The Use of Process Metrics to Evaluate Product Development Projects

by

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Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for the Degree of

Master of Science in Engineering and Management

at the

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ABSTRACT

Product development success is an important strategic factor in today's business environment. The ability to accurately predict the outcome of product development projects would be a useful strategic tool. This research will use a product development process assessment survey called "Perform" to evaluate project success and also evaluates the effectiveness of the "Perform" survey. Two abilities of the survey are evaluated. The first is the consistency of the responses from different members of the development team. The second is the ability of the survey to predict the outcome of the project.

The survey is evaluated by applying the survey to two projects that have been completed. The results of each respondent are compared for consistency. The results of the project are also compared to the results of the survey to gauge the predictive ability of the survey.

Perform was found to provide fairly consistent responses from members of the development team. The survey did a good job of predicting project outcome.

Acknowledgments

I would like to thank Professor Warren Seering for all of his skilled guidance throughout this process. His involvement made this a very rich experience.

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1. Introduction

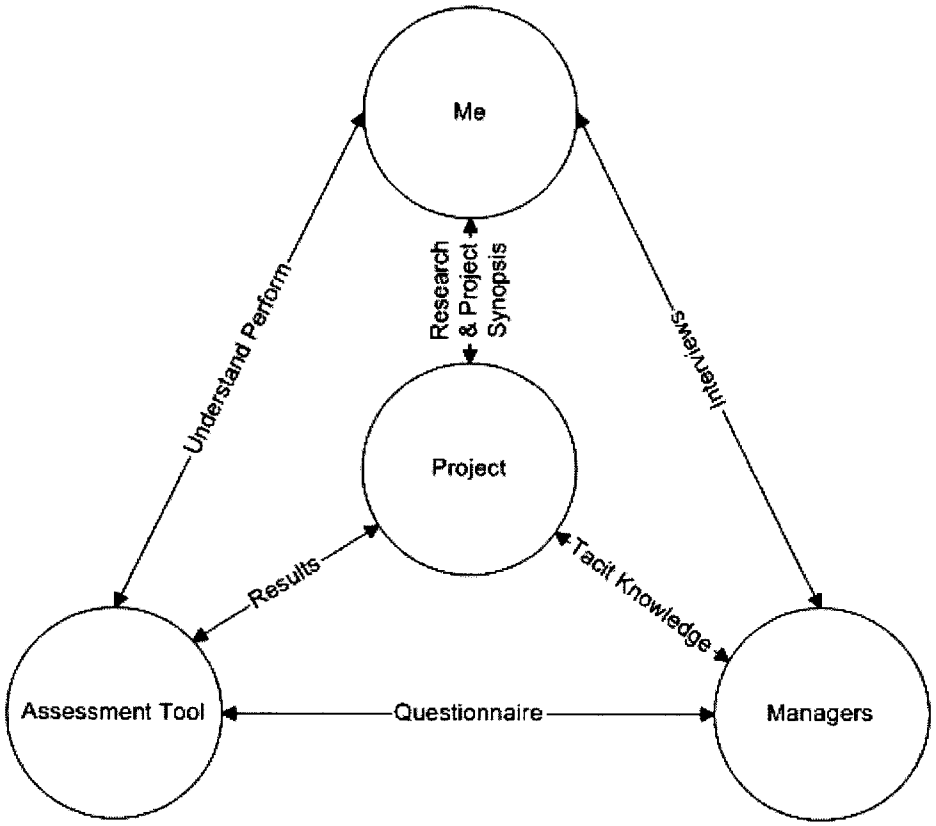
1.1. Objective of thesis

The objective of this thesis is to identify factors of product development projects that affect the outcome of the project. An assessment tool called "Perform" will be used to identify these factors. New product development is an important strategic concern of many companies. Developing new products is a very complex process involving numerous market, technical, organizational, financial and managerial factors. If the development of new products is improved, then companies can benefit from reduced development costs, faster time to market, and improved product quality. Product development capability measures can be useful to predict the outcome of development projects, to help make managerial decisions, and to improve development organizational structure. By identifying important product development success factors, an organization's development capability can be assessed and potentially improved. New product development projects vary widely from one to the next. The difficulty of using capability measurements is determining if the assessment tool is an accurate representation of the true success factors. If the correct factors are identified, then product development managers can use the factors as guidelines for successful completion of product development projects. This thesis will explore topics of both engineering and management as they apply to product development. The product development success factors represent the engineering concepts of creating a new product. How the success factors are applied and used within a development organization represents the management concepts. Assessing the projects and making recommendations on how to improve the assessment tool provides the engineering content of the thesis. Making recommendations on how to implement the results of the assessment tool within my development organization provide the management content of the thesis. The detailed case studies of two product development projects also provide both engineering and management content. The case studies require

identification, understanding, and evaluation of the engineering and management processes used in the projects. Specifically, I will attempt to calibrate the assessment tool they have developed by applying the tool to 2 development projects that have been completed by my company.

The approach to the research can be broken into 3 steps. First, I will create case studies of 2 projects. Secondly, I will perform an assessment of the projects by having the project managers complete the assessment questionnaire. Lastly, I will evaluate how well the tool assesses product development capability based on the results of the assessment and the case studies of the projects.

Framework Diagram



1.1.1. Outline of this Thesis

After the outline, the first section of the thesis is the literature review. In this section, existing literature is summarized and compared to the research in this thesis. The two case studies of the project and the description of the Perform survey are the next sections. The results of the survey are summarized and then analyzed. From the analysis, conclusions are created and recommendation on how to improve the projects and the Perform survey are made. Finally, the thesis closes with suggestions for further research in this area. The appendices include the raw data of the survey results and the survey itself.

2. Literature Review

2.1. Product Development: Past Research, Present Findings, and Future Directions

(Shona L. Brown and Kathleen M. Eisenhardt)

This article organizes the existing literature, creates a model of factors that affect product development success, and finally, suggests areas of future research. The main focus of the research is on the structures and processes that organizations use to develop new products. The existing literature is broken into three categories: rational plan, communication web, and disciplined problem solving.

The rational plan approach focuses on financial performance of the final product. The key idea of the rational plan is that success is derived from superior products in the appropriate markets delivered by a rational organization.

The communication web approach focuses on information processing and resource dependencies of market research. The key idea of the communication web is that success depends on internal and external communication.

The discipline problem solving approach focuses on problem solving strategies, deductive research and global industry. The key idea of discipline problem solving is that success depends on solving problems with discipline.

These three approaches to product development can be integrated into a single integrative model of product development. This model has three parts. The first is that the project team, leader, senior management and suppliers affect process performance. Secondly, the project leader, customers, and senior management

affect product effectiveness. Finally, a combination of an efficient process, effective product, and market shapes the financial success of the product.

This thesis relates to this research through the processes used in the Perform survey. Many of the processes contained within Perform align with Brown and Eisenhardt integrative model. Specifically, there is a similar focus on the financial performance of the final product, the use of information, and the roles of the project team and leaders to affect both the product and the process. The Perform survey also has questions concerning problem solving, but it is not a specific section. Perform also has the added focus on product delivery as an important product development process.

2.2. Benchmarking the Firm's Critical Success Factors in New Product Development

(Robert G. Cooper and Elko J. Kleinschmidt)

Cooper and Kleinschmidt use a benchmarking survey to improve the understanding of what leads to product development success. The survey uses ten performance measures that are reduced to the two dimensions of program profitability and program impact. The companies are then categorized based on the results of the survey to identify the companies that are good at product development. The processes that had the most impact on performance are:

- A high-quality new product process
- A clear, well communicated new product strategy for the company
- Adequate resources for new products
- Senior management commitment to new products
- An entrepreneurial climate for product innovation
- Senior management accountability
- Strategic focus and synergy
- High quality development teams
- Cross functional teams

The Perform survey has many process that align very closely with the important processes identified by Cooper and Kleinschmidt. These processes include a new product process, strategy, resources, management accountability and commitment, and high quality, cross-functional teams. Perform also has processes related to information and product delivery.

2.3. Further Evidence on the Validity of the Theoretical Models Underlying the Baldrige Criteria

(Barbara B. Flynn, Brooke Saladin)

The Baldrige criteria framework has changed over the years to update and improve the criteria. This study shows that the updates to the framework have been appropriate and have improved the criteria. The first question addressed is if there is empirical evidence to support the theoretical basis of the criteria. The second question asked deals with the weighting of each category. The Baldrige criteria was created in 1988 and stayed unchanged until 1992 when the framework changed the causal relationships between the categories. In 1995, an increased emphasis was placed on results. In 1997, a major change took place within the framework and the criteria to place greater emphasis on organizational strategy and organizational learning.

A total of five hypotheses are tested. The first hypothesis is that the path model suggested by the 1992 Baldrige framework will be a better fit than the 1988 model. The first hypothesis was strongly supported.

The second is that the path model suggested by the 1997 Baldrige framework will be a better fit than the 1988 of 1992 models. The second hypothesis was not supported.

The third is that the weights implied by the 1988 path analysis will approximate the weights specified in the 1988 Baldrige criteria. The third hypothesis was not supported.

The fourth is that the difference between the framework weights and the weights implied by the path analysis will be less for the 1992 Baldrige model than it was for the 1988 model. The fourth hypothesis was supported.

The fifth is that the difference between framework weights and the weights implied by the path analysis will be less for the 1997 Baldrige model than it was for the 1988 or 1992 models. The fifth hypothesis was not supported.

2.4. *An Empirical Investigation of the Malcolm Baldrige National Quality Award Causal Model*

(Darryl Wilson and David Collier)

The research has the following objectives:

- Test the theory and causal performances linkages implied in the MBNQA.
- Uses 101 questions tied to specific criteria in the MBNQA.
- Test the MBNQA performance relationships and causal models using comprehensive measurements and structural models.

The research uses a survey to measure the "content, philosophy, and intent" of the MBNQA. The survey's ability to assess the MBNQA is important in order to be able to draw conclusions. 101 measurements are used in the assessment tool.

The basic MBNQA theory is that "leadership drives the system that creates results". From this several hypotheses are created that proposed that certain activities predict certain outcomes.

The research yielded the following results:

- MBNQA criteria are consistent predictors of organizational performance.
- The theory that "leadership drives the system that creates results" is supported.

- The model presented here is an improvement in understanding the performance relationships in the MBNQA.
- The premise that the company leadership has direct impact on financial results is not supported.
- Leadership has an impact on process management.

The conclusion that is drawn from these results is that the performance relationships are useful to predict an organization's outcome, but could use some improvement particularly related to the financial results. The assessment tool that was used in this study was directly linked to the MBNQA criteria. A modified MBNQA model is proposed that better represents the importance of some of the MBNQA criteria. This study is the basis for a causal model based on the MBNQA criteria.

2.5. Improving Product Development Performance: Key Management and Organizational Factors.

(Ian Barcly and Zoe Dann)

Product development will be an important competitive factor to companies. Most of the continuous improvement involves internal assessment and external benchmarking. Given the differences in products and the confidentiality of business practices, external benchmarking can be difficult. A non-product specific 'taxonomy' could be developed to make benchmarking easier. Structural complexity and functional complexity were the two measurements used to evaluate product develop performance. Several structural complexity models existed, but nothing existed to measure functional complexity. By interviewing a number of product development professionals, the most important factors that affected product development were:

- Structural complexity
- Functional complexity

- Product newness
- Project complexity
- Commercial constraints

The following measures were developed to evaluate product development:

- Complexity measures
- Models of the NPD environment
- Performance measurement systems and metrics.

In the course of creating the performance measurements, models of NPD were identified to create the list of measurements.

The assessment tool that was created had four parts:

- Success criteria and performance
- Product complexity
- Integration activities
- Development process.

The research mainly addresses the results of the assessment tool as to what factors lead to product development success. The assessment tool seems to be sensitive enough to identify the important processes that lead to product development success. Given this ability and the fact that the assessment tool is easy to use, the tool appears to have some value.

2.6. Product Development Processes and Their Importance to Organizational Capabilities

(Bing Liu)

The objectives of this research are to:

- Provide a framework to determine the importance of product development processes and their relationship with organizational capabilities.
- Provide an assessment vehicle that helps organizations assess their capabilities and make improvement.

- Improve prediction of project outcomes.

The research fulfills these objectives by:

- Identifying important processes of product development.
- Identifying an organization's capability using important product development processes identified through literature and survey.
- Studying various factors that influence the determination of the importance of product development and the capability of product development.

A questionnaire was constructed by first reviewing the literature which produced 352 processes. These 352 processes were then combined into 140 processes to create the questionnaire.

The research methods used are to first identify important processes in product development and identify an organization's capability in regard to important product development processes. This is done through literature review, survey design, and data collection. The second method used is to study various factors that influence the determination of importance if product development, and study various factors that contribute to the capability of product development. The three factors that are investigated are company size, professional experience and company performance. The third method used is to determine the discrepancy of product development importance and the organizational capability by two hypotheses.

The first hypothesis is that a correlation exists between the importance of product development processes and the length of professional experience of those who participated in product development. This hypothesis was found to be true.

The second hypothesis is that process importance correlates to company size and length of professional experience. This hypothesis was also found to be true.

My research builds on this research very closely, especially in the areas of providing a framework to determine the importance of product development

processes and their relationship with organizational capabilities, providing an assessment vehicle that helps organizations assess their capabilities and make improvement, and improving prediction of project outcomes. Specifically, I will confirm that the assessment tool includes the proper product development capability factors that lead to successful product development, evaluate an assessment tool's ability to predict project outcomes, and evaluate an assessment tool's ability to evaluate an organization's product development capability.

3. Project Descriptions

A large amount of information was accessed to create these cases studies. Although a great amount of detail was available to characterize these projects, these project descriptions are just overviews that provide description relative to the survey and the specific research of this thesis.

The project descriptions will be used as a means to evaluate the Perform survey. By establishing a baseline characteristic of the projects, the results of the survey can then be compared to the projects as outlined in the descriptions. This comparison will then be used to assess the performance of the survey in terms of project characterization, consistency of respondent scores on the survey, and the ability for the survey to predict the outcomes of the projects.

3.1. Project A Project Description

3.1.1. Background

This project was initiated to deliver a new product to a number of specific regions. The scope of the project changed midway through the project to make the product a global offering. This change, in conjunction with project execution problems and unanticipated regularity requirements, resulted in a long development of a product that was eventually removed from the market shortly after it was launched. For the case study, the project will be broken into the following five phases:

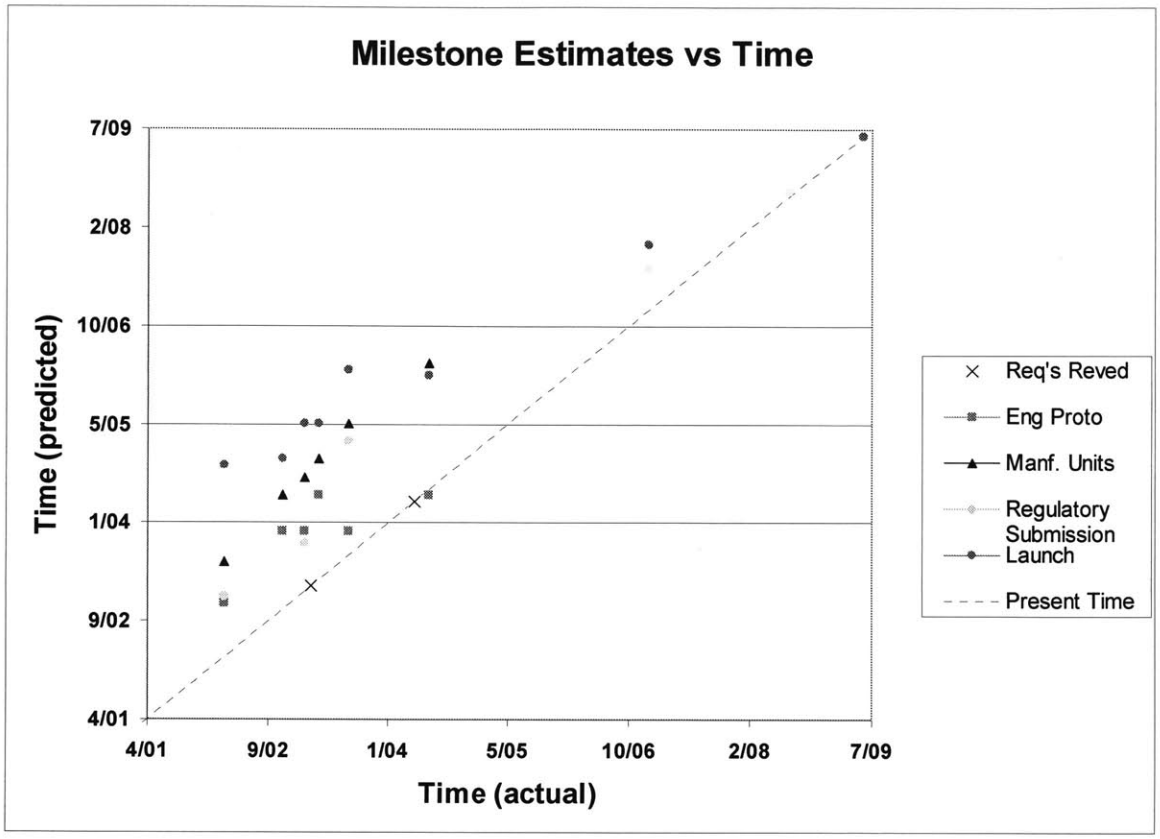
Proposal and Approval: Year 1 to 2
Scope One: Year 3 to 4
Scope Change: Years 4 to 5
Development: Years 6 to 9
Launch Years: 9 to 10

3.1.2. Overall Schedule

Over the course of the project, there were numerous scope changes and resulting schedule slips. The actual timeline was:

Project Proposals – Years 1 and 2
Project Approval – Year 3
Regulatory Approval – Year 8
Launch – Year 9

A summary of the milestone dates for the project is shown below.



3.1.3. Phase 1 Proposals and Approval

The first two years of the project were a time of product and project formulation. The activities in the first year addressed market trends and segments in different regions. This activity was conducted in June of year one by a team of the project leader, senior engineering and marketing employees, and consisted of a survey of the different regions to establish product needs for the future

A project proposal was made in September of the first year, but no funding was granted.

In June of year two, a task force was formed to assess the customer needs, propose technology and a device to meet these needs, and ultimately gain project approval by the New Product Committee. Early in year two, a preliminary requirements document was written that identified what requirements were to be in the first phase and what requirements were to be accommodated for second-generation development.

The preliminary Product Requirements were written in April of year two. This was an informal listing of requirements, with little specific information. Basically, it listed what features were to be included. There were five categories of features. Within each category there were three levels of requirements: include, include if time permits, and put in hooks for the second generations. The last level of requirement type indicates there was a vision or plans to create a second generation of machine, based on the new machine platform.

A design philosophy was written in March of year two by the technical project leader that emphasized the use of existing technology. Specifically, the existing product platform would be repackaged. There was also a desire for "ease of use". Basically the new product architect was to take the existing platform and technology and repackage it to make it easier to use. The schedule that was

proposed in the design philosophy was characterized as aggressive and could be met only if no mistakes were made.

The project was again proposed in August of year two. The project was not officially approved, but it received limited funding for activities in year three.

By early year three, the goals of the program were characterized as:
Improved User Interface
Superior Reliability
Ease of Service
Low Cost / High Benefit

3.1.4. Phase 2 – Scope 1

The next phase of the development is the initiation and early development. In February of year three, the project was officially approved and formalized. The goals for the product were Ease of Use, Reliability, and Low Operating Cost. The target markets were two specific regions. The requirements of the device were further developed, but still relied on the existing platform. The team structure was in place and the requirements were signed off on March of year four. The project was off to a good start with adequate staffing, budget and direction.

3.1.5. Phase 3 – Additional Markets

The original plan did not include a certain region as a target market, but in July of year four, the development team was approached by managers in this region about adapting the development for their use. A proposal was created, outlining time and cost to extend the project to include a version of the device for this region.
Early in year five, the development team was approached by a business group that was interested in a version of the device for their use. The requirements for

this business unit were very comprehensive and specific. As a result of these requested versions of the product, a single global product was decided upon. The effect of expanding the requirements needs to be considered. Given the additional range of requirements, the suitability of the original platform becomes questionable. In the end, the development team agreed to develop this single version of the product and the team moved forward with this goal.

3.1.6. Phase 4 - Development

Now that the different versions of the products had been resolved, there is a focus on executing the plan.

In addition to the change to make a single, global product, two other changes to the project were significant. The first was the addition of design control requirements by the FDA. This required a total re-vamp of the Product Development Process. This required new procedures, documents, validation and verification activities, and quality reviews. The second major change was the replacement of the project leader. The project leader not only was responsible for the project, but also insuring all of the new regulations were met. A new and comprehensive validation and verification program was also implemented to meet the new FDA regulations. The new program manager created a new schedule to reflect the recent changes to the program.

At the same time as these new changes occurred, there was a realization that the technology that was currently in use was not adequate to meet the requirements of a single global product and that the electrical systems and software would need to be upgraded. A large effort was made in years seven and eight to upgrade the software and electrical systems. Lack of clear operational requirements and lack of understanding of the current operation made this upgrade very difficult and tedious. The lack of operational understanding and the new regulatory requirements effectively caused the

development team to start the product development documentation from the beginning.

3.1.7. Phase 5 – Launch

The product was finally launched in June of year nine. Two months after the launch of the project, a software bug stopped production for several weeks until the problem could be fixed. The problem was eventually fixed, and production continued as planned with the product receiving relative success in the marketplace. Late in year nine, a competitor's product line was purchased and sold in competing marketplaces along with the product developed in this project. Eventually, the new product was more successful, so the production of the product developed in this project was halted in year ten, approximately one and a half years after launch.

3.1.8. Project Characterization

A number of factors affected the timely and successful launch of this product. These factors include:

- Changing focus from a regional product to a global product was a difficult adaptation.
- Basing the new device on existing technology presented technical difficulties late in the project.
- Late delivery created additional regulatory requirements that were not originally considered.
- Late delivery limited the strategic opportunities of the product.
- A lack of contingency planning allowed changes to the product to have a high impact on the schedule.

3.2. Project B Project Description

3.2.1. Background

This project was the first major platform upgrade to a very successful product that was originally launched five years prior to this project initiation. Design changes to electronics and mechanical systems where made to the original product to allow it to be marketed in additional global markets but nothing was done to change the core operation of the product. The project made major changes to software and electrical architecture as well as changes to the form factor to make it more distinct and modern. This project was a major feature upgrade to existing product requiring major software, electrical, and mechanical modifications.

3.2.2. Overview

Requirement – May, Year 1 to December, Year 1
Project Plan – December of Year 1
Sys Requirements – August, Year 1 to February, Year 2
Mechanical Design – July, Year 1 to April, Year 2
EE Design – July, Year 1 to May, Year 2
SW design – July, Year 1 to July, Year 2
Launch - January, Year 3

3.2.3. Project Initiation: May to June Year 1

The product concept was a result of the realization by the president of a regional business that there was a need to upgrade the existing product. The goal was to create additional functions similar to what was available in the other product lines. The president of the region gave the regional service center a small budget to develop a prototype in a "skunk works" fashion to prove the concept. Traditionally, this type of program would have been developed by the R&D

group, but since the regional president was the champion of the project, he worked with the local technical teams, even though they were not part of the R&D group. The prototype was completed successfully and was useful in advancing the program. The concept was still very rough, mainly demonstrating the technical value of the concept. More work would be needed in order to create a viable product concept. The project manager and engineering director of the R&D group took the technology idea and created a product concept that incorporated the new technology. The director of the R&D group presented the concept to the regional president and convinced him that the R&D group was the best-suited group to develop the product. The engineers that had developed the proof of concept in EU were comfortable handing over the project to the R&D group, since they realized they were not suited for a full product development program.

A design proposal was created in May of year one to illustrate the overall product architecture, the new added features, and the required product upgrades that would be addressed by this project. Even in the short and simplistic design proposal, the new features and product modifications were clear and very thorough. The design proposal was created by the R&D organization and mainly addresses the technical aspects of the project. The design proposal did not address marketing or manufacturing concerns such as the markets targeted nor the product rollout.

In early May of year one, the project leader created project milestones as shown in the milestone table.

The project was originally a regional product, but changed to a global product in June of year one. Global marketing requirements were to be completed by the end of June, year one.

Additionally, the requirement to change the form factor of the device was added in late year one. The result of the addition of this major requirement was an updating of the milestones. Some of the milestones slipped by one month, which was accommodated by the buffer, built into the project schedule, so the launch date did not slip. The plan for test market evaluations was changed, to allow for the product launch to stay on schedule, with only the test market evaluations slipping by two months. This reaction to the additional requirement showed good creativity and understanding of the product launch process that, in turn, prevented the additional requirement from causing a large schedule slip.

3.2.4. Requirements Development

Over the course of the project, four different marketing managers were assigned to the project. The first involvement of the marketing group was the creation of the regional marketing requirements. When the project changed scope from a regional project to a global project, a global marketing manager took over the marketing requirements development. This manager resigned and the development of the requirements was turned over to a third marketing manager. Finally, a fourth marketing manager took over the development of the marketing requirements. The marketing requirements were not first signed until January of year two, much later than had been planned. From the beginning of the project in early year one, the project manager had written marketing requirements to ease the development of the requirements because he knew it was a key part of the project. Once the project manager had written the marketing requirements, they were handed over to the marketing group, but the approval of the marketing requirements still took several months. The main reason for the delay in writing the requirements was the definition of a change to the form factor. The president of the regional business felt that a product feature upgrade also needed to have an updated appearance, so it was a major requirement for this region. Some of the regions felt that a new form factor would increase the cost of the product too much for their specific region. The financial analyses support the decisions to

make the form a factor change in all regions. While the decision about the form factor upgrade was being made, the development team moved forward with the electronic and software development, as those would be little affected by the form factor change.

The goal of showing a prototype at a trade show in April of year two forced a decision to be made to upgrade the form factor.

The late decision to make a change to the form factor put extra pressure on the industrial designers and mechanical engineers designing the housing. The late form factor requirement and the April deadline for the tradeshow stressed the mechanical design team. A lot of effort was put into the case, and the goal of showing the prototype in April of year two was met.

3.2.5. Project Execution

Staffing was a major issue with this project. The internal core team consisted of a project manager, electrical engineer, mechanical engineer, test engineer and software engineer. Other external groups included the applications software group to create an application to interface with the device, and software contractor that had originally written the software, and the industrial designer. The project manager not only had to co-ordinate these and other functional groups involved in the development, but he also acted as the systems engineer, designing and specifying the interaction between three modules of software and two modules of hardware. Clearly, this dual role of project manager and systems engineer was very taxing, and made coordinating the functional groups involved with the development difficult.

3.2.6. Initiation to Prototype

Late delivery of the planning documents was "not a big deal except for the marketing requirements". With the late decision to update the product housing to a new form factor, the mechanical design was the critical design item. Market forecasts and financial analysis were completed during the first phases of the

project as a tool to make the decision to upgrade the form factor of the device. The numbers were late coming to the engineering team, which affected the ability to make good design decisions.

3.2.7. Prototype to Test Market Evaluation

The basic product requirements were satisfied for the test market evaluation, but several desired features were not included that would be added before the launch in January of year three.

3.2.8. Test Market Evaluation to Launch

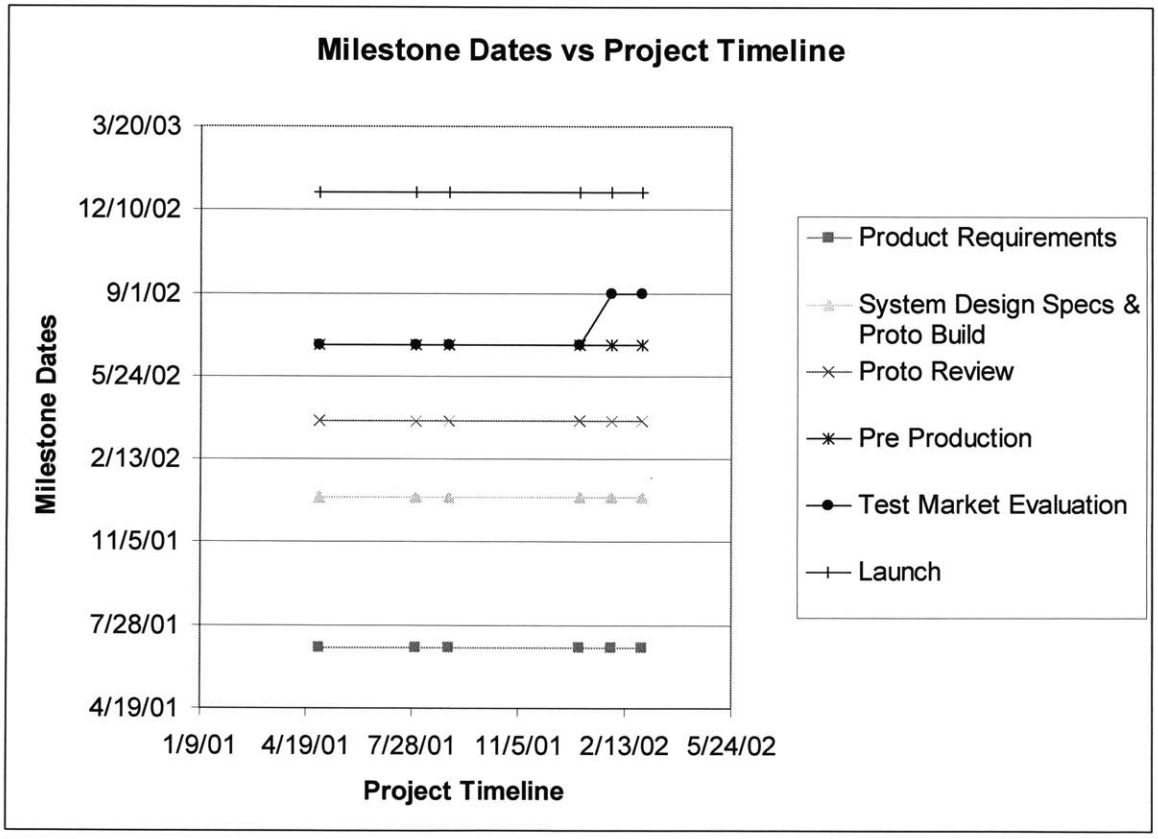
All functions were involved including manufacturing engineering and purchasing, but there was no formal transition group. The test market evaluation was completed on time with no major problems. Some hardware and software fixes were needed, but no major changes were required.

3.2.9. Post Launch

A significant amount of work went into the manuals after the launch of the product.

3.2.10. Milestone Summary Chart

The schedule was created early in the project and essentially handed to the project manager. The lack of marketing requirements made it difficult to schedule and budget the project, and with the addition of the form factor change, the schedule had to be revamped mid-project.



3.2.11. Project Characterization

Even though the project completed on time and the product has been successful in the marketplace, many factors made this achievement difficult for the design team. The project is characterized by the following points:

Late Marketing Information – Target market changed from European early in the project to a global product mid-project. A major requirement was added to change the form factor of the device well into the development.

Good Project Management Reactiveness and Flexibility – With the many changes and late requirements, the project was able to still complete with minimal slippage.

R&D took on too many of the activities. Instead of allowing the functional groups involved with the development to supply their input and deliverables, the R&D group tended to lead these activities and insured the functional groups were satisfied with the output.

The Project Manager was also the systems engineer leaving him overworked with little time to worry about managing the other functional groups involved with the development.

This project was also somewhat of a situation of a new technology looking for a product platform and a market. If the market needs had been investigated initially, the late changes may not have occurred.

4. Assessment Tool Description

4.1. Overview

Perform is a project assessment survey used to evaluate product development projects. The tool is a survey consisting of 75 questions that should be indicative of project outcome. Since this survey was applied to completed projects for this study, a section about results was included, in addition to the question about product development processes.

4.2. Origins

Kevin Otto originally created the Perform assessment survey. This original survey was included in Bing Lui's thesis. Upon the conclusion of Liu's thesis, Victor Tang worked to improve the Perform survey based on the results of Liu's thesis conclusions. A series of Language Processing exercises were performed to group the important processes identified by Liu. These processes were then compared with the processes included in the Perform survey to insure the Perform survey included the proper processes.

4.3. Sections

The Perform survey places the questions into eight different sections based on the question topic. This section groups the questions into similar topic and provides an overall organization to the survey.
The eight sections are:
1.0 Leadership
2.0 Organizational Culture
3.0 Human Resources
4.0 Information
5.0 Product Strategy
6.0 Project Execution
7.0 Product Delivery
8.0 Results

The Leadership section examines key characteristics of the project leader, power delegated, and whether there is a clear strategic direction for the project. The Leadership section specifically evaluates senior management clarification of strategic intent, project leader's experience, and the power delegated to the project leader.

The Organizational Culture section examines the extent to which management has considered and taken advantage of the established values and assumptions of the people to improve project outcomes. The Organizational Culture section specifically evaluates cultural change, teaming, and innovation.

The Human Resources section examines management's actions to improve the skills and the work environment. The Human Resources section specifically evaluates project core competency, multi-disciplinary staffing, training and education, and the work environment.

The Information section examines treatment of data and information as valuable assets, their quality, and the extent they are systematically collected, shared, and analyzed. The Information section specifically evaluates infrastructure and tools, and information analysis.

The Product Strategy section examines the product planning processes and extent to which they promote readiness for development and delivery. The Product Strategy section specifically evaluates strategic objectives, core concept, revenue planning, technology, and functional strategies.

The Project Execution section examines key issues of the product development processes. The Project Execution section specifically evaluates development process, responsibilities of team members, development, milestones and metrics, schedule integrity, and social responsibilities.

The Product Delivery section examines extent to which the project considers manufacturing, sales, service and support; or product "goes over the wall." The Product Delivery Section specifically evaluates Release to manufacturing ramp-up, Transition to sales, Organizational readiness for sales, and Product Complexity Results

The Results section examines the results of the project from multiple dimensions. These multiple dimensions are project financing and market results, project customer satisfaction and loyalty results, organizational effectiveness results, product results, and project benchmarking.

4.4. Methods

Each section has a series of questions related to the section topic. Each question is scored by the respondent completing the survey. Each question is scored on a scale of 1 to 7. The following guidelines are given for each level of score:

- "1" is not necessarily incompetence or worst performance. It gets the job done, albeit with weak results, or in a way you do not want to repeat.
- "3" reflects a competent practice or characteristic.
- "5" reflects an "outstanding" performance, but one that can be achieved with substantial experience, diligence, or training.
- "7" reflects an "exceptional" performance that is very hard to achieve and only a small subset are capable of reaching that level.

In addition to these high level guidelines, each question has a series of descriptive phrases above the 1,3,5, and 7 scores that characterize a score of a specific level. These phrases help to give specific guidelines in answering each question and reduce interpretation variation of the results.

4.5. Purpose

The purpose of the survey is to accurately evaluate a product development project according to several important development processes. By evaluating the project according to these development processes, an overall status of the project can be determined. The results can be used for many purposes including predicting the success of the outcome, identify areas of the project that are need to be improved to improves project success likelihood, and evaluate the effectiveness of the project leadership, to name a few.

5. Results

5.1. Perform Results for Project A

The complete Perform survey is attached for reference is appendix B.

5.1.1. Overview

The results of the perform survey are broken into the following sections:

1. Respondent Description
2. Survey Robustness
    a. Comparison between respondents
        i. Difference Analysis
            1. Average Difference
            2. Respondent Difference
            3. Questions with most difference
                a. Reasons for difference
        ii. Correlation Analysis
    b. Correlation between responses and results
        i. Overall
        ii. Sections

5.1.2. Respondent Description

For the first project, Project A, the project leader, the marketing manager, and I completed the Perform survey. The project manager came to the project about halfway through development and managed the project through launch. The project manager continues to manage new development projects. The marketing manager came to the project about one third of the way through the development though launch. The marketing manager has since left the company.

As the author of this thesis and the case studies, I also completed the survey based on my research on the project. My results to the survey will also be included in this analysis.

5.1.3. Survey Robustness

The purpose of this section is to summarize the Perform survey results from each respondent and determine how well Perform works in terms of response consistency, comparison to the case study and the prediction of the results of a project. The goal from the result will be to provide recommendations on how the Perform survey can be improved.

Comparison Between Respondents

The purpose of this section is to determine how consistently the respondents answered each question. In order to use Perform to accurately predict project outcomes, there needs to be consistency in the answers by the different people completing the survey. If there is a large difference between the score given to a particular question, this question may need to be improved or removed from the survey.

The comparison will be done in two ways. The first method is a difference analysis that will determine the differences in score between the respondents for each question. Within the difference analysis, two different differences will be analyzed. The first difference analysis is the Average Difference Analysis. This

analysis will compare each respondent's score to the average score for each question. The second difference analysis is the Respondent Differences. This analysis will compare each respondent's score to the scores of the other respondents.

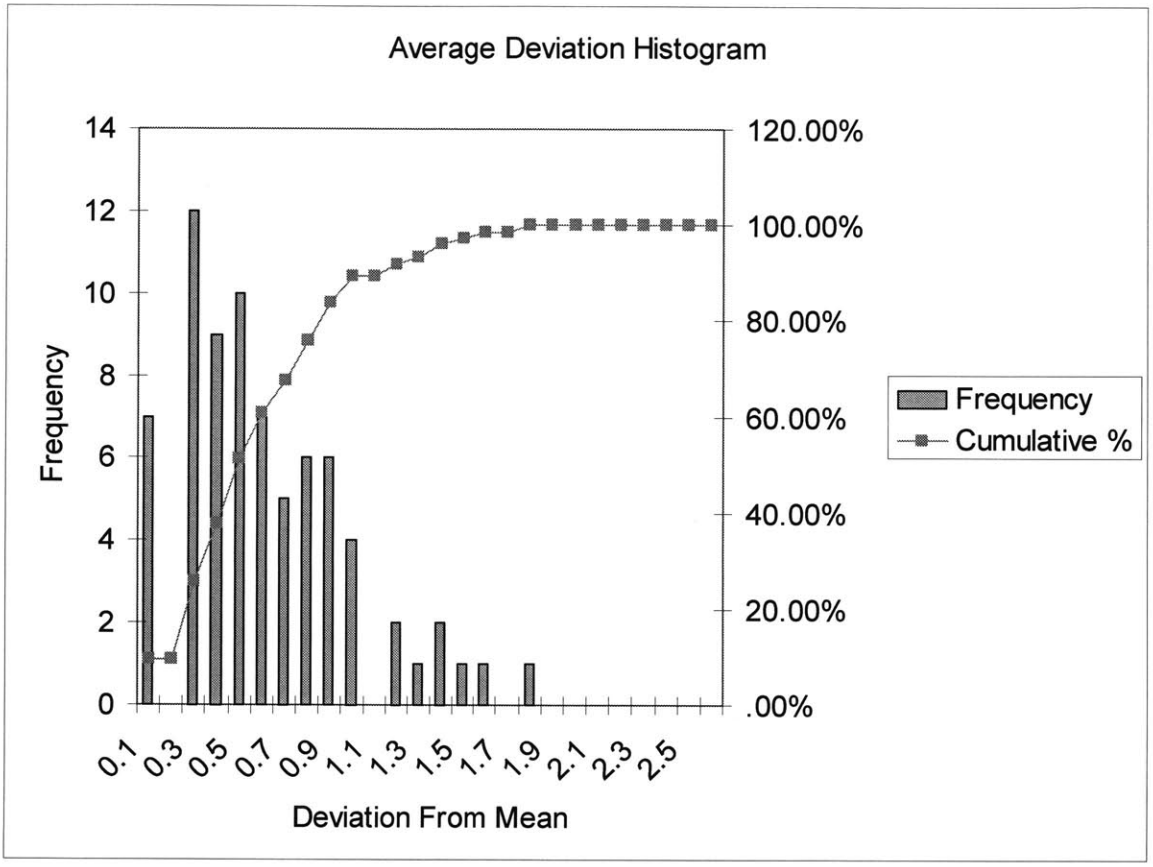
The results from these two difference analyses can be used to identify which questions had the least agreement from the respondents for further critique and improvement.

The second method is a correlation analysis that will determine statistically if the results of the respondents are significantly equivalent.

Average Difference Analysis

By calculating the mean score for each question and the corresponding difference from this mean by each respondent, the questions with the most variance can be identified. For this calculation, the difference from the mean score for each answer was calculated. The average of the differences was then taken to get an average difference for each question.

The following histogram illustrates the distribution of differences between each respondent and the mean.



There are eight questions that have a high level of difference that are of interest. These eight questions have differences of great than 1.1 from the mean score for the question. These eight questions are:

2.1.2 Cultural Change Management

4.2.2 Customer Satisfaction Data

5.5.1 Make Buy Decision

6.3.1 Prototype Plan

8.1.2 Product Volumes

8.1.6 Product's Market Share in Revenue

8.2.1 Customer Loyalty

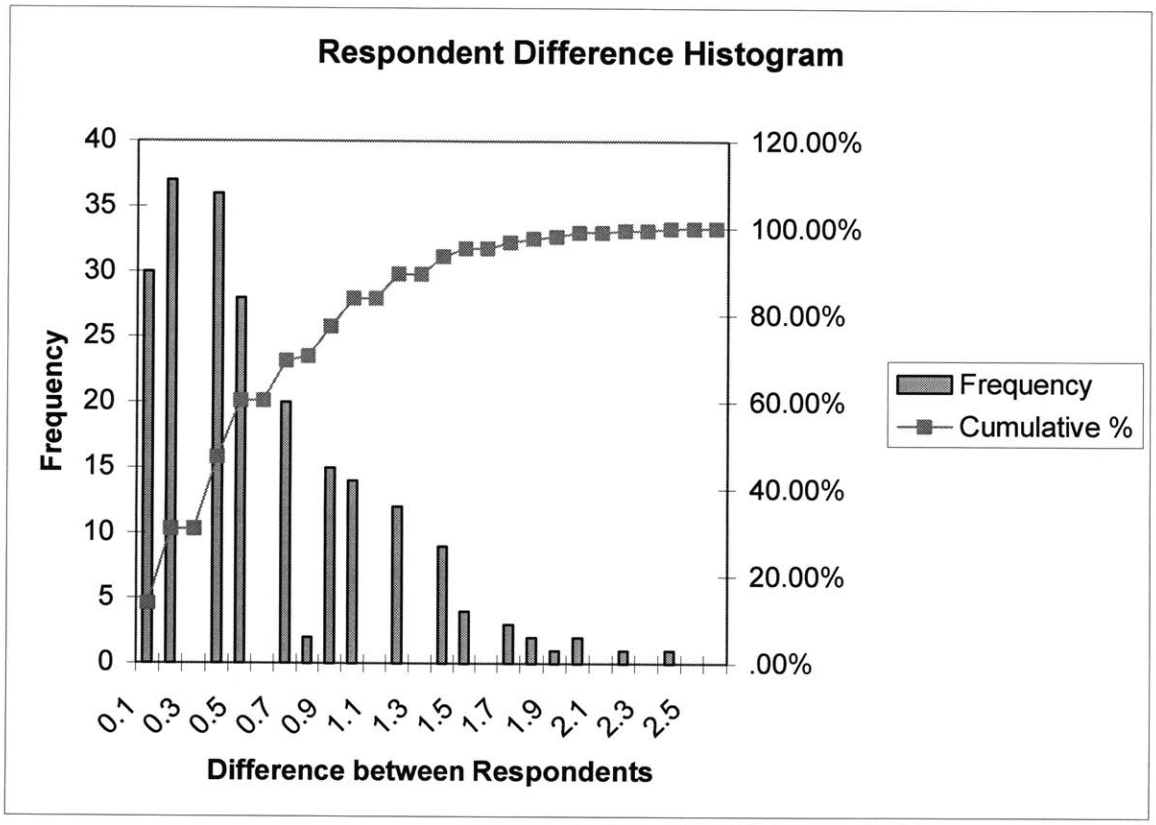
8.2.2 Satisfaction with Price for Value

These questions will be compared with the results of the Respondent Difference Analysis to select the final pool of questions with extreme difference.

Respondent Difference

By calculating the difference for each question between each respondent, the questions with the most variance can be identified.

The following histogram illustrates the distribution of differences between each respondent.



There are eight questions that have a high level of difference that are of interest. These eight questions have differences of greater than 1.6 from the comparison between respondents for the question. These eight questions are:

2.1.2 Cultural Change Management

4.2.2 Customer Satisfaction Data

5.5.1 Make Buy Decision

6.3.1 Prototype Plan

8.1.2 Product Volumes

8.1.6 Product's Market Share in Revenue

8.2.1 Customer Loyalty

8.2.2 Satisfaction with Price for Value

These eight questions are the same eight questions that were identified in the Mean Difference analysis

5.1.4. Questions with Most Difference

These eight questions had respondent differences greater than 1.6 and an average difference of greater than 1.1. In many cases, the difference was a result of the marketing manager scoring higher than the project manager and me. The actual differences and possible reasons for such high discrepancies are explored below.

Question	Me	Proj. Leader	Marketing	Mean	My Difference	Proj. Leader Difference	Marketing Difference	Avg Difference
2.1.2	1	4.5	2.5	2.67	1.67	1.83	0.17	1.22
4.2.2	3	5	6	4.67	1.67	0.33	1.33	1.11
5.5.1		4.5	1	2.75		1.75	1.75	1.75
6.3.1	4.5	4.5	1	3.33	1.17	1.17	2.33	1.56
8.1.2	1	1	4	2.00	1.00	1.00	2.00	1.33
8.1.6	2	1	4.5	2.50	0.50	1.50	2.00	1.33
8.2.1	1.5	1.5	4	2.33	0.83	0.83	1.67	1.11
8.2.2	2	1.5	5	2.83	0.83	1.33	2.17	1.44

Question 2.1.2: Cultural Change Management

My Score: 1

Project Manager Score: 4.5

Marketing Manager Score: 2.5

Description of Discrepancy

This question deals with the level of effort spent changing the culture to meet the needs of the project and company strategy.

Possible Reason for Discrepancy

This could be a temporal effect that the survey has a hard time dealing with. Overall, I saw little change of culture. The major attempt to make a cultural change was to bring in a new project manager, which is probably why he scored this higher than the marketing manager and me.

Question 4.2.2: Customer Satisfaction Data

My Score: 3

Project Manager Score: 5

Marketing Manager Score: 6

Description of Discrepancy

This question addresses the availability and quality of customer satisfaction data used by the development team.

Possible Reason for Discrepancy

The marketing manager scored much higher on this question, which is not necessarily surprising, given the fact that the marketing manager had closer ties to the marketplace than did the rest of the development team.

Question 5.5.1: Make Buy Decision

My Score: NA

Project Manager Score: 4.5

Marketing Manager Score: 1

Description of Discrepancy

The question addresses the process used to make the make buy decisions. I found these decisions to be somewhat ad-hoc, where as the project manager perceived more of a structured cross-functional approach.

Possible Reason for Discrepancy

Again the discrepancy is probably due to who had visibility within this activity. The project manager scored high on this because he was probably involved, if not directly responsible for making the make buy decisions. It is also a matter of the quality of decisions that were made. Even if a cross-functional team was involved in these decisions, many poor decisions could have been made that would result in a lower score.

Question 6.3.1: Prototype Plan

My Score: 4.5

Project Manager Score: 4.5

Marketing Manager Score: 1

Description of Discrepancy

This question addresses the consistency and robustness of the prototype plan.

Possible Reason for Discrepancy

I found the prototype plan to be fairly well defined and executed, even though overall project delays affected the schedule of the prototype builds. The marketing manager scored much lower, possibly because his expectations of what each prototype should contain were not met.

Question 8.1.2: Product Volumes

My Score: 1

Project Manager Score: 1

Marketing Manager Score: 4

Description of Discrepancy

This question asks if the product volume goals established at the beginning of the project were met.

Possible Reason for Discrepancy

For the time the product was on the market it may have met its volume goals, but the fact that it was replaced by a different model make it clear that the product was retired before it could meet all of its volume goals. This circumstance of the introduction of a product that displaced the product developed in this project was impossible to predict during the course of the project, so it was a matter if "the

product would have met the goals" if it were not for the mitigating circumstances of a different product introduction.

Question 8.1.6: Product's Market Share in Revenue

My Score: 2

Project Manager Score: 1

Marketing Manager Score: 4.5

Question 8.2.1: Customer Loyalty

My Score: 1.5

Project Manager Score: 1.5

Marketing Manager Score: 4

Question 8.2.2: Satisfaction with Price for Value

My Score: 2

Project Manager Score: 1.5

Marketing Manager Score: 5

For all of the above questions, the reason for the discrepancy is essentially the same. For the time the product was on the market, it had relative success. However, since the product was quickly displaced by another product, offering it did not meet many of its goals.

5.1.5. Correlation Analysis

A T-test can be used to determine the statistical correlation between the scores between the respondents. For this analysis, the results of two respondents are paired. A T-test is then run on each of the three pairs.

The T-test test is a hypothesis test for equivalency of means between paired data. The hypothesis is that the difference between the pairs of means is zero. Stated mathematically:

Ho = Mean difference of 0.

For this to be true using a 2 tailed analysis:

T Stat < T Critical and

T Stat > - T Critical

If theses criteria are met, then the hypothesis that the mean difference is 0 is true.

If these criteria are not met, then the hypothesis that the mean difference is 0 is false.

T-Test for Project Manager and the Marketing Manager

Project Manager and Marketing Manager

T-Test: Paired Two Sample for Means

	4	
Mean	2.794520548	2.821917808
Variance	1.186358447	1.509512938
Observations	73	73
Pearson Correlation	0.252499906	
Hypothesized Mean Difference	0	
df	72	
t Stat	-0.16469678	
P(T<=t) one-tail	0.434822082	
t Critical one-tail	1.666294338	
P(T<=t) two-tail	0.869644164	

Ho = Mean difference = 0

For Ho to be true:

t Stat < tCrit TRUE

and

t Stat > -tCrit TRUE

Significantly Equivalent

alpha (level of significance) = 0.05

T-Test for Project Manager and Me

Project Manager and Me

t-Test: Paired Two Sample for Means

	2	
Mean	2.462121	2.772727
Variance	0.987005	1.162937
Observations	66	66
Pearson Correlation	0.480075	
Hypothesized Mean Difference	0	
Df	65	
t Stat	-2.38301	
P(T<=t) one-tail	0.010052	
t Critical one-tail	1.668636	
P(T<=t) two-tail	0.020104	
t Critical two-tail	1.997137	

Ho = Mean difference = 0

For Ho to be true:

t Stat < tCrit TRUE

And

t Stat > -tCrit FALSE

Not significantly equivalent

alpha (level of significance) = 0.05

T-Test for Marketing Manager and Me

Marketing Manager and Me

t-Test: Paired Two Sample for Means

	2	
Mean	2.492537	2.843284
Variance	1.034034	1.516735
Observations	67	67
Pearson Correlation	0.301516	
Hypothesized Mean Difference	0	
Df	66	
t Stat	-2.14254	
P(T<=t) one-tail	0.017921	
t Critical one-tail	1.66827	
P(T<=t) two-tail	0.035842	
t Critical two-tail	1.996564	

Ho = Mean difference = 0

For Ho to be true:

t Stat < tCrit TRUE

And

t Stat > -tCrit FALSE

Not Significantly Equiv

alpha (level of significance) = 0.05

The project manager and the marketing manager are the only pair that is significantly equivalent. In both cases, my scores were lower as compared to the project manager's and the marketing manager's scores.

5.1.6. Predictive Ability of Survey - Correlation Between Survey Questions (Sections 1 through 7) and Survey Results (Section 8)

For this analysis, the ability for Perform to accurately predict the results of the project is examined. If Perform can adequately predict the results of a project, then the scores for the questions in sections one through seven should be similar to the scores for the questions in section eight. For this analysis, two topics will be investigated. The first is the ability for the survey as a whole to predict project outcomes. The second is to determine if certain sections align with the results of the project to insure the predictive ability for each section.

Predictive Ability of Overall Survey

As a whole, Perform does a very good job of predicting project outcome. The average of the scores of sections one through seven for all respondents was 2.92. The average score for section eight for all respondents was 2.27. This is a difference of 0.65, which indicates very good prediction of results. The respondent that indicated the worst predictive ability of the survey was the project manager that had a difference between predicted and actual results of 1.02. The respondent that indicated the best predictive ability of the survey was the marketing manager that had a difference between predicted and actual results of 0.21.

	Avg. All Respondents	Avg. of PM & MM only	Me Avg. Only	PM Avg. Only	MM Avg. Only
Sects 1 thru 7	2.92	3.02	2.70	3.14	2.90
Section 8	2.27	2.41	1.92	2.13	2.69
Difference of 1 thru 7 & 8	0.65	0.61	0.78	1.02	0.21

One must consider the fact that all were answered at the same time and it was a retrospective analysis. Would the survey predict as well if the project was not yet

complete? The fact that all of the scores were relatively low must also be considered. If the scores had been higher, more variation may have been seen.

Predictive Ability of Individual Sections

Most of the sections had an average score that was less than one number away from the average score of section eight. This indicates that all of the sections contribute equally to an accurate prediction of project results. The two sections that had the largest difference between the results section were the Human Resources section and the Product Delivery section. The mean score for all respondents for the Human Resources section was 3.20, giving a difference from the Results section of 1.02. The mean score for all respondents for the Product Deliver section was 3.36 giving a difference of 1.09. These larger differences indicate that these two particular sections may not predict the project results as well as the other sections and may not be as critical for project outcome. For example, the Product Delivery section may not affect the results for a project because it may be possible to have a good manufacturing transfer of the product even though the product was not appropriate for the market. So even though the manufacturing transfer went well, the product ultimately failed in the marketplace.

	Avg. All Respondents	Avg. of PM & MM only	Me Avg. Only	PM Avg. Only	MM Avg. Only
1.0 Leadership	3.06	3.17	2.83	4.17	2.17
2.0 Org. Culture	2.98	3.31	2.33	3.33	3.28
3.0 HR	3.29	3.13	3.63	3.13	3.13
4.0 Info	2.76	3.00	2.29	2.93	3.07
5.0 Prod Strat	2.95	2.98	2.88	2.79	3.15
6.0 Proj Execution	2.61	2.61	2.59	3.18	2.05
7.0 Product Delivery	3.36	3.44	3.17	3.25	3.63
8.0 Results	2.27	2.41	1.92	2.13	2.69
Difference of Sections 1 and 8	0.79	0.76	0.91	2.04	0.52
Difference of Sections 2 and 8	0.71	0.90	0.41	1.21	0.59
Difference of Sections 3 and 8	1.02	0.72	1.70	1.00	0.44
Difference of Sections 4 and 8	0.49	0.59	0.36	0.80	0.38
Difference of Sections 5 and 8	0.68	0.57	0.95	0.67	0.47
Difference of Sections 6 and 8	0.34	0.21	0.67	1.06	0.64
Difference of Sections 7 and 8	1.09	1.03	1.25	1.13	0.94

5.2. Perform Results for Project B

5.2.1. Overview

The results of the perform survey for Project B are broken into the following sections:

1. Respondent description
2. Survey robustness
    a. Comparison between respondents
        i. Difference analysis
            1. Average difference
            2. Respondent difference
            3. Questions with most difference
                a. Reasons for difference
        ii. Correlation analysis
    b. Correlation between responses and results
        i. Overall
        ii. Sections

5.2.2. Respondent Description

For this project the project manager, the engineering director, and I completed the Perform survey. The project manager was a senior engineer that applied for the job. It was his first formal project management job. The engineering manager managed the development group that developed this product as well as a number of other products. Before becoming a group director, this respondent had been the project manager for a product that had launched two years before the start of this project. As the author of this thesis and the case studies, I also completed the survey based on my research on the project. My results to the survey will also be included in this analysis.

5.2.3. Survey Robustness

As was stated in the analysis of Project A, the purpose of this section is to summarize the Perform survey results from each respondent and determine how well Perform works in terms of response consistency and prediction of the results of a project. The goal from these results will be to assess the consistency and prediction and provide recommendations on how the Perform survey can be improved.

Comparison Between Respondents

As was stated in the analysis of Project A, the purpose of this section is to determine how consistently the respondents answered each question. In order to use Perform to accurately predict project outcomes, there needs to be consistency in the answers by the different people completing the survey. If there is a large difference between the score given to a particular question, this question may need to be improved or removed from the survey.
The comparison will be done in two ways. The first method is a difference analysis that will determine the differences in score between the respondents for each question. Within the difference analysis, two different differences will be analyzed. The first difference analysis is the Average Difference Analysis. This analysis will compare each respondent's score to the average score for each question. The second difference analysis is the Respondent Differences. This analysis will compare each respondent's score to the scores of the other respondents.

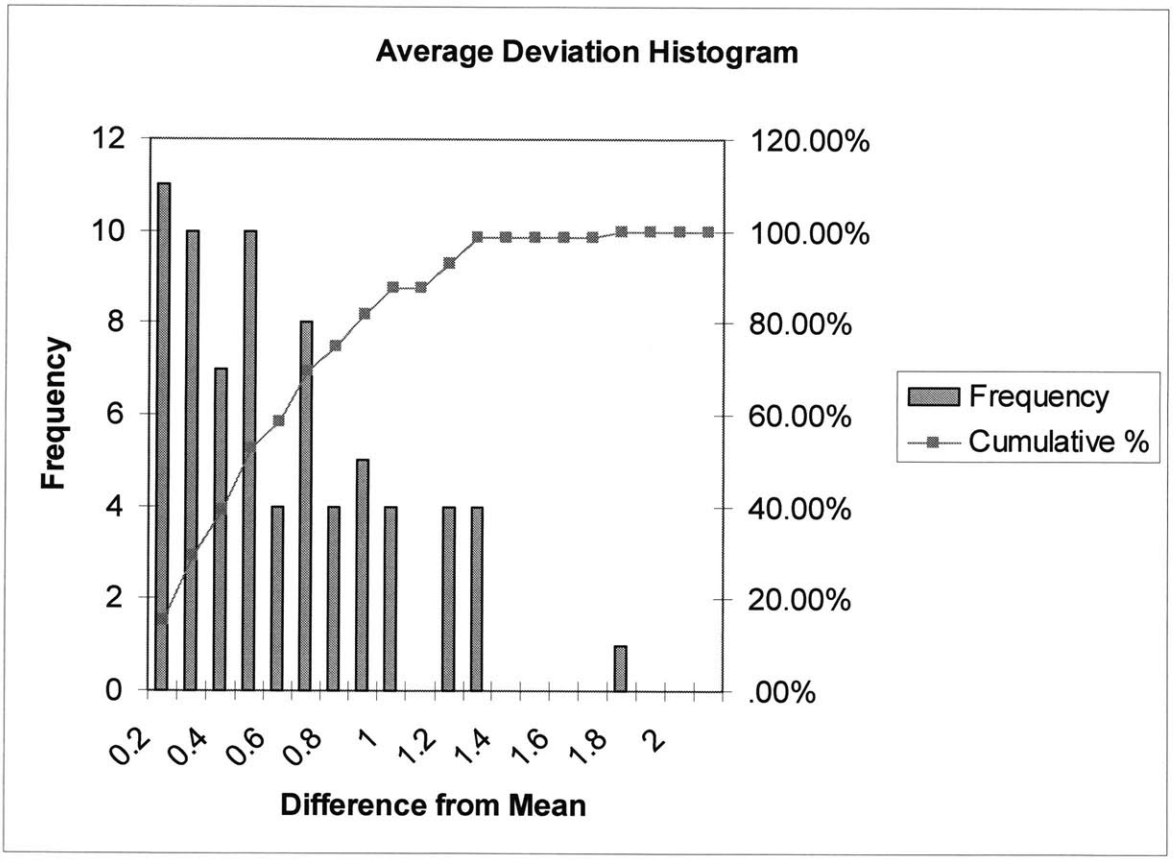
The results from these two difference analyses can be used to identify which questions had the least agreement from the respondents for further critique and improvement.

The second method is a correlation analysis that will determine statistically if the results of the respondents are significantly equivalent.

Average Difference Analysis

As was stated in the analysis of Project A, by calculating the mean score for each questions and the corresponding difference from this mean by each respondent, the questions with the most variance can be identified. For this calculation, the difference from the mean score for each answer was calculated. The average of the differences was then taken to get an average difference for each question.

The following histogram illustrates the distribution of differences between each respondent and the mean.



There are nine questions that have a high level of difference that are of interest. These nine questions have differences of greater than 1.1 from the mean score for the question. These nine questions are:

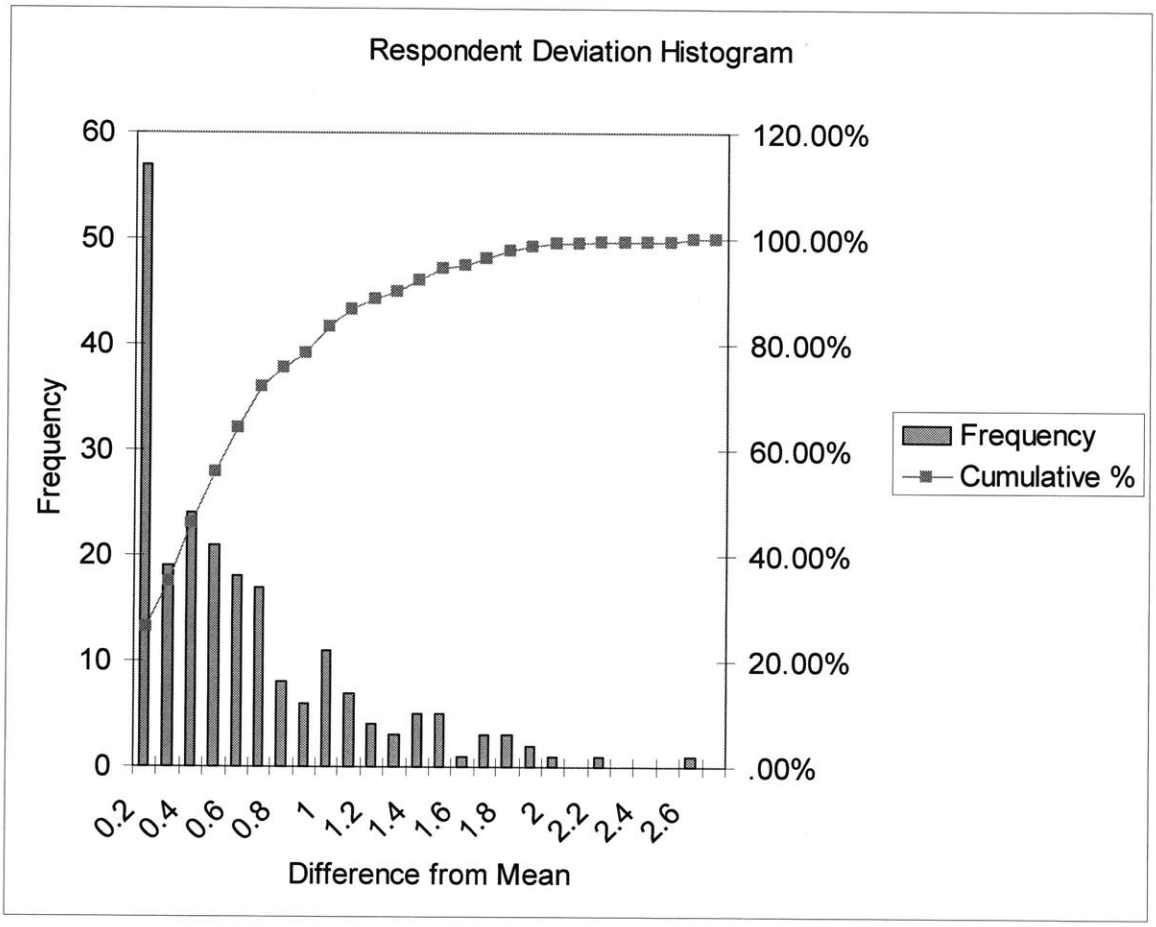
2.1.1 Leveraging organizational culture
4.1.2 Reuse of physical and design assets
5.1.2 Portfolio of product opportunities
5.2.2 Product architecture
5.4.2 Technology readiness
5.5.2 Product service processes
6.4.2 Project financial goals
7.2 Transition to sales
7.3 Organizational readiness for sales

These questions will be compared with the results of the Respondent Difference Analysis to select the final pool of questions with extreme difference.

Respondent Difference

By calculating the difference for each question between each respondent, the questions with the most variance can be identified.

The following histogram illustrates the distribution of differences between each respondent.



There are six questions that have a high level of difference that are of interest. These six questions have differences of greater than 1.7 from the comparison between respondents for the question. These six questions are:

4.1.2 Reuse of physical and design assets

5.1.2 Portfolio of product opportunities

5.4.2 Technology readiness

5.5.2 Product service processes

6.4.2 Project financial goals

7.3 Organizational readiness for sales

These six questions are contained within the nine questions that were identified in the Mean Difference analysis

5.2.4. Questions with Most Difference

These nine questions had an average difference of greater than 1.1. In many cases, the difference was a result of me scoring higher than the project manager and engineering director. In some of these situations, I probably scored high based on my limited project exposure given my retrospective analysis. In other cases, I believe the difference shows areas of the organization that could be improved. The actual differences and possible reasons for such high discrepancies are explored below.

Question	Me	Proj. Mang.	Eng. Dir.	Mean	My Difference	Proj. Mang. Difference	Eng. Dir. Difference	Avg. Difference
2.1.1	5	2	4.1	3.70	1.30	1.70	0.40	1.13
4.1.2	6	2.5	4.4	4.30	1.70	1.80	0.10	1.20
5.1.2	6.5	3.5	1.8	3.93	2.57	0.43	2.13	1.71
5.2.2	5.5	3.5	2.4	3.80	1.70	0.30	1.40	1.13
5.4.2	5.5	5	2.5	4.33	1.17	0.67	1.83	1.22
5.5.2	6	3.5	2.8	4.10	1.90	0.60	1.30	1.27
6.4.2	5	2	2.2	3.07	1.93	1.07	0.87	1.29
7.2	5.5	3.5	2.5	3.83	1.67	0.33	1.33	1.11
7.3	5.5	3.5	2.2	3.73	1.77	0.23	1.53	1.18

Question 2.1.1: Leveraging organizational culture

My Score: 5

Project Manager Score: 2

Engineering Director Score: 4.1

Description of Discrepancy

This question addresses how well the project matches the organizational culture and strategy.

Possible Reason for Discrepancy

Since the project was an upgrade to an existing product, I felt the project fit the existing culture quite well. This discrepancy may stem from the origins of the project and the technology that was used.

Question 4.1.2: Reuse of physical and design assets

My Score: 6

Project Manager Score: 2.5

Engineering Director Score: 4.4

Description of Discrepancy

This question addresses the amount of re-use of product architecture to establish a product platform. Given this product was built on an existing architecture I scored this question very high.

Possible Reason for Discrepancy

This is an instance where I believe the project manager and engineering director scored too low. Possible reasons for their low scores are, first, that even though the product had similar architecture, the advantages of having a platform were not captured. Secondly, there was no overall planning for this product platform during this project or previous projects. The fact that this project used an existing architecture was done out of convenience.

Question 5.1.2: Portfolio of product opportunities

My Score: 6.5

Project Manager Score: 3.5

Engineering Director Score: 2.8

Description of Discrepancy

This questions addresses product portfolio planning. I scored this question high given this was a platform product and that a number of financial scenarios were done when trying to establish the product design.

Possible Reason for Discrepancy

The reason for the low scores from the project manager and the engineering director may be due to the fact that the financial scenarios were done too late in the project as a way to finalize the requirements. So even though the correct activities were done, they were done as an afterthought as opposed to up front strategic planning activities.

Question 5.2.2: Product architecture

My Score: 5.5

Project Manager Score: 3.5

Engineering Director Score: 2.4

Description of Discrepancy

This question addresses how the product architecture relates to product strategy.

Possible Reason for Discrepancy

I found the product architectures to leverage existing company capabilities, product offerings and brand. Even though the product was built on an existing platform, this platform was not originally designed to be upgraded. Since the original design was not planned for this upgrade, the technical changes were difficult.

Question 5.4.2: Technology readiness

My Score: 5.5

Project Manager Score: 5

Engineering Director Score: 2.5

Description of Discrepancy

This question addresses the level to which the technology was developed and ready before it was applied in a product development project.

Possible Reason for Discrepancy

Even though the technology had been prototyped, there may have been problems with the technology during development or the technology originally specified was improper for the actual product application. For example, even thought the functional capability was demonstrated, it was accomplished with the wrong technology. Also only the product function may have been investigated with little consideration of manufacturing or service.

Question 5.5.2: Product service processes

My Score: 6

Project Manager Score: 3.5

Engineering Director Score: 2.8

Description of Discrepancy

This question addresses the level that service was considered during development. Given this project was an upgrade, the existing service infrastructure was considered to insure the new product would align with the existing infrastructure.

Possible Reason for Discrepancy

This discrepancy could be due to a problem seen throughout the project in which the R&D group led the development activity of other groups. Instead of having clear roles and involvement from other functional groups, the R&D group often took responsibility of the activities in other functional groups and then got the other functional groups involved to insure all of their issues had been addressed.

So even though these activities were done, it was a matter of the limited level of involvement by the other functional groups.

Question 6.4.2: Project financial goals

My Score: 5

Project Manager Score: 2

Engineering Director Score: 2.2

Description of Discrepancy

This question addresses the financial analysis and goals during the development. There was a great deal of financial analysis in evaluating design decisions.

Possible Reason for Discrepancy

Two possible reasons for this discrepancy is who did the financial analysis and when was it done. Again, this may have been a situation where the R&D group took the lead on the financial analysis and insured that all of the financial issues were addressed. Secondly, the financial analysis was done in the middle of the project when tough design decisions were being made. If the financial analysis had been done during the beginning of the project, perhaps these decisions would have been easier to make.

Question 7.2 Transition to sales

My Score: 5.5

Project Manager Score: 3.5

Engineering Director Score: 2.5

Description of Discrepancy

This questions addresses if the product was ready for sale when it was launched. Early prototypes were shown at trade shows before launch. A test market evaluation was conducted before launch.

Possible Reason for Discrepancy

The reason for this discrepancy could be attributed to the level the product was developed when it was shown to customers. When the first prototype was shown to customers at the trade show, the product was still in development and it took a great effort to get the prototype ready to show, so maybe it was premature to show the prototype given the amount of development that remained.

Question 7.3 Organizational readiness for sales

My Score: 5.5

Project Manager Score: 3.5

Engineering Director Score: 2.2

Description of Discrepancy

This question addresses the sales organizations readiness to sell the product.

Possible Reason for Discrepancy

The possible reason for this discrepancy is who did the sales preparation. The sales preparation was largely done by the marketing group, with little involvement of the sales organization in the development team. So, even though the sales preparation was done, there was little involvement by the sales organization.

5.2.5. Correlation Analysis

A T-test can be used to determine the statistical correlation between the scores between the respondents. For this analysis, the results of 2 respondents are paired. A T-test is then run on each of the 3 pairs.

The T-test test is a hypothesis test for equivalency of means between paired data. The hypothesis is that the difference between the pairs of means is 0. Stated mathematically:

Ho = Mean difference of 0.

For this to be true using a 2 tailed analysis:

T Stat < T Critical and

T Stat > - T Critical

If theses criteria are met, then the hypothesis that the mean difference is 0 is true.

If these criteria are not met, then the hypothesis that the mean difference is 0 is false.

T-Test for Project Manager and Me

Project Manager and Me
t-Test: Paired Two Sample for Means

	5	
Mean	3.907143	3.164286
Variance	1.270238	0.389286
Observations	70	70
Pearson Correlation	0.264174	
Hypothesized Mean Difference	0	
df	69	
t Stat	5.476433	
P(T<=t) one-tail	3.3E-07	
t Critical one-tail	1.667238	
P(T<=t) two-tail	6.6E-07	
t Critical two-tail	1.994945	

Ho = Mean difference = 0
For Ho to be true:
t Stat < tCrit FALSE
and
t Stat > -tCrit TRUE

Not significanly equivalent
alpha (level of signifiance) = 0.05

T-Test for Engineering Director and Me

Engineering Director and Me
t-Test: Paired Two Sample for Means

	5	
Mean	3.888889	3.180556
Variance	1.248044	0.617645
Observations	72	72
Pearson Correlation	-0.02094	
Hypothesized Mean Difference	0	
df	71	
t Stat	4.357582	
P(T<=t) one-tail	2.18E-05	
t Critical one-tail	1.666599	
P(T<=t) two-tail	4.35E-05	
t Critical two-tail	1.993944	

Ho = Mean difference = 0
For Ho to be true:
t Stat < tCrit FALSE
and
t Stat > -tCrit TRUE
Not significanly equivalent
alpha (level of signifiance) = 0.05

T-Test for Project Manager and Engineering Director

Project Manager and Engineering Director
t-Test: Paired Two Sample for Means

	3	
Mean	3.164286	3.191429
Variance	0.389286	0.617027
Observations	70	70
Pearson Correlation	0.187733	
Hypothesized Mean Differenc	0	
df	69	
t Stat	-0.25043	
P(T<=t) one-tail	0.401499	
t Critical one-tail	1.667238	
P(T<=t) two-tail	0.802997	
t Critical two-tail	1.994945	

Ho = Mean difference = 0
For Ho to be true:
t Stat < tCrit TRUE
and
t Stat > -tCrit TRUE
Significanly equivalent
alpha (level of signifiance) = 0.05

The project manager and the engineering director are the only pair that is significantly equivalent. In both cases, my scores we higher as compared to the project managers and engineering director.

5.2.6. Predictive Ability of Survey - Correlation Between Survey Questions (Sections 1 through 7) and Survey Results (Section 8)

The analysis performed in this section is identical to the analysis of project A in section 5.1.6. For this analysis, the ability for Perform to accurately predict the results of the project is examined. If Perform can adequately predict the results of a project, then the scores for the questions in sections 1 through 7 should be similar to the scores for the questions in section 8. For this analysis 2 topics will be investigated. The first is the ability for the survey as a whole to predict project outcomes. The second is to determine if certain sections align with the results of the project to insure the predictive ability for each section.

Predictive Ability of Overall Survey

As a whole, Perform does a very good job of predicting project outcomes. The average of the scores of sections 1 through 7 for all respondents was 3.38. The average score for section 8 for all respondents was 3.49. This is a difference of 0.11, which indicates very good prediction of results. All 3 respondents had a difference between predicted and actual results of less than 0.40.

	Avg. All Respondents	Avg. of PM & EDonly	Me Avg. Only	PM Avg. Only	ED Avg. Only
Sects 1 thru 7	3.38	3.07	4.01	3.05	3.08
Section 8	3.49	3.41	3.66	3.45	3.38
Difference of 1 thru 7 & 8	-0.11	-0.35	0.35	-0.40	-0.30

Again, one must consider the fact that all were answered at the same time and it was a retrospective analysis. Would the survey predict as well if the project was not yet complete?

Predictive Ability of Individual Sections

All of the sections had an average score that was less than 0.54 away from the average score of section 8. This indicates that all of the sections contribute equally to an accurate prediction of project results. The section that had the largest difference between the results section was the Human Resources section. The mean score for all respondents for the Human Resources section was 2.95 giving a difference from the Results section of 0.54. These large differences indicate that this particular section may not predict the project results as well as the other sections and may not be as critical for project outcome. For example, the Product Delivery section may not affect the results for a project because it may be possible to have a good manufacturing transfer of the product even though the product was not appropriate for the market. So even though the manufacturing transfer went well, the product ultimately failed in the market place.

	Avg. All Respondents	Avg. of PM & EDonly	Me Avg. Only	PM Avg. Only	ED Avg. Only
1.0 Leadership	3.52	3.19	4.17	2.83	3.55
2.0 Org. Culture	3.39	3.19	3.78	2.83	3.54
3.0 HR	2.95	2.80	3.25	3.00	2.60
4.0 Info	3.25	3.12	3.50	2.86	3.39
5.0 Prod Strat	3.55	3.00	4.65	3.19	2.80
6.0 Proj Execution	3.38	3.11	3.91	3.14	3.08
7.0 Product Delivery	3.39	2.96	4.25	3.38	2.55
8.0 Results	3.49	3.41	3.66	3.45	3.38
Difference of Sections 1 and 8	0.02	0.22	0.51	0.62	0.17
Difference of Sections 2 and 8	0.11	0.22	0.12	0.62	0.17
Difference of Sections 3 and 8	0.54	0.61	0.41	0.45	0.78
Difference of Sections 4 and 8	0.25	0.29	0.16	0.59	0.01
Difference of Sections 5 and 8	0.05	0.42	0.99	0.26	0.58
Difference of Sections 6 and 8	0.12	0.30	0.25	0.31	0.30
Difference of Sections 7 and 8	0.10	0.45	0.59	0.08	0.83

6. Conclusions

6.1. Consistency of Respondent Scores

Perform returned fairly consistent results from different views of the project, but some evidence exists that different functional groups may score differently. Much of this variation appears to be due to the amount of information the respondent had about particular areas of the project. For example, some respondents scored certain marketing activities low because they were not fully aware of what had been done in this area. This variation between different respondents based on level of project knowledge may be indicative of the communication during the project, but may not accurately portray the project characteristics.

Another area was inconsistency was associated with the temporal nature of the projects. Respondents that only had exposure to certain phases of the projects scored according to their experience. In some cases this limited exposure resulted in an inaccurate portrayal of the project as a whole.

6.2. Prediction

Perform did a very good job of predicting project outcome, given the results of this retrospective analysis. All of the section scores aligned well with the results section. However, in both cases, the Human Resources section had the largest difference in average score as compared to the results section.

6.3. Scoring Scale

For some of the questions, a low score of 1 did not accurately portray how poorly something actually was done.

7. Recommendations

7.1. Perform

The results of this research suggest a number of changes to the Perform survey. The first is to reevaluate the Human Resources section. The results suggest this section may not accurately predict the results of the project as well as the other sections.

The second is to address the ability of Perform to address the temporal nature of projects. Given the retrospective nature of this research, temporal issues on projects were difficult for respondents to score. For example, how should a respondent score a situation when at the beginning of the project the project management was ineffective, but then a new project manager was hired and the project was successful for later parts of the project? Depending on how Perform is used, this issue should be addressed for retrospective application.

The scaling of the scores should also be addressed. For some questions, the score of "1" was not low enough to address how poorly a certain process was being conducted. The lower score criteria should be changed to reflect poorer performance than is currently used in the scoring descriptions.

7.2. Project Management

Even though the main focus of this research is on the assessment of the Perform survey, there were a number of factors for improvement to the projects that were studied that should be mentioned. There was evidence that showed that the R&D group took on too many tasks outside of their area of responsibility. The R&D group was responsible for the completion of the project, so they often took on these responsibilities to insure the project was completed on time, but this defocused the R&D group and set a bad precedent about which groups should complete certain tasks. There should be more involvement and defined roles for

all functional groups. All of the necessary functional groups should actively be involved, not just acknowledged and addressed.

There was not enough emphasis placed on delivery of marketing requirements. The R&D group should have been adamant about receiving information when needed and insuring that the appropriate functional groups supply this information. The project manager should insure information is not simply created by the R&D groups and approved by the functional groups. The functional groups responsible for certain information should be actively involved to insure all of their issues are met.

For small to medium projects, it is tempting to have the project manager also act as the technical lead or systems engineer. This dual role should be avoided. A dual role for the project manager takes the emphasis off of the project management role and often does not leave enough time to accomplish the responsibilities of either the project management or technical roles. The project manager should be responsible for insuring that the enterprise needs are met and that the project proceeds through the development processes properly; this should be the main focus for the project manager.

In many instances, the reason for a schedule slip or changes to technology was because of poor contingency planning. When a problem arose, major effort went into re-directing the project. If a contingency plan had been in place, it would have been easier to redirect the project without major changes to the product or project schedule. Problems will inevitably arise on all development projects, so it is important to be able to anticipate and manage these problems to minimize the impact on the project.

8. Areas of Future Research

The results of this research present opportunities for continued research of the Perform survey. The largest unexplored area is applying the survey to projects that are currently underway. The retrospective nature of this study did not assess how well the survey would provide accurate prediction of project outcome for projects that have not completed. There is nothing in the results that would indicate that Perform would not accurately predict results of projects that have not completed, but a retrospective cannot confirm this conclusively. Applying the survey at various stages of development and then comparing these results to the results of the project when it is completed, with the product launched, would be a way to confirm Perform's ability to accurately predict project outcomes.
A second area of future research could address the temporal nature of projects and how the Perform survey addresses project changes over time. In this retrospective investigation of projects, the survey had difficulty in examining changes over time. Depending on how the survey is used, this may or may not be an issue. Certainly when using the survey in a retrospective nature, the temporal issues are important. A method for dealing with these temporal issues should be addressed for retrospective use. When using Perform on projects that are underway, the ability to address temporal issues is not as important. Rather, it is the ability of Perform to recognize these changes to the project and correlate them to differences in project execution and more importantly, project results. Also, by applying the survey at different stages in the project to determine which phases are most important to project outcome.

This research focused heavily on responses to the survey by members of the development team that were part of the R&D organization. The survey should also be given to members of the development team outside of the R&D group such as service, regulatory, and manufacturing. Results from other functional groups could then be used to determine if Perform accurately characterizes projects from different functional points of view.

The projects used in this research could not be described as great successes, so the results of the survey performance apply specifically for projects at the lower end of the scoring scale. It would be useful to conduct similar research to a project that had huge success in order to confirm the surveys accuracy at the high end of the scoring scale.

9. References

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10. Appendix A – Data

10.1. Project A Data

	Question	Me	Project Manager	Marketing Manager
1.0 Leadership	1.1	2	4	2
	1.2	3	3.5	2
	1.3	3.5	5	2.5
2.0 Organizational Culture	2.1.1	3.5	3	3
	2.1.2	1	4.5	2.5
	2.1.3	2	2	1.5
	2.2.1	2.5	5	4
	2.2.2	3.5	4	4
	2.2.3	2	4.5	3.5
	2.2.4	2	2.5	4
	2.3.1	1.5	3	4.5
	2.3.2	3	1.5	2.5
3.0 Human Resources	3.1	4	2.5	2
	3.2	4	3.5	3
	3.3	3.5	3	4
	3.4	3	3.5	3.5
4.0 Information	4.1.1	2.5	3.5	3
	4.1.2	3.5	3	4
	4.1.3	1.5	2.5	1
	4.2.1	1.5	2	2.5
	4.2.2	3	5	6
	4.2.3	2	2	1
	4.2.4	2	2.5	4
5.0 Product Strategy	5.1.1	3.5	2.5	3.5
	5.1.2	2.5	3	4
	5.1.3	3	3	3
	5.2.1	1	2.5	3.5
	5.2.2	2	1.5	4
	5.2.3	3	2.5	4
	5.2.4	3	3	2.5
	5.3.1	4.5		4.5
	5.3.2	3	3	2.5
	5.4.1	1.5	2.5	2
	5.4.2	2.5	1.5	1.5
	5.5.1		4.5	1
	5.5.2	5	4	5

	Question	Me	Project Manager	Marketing Manager
6.0 Project Execution	6.1	2.5	3	2
	6.2	3	3.5	3
	6.3.1	4.5	4.5	1
	6.3.2	2.5	3.5	3
	6.4.1	1	1.5	1
	6.4.2	2	2	1
	6.5.1	2.5	2.5	1
	6.5.2	1	2.5	1
	6.5.3	3	4	2
	6.5.4	2	3.5	3
	6.6	4.5	4.5	4.5
7.0 Product Delivery	7.1	3	3.5	3.5
	7.2	2	4	3.5
	7.3		2	3.5
	7.4	4.5	3.5	4
8.0 Results	8.1.1	2	1	1
	8.1.2	1	1	4
	8.1.3	2	1	3.5
	8.1.4	1.5	1	1
	8.1.5		1	3
	8.1.6	2	1	4.5
	8.2.1	1.5	1.5	4
	8.2.2	2	1.5	5
	8.2.3	3	2.5	2.5
	8.2.4		4.5	4.5
	8.3.1	1	3	3
	8.3.2	1	1	1
	8.3.3	1	1	1
	8.3.4	2	1.5	3
	8.3.5	1.5	3	3
	8.3.6	2	3	1
	8.3.7	2.5	3	2.5
	8.4.1	2	3	2
	8.4.2	3	3	2
	8.4.3	1.5	2.5	2.5
	8.4.4	4	2	2.5
	8.4.5		3	4
	8.4.6		3	3
	8.5.1		3	1

10.2. Project B Data

	Question	Me	Project Manager	Engineering Director
1.0 Leadership	1.1	5	3	4.25
	1.2	3	3	2.8
	1.3	4.5	2.5	3.6
2.0 Organizational Culture	2.1.1	5	2	4.1
	2.1.2	3	3	3.6
	2.1.3	4	2	2.7
	2.2.1	4	3	3.9
	2.2.2	3	2.5	3.6
	2.2.3	5	3	3.2
	2.2.4	3	3.5	3.9
	2.3.1	2.5	3	3.9
	2.3.2	4.5	3.5	3
3.0 Human Resources	3.1	4	3	4
	3.2	4	3	2
	3.3	3	3	2.4
	3.4	2	3	2
4.0 Information	4.1.1	2.5	2.5	4.2
	4.1.2	6	2.5	4.4
	4.1.3	1.5	2.5	3.2
	4.2.1	3	2	3.3
	4.2.2	4	3	3.5
	4.2.3	2.5	3	2.5
	4.2.4	5	4.5	2.6
5.0 Product Strategy	5.1.1	3.5	3	4.4
	5.1.2	6.5	3.5	1.8
	5.1.3	4	2.5	2.1
	5.2.1	3.5	3	4.2
	5.2.2	5.5	3.5	2.4
	5.2.3	5	3	2.6
	5.2.4	2	3	2.6
	5.3.1	5	3	3
	5.3.2	5	3	2.5
	5.4.1	5	3	3
	5.4.2	5.5	5	2.5
	5.5.1	4	2.5	2.5
	5.5.2	6	3.5	2.8

	Question	Me	Project Manager	Engineering Director
6.0 Project Execution	6.1	3	3	3.6
	6.2	2	3.5	3.6
	6.3.1	4.5	3.5	2.4
	6.3.2	4	2.5	2.6
	6.4.1	2.5	2	1.2
	6.4.2	5	2	2.2
	6.5.1	4	4	2.9
	6.5.2	6	3.5	4
	6.5.3	2.5	3.5	3.4
	6.5.4	5.5	3.5	3.7
	6.6	4	3.5	4.3
7.0 Product Delivery	7.1	3	3	3.1
	7.2	5.5	3.5	2.5
	7.3	5.5	3.5	2.2
	7.4	3	3.5	2.4
8.0 Results	8.1.1	4	3	1.6
	8.1.2	3	2.5	2.4
	8.1.3	3		2.1
	8.1.4	3	3.5	2.9
	8.1.5			2.5
	8.1.6			2.5
	8.2.1	4	4	4
	8.2.2	3	3	4
	8.2.3	4.5	4.5	4.1
	8.2.4	5	3.5	3.7
	8.3.1	4.5	3	4.2
	8.3.2	3.5	4	4.1
	8.3.3	3.5	3	4.1
	8.3.4	3.5	3	3.3
	8.3.5	3	3.5	3.9
	8.3.6	4	3.5	3.8
	8.3.7	2	2.5	2.3
	8.4.1	3.5	3.5	4.1
	8.4.2	4	3.5	3.7
	8.4.3	4	4.5	4
	8.4.4	3.5	3.5	3.1
	8.4.5	4	3	3.1
	8.4.6	4.5	4.5	4.1
	8.5.1	3.5		3.5

11. Appendix B – Perform Survey

1.0 Leadership

Examines key characteristics of the project leader, power delegated, and whether there is a clear strategic direction for the project

1.1 Senior management clarification of strategic intent

Intensity and clarity of senior management communications on the project's strategic intent

1.2 Project leader's experience

Scope and experience of the project leader

1.3 Power delegated to the project leader

How much power is bestowed on the project leader

2.0 Organizational culture

Examines the extent to which management has considered and taken advantage of the established values and assumptions of the people to improve project outcomes.

2.1 Cultural Change

The extent to which management takes advantage of culture and tries to improve it

2.1.1 Leveraging organizational culture.

2.1.2 Cultural change management.

2.1.3 Risk taking rewards and incentives.

2.2 Teaming

Scope and intensity of teamwork

2.2.1 Teamwork culture.

2.2.2 Internal communications mechanisms.

2.2.3 Customer relationships.

2.2.4 Ties between PD and suppliers.

2.3 Innovation

Extent to which innovation and learning are encouraged

2.3.1 Motivating breakthrough ideas.

2.3.2 Pursuit of organizational learning.

3.0 Human Resources.

Examines management's actions to improve the skills and the work environment

3.1 Project core competency

Scope and depth of technical competency of the PD group

3.2 Multi-disciplinary staffing

Extent and strength of the diversity of the skills of the group

3.3 Training and education

Scope and intensity of skills development

3.4 Work environment

Commitment to workplace, work systems, and employee well-being

4.0 Information

Examines treatment of data and information as valuable assets, their quality, and the extent they are systematically collected, shared, and analyzed

4.1 Infrastructure and tools.

The scope of physical and non-physical assets and tools for PD

4.1.1 Investments in PD methods, tools, and databases.

4.1.2 Reuse of physical and design assets

4.1.3 Knowledge management system.

4.2 Information Analysis

How data and information are used

4.2.1 Use of data

4.2.2 Customer satisfaction data

4.2.3 Use of project performance metrics

4.2.4 Risk management

5.0 Product Strategy

Examines the product planning processes and extent to which they promote readiness for development and delivery.

5.1 Strategic Objectives

The project's strategic objectives and how they drive the product

5.1.1 Product positioning.

5.1.2 Portfolio of product opportunities

5.1.3 Project linkage to corporate objectives

5.2 Core concept.

How the product concept is developed and key considerations in its formulation.

5.2.1 Concept development

5.2.2 Product architecture

5.2.3 Product functional content

5.2.4 Product end-of-life (EOL)

5.3 Revenue Planning

Key factors in determining revenue

5.3.1 Knowledge of market potential

5.3.2 Product pricing

5.4 Technology

Key factors in managing technology for the product

5.4.1 Forecasting technology

5.4.2 Technology readiness

5.5 Functional Strategies

5.5.1 Make-buy decisions

5.5.2 Product service processes

6.0 Project Execution

Examines key issues of the product development processes

6.1 Development Process

What is the development process and why

6.2 Responsibilities of team members

Clarity, scope, and incentives of PD team members

6.3 Development

How the product specifications are formulated

6.3.1 Prototype plan

6.3.2 Product attributes and their values

6.4 Milestones and Metrics

Key metrics for tracking and measurements

6.4.1 Team productivity

6.4.2 Project financial goals

6.5 Schedule Integrity

How project's schedule integrity is maintained

6.5.1 Project delays

6.5.2 Time to Market

6.5.3 Concurrent development

6.5.4 Internal task coordination

6.6 Social Responsibilities

How the project meets social responsibilities

7.0 Product Delivery

Examines extent to which the project considers manufacturing, sales, service and support; or product "goes over the wall."

7.1 Release to manufacturing ramp-up.

How ready is manufacturing for production

7.2 Transition to sales

Is the product ready for sales?

7.3 Organizational readiness for sales

Is the sales organization ready for the product?

7.4 Product Complexity Results

Is service and support groups ready for the product?

8.0 Results

Examines the results of the project from multiple dimensions.

8.1. Project Financial and Market Results.

8.1.1 Project IRR and NPV
8.1.2 Product volumes.
8.1.3 Product revenues.
8.1.4 Product cost
8.1.5 Product SG&A
8.1.6 Product's market share in revenue

8.2. Project Customer Satisfaction and Loyalty Results.

8.2.1 Customer loyalty.
8.2.2 Satisfaction with price for value.
8.2.3 Satisfaction with product functionality and performance.

8.2.4 Satisfaction with service and support capabilities.

8.3. Organizational Effectiveness Results.

8.3.1 Strategic Intent.

8.3.2 Development cycle time and slip rate.

8.3.3 Development budget

8.3.4 Partner satisfaction and loyalty.

8.3.5 Project team morale.

8.3.6 Productivity.

8.3.7 Contribution to knowledge assets.

8.4. Product Results.

8.4.1 Product Functions and Performance versus specifications.

8.4.2 Patents and industry awards.

8.4.3 Core technology newness.

8.4.4 Platforming extent.

8.4.5 Manufacturing Complexity

8.4.6 Sales and Service Complexity

8.5. Project Benchmarking.

8.5.1 Benchmarks

1.0 Leadership

This part of the survey examines the project leader's key characteristics, the power delegated to him, and whether senior management has offered a clear strategic direction for the project.

1.1 Senior management clarification of strategic intent.

Executives' communications are thin and sparse. Project's importance is narrowly defined, vague and left to personal interpretation. Project leader consistently needs executives' help to set direction and priorities.	Executives communicate project's strategic intent, but their actions are not consistent. Project leader has to overcome these obstacles to drive the project.	Executives actively communicate project's strategic intent, reinforced frequently and supported by consistent actions. Makes the job of setting direction and prioritizing easy for the project leader.	CEO and senior management actively communicate the project's strategic intent. This is reinforced by visible actions, rewards and incentives. Consistent message at all levels.

---------→1 --------→ 1.5 --------→ 2 --------→ 2.5 --------→ 3 --------→ 3.5 --------→ 4 --------→ 4.5 --------→ 5 --------→ 5.5 --------→ 6 --------→ 6.5 ---------→ 7 -----

1.2 Project leader's experience.

Experience limited to narrow product issues, weak in other areas. Needs help and rework very frequently.	Experienced in many of the technical issues, requires some direction on business, financial and customer issues. Needs help occasionally.	Has managed technical, business, financial and customer issues. Does not need help.	Has track record of delivering complex technical projects, business, financial, and customer issues. His advice is frequently sought after.

---------→1 --------→ 1.5 --------→ 2 --------→ 2.5 --------→ 3 --------→ 3.5 --------→ 4 --------→ 4.5 --------→ 5 --------→ 5.5 --------→ 6 --------→ 6.5 ---------→ 7 -----

1.3 Power delegated to the project leader.

Project leader has no real power. Executive micromanagement is visible. Project leader must frequently request approval for simple decisions.	Visible executive support for project when requested. Some senior executives have bought-in, but their visibility is not strong.	Visible and frequent executive support for project initiated by the executives. Have senior executives buy-in and they actively work to form high-majority consensus.	Project leader has final say on all project tradeoffs; senior executives do not and cannot easily subvert or slow down the project. Executives communicate forcefully their trust and confidence in the project leader.

---------→1 --------→ 1.5 --------→ 2 --------→ 2.5 --------→ 3 --------→ 3.5 -------→ 4 --------→ 4.5 --------→ 5 --------→ 5.5 -------→ 6 --------→ 6.5 ---------→ 7 -----

2.0 Organizational Culture.

This part of the survey examines the extent to which project management has considered and taken advantage of the established values and assumptions of PD personnel in order to improve project outcomes.

2.1 Cultural Change. Evaluate the extent to which management takes advantage of culture and whether it tries to improve it.

2.1.1. Leveraging organizational culture.

Not considered high priority. Project does not fit well with the cultural values of the firm; it is a forced-fit that impacts PD in many ways.	Firm's current project and its cultural values are not completely aligned with each other. The project has some difficulty fitting.	Project is aligned with the strategy and values of the firm.	Organizational culture and project are mutually reinforcing. Project promotes the culture and values of the firm and vice versa.

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2.1.2. Cultural change management.

Too much complacency. No real vision communicated for the product. No short term wins. Victory declared simply when project is over. Project forced some cultural change, but it was resisted at every opportunity. The project was pushed forward at great effort.	Complacency present in some functional areas. Project forced some cultural change driven by executive levels, but not well enforced down through the organization. Change came about due to project leaders' respect and effort, but change is not sustainable.	No complacency on change. Project forced cultural change championed at the executive level and enforced down through the organization. No product deficiencies due to lack of cultural change. New processes are in place, and enforced. There is a growing group of believers.	No complacency on change. Project drove areas that required cultural change; the remainder is compatible with culture. There are product breakthroughs due to correct areas of cultural change. Organization is now transformed and setting example for the firm.

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2.1.3 Risk taking rewards.

System for rewards exists. It is conservative and risk averse. Functional managers allocate rewards, conduct performance evaluations and promotions.	System for rewards exists. Rewards and performance evaluations are determined cross-functionally by functional managers and project champions.	Rewards given for exceeding objectives by virtue of execution excellence. The project champion allocates rewards to the team. Performance evaluations determined cross-functionally by functional managers and project leaders.	Rewards given for exceeding objectives and execution excellence. Some rewards awarded repeatedly for sustained extraordinary impact. Successes driven by outlier events do not diminish or magnify rewards. Evaluations determined cross-functionally by project champion and functional managers.

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2.2 Teaming. Evaluate the scope and intensity of teamwork.

2.2.1 Teamwork culture.

Parochial loyalties are deeply rooted. Group interactions are guarded with too many power games. Management intervention needed to make groups work together and resolve disputes.	Intra-functional teamwork exists, but inter-functional teamwork and problem solving need management push. Conflicts remain unsolved too long and require management intervention.	Management has leveraged informal networks to promote cross-functional teamwork and problem solving. Conflicts are open, business-like, and readily resolved.	Self-organized cross-functional networks (formal and informal, with customers and with partners) actively promote problem solving. They interact freely, and conflict resolution is fast and effective.

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2.2.2. Internal communication mechanisms.

Communication is inhibited and lacks spontaneity. It is dominated by stylized and formal mechanisms. Informal networks' span is narrow.	Formal mechanisms are in place. Informal networks are more effective, but barely visible to management.	Formal mechanisms in place built by leveraging informal communications networks, are in place.	Formal and informal mechanisms dominate the communications channels. They are open, direct, and honest. There is propensity to listen.

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2.2.3 Customer Relationships.

Customers have little contact with the design or development teams.	Customers are visited occasionally, particularly in the up-front activities.	Customers are consulted regularly throughout the development cycle about the product and lifecycle requirements (service, updates, availability, etc.), but do not have a voice in the design decision-making.	Users and customers are co-developers throughout the PD cycle and critics during field operations. They review development specs, field manuals, and key functional strategies. They are readily consulted on unexpected problems.

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2.2.4. Ties between PD and suppliers.

Ties are very formal, colored by a zero-sum "we/they" attitude. Mutual trust is minimal.	Ties are formal with informal personal ties. There is sufficient mutual trust and confidence that development proceeds unimpeded.	Both formal and informal ties exist. Suppliers review development specs and key functional strategies. They are consulted on problems. Mutual trust and respect is strong.	Suppliers are co-developers throughout the PD cycle. They define some of the development specs and key functional strategies. They are assigned to solve tough problems. Supplier loyalty is firm.

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2.3 Innovation.

Examine the extent to which innovation and learning are encouraged.

2.3.1 Motivating breakthrough ideas.

PDP innovations occur when management pushes them forward.	Innovations are considered and implemented when it is clear how they will benefit.	Open to PDP innovations; if the benefit is unclear, respect for the project leader will still carry it forward.	Have a management system and culture that promotes fresh ideas. Innovation is prized and rewarded, especially from sources outside their normal expertise.

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2.3.2 Pursuit of organizational learning.

Does the organization learn from past projects or does it have to relearn the same lessons with each new project?

Organizational learning begins and ends with personal learning.	There is an information system to capture lessons from prior projects, but it is barely used.	The organization takes advantage of lessons from its latest project and pursues its key people to learn how to apply those lessons to its new project.	The Organization has many formal and informal incentive mechanisms. Effective practices are readily adopted by organization. A High percentage of employees read journals, books and trade press.

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3.0 Human Resources. This part examines the work environment, skills of the organization, management's commitment and actions for improvement.

3.1 Project core-staff competency.

Staff understands limited to narrow product issues, weak in other areas. Group needs help and reworks tasks very frequently.	Staff is capable of solving problems in their domain. Needs help occasionally.	Core staff has experience from previous projects, is equipped with advanced degrees, and is able to provide and guide others. Staff does not need help.	Core staff has demonstrated capability in many breakthrough concepts. Has 10 years experience and is equipped with advanced degrees from top institutions. Staff's advice is frequently sought.

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3.2 Multi-disciplinary staffing.

We had staff from as many non-engineering disciplines as we could get, but it was not enough.	For every team of a few dozen, there was one marketing person, one industrial designer, and a few production engineers involved.	For every two dozen engineers, there were two marketing persons, 2 industrial designers, 2 systems engineers, and 8 test engineers.	The team was fully loaded with non-engineers for disciplines needed as determined.

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3.3 Training and education.

Training is limited to on-the-job learning.	Delivery pressures limit scope and extent of training. Training and education constantly limited by other budget priorities. Technical effectiveness and proficiency measurements are subjective.	Senior executives, functional managers and project champion are committed. Training is fully funded and effectiveness is measured. Product delivery pressures do not circumvent training.	The organization's culture values technical proficiency. Training is fully funded, is never an issue, and effectiveness is measured. Product delivery pressures do not circumvent training. Training includes partners.

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3.4 Work environment. Commitment to work place, work systems, and employee well being.

Focus is on maximizing work output. Employee well being, satisfaction, and services are a low budget priority.	Focus is on maximizing work output, but with a concern for morale. Enough attention to employee well-being, satisfaction, and services to avoid high turnover.	Focus is on high performance and high morale. Initiatives are in place to support employee well-being and satisfaction in order to sustain productivity, quality, and morale.	Recognized as an industry leader. The organization's policy addresses workplace, systems, and programs for employee well being and satisfaction. Focus is also on the well being of the community.

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4. Information.

This part of the survey examines whether data and information are treated as valuable assets and the extent to which they are systematically collected, shared, and analyzed.

4.1 Infrastructure and tools.

4.1.1 Investments in PD methods, tools and data-bases.

PD Methods, tools, and DB are a low budget priority. They retard progress. IT infrastructure is inconsistent with the project. IT is always behind, and too many PD resources are diverted and spent on IT. PD has to develop many of the tools required.	Methods, tools, and DB are sporadically improved and created. IT infrastructure and support are adequate for the project, but some PD resources are spent on IT. All need improvement. PD has to justify to management the acquisition of key tools.	Methods, tools, and DB are continuously improved and created. IT infrastructure fits the project and works to support it; it is generally timely, with some priority conflicts. PD progress not inhibited by tools and their support.	Methods, tools, and DB are the envy of the industry. IT infrastructure is tailored for the project. IT support is dedicated to the projects, and not vice versa. Domain experts identified and assigned to support PD.

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4.1.2 Re-Use of physical and design assets

Re-use is not actively addressed.	The goal of re-use is driven by cost only. Engineering managers are given targets for the re-use of electrical and mechanical design, software, packaging, purchased parts, test programs and test equipment.	The product architecture enables re-use that optimizes cost. From this a re-use target is established for electrical and mechanical design, software, packaging, purchased parts, test programs and test equipment.	Product families are established on architectures. Re-use also includes subsystems and their ability to interoperate. This analysis is used to target and maximize the reuse of systems, software, test programs, and hardware assets.

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4.1.3 Knowledge management system.

Is knowledge in the organization captured only by individuals, or is there a way that it is stored and usable by all?

Capturing and cataloguing project's knowledge assets are a low priority activity. Past project info is not easily accessible for probing questions. Project knowledge begins and ends with personal knowledge.	Capturing and cataloguing project's knowledge assets are done as deemed necessary by the project leader for sharing within the team. Past project info not really accessible.	Standard practices include efficient means to naturally capture and catalogue project's knowledge assets for the team. Past project info is accessible, but hard for probing questions. Experts who can help are informally known to people.	Project's knowledge assets are systematically captured and catalogued. Past project info is easily accessible for probing questions. Formal knowledge communities exist and are available to share and expand knowledge.

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4.2 Information Analysis. Evaluate how data and information are used.

4.2.1 System of data collection, management, and usage.

There is such a system, but for a variety of reasons, large volumes of data remain unused or ignored. Personal libraries and collection mechanisms dominate the practice.	There is such a system and it provides large volumes of data. Senior managers have budget to collect more data and develop local expertise.	Such a system exists. Senior managers budgeted to collect more data and develop local expertise. Members must share expertise via reports, on demand consultations, etc.	Such a system exists. Senior managers budgeted to collect more data and develop local expertise. System highly integrated with learning, knowledge, and information tools and processes.

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4.2.2 Customer satisfaction data.

Data is anecdotal or generic making it difficult to react and improve customer satisfaction. A large effort is needed to improve the accuracy and completeness of the data in order to make it useful.	Customer feedback, warranty and repair data is made available by the sales and service staff. System promotes extended enterprise communications with customers.	Customer feedback, warranty and repair data is made available in reports, documented and structured. System promotes customer extended enterprise teamwork to make the project succeed	Web site exists for customer feedback. Warranty and repair data is also on-line and easily available for use by product development teams and functional groups. Customers and partners readily provide proprietary data for their mutual benefit.

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4.2.3 Use of project performance metrics.

Examines the quality of project operational data and how it is used.

Use is dominated by corrective actions and surprises. Metrics are tracked or measured, but not always consistently. People are not well informed about the project's progress. Data accuracy and completeness is lacking.	Use includes proactive actions. Metrics are regularly measured and reviewed by management. People and management are kept informed of project's performance. Data requires and effort to improve accuracy and completeness. Usage is isolated in functional silos.	Bias is to proactive actions, team morale and learning. Many metrics are derived from predictive models. Metrics are tracked regularly. Key customers and partners are kept informed. Operational data is readily usable and it is accurate and complete.	Bias is to proactive actions, morale, learning, and knowledge capture - in the firm, with lead users and with partners. Metrics are available on line, always measured and reviewed against corporate objectives. Usage promotes cross-functional teamwork. Data can be trusted.
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4.2.4 Risk management analysis.

Uncertainties and risks are barely considered. Uncertainly and risk mitigation is not part of the process and neither is robustness.	Few uncertainties and risks are characterized and most remain vague. Some plans exist to address the risks. Robustness is not part of the process.	Many uncertainties and risks are characterized. Based on this, plans are formed to ensure robustness.	Key uncertainties and risks are characterized. Sensitivity analysis is done to identify key sources of risk. Based on this, plans are formed to ensure robustness.
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5.0 Product Strategy

This part of the survey examines the product planning processes and the extent to which they promote readiness for development and delivery.

5.1 Market Analysis

5.1.1 Product positioning.

Product is positioned in a replacement business. Specifications are determined with no direct links to customer needs.	Product positioned as improvements for the current customer base.	Product positioned to new markets, with strong competitors. New growth opportunities, buying behavior, and market evolution are characterized. Product definition is differentiated and competitive.	Product and its derivatives are targeted for market creation in the industry. Product is unique – there are no competitive products or precedents. All key functions and processes are realigned for this product.

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5.1.2 Portfolio of product opportunities

Current offerings and customers dominate the organization's view of opportunities. Portfolio planning is ad-hoc and informal led by a single function. Consistent methods and business processes are sparse.	A collection of product families exists. They are rationalized qualitatively, by organizational structure and product managers. There is financial planning and roll up, but no real portfolio optimization.	A collection of product families exists. Finance and product managers plan and manage revenue and profit. Optimization done through simple scenarios and a handful of alternative cases.	Portfolio decisions drive new product development. Portfolio planning linked to market, business, and functional strategies. Its methods are quantitative and qualitative engaging senior executives and PD managers.

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5.1.3 Project linkage to corporate objectives.

Most of the project's benefits are vaguely mapped onto quantifiable business objectives and goals. Many inconsistencies remain with no plans for their resolution and are left to personal interpretation.	Many of the project's benefits can be mapped onto quantifiable business goals and objectives. Remaining inconsistencies are known but avoided and deferred for later resolution (no comeback dates are defined).	Project's benefits are explicitly mapped onto key quantifiable business goals and objectives. Mission and goal inconsistencies are known and delegated with due dates for resolution.	All project benefits are explicitly and comprehensively mapped onto key quantifiable business goals, objectives, and business initiatives. Few and only trivial mission and goals inconsistencies remain open.

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5.2 Core concept.

Evaluate how the product concept is developed and the key considerations in its formulation.

5.2.1 Concept development.

Brainstorming sessions were held.	Participation in concept development is limited to a very small group. Concepts are extensions of existing products. Bold ideas are not adequately considered. Concepts are shown to customers after the fact.	Concept development is unconstrained. Uses generation tools and methods with broad participation from key functions. Options are explored with lead users and partners. Industrial design is a key consideration.	Brilliant people with proven track records are given unconstrained freedom to create concepts. Concept space is large and down selection systematic. Concept development relies on broad internal and external participation.

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5.2.2 Product architecture

Consideration is limited to the single product.	There is a product architecture that considers future upgrades and derivative products.	Architectural integrity is enforced in product design and system validation. Architecture reinforces brand identity.	Architecture is a strategy issue determined by senior executives. Architecture addresses all key functions of the firm.

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5.2.3 Product functional content

Largely driven by extensions of existing products and customer complaints.	Largely derived from extensions of current products and product family consistency. Known customer base and competitors shape content.	Driven by market segment needs, strategic positioning, architecture, and input from benchmarks. Use of repeatable methods is made to prioritize and determine value to customers and to the firm.	Markets new to the firm and to the industry shape content. Architectural advantages leveraged. Functional content sets new level of competitive advantage.

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5.2.4 End-of-Life strategy (EOL).

Do not have an EOL strategy process. Surprises from competitors drive product withdrawals.	EOL is reactive. React to technology maturation, deceleration of sales and profit, and increasing competitive pressure.	EOL is opportunistic. Ready with new product at early signs of technology maturation, deceleration of sales and profit, and increasing competitive pressure	Business strategy and corporate goals set EOL. EOL is planned by architecture, technology, and pricing. No problem cannibalizing any existing product.

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5.3 Revenue Planning.

Evaluate the key factors that determine product revenue flow.

5.3.1 Knowledge of market potential

Market potential determined from historical sales data and sales of known competitors.	Market potential determined from expected sales of product line extensions and from currently served market segments. PD uses momentum models.	Forecasts of industry and market growth, adoption curves, pricing and revenues are considered. Focus on key competitors' future actions. Some formal models used.	Product used to create a new market. Knowledge of market growth and acceleration is more important than potential size of the market.

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5.3.2 Product Pricing strategy.

Momentum pricing. Target price is determined by ensuring consistency with the current and to-be-replaced product offers.	Price to competition. Target price is determined through positioning analysis against competitor product offers.	Price to customer preferences. Use front-end consumer analysis methods, such as conjoint studies, to establish target price, consistent with the desired competitive market position of the product.	Price to customer value. Use EVA to price the product. Analyzed with lead users' usage within their business processes. Pricing consistency with strategic intent is validated.

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5.4 Technology.

Evaluate the key factors in managing technology for the product.

5.4.1 Forecasting Technology.

A technology follower - new technology adopted only when widely adopted in the market. Uses familiar and mature technology, reuses known manufacturing processes.	Technology forecasting based on capabilities of the organization and knowledge of the state-of-the-art. Capabilities determine adoption and competitive pressures trigger make/buy decisions.	Technology and manufacturing roadmaps with a competitive lead are defined. Work is done with customers to understand technologies. New product pipeline planning considers this when scheduling development activity.	Have preemptive roadmaps in technology and manufacturing. Technology is validated in lead user application environments. IP control points identified. Sustaining and disruptive technologies and synch PD against P/P half-life.

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5.4.2 Technology readiness

Determined by technology demonstrations under controlled environments. Executive fiats influence timing of technology transfer to PD, and require large engineering resources to make ready.	Readiness is joint effort between scientists and PD. Transition to PD is rocky. PD invests substantial resources to stabilize technology for transfer to PD.	Readiness is determined by internal simulation and application in prototype systems. Customers and partners are consulted. Readiness is a joint process between engineering, technologists, and manufacturing.	Readiness is determined by actual application of the technology in final form, in a stressed system and in actual customer environments. Products used are from actual short run manufacturing lines. Readiness is a joint process between engineering, technologists, and manufacturing.

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5.5 Functional strategies.

5.5.1 Make-buy decisions

Dominated by tactical and ad-hoc considerations, without considering strategic implications to the firm.	Process is led by product planning and principally determined by engineering and cost reasons.	There is a cross-functional team to ensure PD, manufacturing, and finance are considered. Customers and partners are informed. Scalable parameters are identified which provide a range of applications for the technology.	Considered a strategic decision. Deliberated with senior executives to consider architecture, IP, manufacturing, finance, strategic and competitive implications to the product. Full critical parameter model developed, including scalable and sensitive parameters.

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5.5.2 Product service processes. .

Not a high priority for product design. Process concentrates on costs rather than customer satisfaction. Service is viewed as a "downstream" issue.	Engineering leads the process and brings in the service groups to ensure that the product design addresses serviceability and support issues.	There is a cross-functional team to ensure product design, manufacturing and finance address serviceability and support. Customers and partners are informed.	Process includes a cross-functional team that includes customers and partners to ensure product design, manufacturing, and finance address serviceability and support.

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6.0 Project Execution.

This part of the survey examines key issues of the product development processes.

6.1 Development process.

Evaluate what best characterizes the development process.

The project did not follow a standard process.	A standard process with no changes is used. Go/no-go decisions were made at each phase gate. Decisions were passed that should not have been passed.	Well defined go/no-go criteria exist at each phase gate. Measured plan-variances, assessed their overall effects, and specified contingency plans to reduce risk.	Standard process was redesigned for this project by the project champion and core team who have proven competence and a successful track record.

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6.2 Responsibilities of team members

Narrowly defined, largely at the task level. For many, it is difficult to link their work to the overall project mission. There is micromanagement, slow decision making, and false starts.	Team members understand their roles and responsibilities. They know how their work promotes the project's mission. There is respect for multifunctional views.	Team roles and responsibilities are determined through extensive discussions among management and employees. How to meet project goals is delegated to the project leader. Suppliers and partners review and comment.	Determined via extensive discussions at all levels with participation from suppliers and partners. Strong power delegated to project leader. Most have a desire to go beyond the job descriptions. All know their role and responsibilities relative to key functions.

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6.3 Development.
Evaluate how the product specs are formulated.

6.3.1 Prototype plan.

Subsystems developed and integrated into the product. **Alpha** prototype worked in a controlled environment. **Beta** prototype developed using parts from real tooling, and the prototype worked as expected in a controlled environment.	Subsystems developed and debugged. Manufacturing suppliers are consulted and standard tolerances used. **Alpha** prototype worked as expected. **Beta** prototype developed using parts from real tooling and system integrated from short runs, and the prototype worked as expected. Key tolerances assigned. Design consults with production, service, and sales on their development efforts.	For **alpha**, developed architecturally consistent and robust subsystems for system integration. Explicit key dimensions were used. Prototypes worked in wide range of conditions. **Beta** uses critical parameters management and robustness for key dimensions and tolerances. Test customers used short runs made using real tooling. Prototypes work. Manuals, sales and service plans proceed concurrently.	**Alpha** prototype was fully functional under a range of conditions. Lead users have alpha units. All learned product features and customer operation changes by doing. Critical parameters were validated using the alpha. For **beta**, lead customers, given short run prototypes, work at the development site to test performance and usability. Design, service, production and sales all use the beta to validate their plans.
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6.3.2 Product attributes and their values.

Process is dominated by current products, engineering doability, and costs.	Process considers current products strengths and weaknesses relative to its key competitors.	Process based on consumer preference methods, such as conjoint studies, to select product attributes and their values.	Process considers consumer preferences and EVA in their use environment. Validated with lead users and suppliers. Cost benefit analysis performed using quantified value propositions and models.
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6.4. Milestones and metrics. Tracking, measurements, and actions.

6.4.1 Team productivity. Examine processes and methods used to measure PD productivity and the type of actions planned and taken.

Have aggregate measures, which are difficult to diagnose for corrective and proactive improvement actions. Total project hours and errors are obtained with great difficulty.	Productivity and total project error data were collected and analyzed against historical norms. Heuristics are relied upon and there is limited use of predictive modeling.	Productivity is measured and tracked using analytical models that permit proactive action. Information is available on-line for management review and queries.	Productivity measured and tracked with predictive models for proactive actions. Information is available on-line for management and key team members' review and queries. Information is also linked to other functional systems for a complete picture of project productivity.

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6.4.2 Project financial goals.

Meeting the project's financial goals is led by finance with participation of PD and other key functions. PD role is passive other than meeting budget and product cost.	Finance has the lead to ensure project meets financial goals. PD's financial metrics are budget and product cost. Can comment, but have limited power on sales, distribution, and service expense strategies and tactics that influence financial goals.	PD is part of a formal multi-functional group that addresses financial issues. PD's responsibilities are budget and product cost. PD is also in a group that addresses sales, distribution, and service expense strategies and tactics.	Financial goals were determined through options-assessment and flexible planning during the development cycle.

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6.5 Schedule Integrity

Evaluate how the project's schedule integrity is maintained.

6.5.1 Project delays.

Delays ranging from small to 100% are common.	Monthly review meetings are held to monitor delays and take action. Key dependencies informed of status of delays.	Have weekly review meetings to monitor delays and take action. Meetings and actions coordinated with key functional dependencies.	Daily updates to project plan and to take action among PD and functions. Project slips measured versus commitment at project funding time - not just versus most recent revised schedule.

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6.5.2 Time to Market (TTM).

Evaluate how well TTM is managed

TTM not controlled versus product specs. Product goes to market when development is complete.	TTM controlled by inflating schedules with large buffers. When buffers are exhausted, forced overtime and additional people are placed on the project.	Have flexibility to cut functions to meet delivery or version product to meet schedule. Knowledge of market and competition are able to minimize market impact.	TTM addressed by concurrent development and co-development with customers and partners.

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6.5.3 Concurrent development.

Evaluate whether concurrent development is being implemented

Functional silos connected by specs and very formal meetings.	Have functional orientation with informal and personal cross-functional relationships to work out dependencies and concurrencies.	Formal cross functional groups organize tasks for maximum concurrency.	Strong cross-functional teams led by experienced project leader. Leader supported by motivated and skilled functional participation.

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6.5.4 Internal task coordination.

Evaluate the mechanisms for internal coordination

More time spent in meetings than product development. Many surprises at all levels of the organization.	Use specs between silos for task coordination. Personal initiative and informal relationships help close many gaps but cannot prevent surprises.	Formal specs and formal cross-functional meetings used to discuss dependencies, timing, and content of task coordination.	Information handoffs include detailed walkthroughs of specs, functions and dependencies. Results are reflected in extended task mapping documents.

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6.6 Social responsibilities.

Evaluate whether the project meets social responsibilities.

Product meets minimum legal requirements.	Product meets all legal requirements and exceeds in many areas.	Product meets all legal requirements and exceeds in many areas. Manufacturing meets and exceeds many regulatory standards in environmental compliance.	Product leads in meeting legal requirements and environmental compliances relative to its leading competitors. Product has proactively addressed many social responsibility issues not in statutes or regulations.

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7.0 Product Delivery.

This part of the survey examines the extent to which manufacturing, sales, service and support are considered in product development. Does the product "go over the wall"?

7.1 Release to manufacturing ramp-up.
Is manufacturing ready to commit production?

Manufacturing commits to the product and ramp-up plan, both of which contain many qualifications and contingencies for PD, other key functions, and suppliers.	Manufacturing commits to the product and ramp-up plan with negotiated engineering assistance during early production and relief /slack from other key functions and suppliers.	Manufacturing, development and suppliers have proceeded in parallel development for some time. Manufacturing commits to the product without reservation and with support from other key functions. Critical parameters identified.	The release to manufacturing is a non-event; manufacturing has been developing (with suppliers) their systems for some time and is well prepared to ramp-up with credible plans. Critical parameters quantitatively related to requirements and scalable parameters are identified.

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7.2 Transition to Sales.
Is the product ready for sales?

Sales organization develops sales plans when PD "releases" to sales. Readiness takes great effort. Sales presence is largely absent during PD cycle except when the product is tossed "over the wall."	Sales participates in all key review checkpoints during PD. Sales has reviewed and critiqued the product specs and prototypes during PD.	Product validated with lead users and beta customers with sales groups as full-fledged team members. Sales is confident of the product and its ability to perform in customer environment.	Product readiness is a non-issue. Sales has been a co-developer from the concept development stage. Product issues from sales are resolved as they arise throughout development.

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7.3 Organizational readiness for sales.

Is sales organization ready to commit?

Sales commits to units, revenue, and expenses after negotiating technical support from development, pricing flexibility from finance, delivery from manufacturing and other issues from key functions.	Sales commits to units, revenue and expenses with negotiated engineering assistance during early customer usage.	Sales and development have proceeded in parallel for some time. Sales commits without reservation – conflicts were resolved during development.	Sales readiness is a non-issue. Sales persons, systems, campaigns, and service and support are all coordinated. Sales has been an integral part of development along with other key functions.

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7.4 Service and Support (S&S) complexity.

Are the service and support groups ready for the product?

PD concentrates on function and performance, not service and support, which are viewed as "downstream" responsibilities of other functional groups.	There is a formal PD process that brings in the service and support groups to ensure design addresses serviceability and support. The functions have equal clout.	Cross-functional team that includes customers has been working on this issue early in the process. Customers review S&S specs and comment.	Service and support has been part of the beta prototype testing with lead users to refine S&S strategy and plans. This issue has strong support from project leader.

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8.0 Results.

This part of the survey examines the PD results from five perspectives: financial, customer satisfaction, organizational effectiveness, product, and benchmarking.

8.1. Project Financial and Market Results.

8.1.1 Project IRR and NPV

Project does not meet IRR and NPV financial metrics even after many retargeting decisions and many other accounting and financial adjustments.	Project meets IRR and NPV financial metrics after some accounting and financial adjustments.	Project meets IRR and NPV metrics as committed during project funding.	Project exceeds IRR and NPV metrics committed during project funding.

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8.1.2 Product volumes.

Product volumes below forecast established during funding stage.	Product volumes on track with forecast established during funding.	Product volumes exceed forecast established during funding.	Product volumes far exceed forecast established during funding.

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8.1.3 Product revenues.

Product revenues below forecast established during funding stage.	Product revenues on track with forecast established during funding.	Product revenues exceed forecast established during funding.	Product revenues far exceed forecast established during funding.

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8.1. 4 Product costs.

Product costs do not meet the plan established during funding, and its negative impact is visible in the product's financial performance.	Product costs on track with the plan established during funding.	Product costs meet all, and even exceed some performance targets established during funding.	Product costs' performance far exceeds the plan established during funding and the positive impact is visible in the product's financial

position.

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8.1.5 Product SG&A.

Product's SG&A does not meet plan established during funding and the negative impact is visible in the product's financial performance.	Product's SG&A on track with plan established during funding.	Product's SG&A meet all, and even exceed some performance targets established during funding.	Product's SG&A performance far exceeds the plan established during funding and the positive impact is visible in the product's financial position.

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8.1.6 Product's Market share in revenue.

Product's revenue market share trends show market share is decreasing in key targeted segments specified funding stage of base plan.	Product's revenue market share trends show market share is uneven in target markets specified during funding stage of base plan, but adequate in aggregate.	Product's revenue market share trends show market share is increasing in many key segments established funding stage, and increasing in aggregate versus base plan.	Product's revenue market share trends show product has established a new market segment and its share growing dramatically.

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8.2. Project Customer Satisfaction and Loyalty Results.

8.2.1 Customer loyalty.

Customers are displacing the product with competitor's products at an increasing rate. They are not recommending the product to others.	Customers will consider competitive products for repurchase. They recommend the product with some qualifiers.	Customer's repurchase rate is exceeding forecast. They recommend the product when asked.	Customer's repurchase-rate is exceeding expectations by a wide margin. Without prompting, they are visibly endorsing the product in important forums.

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8.2.2 Satisfaction with price for value.

Customers consider the product to be overpriced for the value they are deriving from its use.	Customers consider the product price to be fair considering the value they are deriving from its use.	Customers consider the product price to be attractive due to the value they are deriving from its use	Customers consider the product price to be an extraordinary value due to the unique benefits they are deriving from its use.

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8.2.3 Satisfaction with product function and performance.

Customers consider the product's function and performance to be disappointing.	Customers consider the product's function and performance to be acceptable and to have met their expectations.	Customers consider the product's function and performance to have exceeded their expectations.	Customers consider the product's function and performance to have created unprecedented and extraordinary competitive advantages.

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8.2.4 Satisfaction with service and support.

Customers consider the product service and support to b e disappointing.	Customers consider the product service and support to be acceptable. Overall, their expectations have been adequately met.	Customers consider the product service and support to have exceed their expectations.	Customers consider the product service and support to be surprisingly competent and efficient considering the unprecedented functions and applications of the product.

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8.3. Organizational Effectiveness Results.

Evaluate the operational effectiveness of the project's PD organization.

8.3.1 Strategic Intent.

This product did not help the strategic and competitive position of the firm.	This product maintained the strategic and competitive position of the firm.	This product improved the strategic and competitive position of the firm.	This product redefined the strategic and competitive position of the firm.

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8.3.2 Development time and slip rate.

Project slipped from original schedule committed during funding. Management intervention, decoding, and additional resources were required.	Project missed milestones committed during funding by small and acceptable margins. Needed some management intervention and incremental resources to maintain scope and schedule margins.	The project was completed on time and met every schedule milestone defined during funding. No management intervention was required.	The committed during funding. Project beat the every schedule milestone.

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8.3.3 Development budget and schedule

Project slipped from original schedule and overran budget. Management intervention, decoding, and additional resources were required to keep revised schedule on time.	Project missed milestones and budget by small yet acceptable margins committed during funding. Some management intervention and incremental resources to maintain scope and schedule margins were needed.	The project was completed on budget, on time, meeting every milestone, and without any slips. No management intervention was required.	The project beat the budget and every schedule milestone.

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8.3.4 Partner satisfaction and loyalty.

Key partners have discontinued their business relationship. Having difficulty recruiting new ones.	All things considered, partners are satisfied and loyal.	Partner's satisfaction and loyalty exceed targets. They recommend our firm. No difficulty finding new candidates.	Partner's are excited and enthusiastically recommend our firm. New candidates competing to become business partners.

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8.3.5 Project team morale.

The project team morale is low. Staff and management turnover and absenteeism are high. Staff and management recruiting was difficult.	The project team morale is acceptable with some exceptions. Staff and management turnover is acceptable.	The project team morale is high and surveys support this fact. Staff and management turnover is low. Recruiting is easy.	The project team morale and excitement are high and surveys support this fact. Staff and management fight to join the project.

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8.3.6 Productivity.

Project team's productivity did not meet its objectives. Productivity deficits visibly affected the financial measures or the schedule.	Project team's productivity indicators meet their targets within adequate margins. Productivity deficits' impact on financial measures and the schedule are within adequate margins.	Project team's productivity indicators meet and exceed most of their targets. Productivity results in incremental improvements in financial measures and the schedule.	Project team's productivity indicators exceed all key targets. They do so sufficiently to have a positive and visible impact on financial measures and schedule.
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8.3.7 Contribution to knowledge assets.

We have project documents in the archives.	We did a lessons learned.	Lessons learned are actioned. Process was changed and information improved. We now prevent a failure from occurring.	Lessons, actions, process, and information improvements now transformed organizational processes and information in fundamental ways.
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8.4. Product Results.

Evaluate the mechanical complexity of the resulting product.

8.4.1 Functions and Performance versus specifications.

Product missed key specifications committed after beta prototype. Many renegotiations are required to continue development. These negotiations are impacting financial performance and customer/partner	Product meets specifications committed after beta prototype. Minor renegotiations are required to adjust specifications to continue development.	Product exceeds specifications. Product is competitive. No negotiations are required to adjust specifications to continue development.	Product's specifications are setting industry de facto standards. Product is widely imitated. Positive impact visible in financial performance and customer and partner propensity to recommend the product.

satisfaction and loyalty.

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8.4.2 Industry awards.

No industry awards for this product.	No industry awards for this product. Mentioned in the trade press, but barely visible in analysts and consultant's reports.	Few industry awards, but many visible and favorable industry reports for the product.	Prestigious industry awards for the product. Me-too imitators appearing.

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8.4.3 Core technology newness.

Cost reduction or product repositioning, update.	New to the firm. Competitor already offers technology in this market.	Technology exists and is implemented in completely different types of products. New to the market.	Technology is entirely new, has never appeared in any type of product sold in the market. The technology is fresh out of the research lab and is causing competitive disruption.

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8.4.4 Platforming extent.

Project considered only the single product.	Project considered accommodating future derivatives and/or updates. There is a planned architecture.	Project developed multiple variants. Full platform development for a product line. The architecture is developed along product variants.	Project developed multiple variants and accommodated future technologies requiring architectural changes.

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8.4.5 Manufacturing Complexity

Negligible changes were made to the manufacturing processes. Small adjustments in vendors, tools, and parts, but fundamentally very familiar and used before.	Minimal new parts, vendors, custom parts, tools, materials, and small process changes introduced to manufacturing. New skills training is localized and for small groups.	New parts, vendors, custom parts, major tools, materials, and redesigned processes introduced to manufacturing. Specialized skills development and training are required.	Large number of new parts, new vendors, new custom parts, major retooling, new materials, and new and redesigned processes introduced to manufacturing. Large range of skills training and education required.

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8.4.6 Sales and Service Complexity

Sales and service approach unchanged. Product sales based on cost reductions, update, or similar repositioning to slow down customer defections.	Sales and service approach largely unchanged, but tuned and adjusted in order to maintain customer base against competitors.	Sales and service approach redefined to showcase product's function, performance, and technology in order to expand existing market share.	Product's unique value proposition and functionality required new sales and service processes to expand market share and occupy new market segments.

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8.5. Project Benchmarking.

8.5.1 Benchmarks.

Benchmarks only occasionally done. Results show that the product is under performing versus its key competitors in many key measures.	Benchmarks show that the product is about equal to its key competitors in key measures.	Leading product development organizations benchmark their products against yours. Product is used as a model of best of breed.	Industry, standards groups, and PD groups seek to study your product, PD practices and organizational issues to develop PD norms and de-facto standards.

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