felt that the feedback was vague and nothing could be done with it.

A third issue is that interviewees remember very clearly what occurred around launch, but very little about earlier stages in the product development process. As a result, a significant chunk of the interview data is focused around Phase 3 of the methodology and launch itself. Exhibit 22

shows that comments that can be traced to specific methodology phases are heavily weighted to when the interviews occurred—immediately after Phase 3 and the start of Phase 4. Feedback from earlier phases is also less specific than feedback on later phases. Comments traceable to Phases 2 and 3 often referred to a particular event or feature of an engineer's design, while Phase 0 comments exhibited none of that kind of specificity.

Feedback by Phase
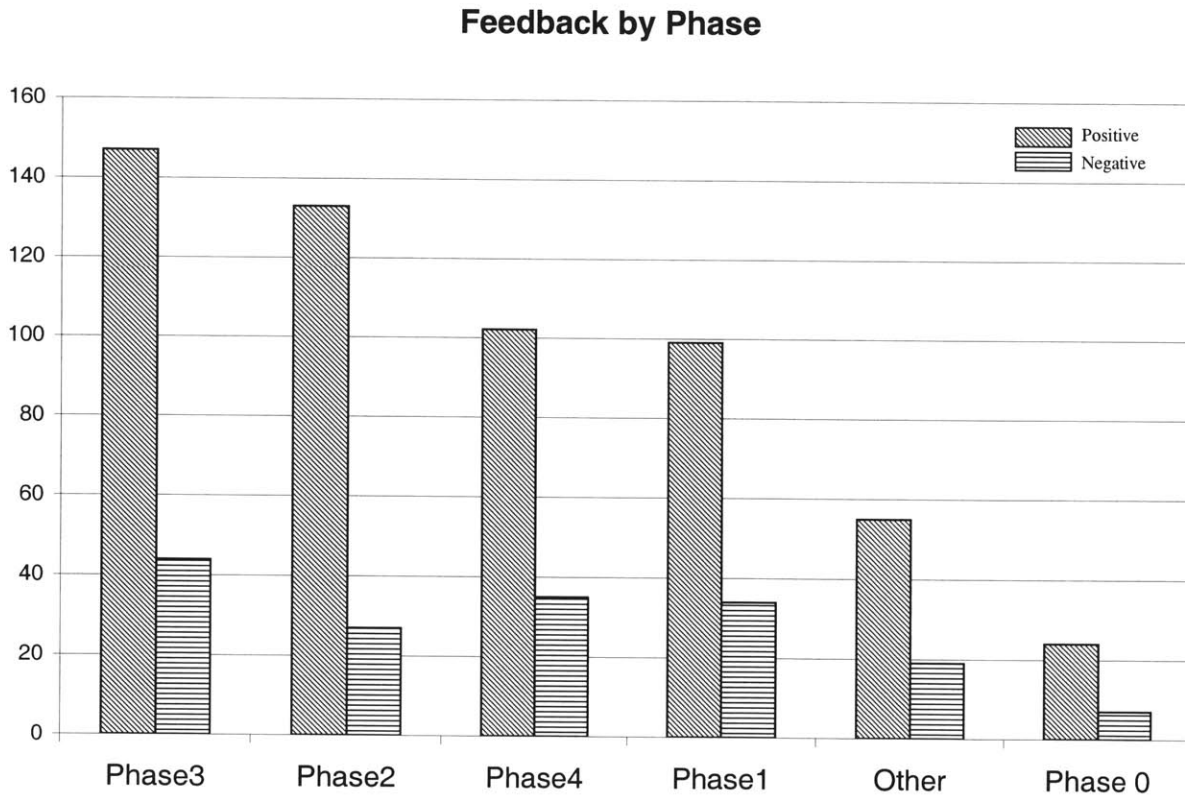
Exhibit 22 Interview feedback is heavily weighted toward the present

Fourth, conducting an assessment once a year limits the value of the feedback because it delays any action that can be taken from it. If experiments on the "system" can be performed and evaluated after each phase it would is possible to more quickly implement change. The 2001-year assessment process concluded interviews three months after the launch, and published the final report six months after the launch. In previous years this timeframe was a little longer. As a result, the earliest that any proposed initiative (originating in the assessment results) can be implemented at least seven months after launch and effectiveness evaluation at an even later date.

5.3   The Future State of Assessments

The key to any product development process assessment is possessing the ability to accurately pinpoint systemic problems. Employees generally do not try to make mistakes but are often forced to by the system. A general solution approach should involve a more timely and quicker feedback mechanism in order to speed up the process improvement cycle. In addition, the assessment process should be geared toward obtaining more specific feedback that allows the methodology to be improved upon. A key characteristic of future assessments should be to continuously and rapidly provide specific feedback at all levels of the product development process.

An available tactical option is leveraging the Company D Intranet in the feedback process. Web-based interviews by phase can be conducted anywhere the Intranet is available, and the web can act as the interface between users and a database. Questions can be constructed to mine information related to specific methodology steps, particularly if they are discovered (via an automatically generated Pareto diagram) to be a common issue. If questions are asked specific to methodology steps, responses will be forced to be specific. Drilling for even deeper detail on process steps that are clear successes or failures also becomes possible. A pilot web tool has been developed to be focus group tested, with the intent to develop it as an enterprise wide tool. Exhibit 23 depicts conceptually what this system look like.
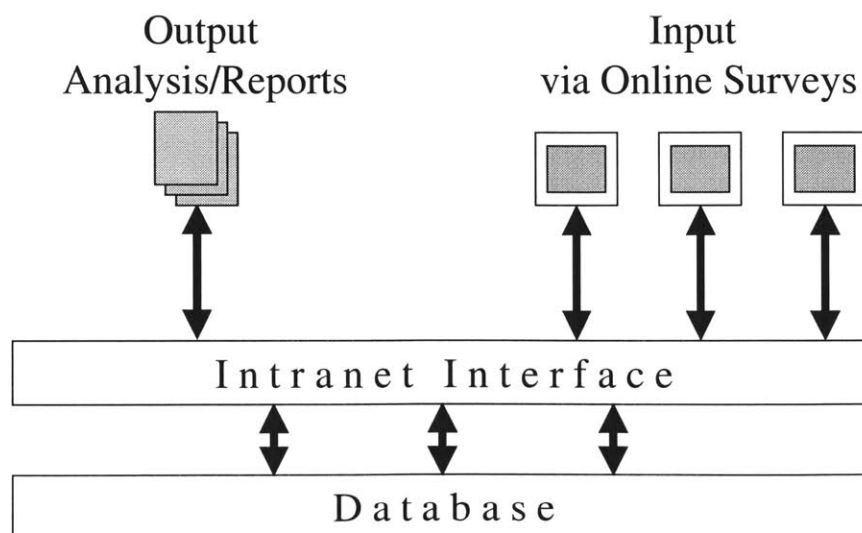

Exhibit 23 Online process feedback system

Once data is collected, the web interface can be programmed to produce standardized reports by phase and project at any point in time. Individual projects will be able to take corrective action based on feedback to that particular project and the phase that it is on. Product teams can react to issues specific to their platform. In short, deploying a web-based assessment process with methodology-specific surveys solves the current issues of timing and specificity.

While being able to obtain immediate and more precise feedback from participants in the product development process, an online, web based system does in fact have drawbacks that need to be considered. A move in this direction will significantly de-personalize the launch feedback experience and has the potential to de-motivate participants. The current process may be labor intensive, but participants have been sitting down with an outsider to the company and having personal, face-to-face discussions. Sitting in front of an anonymous computer screen to fill out a survey may have the effect of making the "interviewee" be less willing to impart as detailed information as previously. While for some people not having to share thoughts with another human will allow them to express thoughts more freely, others may not be willing to participate in the process at all. Conversely, an online system gives the survey administrator the ability to track how uniform organizational participation is and prod delinquents into action. Of course, this will raise privacy and anonominity issues to others. Given the historical evolution of the assessment process, implementing a system such as this will be a delicate matter.

6. Results and Recommendations

6.1 Summary of Results

Summing up the key issues that are discovered by the product development process assessment in light of Company D's company environment, we find the root issue is timing. Timing encompasses

- Correct sequencing of methology steps
- Allowing enough time to complete methodology steps
- Making information available when it is needed
- Avoiding lob-ins
- Establishing detailed project schedules with real dates
- Completing project schedule dates on time

It can be seen in performance data that from a timing standpoint, executing the product development methodology is not particularly successful, resulting in work piling up at the end of the entire process near the launch date. A second conclusion is that the themes in the data suggest that new initiatives can be proposed to address specific process issues. Third, the assessment process itself needs to be examined at and revamped into a more directed tool that delivers more timely data.

6.2 Leveraging New Knowledge

Three categories of recommendations that address the conclusions from the interview data are presented in this section. These recommendations will help moving toward predictable product development and future cycle time reductions.

6.2.1 Implementing Project Management Principles

Action needs to be taken to eliminate the timing issues in the product development methodology. Even in instances where the official sequencing of methodology steps is consistent with good product development practice, projects deviate from this standard, creating negative ripple effects across the product development organization. Currently the organization has no effective way to discretely understand and/or react to these ripple effects. The eventual consequence is that expected upstream effort accumulates in front of the launch week. Two specific actions can

defeat this problem--implementing a systematic project management process, and taking corrective action after regularly reviewing projects' progress. A re-examination of the Berkley model shows where Company D needs to go in order to increase its project management proficiency. Exhibit 24 lists characteristics of the first three levels of competency in the left column, and the right column explains tactical actions to move Company D up the competency ladder.

Level	Berkley Model	Implementing Project Management at Company D
1	Ad hoc • No formal PM procedures • Scope is poorly defined • Inferior cost estimating • Unsystematic PM data collection and analysis • Inconsistent use of PM tools	Organizational and Cultural Tactics • High level management sponsorship • Organization recognizes timing is the issue and PM is the solution • Create a Project Manager position and add support staff for project tracking and cost • Redefine current management job definitions to include PM expectations • Include PM in performance plans and reward structures • Bottom-to-top training and buy-in • COTS software strategy • Ground-level PM templates
2	Planned • Informal PM processes used • Some PM problems are identified but not corrected • PM processes are partially recognized and controlled by project managers • Individual planning/management of projects • More team oriented organization	Project Management Tactics • Implement a process to develop and manage scope and resources • Implement process to regularly analyze project interdependencies • Implement process for organizations to regularly negotiate schedule and resource commitments • Conduct weekly progress assessments at platform level with risk assessment • Conduct bi-weekly organizational level progress assessment and risk assessment
3	Managed • PM processes more robust • PM problems are formally identified and documented • PM-related data is collected for project managing/control • Trend data is shared by the project team throughout the project duration	Advanced Tactics • Product development is understood well enough to reduce cycle time • System integration is a core competency • Critical chain PM implementation

Exhibit 24 Moving up the Berkley Model Competency Ladder

To lay the groundwork for a project management system, organizational and cultural changes need to be tackled first. The exhibit describes changing the organization structure as well as training and communicating a greater organizational commitment to project management principles. After these changes are accomplished, new processes can be introduced to manage projects. The new processes would include breaking down project effort to more granular detail, allowing organizations to negotiate with each other to commit to timing of deliverables, and performing regular critical path and capacity requirements for each project. A continuous understanding of each project's load on each engineer can help avoid over-commitment of peoples' time. Good project management practice implementation would not only empower project managers to better control each individual project (per Company D's culture), but also permit a platform and an organizational rollup of project performance data.

It is important to recognize that implementing a project management system also requires management commitment to frequently review all the projects' progress. By doing so, the organization will be able to gauge its health at any point in time and adjust with real contingency plans to exit phase variances and provide data for predictive metrics. This requires a great deal of energy through weekly or bi-weekly organizational roll-up reporting meetings and the subsequent follow-up on contingency and risk plans. However, regular accountability reviews will uncover obstacles and create many small deadlines, working against the current mindset that "launch is the only deadline."

The benefits of doing this are enormous. Cost can be tracked more effectively, employment decisions can be justified more easily, management decisions (such as lob-ins) are better understood, global risk analysis and upstream work can be planned to be completed in a more timely way. Resource requirements can be negotiated and scheduled across participating organizations. If all organizations plan their work in a similar manner, there will be common ground from which to negotiate organizational effort and priorities. Also, critical path analyses will highlight and facilitate the elimination of the disjointed timing issues (making information available when needed, for example) that are now seen in the system. Eliminating timing and schedule difficulties will allow the organization to meet its goal of reducing product

development cycle time and allow it to consider using quicker development time as a strategic weapon.

Implementing project management principles is the logical next step in methodology implementation. Methodology has provided a degree of process standardization but cannot provide the timing rigor that is need to meet the organization's goal of becoming predictable and repeatable. These steps will also pave the way for advanced techniques, such as critical chain (Goldratt's theory of constraints) project management.

A difficult challenge is to implement this in a way that does not upset the Company D culture. The old command-and-control culture is gone, and a more self-directed work effort culture has replaced it. Giving engineers training, project management tools, and support to accomplish this at a working level (i.e., empowerment) is a momentous task. The company will then begin to value fire fighting not as a normal course of business, but only when it is truly necessary, and as a sign that things have gone wrong, not right.

6.2.2 Initiatives for Improving Processes

Many current initiatives are aimed at developing the essential structural framework in which we do everyday product development. The themes in exhibit 7 point out high-leverage process development areas. Design for Manufacturing is a high leverage area. DFM is currently justified as complete by calling a factory worker and asking if it is manufacturable—this is not the fault of any engineer but the fact that the methodology requirements are incomplete. Engineers are given neither a process nor training to accomplish true DFM requirements. An initiative implementing more rigorous DFM analysis will help stimulate greater factory involvement in the early stages of product development, and possibly facilitate the introduction of more factory workers into the formal platform structure among the engineers. The Pareto analysis in Exhibit 7 also suggests that people want continued effort on improving the methodology and PPAP process.

Implementing project management principles will have a positive complementary effect on process initiatives. As project management principles become firmly grounded in the

organization, the timing problems between testing, PPAP, and design and process validation can be solved, allowing initiatives aimed at these specific processes to perform better.

6.2.3 Refining the Assessment Process

The current assessment process is valuable and desirable but has flaws. For example, the most specific feedback as well as the majority of feedback relates to the end of Phase 2 through Phase 4. When an assessment is done once a year, it is hard for people to remember in specific detail what really occurred several months or years ago. Also, when analysis of the results is published, it is retrospective, and thus useless for midstream corrections for individual projects. Third, the current process is quite labor intensive. A more value-added approach as suggested in Section 5.3 is more instantaneous and less time-consuming. If projects can identify problems early in the design development process, corrections can be made immediately.

6.3   Future Research Topics

Implementing project management principles is difficult and has potential for creating material for future projects. For example, developing a model that maps the critical path of methodology steps from Phase 0 through the completion of Phase 4 would assist in finding low impact steps to consolidate or eliminate in order to shrink product development time. Another area to consider is how the organization and culture adopts PM principles and is impacted by them. At a future point, a pilot Critical Chain schedule (a project with no built in slack but has buffers at the end of the project) can be attempted to test its validity in the organization.

Specific processes also hold promise for future research. The testing process is especially interesting to try to examine why major design issues appear at launch. One approach is to compare actual test issue closure times with expected closure time. By segmenting this analysis by priority, type, and in particular, phase, it becomes possible to create a performance metric that works against the culture of "Launch is the only deadline!" For example, if TIRs that are expected to be solved in Phase 2 effort appear in Phase 4, there may be a systemic reason for the occurrences. Another possible research area is utilizing a platform level ongoing DFM process to study existing parts and assemblies for wringing out recurring cost across multiple platforms.

7. References

Burchill, G., and Brodie, C., "Voices into Choices," Joiner Associates, (1997).

Dettmer, H. W., "Goldratt's Theory of Constraints," ASQC Quality Press, (1997).

Goldratt, E.M., "Critical Chain," The North River Press, (1997).

Ibbs, C. W., and Kwak, Y.H., "Assessing Project Management Maturity," PM Journal March 2000

Ibbs, C. W., and Kwak, Y. H., "Calculating PM's Return on Investment," PM Journal June 2000

Kacandes, Peter. "Product Development Process Postmortem Assessment", Leaders for Manufacturing SM Thesis, June 1997.

Kendrick, J., "Studies Show TQM ups Revenues, Productivity," Quality; Wheaton; Dec 1993

McConnell, S., "Rapid Development," Microsoft Press, (1996).

Meredeth, J., and Mantel, S., "Project Management: A Managerial Approach," 3rd Ed., John Wiley & Sons (1995)

Morrison, C., "Product Development Process Assessment," Leaders for Manufacturing SM Thesis, June 2000

Paulk, M. C., "Capability Maturing Model in Software," Technical Report CMU/SEI-91-TR-24, Software Engineering Institute, Carnegie Mellon University (1991)

Senge, P., "The 5th Discipline," Doubleday, NY, NY (1990).

Shiba, S., Graham, and Walden "A New American TQM", The Center for Quality Management, Cambridge, MA (1993)

Smith, Preston G., "Your Product Development Process Demands Ongoing Improvement", Research Technology Management Mar/April (1996)

McGrath, M.E., "Revving Up Product Development," Electronic Business, Jan 1998

Sterman, J., "Business Dynamics: Systems Thinking and Modeling for a Complex World," McGraw-Hill (2000)

Ulrich, K., and Eppinger, S., "Product Design," 2nd Ed., McGraw-Hill (2000)

8. Appendices

8.1 Acronym List

COE	Centers of Expertise (functional groups)
COTS	Commercial Off The Shelf
DIB	Design Intent Build
FMEA	Failure Mode Effect Analysis
FPE	First Production Event (vehicle)
LCP	Life Cycle Plan
OE	Original Equipment
P&A	Parts and Accessories
PAR	Project Appropriation Request
PDL2T	Product Development Learning & Leadership Team
PDO	Product Development Office
PPAP	Production Part Approval Process
PPC	Product Planning Committee
PPG	Produce Products Group
QCT	Quality / Cost / Timing
QRL	Quality Reliability Leadership
TIR	Test Incident Report
CPPDM	Concurrent Product & Process Definition Methology

8.2 Project Size (BIN) Definitions

Bin 1--Consists of a project requiring up to 10k engineering man-hours and follows the Methodology process including timing. These projects are of small scope and are considered tactical updates to existing models or systems.

Bin 2--Is similar to a Bin 1 project in that the Methodology process is followed but not the timing. This would be a quick-to-market project to "fix" a market need. However since all methodology requirements (except timing) are met the risk is considered "normal".

Bin 3--Is similar to a Bin 2 project but does not follow the Methodology process (skips steps). The most important objective in a Bin 3 is timing. This would also be a quick-to-market project to "fix" something. However, since methodology requirements are not followed the risk is considered high.

Bin 4--Is a project requiring between 10k - 50k engineering hours and follows Methodology. These projects are considered derivatives of existing models, evolutionary, tactical and 1-3 years through development and launch.

Bin 5--Is similar to a Bin 4 project in that the Methodology process is followed but not the timing. This would be a quick-to-market project of a 10k - 50k hour scope to "fix" a market need. However since all methodology requirements (except timing) are met the risk is considered "normal.

Bin 6--Consist of large projects requiring 50k- 250k engineering hours. These projects follow Methodology, are considered breakthrough, strategic, grow the business and require more than 4 years through development and launch.

8.3   Pre-interview question list

Here are some questions designed to stimulate brainstorming and draw out your important feedback. What is on your mind about the year 2001 launch? Please write it down and bring it to the meeting or email Mike.Vanderwel@xxxxxxxxx.com if you wish to remain anonymous. Confidentiality will be maintained.

CPPDM / Phase

The launch--did you package product at the end of the day?

Were there a lot of quality problems? Missing parts? Why or why not?

Did you have all the parts you needed? Why or why not?

What problems were repeated from last year's launch?

Will the customer be satisfied? Why or why not?

Will it be easy to validate the production system?

Do you feel like there is enough capacity to handle the extra complexity from new variants?

Do you expect to continue to deal with many TIRs?

Were there Priority 1 TIRs open that interfered with launch? How?

Do you think the CPPDM methodology helped or hurt you to launch product? Why?

Did you feel you had enough involvement in the design process? Why or Why not?

Was testing completed far enough in advance? Why or Why not?

Were the designs finalized in time? Why or Why not?

Are there any new/changed processes as a result of this launch? Do they hurt or help?

Were you trained adequately for the launch year changes? Why or Why not?

Organizational Issues

Which departments delivered effective: 1) results 2) smooth hand-offs 3) timely feedback???

Did one department's way of doing business conflict with yours? Please describe.

CPPDM Macro process

<u>Process Administration</u>

--If you could change one thing about the CPPDM, what would it be?

--Were enough skilled people assigned to your team?

--Was the original project scope/plan the same by launch? Why or Why not?

--was the build volume what was originally forecasted? Did it cause specific problems?

<u>Design Reliability</u>

--Did the mockup process help? Why or Why not?

--Were technical design reviews effective? Why or Why not?

Product Support Service

--Is the marketing, service, and sales information complete and satisfactory? Why or Why not?

Was it completed in a timely manner? Why or Why not?

<u>Purchasing</u>

Were suppliers on board for the whole process? Why or Why not?

--Was PPAP completed far enough in advance of launch time? Why or Why not?

8.4 Summary of Themes

This explains the list of themes that emerged from the free flowing format of the interviews. Some of them overlap because as individual specific feedback emerged during interviews, the data was grouped under the following themes. The fact that interviewees came from a variety of geographical locations and functions caused different perspectives on theme definition.

PPAP/ procurement --This theme deals with the relatively new procurement process. It relates to internal and external part delivery process verification, in terms of processes and actual performance in implementation.

Production System preparation for Launch deals with taking the design from the design side of the house to the production floor. Achieving this involves understanding the intent of the design as described by released drawings and developing new processes and purchasing new fixtures or tools. It also deals with changeover issues and new employee training.

Cross-functional Communication--Communication needs to occur across functional organizations for any company to work properly. Comments with regard to design input, teaming, and informational meetings landed in this category.

Design issues--dealt with how designs affected the shop's process preparation as well as impacts to PPAP development.

System/methodology issues--This theme relates to feedback regarding specific methodology or process related comments. The feedback received in this theme also discusses issues that are not part of a current process or methodology.

Executing the launch--On launch day, many issues come up with respect to job changes and training, carryover issues, 'float,' quality issues, and part shortages.

Support Services--deals with service tech issues, dealer literature, cost targets, and marketing issues.

BOM accuracy / configuration mgmt.--Specific Bill of Materials comments regarding accuracy and completeness.

Testing--covers comments dealing with test plans and test execution at Test or in a lab environment.

Support --Certain organizations, particularly in the factory environment, directly support another organization's efforts in order to complete the job. For example, purchasing engineering supports the factory and engineering, and maintenance supports certain tooling changes.

Design for Mfg. issues--Comments dealing with a lack of design effort with an eye toward production requirements as well as difficult to manufacture parts.

Administrative problems--This theme primarily deals with resource planning, specifically insufficient resources.

Bad flowtime associated with design changes--Changes between builds and late designs can cause compressed process development times.

Quality/inspection procedures--deals with quality and inspection processes.

Training--Feedback indicates that computer, assembly processes, and diagnostics training was lacking.

Process Administration--This theme looks at the paperwork that is driven by methodology--from reviews, FMEA's, and fulfilling methodology.

Inadequate design definition--This theme is pretty specific to problems on the face of the drawing. Examples include tolerance problems and cosmetic zoning.

Build issues--deals with build quantities and build date coordination and execution

Drawing changes--is a theme that encompasses authorization issues.

8-day rule / handoff to mfg.--When the 8-day rule was violated, it fell into this category.

Shop conflict due to conflicting methodologies/communication--This theme covers communication of exit forms in addition to the shop/suppliers conflicts caused by multiple methodologies.

Part commonality (lack of)--This theme captures opinions that certain parts can be used across platforms.

8.5 Historical Comparisons of Themes

The table in Appendix A groups similar themes into each row. For instance, the first cell under the title '1999' contains all themes that deal with process and methodology. Each theme starts with a number that designates its level of importance for that year. On the left of the column are themes--thus, the first row deals with 'methodology.' This table is sorted by the 2001 launch year, and allows for a comparison between launch years. The top two issues in 2001 were methodology and procurement, followed by 'Production System preparation for launch' and design issues.

	1999	2000	2001
Methodology	2Not following methodology 6Missing needed development tools and processes 12Inadequate engineering information systems	2Not following methodology 9Inadequate engineering information systems 11Mfg/assy not involved with methodology steps 16Parts get through methodology that are not right 18Success for a project is based on a person not the process. 19Missing needed development tools and processes	1system/methodology issues 22Process Administration 17Shop conflict due to conflicting methodologies/communication
Procurement	15Weak purchasing processes and support	4Poor supply chain management 10Use of long-term rather than most qualified vendor 23Poor communication with suppliers.	2PPAP/ procurement
Process		21Current operations undermines new product development	3Production System preparation for launch 16training

Design Issues	4Design Instability 5Product Objectives changed	1Known problems are not resolved 20Not enough parts run during builds/tests	4Bad flowtime associated with design changes 5Design issues 8Design for Mfg issues 9BOM accuracy / configuration mgmt. 18inadequate design definition 19Drawing changes 21Part commonality (lack of)
Communication	3Information I needed I could not get 7Lack of communication between engineering and ____ 13Lacking integration of goals/organization/plans	14Lack of communication between engineering and ___	6Cross-functional communication 12Support
Staffing	1Low staffing, missing people 11Insufficient definition of roles and responsibilities	3Low staffing, missing people 7Engineering lacking proper skills/depth of expertise 12Insufficient definition of roles and responsibilities 13Lack of consistency of people during development	7Administrative problems--resource planning
	8Simultaneous transitions, taxing people, jeopardizing quality	8More engineering support for builds and launch	10Executing the launch 13Build issues--changing dates & numbers 14 8-day rule / handoff to mfg
		17Not enough incoming/outgoing parts inspection (part does not match print)	11Quality/inspection procedures
	9Testing late and testing resources insufficient	5Not enough what-if testing 15Testing late and testing resources insufficient 22Failures from testing are not acted upon	15testing
			20Support Services
	10Gap between vision for PD and what we really do 14No mechanisms to manage dependencies among projects	6Decisions are driven by emotion not data	