An Investigation of the Enablers and Inhibitors to Achieving a Shorter Cycle Product Development System

by

Michael P. Pepin

B.S. Business Administration, Central Michigan University (1984)
B.S. Mechanical Engineering, Lawrence Technological University (1989)

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

Massachusetts Institute of Technology
December 1999

Signature of Author ______________________________
System Design and Management Program
December, 1999

Certified by ______________________________
Joyce M. Warmkessel
Senior Lecturer, Aeronautics and Astronautics
Thesis Supervisor

Accepted by ______________________________
Thomas A. Kochan
LFM/SDM Co-Director
George M. Bunker Professor of Management

Accepted by ______________________________
Paul A. Lagace
LFM/SDM Co-Director
Professor of Aeronautics & Astronautics and Engineering Systems

An Investigation to the Enablers and Inhibitors to Achieving a Shorter Cycle Product Development System

by

Michael P. Pepin

Submitted to the System Design and Management Program
on December 1, 1999 in Partial Fulfillment of the
Requirement for the Degree of Master of Science in
Engineering and Management

Abstract

The research in this paper focused on what the inhibitors and enablers are to reducing product development cycle time in the automotive industry. I chose the automotive industry due to its lengthy history and evolution from its beginnings as a craft industry in the 1880's through its transition to mass production in the 1990's. It was an ideal industry to study.

One company was used as the primary focus, Ford Motor Company. Over the past 20 years Ford has spent much time and money on developing ways to reduce cycle time. My research examined some of these strategies by reviewing the various product development systems of the past and what is currently being done today. Extensive surveys were done with various individuals involved in the different phases of Ford's product development system, e.g., Engineering, Testing, Manufacturing, Quality, Service, etc.

In addition to the work done at Ford, research was conducted on what some of the experts today are theorizing about this topic. To also gain some additional insight into what other mass marketers are doing, a study of Xerox's product development strategy was performed.

The research concludes with a case study on one project at Ford that was able to dramatically reduce cycle time in delivering a new product. Many of the enablers identified in this research were validated through showing how they were used on an actual program to help reduce cycle time.

Thesis Supervisor: Joyce M. Warmkessel,
Title: Senior Lecturer, Aeronautics and Astronautics

Acknowledgements

I dedicate this thesis to my wife Toni Marie Pepin. The last two years have truly been an emotional and physical strain on our relationship. Through the peaks and valleys of the program, I found Toni to be my sanity and my safe harbor. She is truly the love of my life. I also want to thank my daughter Ali for her understanding of why I could not spend my entire weekends with her. Finally, I need to recognize my new son, Zachary, who in the heat of the battle of everyday life, always has a smile for me that melts away all the stress of the day. Without the strength of my entire family, I know this journey would not have been possible.

It is important that I also recognize my High Performance Team co-workers on the 2000 USPS Explorer CRV Program! Through the past year, the road has been very tough on the group and in the middle of all the turmoil, I had to take this academic break. My teammates were more than understanding and not a single negative comment was ever made. At least not in front of me! I would like to acknowledge my other two Management team members, Stu Simon and Keith Zeitz, their tenacity and work ethic were inspirational throughout this project.

I would also like to recognize the class of 1998, especially all of my new found friends. Through the many long hours of group projects, I found the personal discussions that took place just as important as the education. I feel each one of us learned a little more about each other as well as about ourselves. The conversations many times caused much personal reflection about careers and family. To that point, I want to thank everyone with whom I had a chance to work with, on these projects. I know in the end, no matter where we all end up in the game of life, each one of us is already a winner.

I would also like to recognize the System Design and Management staff. I want to thank each of them for their hard work and dedication to make this program a winner. I believe everyone in the class recognized the amount of effort that went into developing this program and truly understood that many of the issues were not the fault of the staff, but were due to the growing pains associated with any new venture. Beyond the small disruptions and problems recognized by the students, overall the program was fundamentally sound.

I need to also comment on the teaching staff. Excellent job! The dedication of all the instructors was very evident. I believe not only did they challenge us but we in turn challenged them. The exchange between academia and industry benefited all.

Finally, it is important that I recognize Joyce Warmkessel, my thesis advisor. Joyce was incredibly supportive on my thesis topic and provided great insight throughout the development of the project. Joyce provided feedback, which caused me to consider the human aspects of the product development system. She advised me to think about things outside of the process, such as relationships, good communication, and other factors that go beyond the confines of the product development system. She emphasized that there may be other factors beyond the company structure and processes that truly make a project successful. It was those intangibles studied that also added significant additional value to the project. Joyce's insight helped to realize that the human dynamics that take place on a project will heavily influence the product development system. I learned that a Product Development System is a road map and the human element is the means by which the product is transported successfully and expeditiously from theory into a physical reality.

Table of Contents:

An Investigation of the Enablers and Inhibitors to Achieving *a Shorter Cycle* Product Development System - Thesis

Chapter 1 – Thesis Background

1.1 *Focus on the Automobile Industry*

My research was focused on the automobile industry, specifically in the area of light truck and passenger car Product Development. The objective of the project was to identify the Inhibitors and Enablers to achieving a *Shorter Cycle* Product Development System (SCPDS).

The automotive industry was chosen because of its long history and evolution from a craft industry in the 1880s through its transition to mass production in the 1990s. As we enter the next millenium this evolution will continue with many companies already well on their way towards the next revolutionary change, "mass customization". Throughout this evolution one common objective has persisted among all the manufacturers and that is how to bring products to market faster.

Each generation of new vehicles has resulted in a product that is far more complex and technologically advanced. If one were to compare vehicles of the past to those of today, exponential improvements would be found in the areas of engine performance, handling and ride characteristics, machine operator interfaces, internal system diagnostics, ergonomics, and safety. Many of these improvements have been driven by external inputs such as federal and state regulations, competition, customers needs and/or wants, technology breakthroughs, assembly innovations, and new techniques in design and development.

The ever-increasing complexity in the light trucks and passenger cars has caused many of the automobile companies to develop massive organizations where the design is divided up into specific specialties. Professor Kim Clark, of the Harvard Business School, cited one example were she found an engineer in a mass production auto company who had spent his whole career designing auto door locks. He was not an expert on how to make door locks. However, that was the job of the door lock manufacturer engineer. The door lock design engineer simply knew how they should look and work if made correctly.[1]

The weaknesses of this system of divided labor are easy to see and mass production companies over the years have tried to devise control mechanisms through complex product development processes. The consequences of such an approach over time has resulted in many of the companies having organizational structures and product development processes which are extremely inflexible, slow to react to the changing markets or competition, unable to deliver products that the customer wants, or in some extreme cases the quality and high mileage reliability of the product, has declined significantly. These massive organizations are paralyzed by inefficiencies and the basic fundamental systems and processes have evolved into a proliferation of steps and procedures that are not value added, frustrate the individuals who use them, and waste valuable resources, specifically time. Many of these auto manufacturers today are finding that these problems are causing low morale, budgets being over spent, and projects coming in behind schedule. The external affects are even worse, customers are lost, revenues are flat or decline, overall profits drop, market share declines, and stock prices fall. These companies fight back to retain market share and revenues through short sighted means such as rebates, internally subsidized low financing rates, and/or company wide cost reduction product blitzes. In some instances companies have acquired other auto manufacturers to increase market share. Over time the same problems resurface, with the root causes never truly being addressed, one of which being the length of time required to get products to market.

[1] Womack, James P., Jones, Daniel T., Roos, Daniel. (1990). "The Machine that Changed the World". ISBN 0-89256-350-8. Rawson Associates, Macmillan Publishing Co., 866 Third Avenue, New York, NY 10022.

As an overall industry, the automobile manufacturers have made improvements in reducing cycle time. For example, Ford produced the 1990 Town Car in about 41 months versus the 1986 Taurus which took approximately 60 months.
The Asian manufacturers, specifically the Japanese, have made the greatest improvements in cycle time. Mazda, for example, in 1997, delivered the Demeo from surface freeze to Job 1 in 15 months, which at that time was a record for the industry.[2] Many of the other manufactures are trying to reduce cycle time by restructuring their organizations or revamping their product development systems. Neither approach really addresses the inhibitors or enablers to achieving faster cycle time, therefore they continue to lag behind the Japanese manufacturers.

One company that has been trying to address the inhibitors and enablers is Ford Motor Company.

1.2 *Ford Motor Company*

Ford Motor Company has been producing automobiles and trucks for over 96 years. The very first line of vehicles were designated alphabetically according to the Model level which began with A. Most people recognize the Model T, which was Ford's first truly mass produced vehicle. The Model T came in nine body styles – including a two seat roadster, a four-seat touring car, a four-seat covered sedan, and a two seat truck with a cargo box in the rear. However, all rode on the same chassis, which contained the same mechanical parts. In 1923, the peak year of Model T production, Ford produced 2.1 million Model T chassis, a figure that would prove to be the high water mark for standardized mass production.[3]

---

[2] Ford Motor Company. "FPDS Process Overview – Total Process". June 10, 1998.
[3] Womack, James P., Jones, Daniel T., Roos, Daniel. (1990). "The Machine that Changed the World". ISBN 0-89256-350-8. Rawson Associates, Macmillan Publishing Co., 866 Third Avenue, New York, NY 10022.

Today, Ford Motor Company produces over several dozen different model cars and trucks. As of 1998 Ford has produced a total of 270 million cars and trucks since its incorporation in 1903. Ford Motor Company is the second largest automotive company in the world with a market share of 24.6%.[4] The 1999 calendar year is expected to be a record sales year for Ford.

But, with all those achievements Ford cannot sit back and rest on these accomplishments because it is being attacked by both domestic and foreign competitors. The industry as a whole is over capacity by almost 22 million units. To gain a perspective on this amount, every automobile factory in North America could close and there would still be excess capacity.[5]

The majority of Ford's current profits reside in the Light Truck and Sport Utility segments. Currently Ford is losing money on many of its small and midsize passenger cars. If the economy would enter a recession or fuel prices would escalate, Ford could be in a precarious situation with its expensive high fuel consumption Light Truck and Sport Utility vehicles. The competition is also fighting back with the introduction of many new high and low end Sport Utility vehicles. In the truck segment, Toyota is also threatening Light Truck sales with its new Tundra.

Internally Ford also struggles with cumbersome systems, a product development process which is inflexible, inefficient, and doesn't scale to smaller projects below 18 months, and has engineering tools which are not being fully used. The company has also reorganized itself several times with yet another reorganization scheduled before the year 2000.

For Ford to fend off the competition, resolve its internal problems and retain its market share, the company has recently implemented a new consumer focused

---

[4] Ford Motor Company's 1998 Annual Shareholder Report.

[5] The Economist. May 1997.

philosophy known as "Spirit of Ford". In Spirit of Ford, all employees are requested to become more customer focused in their daily work tasks. The overall objectives for the company are:

1. Focus on developing vehicles with the highest of quality and perceived value.
2. Deliver products that are exciting and innovative which meet or exceed customer expectations; and
3. Reduce time to market by identifying and eliminating as many inhibitors while identifying and pursuing all enablers through "Best Practices".

The goal of the research in this thesis is to address objective three, by studying what are the inhibitors and enablers to achieving a *Shorter Cycle* Product Development System.

1.3 *Research Strategy for Thesis*

This thesis begins by defining what a basic Product Development System tries to accomplish and who are the typical stakeholders involved. Even though the focus of this study was on the auto industry, many of the findings and theories can be applied to other industries. Once I developed a framework for what Product Development encompasses, I proceeded to examine what the expectations of the customer are and how these expectations evolve, specifically in the area of mass production versus mass customization. From this point, I began my internal investigation of the evolution of Ford's product development system. By studying the various product development systems used over the past 20 years, e.g., Concept to Customer, World Class Timing, and Ford Product Development System, I was able to extract key inhibitors and enablers through a comparison of the various systems.

After looking internally at Ford's processes, I proceeded to look at what is done at another successful high volume consumer product manufacturer. The product development system of Xerox Corporation was researched By analyzing this other system, I was able to define additional enablers that would complement those found internally.

After I completed my review of Ford's internal processes and a look at some other industry's product development processes, I expanded my research to find out what some of the experts in the field had to say about how to achieve faster cycle time.

1.3.1 *Data Gathering*

The next step in this research was the gathering of actual data within Ford. The data collection involved conducting extensive interviews among the various activities within Ford Motor Company to isolate as many inhibitors and enablers as possible. A total of 20 individual interviews were performed along with a single focus group interview. Once these surveys were complete, Affinity and Ishakawa diagrams were used as the tools to extract key information from all survey data. Once the empirical data was analyzed and conclusions were drawn, an actual case study was reviewed to validate these conclusions. The 2000 Model Year, United States Postal Service, Carrier Route Vehicle project was selected for the case study.

Figure 1.1 is the flow chart, which schematically illustrates the path that was followed:

SCPDS Inhibitors and Enablers - Thesis Schematic

Product Development System Definition

Defining the Needs of the Customer

Industry Expert Research

Internal Ford Motor Company Historical Research
- Concept to Customer
- World Class Timing
  - Go Fast Timing
- Ford Product Development System

External Company Research
- Xerox

Internal Surveys and Focus Group Data Gathering

Conclusions and Validation Through 2000 MY USPS CRV Case

Figure 1.1

Chapter 2 – Product Development Fundamentals

2.1 *Definition of Product Development System*

A *Product Development System* is a map, which an organization uses to deliver a product that a customer needs or wants. The Product Development System can be modeled as shown in Figure 2.1, and is analogous to the P-Diagram used in Robust Engineering theory.[6] The P-Diagram is a model used to describe the technique of how to achieve a Robust Design, that is making a product which is resilient to the surrounding environment, in which it operates.

2.2 *Product Development Systems and the P-Diagram*

In the Robust Engineering model, the design and development of a new product requires the Engineer to first determine how the user or operator wants the product to perform or respond. The strength and accuracy of the *Response*, that is how the product will fit or function, relates to how well the Product was resilient to the *Noise Factors* when the ideal *Control Factors* are used during the design and development phase. In contrast, as a Product moves from Concept through manufacturing and delivery, the Product Development System has Inhibitors (*Noise Factors*) throughout the process, but through the proper use of the Enablers (*Control Factors*) a final end product is produced and delivered (*Response*), to the customer, to satisfy the need or want.

The P-Diagram, in Robust Engineering, starts with a Signal Factor which is the group of parameters set by the user or operator of the product, i.e., size, fit, weight, operating speed, etc. In comparison to the Product Development System, this Signal Factor is the product or service market opportunity that has been identified.

The next element in the Robust Engineering P-Diagram model is called the

---

[6] Phadke, Madhav S. (1989). "Quality Engineering Using Robust Design". ISBN 0-13-745167-9. P T R Prentice-Hall, Inc. A Simon & Schuster Company, Englewood Cliffs, New Jersey 07632.

Noise Factor. The *Noise Factors* cause the *Response* to deviate from the target specified by the *Signal Factor*, i.e., temperature, humidity, electromagnetic interference, unit to unit variation, deterioration over time, etc. The *Noise Factors* related to the Product Development System model are known as the Inhibitors to the process, i.e., late changes, part failures, miscommunication, incomplete or incorrect information, etc.

The third element of the P-Diagram is the *Control Factor*. The *Control Factor* in Robust Engineering relates to the parameters that are specified by the engineer, i.e., type of material, wire gage, size of the components, cost of the components, etc. The *Control Factors* in a Product Development System are called the Enablers. The Enablers can encompass everything from how groups are organized and communicate, to the tools used by Engineering, to the procedural processes that are put in place that dictate how the group will interact. Some examples include, the use of Collocated Cross Functional teams, Quality Function Deployment (QFD), Computer Aided Engineering (CAE), Computer Aided Design (CAD), Design Failure Mode Effects Analysis (DFMEA), Organizational Charts, etc.

The last element of the P-Diagram is the *Response*. The *Response* in Robust Engineering is how the product fits or functions over the life of its use. In Product Development the *Response* is the final product or service that is delivered to the customer. The final product (*Response*) attributes will include the following: Safe, Reliable and Robust, High Quality, and Low Cost.

Product Development P- Diagram

The product development process can be modeled by the following schematic:

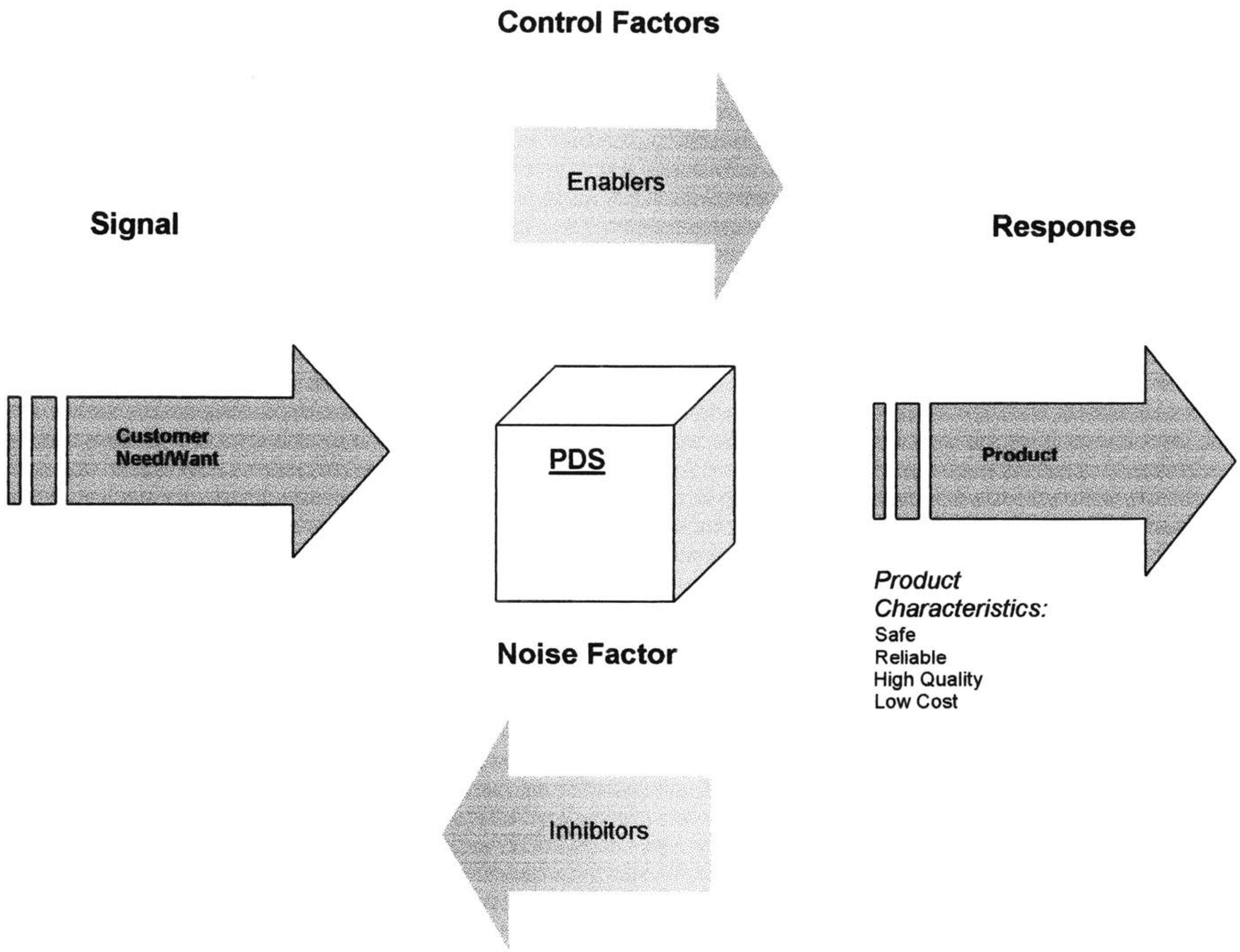


Figure 2.1

2.3 *Generic Product Development Phases*

A *Product Development System* was defined previously as a map which an organization uses to deliver a product that a customer needs or wants. Two key words to describe the process are Planning and Implementing. Product Development is therefore a process by which you layout a detailed plan and then you implement that plan. The generic steps that all companies must go through to implement the plan are shown in Figure 2.2.

Generic Product Development Process Steps

Process Graphic:

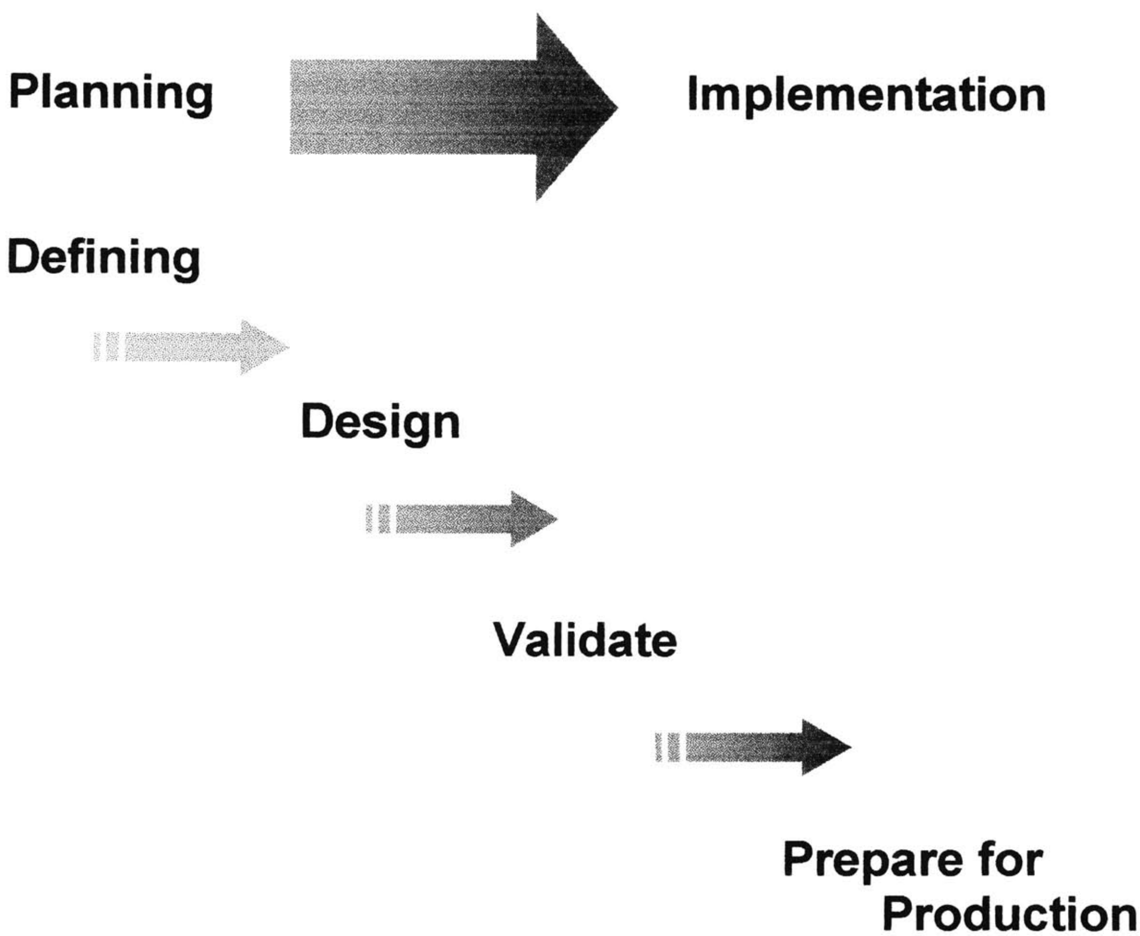


Figure 2.2

Whether the company produces automobiles or software, the four basic steps are followed in all Product Development Systems and these are: Define, Design, Validate, and Prepare for Production.

1. *Defining* – Every product development system must include a step which defines the customers needs or wants. Typically this phase also involves

translating the need or want into explicit specifications that capture all of the attributes of the product. Many times, these specifications are decomposed from a customer user specification, to a system specification, to subsystem specifications. In some cases the product may require 3, 4, or more levels of decomposition depending on the complexity of the product. It is also during this defining phase that most companies develop the financial business case for justification to proceed with the project.

2. *Designing* – During this phase of the Product Development System concepts are developed and analyzed. Depending on the type of product and industry, the concepts developed may be virtual concepts, mathematical models, or physical models (prototypes) which have the actual design fit and function. It is during this phase that concept becomes reality.

3. *Validation* – Validation typically refers to the testing of the product. In this phase the engineer confirms that his or her product meets or exceeds all related specifications through a battery of tests. Many times, at the validation phase, actual physical prototypes are fabricated and assembled. The level of prototype will determine the type of testing required. For example, in the first prototype build at Ford Motor Company, which is called the Confirmation Prototype (CP), the majority of the parts are off prototype tools. The CP vehicles will be tested for fit and function. Some of the later prototype builds at Ford will be used to verify assembly plant tools and equipment. In other industries such as software development, companies will have two levels of validation, one is the alpha version which is the initial prototype level and the beta version which is the production representative level.

4. *Prepare for Production* – The Prepare for Production phase is where the

manufacturing or assembly process is completed. All preparations to deliver the product to the customer are complete, i.e., distribution channels ready, transportation process complete, quality systems are ready, customer service arrangements are complete, and after the sale monitoring systems are ready.

Typically most consumer product manufacturers will follow, in one form or another, all the generic Product Development System phases described. A number of milestones or checkpoints are typically established at each of the phases so that the project team can determine if the program is on schedule or not. The number of milestones or checkpoints will vary depending on the level of complexity within each phase. Regardless of the number of phases, a Product Development System will have many stakeholders involved.

2.4 *Product Development System Stakeholders and Their Needs or Wants*

The various phases of a Product Development System will have many stakeholders. Table 2.1 gives a list of the stakeholders involved in a project. The amount of equity by each group will vary in each of the phases.

Product Development System – Stakeholders/Wants

1. Customer	Safe/Reliable/Robust/High Quality/Low Cost/Timely Product
2. Company	Maximize Profit/Reduce Product Liability/Increase Market Share/Obtain Industry Leadership/Reduce Cycle Time
3. Management	Minimize Manpower Needs/Minimize Cost/Enable Team to Meet Deliverables/Reduce Cycle Time
4. Employees	Clearly Define Objectives/Define Roles & Responsibilities/ Maximize Communication
5. Share Holders	Maximize Return of Investment/Provide Long Term Growth/
6. Engineering	Provide Road Map/Optimization of Product
7. Quality	Reduce Warranty/Eliminate Product Recalls
8. Manufacturing	Reduce Cycle Time/Reduce Scrap
9. Service	Ensure the Product is Reliable/Ease of Service
9. Sales & Marketing	Product Produced Satisfies What Customer Wanted and When the Customer Wanted it.

Table 2.1

Table 2.1 also shows what are the typical wants from each of the groups.

From this list, an overriding want was evident and that is to reduce cycle time. Whether a company has a generic four phase Product Development System or an extremely detailed multiple phase system, the key to being successful is the ability to bring the product to market quickly.

Chapter 3 – Short Cycle Product Development and the Evolution into Mass Customization

3.1 *Short Cycle Product Development System*

Having a *Short Cycle* Product Development System (SCPDS) is a goal all companies strive to achieve. A utopian SCPDS would be one in which a product is delivered instantaneously to the customer the minute a need or want is recognized. Of course, this isn't the case in reality. Typically once a need or want is identified, the time for that new product to reach the customer may take months, years, or decades. In some cases, the product may arrive, and due to the length of the development cycle, it may no longer fulfill the need. The customer has gone on to have his or her need filled by someone else and the company missed out on the opportunity, as well as any future repurchasing that this customer may have done. In today's consumer goods market, companies tend to have varying degrees of product development cycle times. For example, a software company may take a few months to development a new product, compared to the automotive industry were it may take years for a new product to reach the customer, to the aerospace industry were it may take decades to deliver a single product.

Reducing time to market minimizes the need for scarce resources such as Labor and has a dramatic effect on the bottom line. In every industry that develops new products, the key is to get this new product to the market as quickly as possible. The speed at which a company can get its product to market first can enable it to dominate an industry, or at least help capture large amounts of market share. Shorter product development cycle times also assures that what you found as a market opportunity at a particular point in time will still be present once you are producing the product. There have been many cases where a company has missed a market opportunity due to a long drawn out product development system. Successful companies in the next millenium will get to the market fast with a product that meets its customer needs in the area of reliability, cost, and quality. The days of old when you could sell what ever you made at what ever price you wanted are gone, and only reserved for those products that are truly revolutionary. The key to the future, specifically for the automotive industry, is to determine precisely what the customer wants, develop the product as quickly as possible (always continuing to recheck the product to ensure that it meets the expectations of the customer), and get it into production. The product development system must focus on many aspects, the basics for the customer are reliability, low cost, high quality. The product must also be designed for ease of assembly and service. Lastly, new products today must take into consideration the environment by being designed with the ability to be recycled. The product development system must therefore take into account the customer wants, the needs of manufacturing, service, and salvage requirements when disposing of the product at the end of its life cycle.

The product development system should be a map for the system to follow so that it aids the organization. The process should ensure that it emphasizes the use of the latest tools. Short cycle product development systems must be extremely flexible. The key is for the system to ensure the basic tools are used even as it is modified throughout the products development. A new product or a refreshed product must continually be reviewed during the development process to ensure that it meets the initial customer expectations.

The expectations of the customer today are changing. As noted in chapter 1, many automotive companies are evolving their systems into true mass customization processes.

3.2 *Mass Customization*

Mass Customization is the next evolutionary change that is taking place for many consumer product manufacturers and the automotive industry is one of them. But before the theory of mass customization can be explained, one must understand a little history of what steps led the companies to this point, specifically in the area of customer focus.

Customer focused companies have evolved through four stages, Table 3.1 lists these stages.[7]

Stage	Classification	Description
0	Product Out	No Customer Focus
1	Product Businesses	Expansion of Idea of Customer
2	Across Customers/ Between Customers & Company	Integration of Concerns
3	Mass Customization	Satisfy Each Customer Individually

Table 3.1

At Stage 0 companies typically start their businesses by practicing "Product Out". "Product Out" refers to a business only focused on getting the product out the door with little concept of customer focus. The American automotive industry in the 1940's through 1960's had this perspective. The American public was so hungry for personal transportation that what ever was produced was basically snatched up by the public. A few new models here and there did not fair so well but overall this was the state of business during this period. Manufacturers produced what they wanted and consumers were forced to purchase what was available.

In the first era of awakening to customers (stage 1.), product companies discovered the benefits of customer focus. Between the late 1960's and early 1970's the American automotive industries evolved into Stage 1. The change was caused by

[7] Waldon, David. "Evolution of Customer Focus and its Challenges". Chapter 7 of new text book draft. Permission granted by Author, September 1999.

the rise in gas prices and the threat of smaller economical and fuel efficient vehicles by the Asian imports. Until this point, American automobile manufacturers produced large gas guzzling vehicles with little focus on determining what the customer really wanted. American manufacturers had to rethink their practices and begin focusing on producing products that the customers really wanted.

The drawback at this point was not just identifying that one has customers but being able to discover and understand what they cared about. Customer concerns are often multi-faceted, and the company often has a limited mindset about the value the company is providing to the customer.

The next stage of the evolution of customer focus, therefore involves the integration of concerns – across customers, between what customers say and what they need, and between the customer requirements and what the company can provide (Stage 2).

The Japanese manufacturers were first to obtain this level of understanding around the mid 1980's. By the early 1990's this knowledge was clearly understood because the American market share was beginning to erode. Toyota's Camry and Honda's Accord started outselling some comparable American models. The successful launch of Toyota's luxury Lexus vehicle line and the ability to immediately and successfully compete directly with Mercedes, BMW, Cadillac, and Lincoln lines. The American automotive companies took note and pushed their organizations to evolve into Stage 2.

The integration of concerns across customers has made some companies and management thinkers realize that there may be ways companies can provide each customer with exactly what the customer wants rather than a compromise. These companies attempt to practice 1-to-1 marketing. For instance, many retail companies now keep track of exactly what each customer buys from them, and try to provide their customers new offers specifically tailored to each customer. Many grocery stores, in the U.S., now keep track of what individual customers purchase and give discount coupons for future purchases they think a customer might be interested in based on their previous purchases.

Other companies trying to provide customers with exactly what they want are moving to mass customization (Stage 3). For instance, a clothing manufacturer collecting size data on individual customers is then able to produce suits to an individual's own specifications. There are also numerous information services that let users customize the topics covered and format of reports delivered to customers. This 1-to-1 marketing and mass customization tends to depend on information and manufacturing technology to collect the individualized data and to produce the individualized products and services.

3.2.1 *Historical Summary of Mass Customization*

Back in the time of individual craftsmen in little villages, the craftsperson knew everything about the customer, and the customer knew nothing about what was available in the wider world. With the advent of craft shops, the craftpeople knew their customers slightly less personally and the customers had access to a slightly larger vendor base. With mass production, the vendor's knowledge of individual customers became non-existent, but the customer now knew about many vendors, at least regionally and perhaps nationally. With the expansion of mass marketing, customers began to know what was available throughout the world (i.e., they had many many options), and vendors still were not aware of individual customers although they may have begun to learn about national or ethnic differences. As customers knowledge of vendors throughout the world became greater, vendors began to have to care about individual customer needs again to compete, e.g., database marketing. Ultimately the vendors can best serve customers and remain competitive with mass customization.

Figure 3.1, shows how this evolution has taken place. In the left half of the u-shaped curve the desire of vendors to produce lots of identical products drove down the vendors interest in knowledge of individual customers, and expansion of communications technology initially helped this. Eventually (the right half of the u-shaped figure), the expansion of global communications and the choices it gave to customers began to force vendors to become interested in individual customers again. With the increased sophistication of information and manufacturing technology, collection of individualized customer data (database marketing) and production of products and services customized to individuals customers became possible.[8]

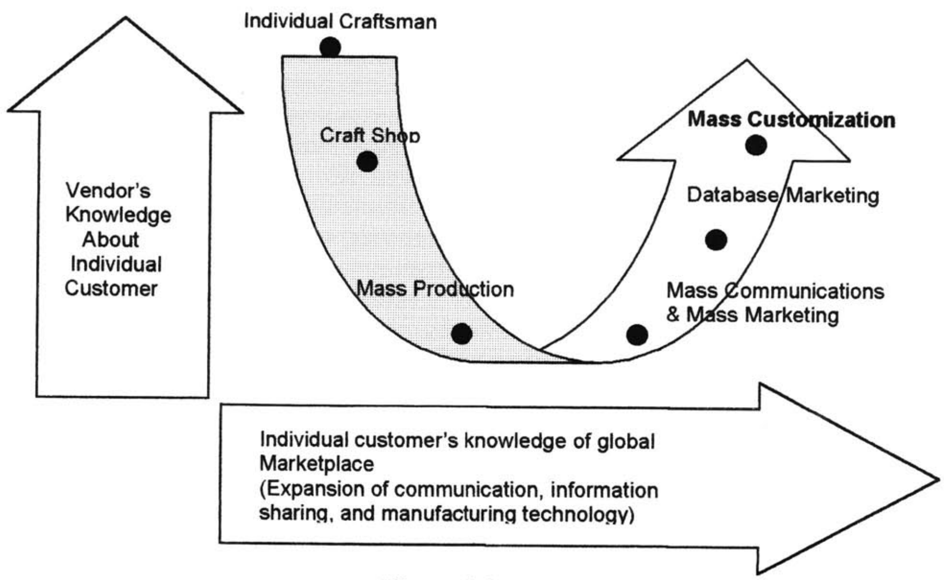


Figure 3.1

As mentioned in Chapter 1, the automotive industry is working hard to achieve this next evolutionary step, mass customization. One important enabler by which this is

[8] Waldon, David. "Evolution of Customer Focus and its Challenges". Chapter 7 of new text book draft. Permission granted by Author, September 1999.

being pursued is by achieving Short Cycle Product Development Systems for low volume niche market vehicles.

3.3 *Niche Markets and Mass Customization*

Many of the automotive companies today are pursuing mass customization through targeting small niche markets. In the past U.S. automakers would have never given a project a second look if the volumes were not more than 100,000 vehicles per year.

It's a costly process taking a car from concept to customer, often running upward of a billion dollars. For example, Ford's first "world car", the Mondeo – which sold in the U.S. as both the Ford Contour and Mercury Mystique cost nearly $6 billion. Just changing a fender or redesigning an instrument panel can add up to $100 million or more. So for mass marketers, like Ford, it simply hasn't made economic sense to turn out products in batches of less than 100,000 units annually.[9]

Jac Nassar CEO of Ford Motor Company recently quoted in a magazine article on the subject, "I personally think the days of the very high-volume vehicle are behind us". Instead, he predicts the cars like the Thunderbird are going to be more the norm than the exception in years to come. The new Ford Thunderbird was planned around volumes as low as 25,000 to 35,000 vehicles.

The difference is the ability to use common platforms and common power trains, Nassar explains. This way, the business case can be constructed so we start making money at very low volumes and very short lifecycles. Another example of this is Ford's new Mercury Cougar. Although its angular, "edge" design stands in sharp contrast to the marshmallow-soft Mercury Mystique, they both share the same chassis. The Cougar uses nearly 70 percent of Mystique's chassis components, everything from its

---

[9] Eisenstein, Paul, A. "Wheel Wise:Creating Their Niche". World Traveler Magazine. September 1999.

steering wheel to the anti-lock brake system.

The next Ford Thunderbird will lift many key parts from the new Lincoln LS sedan. And, in turn, many of those components will be shared with the Jaguar S-Type.

The approach Ford is taking in mass customization is to commonize, across vehicle lines, as many underbody parts as possible while differentiating the models drastically through different body styles. The vehicle's chassis components will be proven out as a system, e.g., crash testing, brake testing, etc. while customizing body styles for the various niche markets. Other automotive manufacturers are also taking this approach.

Chrysler, before its merger with Daimler-Benz AG, scored a series of hits with such low volume specialty vehicles as the Dodge Viper, a retro-styled sports car, and the Plymouth Prowler, a factory-built hot rod. Chrysler's new, retro-looking PT Cruiser is, under the skin, a Dodge Neon.

During the early 1980's, General Motors introduced a wide range of niche vehicles, including the Cadillac Allante, the Pontiac Fiero and Buick Reatta. High production costs and low sales killed those products.

GM hopes to add even more niche cars to its lineup, and they won't carry the price tag of a new Vette. Later this year, the automaker plans to break ground for the first of three new assembly plants. Collectively code-named Project Yellowstone, they can be thought of as a revolution on the assembly line. The three plants will be modular facilities.

A handful of primary – or Tier I – suppliers will set up their own factories adjacent to the GM plants to preassemble 15 large modules, such as instrument panels or complete interior packages. They'll ship the modules to GM on a just-in-time basis, in the same sequence those parts are used on the assembly line.

Modules will require far less assembly effort, and virtually no warehouse space. Thus, a Yellowstone plant will be one-third the size and cost of a conventional facility. The GM side of the workforce will be cut nearly in half, to around 2,000. And though some jobs would simply be transferred to suppliers, most partsmakers pay their workers a fraction of the nearly $50 per hour wages and benefits earned by GM employees.

That would give GM a potentially huge competitive advantage, for profits will go to whichever automaker can do the best – and fastest – job of tapping into shifting market trends. And one thing seems certain: "There's a tremendous cry among consumers for something truly individual," says Bill Robinson, an automotive design instructor at Detroit's Center for Creative Studies.

With the selection that exists in the automotive market today, differentiation will become even more crucial.

"That's especially true among younger car buyers", adds Chris Cedergren, a marketing consultant with NexTrends, Inc. "These new buyers want to customize their cars, take delivery tomorrow – and not pay anything extra for it," he says. That poses a real challenge for automakers unable to learn how to cut development cycles and tooling costs.

Just how far can the industry go with the niche car concept? As part of its "2020 Hot Rod" study, GM is exploring an idea that would go several steps beyond Project Yellowstone. Outsider suppliers would produce not just modules, but whole car bodies, complete with interiors. Consumers would go to their local dealer – or perhaps connect to GM on the Internet – and order a custom body, the same way they'd choose a new wardrobe. The body would be shipped to the assembly line then mated to a special, low volume chassis.[10]

[10] Eisenstein, Paul, A. "Wheel Wise:Creating Their Niche". World Traveler Magazine. September 1999.

Ideally, what today's automakers need is a stream of "new vehicles" to go after as many niche markets as possible. By creating a stream of new products, you avoid the annual new model introductions of the past. You don't have to worry about unloading the last of the years model prior to the new model introduction. The ideal position would be for all the vehicles you are producing to be so exciting that each one commands their own audience. You sell all that you make without having to provide incentives. You price the vehicle appropriately where the company can make a reasonable profit and the customer feels that he or she acquired actual value for the money spent. The ideal world envisioned, would be for the car not to depreciate significantly once the customer walks out of the show room. The car maintains it value or some cases it appreciates due to its limited volume. Ford and the other auto manufacturers must achieve this niche market mind set.

As mentioned throughout the chapters, for a mass marketer to assure that it fills the market need, a Short Cycle Product Development System becomes a critical part of the equation. Most companies in the Automotive Industry and outside the industry understand that reducing time to market is critical. In Chapter 1 it was described that the Japanese have been very successful shortening cycle time and are continually making improvements in this area. Other automakers have realized this, but are plagued by many issues which they believe are outside of their control. What then are the real inhibitors and enablers to achieving faster cycle time? The chapters that follow will try and answer this question.

Chapter 4 – Product Development & What the Experts are Saying

So why are Toyota, Honda, and Mazda so successful in reducing cycle time? What is wrong with us? Is it our systems, our management structures, our engineers, our tools, or our overall approach at designing and developing vehicles? In James Womack's book, The Machine That Changed the World, he states that many of the Japanese auto plants require one half the effort of the American luxury car plants, half the effort of the best European plant, and one sixth the effort of the worst European luxury car producer.

In 1997, Mazda delivered the all new Demeo from surface freeze to Job 1 in 15 months. This directly correlates to 25.5 months in Ford's Product Development System.

Toyota's product development teams are ¼ the size of most American automotive manufacturers and produce as many vehicles.

So why are we so unsuccessful when it comes to reducing our time to market? We seem to do it slower, with more people, and spend much more money at it. The end result is that the American car manufacturers are losing ground against the Japanese.

4.1 *Misunderstandings about Project Timing*

Today many Project Managers believe that the only way to protect the whole is through protecting the completion date of each step. As a result, we pad each step with a lot of safety time. We are suffering from three mechanisms which when combined, waste most of the safety time: a.) a student syndrome, b.) multi-tasking and c.) delays accumulate and advances do not.[11]

The *student syndrome* or simply procrastination in our decision making and project staffing is very common. Clark and Fujimoto, in James Womack's book The

[11] Goldratt, Eliyahu, M. (1997) "Critical Chain". ISBN 0-88427-153-6. The North River Press Publishing Corporation, P.O. Box 567, Great Barrington, MA 01230.

Machine That Changed The World, found that many Western development efforts fail to resolve critical design trade-offs until very late in the project. One reason is that U.S. team members show great reluctance to confront conflicts directly. They make vague commitments to a set of design decisions – agreeing, that is, to try to do something as long as no reason crops up not to. In Japan, by contrast, team members sign formal pledges to do exactly what everyone has agreed upon as a group. So, conflicts about resources and priorities occur at the beginning rather than at the end of the process.

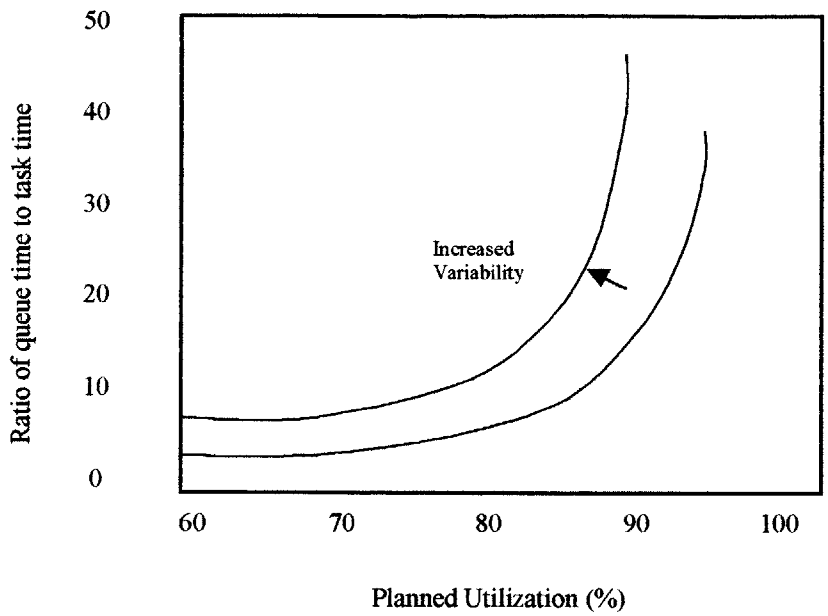
The result is a striking difference in the timing of the effort devoted to a project. In the best Japanese lean projects, the numbers of people involved are the highest at the very outset. As development proceeds, the number of people involved drops as some specialties, such as market assessment and product planning, are no longer needed.[12]

The *multi-tasking* myth. In many firms it is commonly believed that to get more out of the organization each employee should learn how to multitask. By multi-tasking it, is believed that the organization can be more productive. The truth is that projects actually get done faster if the organization takes on fewer at a time. To prove this point the following manufacturing example will be used. In a manufacturing plant, the lead time of a job is the sum of two components: the amount of processing time that the job requires and the amount of time it spends waiting for machines to become available. The time spent waiting at each machine increases with three factors: the planned utilization of the machine, the variability of the workload assigned to that machine, and the variability of the machine's processing capability. The Graph 4.1 shows how these factors interact.[13]

---

[12] Womack, James P., Jones, Daniel T., Roos, Daniel. (1990). "The Machine that Changed the World". ISBN 0-89256-350-8. Rawson Associates, Macmillan Publishing Co., 866 Third Avenue, New York, NY 10022.

[13] Adler, Paul S., Mandelbaum, Avi, Nguyen, Vien, Schwerer, Elizabeth. "Getting the Most out of Your Product Development Process". Havard Business Review, March-April 1996.



Graph 4.1

If the products have to move through several backlogged workstations and if some tasks need rework, little wonder that the plant, which was operating at 90% utilization with high process variability, often needed to quote lead times nearly 20 times the actual processing requirements.

In product development, where work centers are people rather than machines, workload variability is the variability in the number and type of projects taken on and process variability is the variability in the amount of time and the number of iterations needed to complete the tasks. If the number of projects we start implies a planned workload of 90% to 95% of capacity (which it usually does, even when we want to leave a cushion), then it is hardly surprising that our project completion times are more than five times the critical path prediction.[14]

The final misunderstanding is that *delays accumulate and advances do not.*

---

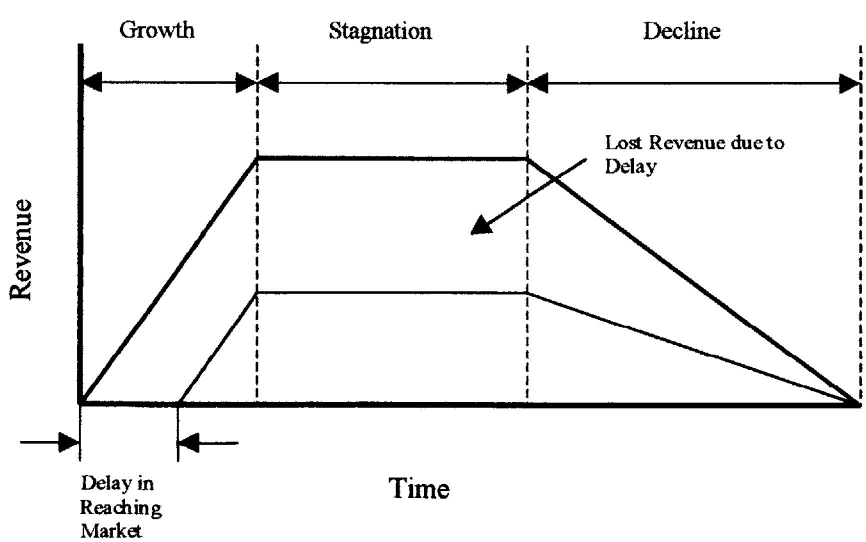
[14] Adler, Paul S., Mandelbaum, Avi, Nguyen, Vien, Schwerer, Elizabeth. "Getting the Most out of Your Product Development Process". Havard Business Review, March-April 1996.

Tasks that complete on time or ahead of schedule, do not always carry forward the time savings to the down stream tasks.

4.2 Financial Implications of Delaying a Project

In the global market, successful companies will be those that learn to make and deliver goods and services faster than do their competitors. These "turbo marketers," as Kotler and Stonich (1991) term them, will have a distinct advantage in markets where customers value time compression enough to pay a premium or to increase purchases.

Today's Executives and Project Managers must fully understand the implications of not getting to market on time. Studies by the consulting firm Mckinsey & Co. have shown repeatedly that being a few months late to market is even worse than having a 30% development cost overrun. Figure 4.1, points up the differences in revenue when a product is on time or late. The model underlying the graph assumes that there are three phases in the product's commercial life: a growth phase (where sales increase at a fixed rate regardless of entry time), a stagnation phase (where sales levels off), and a decline phase (where sales decrease to zero). The figure shows that a delay causes significant decline in revenue. For example, if a market has a 6 month growth period followed by a year of stagnation and a decline to zero sales in the succeeding 8 months, being late by 3 months would reduce revenues by 36%. Thus a delay of 1/8th of the product lifetime reduces the income by over 1/3.



Fiqure 4.1

Such a loss can be especially severe since the largest profits are usually realized during the growth phase.[15]

As one can see from the graphic, delaying a project has significant financial Implications. Therefore, it is critical to get the product to market as soon as possible.

Knowing the timing and cost implications, what are the enablers to achieving faster cycle time?

4.3 *The Classification of the Enablers into the 3P's.*

The common challenge among all mass marketers is how to reduce time to market for their products. Over the years, there have been thousands of books and articles written on the subject. The opinions and theories put forth by academia and industry experts tend to fall into 1 of 3 categories. I call these three categories the 3P's, which refer to the Process, People or Planning. These three categories truly capture the essence of where the root causes lie in reference to the Inhibitors or Enablers to achieving shorter cycle product development. The following are examples of some of the Enablers found under each category according to the experts.

4.3.1 *Process Enablers*

1. Organize and document a repeatable design process – Get out of the habit of treating every project as if it were a clean sheet of paper. Make a competitive weapon out of the fact that some parts of your organization have already learned to develop products well. Carefully define and document what they do.

2. Conduct design reviews at critical milestones; conduct progress reviews when the business needs information – Both of these behaviors help monitor, measure, and control. Too often, all monitoring falls under the umbrella of the monthly progress report,

[15] Shtub, Avraham, Bard, Jonathan F., Globerson, Shlomo. (1994). "Project Management – Engineering, Technology, and Implementation". ISBN 0-13-556458-1. Prentice-Hall, Inc., A Paramont Communication Company, Englewood, Cliffs, New Jersey 07632.

usually in both written and presentation form. These meetings are apt to both produce hasty design decisions and shortchange the business aspects of the project.

Product design and business operate on very different cycles. Product design has natural breakpoints that don't fit neatly into a monthly or quarterly calendar. Business, on the other hand, is periodic, and management has to know at regular intervals about money, people and risk. Fortunately, the solution is straigtforward: Create a clean separation of the two activities; then when each is reviewed, focus on issues critical to the particular area – business or technology.

3. Give priority to product (over function) in the organizational structure – This behavior provides essential structural support to team based development, by asserting that organizations must be built primarily around the products being developed. Tradition tends to go the other way, holding that the functional stove pipes are the real organization. Thus budget control, lines of authority, rewards, and recognition are designed to serve the functional units. For teams to work, this model must be turned inside out, with projects and project managers becoming the real business and functional organizations taking a support or shadow role.

4. Keep team member destiny in the hands of the project leader. For consulting firms such as Booz, Allen & Hamilton and Mckinsey & Co., life is a series of projects. The team leader might be from San Francisco or Sydney, Australia; either way, his or her evaluation of team members' performance will make or break a career. In general, then, the project boss rather than the functional boss should evaluate team members. Otherwise the project concept falls flat.

5. *Project Performance Tracking.* There are two critical aspects to management review of development projects. The first is a phased structure that permits key elements of the design to be examined in detail at major milestones. The following are some examples of really tough questions that should be asked:

- Are we designing what we intended to design?
- Do we fully understand the risk?
- Do we have any good reasons to change course?
- Should we stop now or go on?

The other side of management review is monthly progress reporting. In these reviews, we handle the business of development. Four critical questions should be asked:

- Task status: Are we accomplishing individual milestones?
- Resources: Do we have the people, materials and money to get the job done? If not, where do we get them?
- Earned value: Will this project finish on budget and on schedule?
- Critical issues: What can cause the project to fail and what are we doing about it?[16]

4.3.2 *People Enablers*

1. *Insist on 100% assignment to the team.* Members must be obsessed by the project. Forget "one-fifth obsession": key function members must be assigned full-time for the projects duration.

2. *Place key functions on board from the outset.* Members from sales, distribution marketing, finance, purchasing, operations/manufacturing, and design/engineering should be part of the project team from day one. Legal, personnel, and others should provide full time members for part of the project.

3. *Give members authority to commit their function.* With few exceptions, each member should be able to commit resources from his or her function to project goals and deadlines without second guessing from higher ups.

4. *Live together.* Project teams should be sequestered away from headquarters as much as possible. Team camaraderie and commitment depend to a surprising extent on "hanging out" together, isolated from one's normal set of functional colleagues.

[16] Chambers, Craig A. "Transforming New Product Development – Organizations that carry out successful team – based R&D follow nine best practices". Research Technology Management. November-December 1996. Industrial Research Institute Inc.

5. *Remember the social element.* Spirit is important: " We're in it together." "Mission impossible." High spirits are not accidental. The challenge of the task per se is central. Beyond that, the successful team leader facilitates what psychologists call "bonding". This can take the form of "signing up" ceremonies upon joining the team, frequent (at least monthly) milestones celebrations, and humorous awards for successes and setbacks alike.

6. *Allow outsiders in.* The product development team notion is incomplete unless outsiders participate. Principal vendors, distributors, and "lead" (future test-site) customers should be full time members. Outsiders not only contribute directly, but also add authenticity and enhance the sense of distinctiveness and task commitment.

7. *Involve all functions of the business in the development process.* In firms that do not succeed, critical functions are not involved until too late in the process, sometimes because of turf battles, often for budget reasons or an inability to set priorities.

As a consequence, although present dollars are saved, risk is radically increased. Insistence on the continuous involvement of all functions reduces risk by promoting the intensity of communication and the integration of all elements necessary for the commercial success of the product.

8. *Raise the productivity of the engineering staff.* World class firms do everything possible to keep designers designing, by providing the best tools and a supportive work environment for the team, and by limiting the distractions such as unnecessary meetings and travel. Collocation is also a plus.

9. *Top management support.* The competition for resources, coupled with the high levels of uncertainty typically found in the project environment, often lead to conflict and crisis. The continuous involvement of top management throughout the life cycle of the project increases their understanding of its mission and importance. This

awareness, if translated into support, may prove invaluable in resolving problems when crisis and conflicts arise or when uncertainty strikes. Therefore, continued, solid communication between the project manager and top management is a catalyst for the project to be a success.

10. *Client consultation.* The ultimate user of the project is the final judge of its success. A project that was completed on time according to the technical specifications and within budget but was never used can certainly be classified as a failure. In the conceptual design phase of the project life cycle, client input is the basis for setting the mission and establishing goals. In subsequent phases continuous consultation with the client can help in correcting errors previously made in translating goals into performance measures.

11. *Personnel issues.* Satisfactory achievement of technical goals without violating schedule and budgetary constraints does not necessarily constitute a complete success, even if the customer is satisfied. If relations among team members, between team members and client, or between team members and other personnel in the organization are poor and morale problems are frequent, project success is doubtful. Well motivated teams with a sufficient level of commitment to the project and a good relationship with the client are the key determinants of project success.

12. *Technical issues.* Understanding the technical aspects of the project and ensuring that members of the project team possess the necessary skills are important responsibilities of the project manager. Inappropriate technologies or technical incompatibility may affect all aspects of the project, including cost, schedule, actual performances, and morale.

13. *Client acceptance.* Ongoing client consultation during the project life cycle increases the probability of success regarding user acceptance. In the final stages of

implementation, the client has to judge the resulting project and decide whether or not it is acceptable. A project that is rejected at this point must be viewed as a failure.

14. Communication. The successful transition between the phases of a project's life cycle and good coordination between participants during each phase requires continuous exchange of information. In general, communication in the project team, with other parts of the organization, and between the project managers and the client is made easier if lines of authority are well defined. The organizational structure of the project should specify the communication channels and the information should be generated and transmitted. The formal communication lines, in addition to a positive working environment that enhances informal communication within the project team, contribute to the success of a project.[17]

4.3.3 Planning Enablers

1. *Start the development clock when risk is manageable.* Instead of leaping into the development process with all of the pressure of time and budget, take some unstructured time up front to understand the problem, to let the core team gel, to explore and trade off the alternatives, and to fully identify the elements of risk and find ways to reduce them.

2. *Project mission and goals.* Well defined and intelligible understanding of the project goals are the basis of planning and executing the project. Understanding the goals and performance measures used in the evaluation is important for good coordination of efforts and building organizational support. Therefore, starting at the conceptual design phase of the project life cycle, the overall mission should be defined and explained to team members, contractors, and other participants.

---

[17] Shtub, Avraham, Bard, Jonathan F., Globerson, Shlomo. (1994). "Project Management – Engineering, Technology, and Implementation". ISBN 0-13-556458-1. Prentice-Hall, Inc., A Paramont Communication Company, Englewood, Cliffs, New Jersey 07632.

3. *Project planning.* The translation of the project mission, goals, and performance measures into a workable (feasible) plan is the link between the conceptual design phase and the production phase. A detailed plan that covers all aspects of the project – technical, financial, organizational, scheduling, communication, and control – is the basis of implementation. Planning does not end when execution starts because deviations from the original plans during implementation may call for re-planning and updating from one period to the next. Thus planning is a dynamic and continuous process that links changing goals and performance to the final results.

4. *Project control.* The continuous flow of information regarding actual progress is a feedback mechanism that allows the project manager to cope with uncertainty. By comparing actual progress to current plans, the project manager can identify deviations, anticipated problems, and initiate corrective actions. Lower than planned achievements in technical areas as well as schedule and cost deviations detected early in the life cycle can help the project manager focus on the important issues.

5. *Troubleshooting.* The availability of prepared plans and procedures for handling problems can reduce the effort required for dealing with them should they actually occur.

6. *Set goals/deadlines/or key subsystem tests.* Committees deliberate. Project teams do. Successful project teams are characterized by a clear goal an their focus on achieving this deadline.[18]

4.4 *The Key Element – The Project Team*

As one can see from the experts comments above, the overwhelming enabler recommendations involve the human element. The human element does play a critical

---

[18] Shtub, Avraham, Bard, Jonathan F., Globerson, Shlomo. (1994). "Project Management – Engineering, Technology, and Implementation". ISBN 0-13-556458-1. Prentice-Hall, Inc., A Paramont Communication Company, Englewood, Cliffs, New Jersey 07632.

role in the success of a project. A highly motivated and committed team can overcome many obstacles and achieve inconceivable goals. This people side of the equation will be explored a little further.

What drives an individual from being only involved to being totally committed? What are the variables that make a team cohesive and committed?

During the early 1980's a popular trend was spreading across the automotive industry. This trend was the use of cross functional teams. The term cross functional team refers to a group composed of multiple expertise, e.g., design engineers, manufacturing engineers, quality specialists, etc. These cross functional teams later evolved into collocated cross functional teams. The idea of collocation became popular because it was believed that it would promote communication, keep the team focused, and accelerate decision making. The use of collocated cross functional teams was believed to be the key to reducing cycle time. Logic would force one to the same conclusion, decision making on a project that has all team members located in one area would be more efficient, reduce the chance for miscommunications, and could achieve faster responses to the issues at hand. Much of the Japanese success, in the automotive industry, is that they were the leaders when it came to using cross functional teams. This is not surprising since their cultural philosophy places a higher importance on the group needs rather than that of the individual. Whether this philosophy is right or wrong, one fact that cannot be ignored is that many Japanese automotive companies have been very successful using this approach.

In the early 1990's, Chrysler was the big news story with its new Dodge Viper. This all new ground up vehicle was completed in under 2 years. One of the key points to its success was the use of a collocated cross functional team tucked away from the rest of the company in Highland Park, Michigan.

What then are the elements to a team other than collocation and cross functional, that make it successful? The following are examples of what the experts have said.

From the research of Hans J. Thamhain in his book Engineering Management, it was determined that some of the more important characteristics of a fully integrated engineering team are:[19]

- Being part of a team satisfies members individual needs.
- Members have shared interest.
- There is a strong sense of belonging.
- Members have pride and enjoyment in group activity.
- There is commitment to team objectives.
- Members treat each other with high trust, and low conflict.
- Members are comfortable with interdependence.
- There is a high degree of intra-group interaction.
- There are strong performance norms and result-orientation.

The six drivers that had the strongest positive association to project team performance were:

1. Professionally interesting and stimulating work.
2. Recognition of accomplishment.
3. Experienced engineering management personnel.
4. Proper technical direction and leadership.
5. Qualified project team personnel.
6. Professional growth potential.

While the strongest barriers to project team performance were:

1. Unclear project objectives and directions.
2. Insufficient resources.
3. Power struggle and conflict.
4. Uninvolved, disinterested upper management.
5. Poor job security.
6. Shifting goals and priorities.

Another key element to team effectiveness is the size of the team. In an article by Jon R. Katzenbach and Douglas K. Smith, their findings are that virtually all effective teams they have met, read or heard about, or had been members of have ranged in size between 2 and 25 people. For example, the Burlington Northern "piggybacking" team had 7 members, the Knight-Ridder newspaper team, 14. The majority of them have

[19] Thamhain, Hans J. "Managing Effectively in Technology Base Organizations". Engineering Management. Wiley Series in Engineering and Technology Management. Chapter 12.

numbered less than 10. Small size is admittedly more of a pragmatic guide than an absolute necessity for success. A large number of people, say 50 or more, can theoretically become a team. But groups of such size are more likely to break into subteams rather than function as a single unit. Why? Large numbers of people have trouble interacting constructively as a group, much less doing real work together. Ten people are far more likely than fifty are to work through their individual, functional, and hierarchical differences toward a common plan and to hold themselves jointly accountable.

Large groups also face logistic issues, such as finding enough physical space and time to meet. And they confront more complex constraints, like crowd or herd behaviors, which prevent the intense sharing of viewpoints needed to build a team. As a result, when they try to develop a common purpose, they usually produce only superficial "missions" and well-meaning intentions that cannot be translated into concrete objectives. They tend fairly quickly to reach a point when meetings become a chore, a clear sign that most of the people in the group are uncertain why they have gathered, beyond some notion of getting along better.[20]

One thing is clear, the use of teams are here to stay. With today's mass marketer's highly complex engineering systems and manufacturing systems, the need and use of cross functional teams is imperative to successfully delivering products to market. The group dynamics play a critical role. Mass marketers must therefore clearly understand these group dynamics which promote highly motivated and committed team members. Establishing the right size team, identifying clear cut objectives for the team, providing the tools to complete the job, and rewarding the team, etc., are all critical points in achieving high performance teams that can really bring a project home.

---

[20] Ancona, Deborah, Kochan, Thomas, Sculley, Maureen, Van Maanen, John, Westney, D. Eleanor. (1996). "Managing for the Future – Teams in Organizations". ISBN 0-538-85880-X. South-Western College Publishing, Cincinnati, OH.

4.5 *The Enablers and Inhibitors Inside Ford*

What then is Ford Motor company doing to reduce time to market? What are the inhibitors and enablers in their process? Are Ford's collocated cross functional teams working? The next chapter will explore the history of Ford's Product Development System. The goal of exploring Ford's history is to find the enablers and inhibitors to help its future.

Chapter 5 – Product Development Systems at Ford Motor Company

5.1 *Ford's Product Development History*

Ford Motor Company has been producing automobiles and trucks for over 96 years. Over the last 20 years Ford has been extremely customer focused and would be classified as Stage 2 type company (Stage 2 is the integration of concerns – across customers, between what customers say and what they need, and between the customer requirements and what the company can provide), which was described in Chapter 3. In the 1980's, Ford implemented a new customer driven product development system called Concept-to-Customer (CTC).

Development lead times in 1981 had the domestic automobile makers at around 66 months, with Ford's bench mark program, the Taurus, at 75 months. The Japanese in 1981 were at 40 months from concept to customer. CTC at that time was targeting 48 months which was better than the domestic automotive companies but still behind the Japanese.

Once CTC was launched and functioning throughout Ford Motor Company another revision was made to try and reduce cycle time. The best of the Japanese competitors, at that time, were using the concept of Fast Cycle Time (FCT) or Time-Based Competition to bring products to market faster. Ford combined the concepts with Concept-to-Customer strategy to create World Class Timing (WCT), a new, more time-sensitive product development process. WCT targeted 43 months from concept to customer.

An off shoot of WCT was developed by a core process group within Ford with a goal of reducing cycle time for specific types of projects under 43 months. This system was known as Go Fast Process. Go Fast Process programs were categorized into C/D, E, and F programs. C/D programs were planned around a time line of 42 – 31 months and were generally limited to major freshening and medium powertrain and chassis changes. E programs were planned around a time line of 30 – 19 months and were developed for derivative products. F programs were planned around a time line of 18 – 12 months and generally limited to low volume niche products with little to no powertrain changes and minimal body changes.

Ford Product Development System (FPDS) is the current process being used. This system was implemented in 1995 and was again a derivative of the previous program. The goal of FPDS was to reduce cycle time even further.

Each one of these processes will be reviewed in more detail in the following sections. My goal was to introduce each one of the processes and then conclude with a summary of the inhibitors and enablers to achieving faster cycle time.

5.2 *Concept-to-Customer (CTC)*

"The objective of Concept-to-Customer (CTC) is to significantly improve process and product quality and reduce program execution costs and time." [21]

5.2.1 *Background to CTC*

In 1981, Ford was approximately 25% under GM and Chrysler in Things Gone Wrong per100 cars and trucks (TGW/100) but yet above the Japanese by over 50%. Along with the warranty disparity with the Japanese, Ford was approximately 50% worse in quality.

Development lead times in 1981 had the domestic automobile makers at around 66 months, with Ford's bench mark program, the Taurus, at 75 months. The Japanese in 1981 were at 40 months from concept to customer. CTC at that time was targeting 48 months which was better than the domestic automotive companies but still behind the Japanese.

---

[21] Ford Motor Company. (1988). "Program Control Process – Concept to Customer". 3rd Edition. Ford Motor Company, 20000 Rotunda Drive, Dearborn, MI 48121.

CTC was conceptualized in 1984. The development and implementation of the new process was viewed through the philosophy of Total Quality Management's (TQM) PDCA – Plan/Do/Check/Act. The idea in 1984 was to develop the plan between 1984 and 1985 (Plan), roll it out in 1986 (Do), verify that it works within the organization by phasing it into targeted new programs and then gathering feedback in 1988 (Check), and finally rolling it out to the entire organization (Act).

There were three major goals that were targeted through this new process:

1. Improve quality by 50%.
2. Reduce program execution costs by 30%.
3. Reduce the time required to bring products to market by 30%.

Within CTC, program management provides the framework for actions of both planning and implementation. It is imperative to have experienced and knowledgeable Program Managers.

CTC basic premises involve 4 distinct areas: 1. Defining and selecting from alternative concepts.; 2. Transforming concepts and themes into engineered designs that are manufacturable and meet customer needs and wants.; 3. Providing a systematic process for validating the design.; and 4. Preparing the product for mass production.

CTC had 6 key strategic methods to achieve targets:

1. Prototype phases were eliminated by up front analysis and the mind set that all prototypes were to be Job#1 intent.
2. One phase of functional builds through quality sign off, with parts and processes ready at diamond point 7. (See table 5.1)
3. Early development of a Program Parts List (PPL) and establishment of Affordable Targets.
4. Efficient technology identification and development.

5. Integrated and containable powertrain and technology cycle plan.
6. Heavy emphasis of overlapping approach to problem solving cycles.

5.2.2 *Description of Process*

The CTC product development system consisted of 7 diamond points (milestones) with 3 key events leading up to Job #1. The following Table 5.1 graphically shows these steps. Further explanation is given below.

Timing Targets: Months to Job#1	*Diamond Points & Key Events*	#
48	Program Initiated	1
44	Alternatives Defined	2
40	Alternatives	3
35	Styling Concept Determined	KE
32	Alternative Selected - Go for one	4
29	Program Approval	5
20	Evaluation Prototype Available	KE
15	Program Progress Reviewed	6
11	Verification Prototype Available	KE
6	Production Launch Begun	7

Table 5.1

Program Initiation – At Program Initiation, the objectives are established for cost, weight, and timing. A Total Program Work Plan (TPWP) is developed and the project is fully staffed. The team at this point develops all required assumptions and work begins on developing the various concepts relating to all subsystems.

Alternatives Defined – At Alternatives Defined, various subsystem and system concepts are developed and evaluated. System Workhorse Prototypes are assembled and the development test plan defined. The hardpoints for the vehicle are also established.

Alternatives Screened – At Alternatives Screened, vehicle alternatives to be carried to go-for-one are chosen. Must and want targets, vehicle image and package, powertrain lineup, and body style concepts are evaluated and refined.

Styling Concept – At Styling Concept, the basic interior and exterior architectural theme is selected and agreed upon by the design committee.

Alternative Selected – Go for one – At Alternative Selected, the final production concept is chosen. All supporting assumptions and program targets are confirmed. Inside and outside clay is approved with 80% feasibility.

Program Approval – At Program Approval, the program is thoroughly reviewed to ensure targets will meet customer and company objectives. Final funding is also approved. Development Mechanical Prototypes are also built at this phase in the program to further evaluate the new design.

Evaluation Prototype Available – At the Evaluation Prototype, the first Evaluation Prototypes are built from production design parts off prototype tools. At this point, the design is also frozen.

Program Progress Reviewed – At the Program Progress Review, the team revisits the business plan to see if program is meeting the objectives.

Verification Prototype Available – At the Verification Prototype, the first verification prototypes are built from final engineering released parts. All final vehicle and bench tests are completed and signed off.

Production Launch Begin – At Production Launch, all design work is completed and validated. A series of prototype production builds are completed to evaluate the assembly plant processes, tools, and equipment. These builds continue into Job #1.[22]

5.2.3 *CTC's Enablers and Inhibitors Identified*

In order for CTC to be effective, the following enablers were identified to assure the new product development system would be successful.

1. Strongest possible customer focus internally.
2. Senior managers involved up front in strategy and alternatives development.
3. Coordinated cycle plan including capable technology and balanced resources.
4. Effective program management supported by cross functional teams with up front involvement.
5. Solid go for one disciplines.
6. Necessary skills and expertise identified and developed with some resources moved up front for high payouts in quality and cost.
7. Early simultaneous engineering and manufacturing efforts.
8. High quality up front engineering including Quality Function Deployment (QFD) and Computer Aided Engineering (CAE).
9. Early problem identification and resolution.
10. Engineering prototypes used for validation of customer satisfaction and manufacturing capability.
11. Tooling started just in time to minimize changes.
12. Late changes are manufacturing driven only.

So with this new defined process, CTC, and the enablers identified, was Ford able to reduce their cycle time down to 48 months or less? As a whole the process did reduce cycle time but not to the extent that it was forecasted and worse yet, the Japanese were reducing cycle time beyond where they were prior to the implementation of this process.

One fundamental problem that existed with the new process was that it depended on a large number of prototype build phases. There were a total of 4 rounds of engineering prototype builds, system workhorses, development mechanical's,

---

[22] Ford Motor Company. (1988). "Program Control Process – Concept to Customer". 3rd Edition. Ford Motor Company, 20000 Rotunda Drive, Dearborn, MI 48121.

evaluation prototypes, and verification prototypes. The entire organization was set up to support these phases through the releasing of parts, procuring parts, tracking parts, building these vehicles, and testing them. The basic philosophy with these several prototype phases was that it enabled the engineers to prove out their designs on the first two phases while verifying the quality of the parts on the last two phases. In reality what the multiple build phases had done was that the engineering community used these build phases as design refinements. Instead of doing detailed analysis and simulation up front, the engineers used the prototypes to find and fix problems. As a result, the design process was actually lengthened.

Some of the additional inhibitors that existed during the time of CTC were:

1. Insufficient pre-program planning.
2. QFD's were not used or used infrequently.
3. The programs were not properly staffed on time.
4. Lack of "clear" upstream product assumptions.
5. Objectives were not clearly defined up front.
6. Engineering analysis was done through actual vehicle testing.
7. Engineering tools such as Design Failure Mode Effects Analysis (DFMEA), Process Failure Mode Effects Analysis (PFMEA), Design of Experiments (DOE), were not used.
8. Late changes continued to be made by Engineering and Management.
9. Prototype parts were late for each of the prototype build phases.
10. Prototype vehicle build quality issues.
11. Lack of understanding, responsibility, and accountability to meet all timing events.
12. Total organization focused on supporting prototype dates and not Job #1.

Ford's attempt at truly reducing cycle time with CTC was falling well short of expectations. The inhibitors present far out weighed the enablers and thus Ford had to re-examine its product development strategy. Thus World Class Timing (WCT) was developed.

5.3 *World Class Timing (WCT)*

The best of the Japanese competitors, at the time, were using the concept of Fast Cycle Time (FCT) or Time-Based Competition to bring products to market faster.

Ford combined these concepts with Concept-To-Customer (CTC) strategy to create World Class Timing (WCT) a new, more time-sensitive product development process.[23]

5.3.1 *Ford in the Late 1980's*

In the late 1980's, in the United States, Concept to Job#1 averaged about five years or 60 months. Ford's target through CTC had been 48 months. Ford produced the 1990 Town Car in about 41 months, and they were averaging about 58 months from Concept to Job#1, for all vehicles. At the same time, the Japanese product development target was 37 months to 44 months.

5.3.2 *Background to WCT*

WCT began with support from the top of the organization and was North American Automotive Operation's (NAAO) strategic initiative. Approximately 45 Ford employees met off site for four months to define what WCT would be. In their report to upper management dated August 1990, they identified the following key principles for WCT:

- We are at war with the competition
- Time is a strategic weapon
- Customer satisfaction is the driver
- We must manage processes to achieve results

Subsequently, WCT had been identified as one of the NAAO imperatives critical to the success of Ford in the mid-1990's.

WCT's philosophy was that it changed the way Ford looked at time. In the past, time was a result of the work performed. In WCT, time was recognized as a precious resource, and a limited one. The challenge back then was to put time to the best use and use less of it, without sacrificing quality and cost effectiveness.

WCT therefore, consisted of two critical elements, milestones and deliverables.

[23] Ford Motor Company. (April 20, 1992). "A World Class Timing Overview – Participants Guide". The Emdicium Group, Inc., Bingham Farms, MI.

World Class Timing used milestones to designate when specific program criteria was met. Reaching a milestone meant, very specific tasks had been accomplished. The quality of an event was determined by how well the tasks leading up to it had been accomplished.

WCT specified 5 vehicle builds instead of 8. System workhorse prototypes were used to evaluate major program and system alternatives prior to Program Initiation (PI). The Structural Prototype (SP) and Confirmation Prototype (CP) use prototype parts while the Tool Tryout and Integrated Launch phases use production parts.

The Structural Prototype (SP) is used to prove out engineering. It confirms the function that is built into the parts, validates structure, chassis, durability, and cooling and confirms the result of analytical testing.

The Confirmation Prototype (CP) allows manufacturing to prove out its processes. It has a Job#1 level interior and exterior and is used to certify durability, FMVSS and emissions. It also confirms that design latitude and manufacturing variance objectives can be met.

Another important element of WCT is the sequential freeze process which is where parts of the vehicle design efforts are frozen.

5.3.3 *Description of Process*

The WCT product development system consists of 12 milestones including J#1. Table 5.2 graphically shows the process. Further explanation is given below.

Event	*Timing*
1. Powertrain Declared - <PT>	Pre-Program 60 months
2. Program Definition - <PD>	Pre-Program 43 months
3. Program Implementation - <PI>	37 months
4. Theme Decision - <TD>	31 months
5. Structural Prototype Build - <SP>	27 months
6. Program Confirmation - <PC>	24 months
7. Prototype Readiness - <PR>	21 months
8. Confirmation Prototype - <CP>	17 months
9. Sign Off - <SO>	11 months
10. Launch Readiness - <LR>	3 months
11. Job#1 - <J1>	0 months

Table 5.2

Pre <PD>- Prior to the first milestone, Program Definition, WCT includes an activity called Annual Process which is a Pre <PD> step. Much of what takes place here is ongoing market research, advanced engineering and business planning. The Annual Process, although not a milestone, is critical to WCT.

Program Definition – At Program Definition, a number of design, functional, technology, and manufacturing alternatives are investigated. This is the plan and prove part of the process where alternatives are studied and eliminated so the definition can be finalized and consensus on a vehicle architecture at PI.

Powertrains are declared for the vehicle program and initiation of funding for new or major change engine or transmission programs.

Program Implementation – At Program Implementation, all product specifications are frozen. The program parts list is fully defined with a single architecture defined. The Affordable Targets are established. Affordable Targets are a set of reasonable, consistent, customer-driven goals that support the program direction and provide an acceptable business proposition to the company. At PI, all new technology must be proven to the point that we are willing to take the risk, that it can be implemented without re-timing the program.

Theme Decision – At Theme Decision, the Design Committee gives approval for a single interior and exterior theme. It is also when target ranges are narrowed to a single target. System Workhorses are evaluated and the design is being refined.

Structural Prototypes – The Structural Prototypes are built to validate the analytical model for durability, cooling performance, heat management, fuel system performance, FMVSS/CMVSS, body structure and powertrain noise vibration and harshness

Program Confirmation – Commitment of the total organization to meeting the program objectives takes place at this point. The focus is on execution of drawings, prototype part, and manufacturing and assembly processes. All program funds are approved.

Prototype Readiness – At Prototype Readiness the Program Manager's approval of Job#1 design, the manufacturing process, and Purchasing plans are complete.

Confirmation Prototype – The Confirmation Prototype is built from prototype tooling which represents Job#1 level design and is used to confirm all vehicle targets, i.e., fit and finish, FMVSS/CMVSS certification, and durability.

Sign Off – At Sign Off, the Program Manager certifies that the vehicle product development and manufacturing capability can meet Job#1 customer requirements and quality, emissions, and other objectives.

Launch Readiness – At Launch Readiness, the product has been validated and is ready for production. During this phase the assembly plant builds several rounds of prototypes to validate tooling and equipment.

Job #1 – Production begins.[24]

5.3.4 *WCT's Enablers and Inhibitors Identified*

To ensure the success of WCT, as was done in CTC, a set of enablers were identified to facilitate the flow of information and improve the efficiency of the product development system.

1. Benchmark the competition.
2. Uses dedicated collocated teams.
3. Focus on value added functions.
4. Employ systems engineering throughout process.
5. Apply computer aided engineering up front in the process.
6. Involve management up front and eliminate late changes.
7. Become a learning company.

Note, these enablers were in addition to the ones defined under the CTC process.

WCT was an evolution of CTC. WCT was Ford's first real attempt at using collocated cross functional teams for each of the new vehicle programs. The use of collocated cross functional teams did significantly help the process. More emphasis was placed on up front subsystem analysis and three prototype phases were eliminated. Even with these improvements and all of the enablers identified, the process still depended on too many prototype phases. Engineer's were still depending on actual

[24] Ford Motor Company. (April 20, 1992). "A World Class Timing Overview – Participants Guide". The Emdicium Group, Inc., Bingham Farms, MI.

vehicle testing to prove out the design. The organization was still focused around supporting the vehicle build dates and not focusing on the final end production date. Many of the inhibitors that were present under the CTC process had not been eliminated. What was even worse, for smaller programs, WCT actually slowed the product development process. As an outcome, a small task force was formed to try and develop a process that would address minor program content changes and low volume niche market programs. This process would eventually be called the Go Fast Process. The Go Fast Process was a refined WCT process that was Ford's first true attempt at significantly impacting reducing cycle time. The one requirement to make Go Fast Process work was that it was to be used for programs with specific content changes. The following section will describe in more detail how the process worked and the limitation to its use.

5.4 *Go Fast Process*

The Go Fast Process is based on the premise that Product Development Programs of limited scope and change can and should be completed in less time than the time dictated in WCT model. The Go Fast Process maintains all of the key events and milestones of WCT, while recognizing and adopting efficiencies from programs completed in less than WCT time.

An essential element of the Go Fast Process, is the adjustment of the Total Program Work Plan (TPWP) to the complexity of the product program, not the program to the work plan. Since all product programs differ in complexity, implementation times also differ.

Go Fast Process programs take calculated risks to reduce the overall length of the program. All are characterized by a high level of vehicle carryover content, and complete more tasks in parallel than World Class Timing Programs.[25]

5.4.1 *Background to Go Fast Process*

Go fast process programs are categorized into C/D, E, and F programs. Table 5.2 shows the time lines of all three process. Type C/D Programs are 42 to 31 months in length. These programs are generally limited to major freshening and medium powertrain and chassis changes. Type E Programs are 30 to 19 months in length. This category is defined as a derivative product. Derivatives include minor freshenings, and/or calibration only P/T programs, with flexible Job#1 launch dates. Type F Programs are18 to 12 months in length. These are low volume, niche products with little or no P/T change, a discrete level of interior/exterior change and minor chassis tuning with flexible Job #1 timing.

One of the basic premises behind Go Fast Process is the use of a Powerful Product Statement (PPS) which is a contract that is given to the program team by management. The PPS gives the product team the authority to make decisions within the product theme and module targets, and to take the calculated risks necessary to achieve the aggressive program targets and timing. The PPS contains the signed commitments from all of the stake holders in the Vehicle Center, Assembly Operations, Marketing, Purchasing, Styling and key suppliers, where applicable, to support the project from the Pre <PD> phase through to Job#1.

Go Fast Programs, are characterized as taking the calculated risks of simultaneous engineering, concurrent with the design and development of the vehicle systems, and the long lead assembly tooling. Go Fast Programs, because of their flexibility, combine the deliverables and milestones of a normal WCT Program into a compressed timing schedule from 12 to 42 months in length. As programs go faster, the milestones move closer together. All applicable WCT deliverables still apply to Go Fast

25 Ford Motor Company. (June 1, 1995). "Go Fast Process Guide". Ford Motor Company Publications.

Programs. Affordable targets and engineering and quality disciplines such as FMEA, FMA, DVP&R, quality improvement, and campaign prevention initiatives also apply.

The team itself is led by the Vehicle Line Director until the Chief Program Engineer is assigned. Staffing consists of representatives from all affected organizations in the Vehicle Center. Teams are dedicated and collocated within the Vehicle Program Center. It is desirable to have the full complement of key people together through Job#1. Uninterrupted team continuity helps to assure the success of the project. The team provides the initial design concepts, feasibility studies, prove-out plans and styling support that must be generated in the Pre <PD> stage of the program. Teams must prioritize the task of securing buy-in as one of their first duties. The Pre<PD> Core Team should contact and secure consensus from every individual, function, organization and supplier who will ultimately be involved in the program. Assuring buy-in very early in the product development process decreases program risks, serious delays and additional expenses.

Go Fast program develops a detailed checklist of deliverables up front.

5.4.2 *Graphic of Process*

Go Fast Timing - Program Comparison Chart

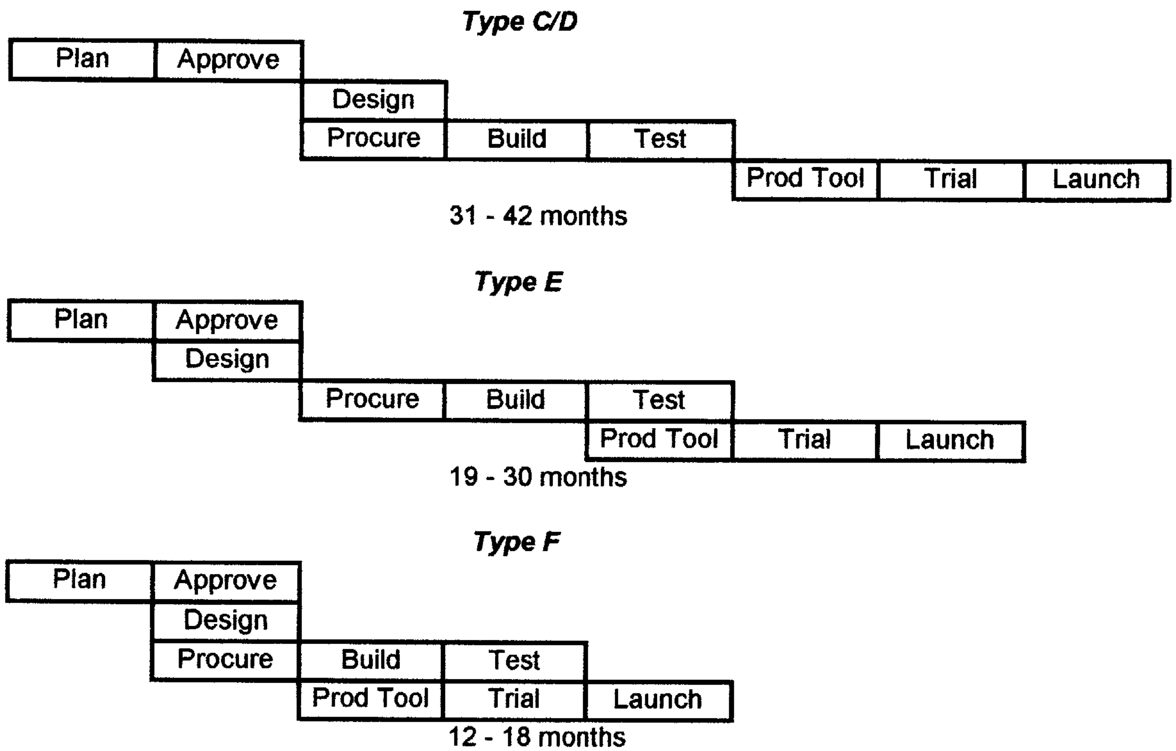


Table 5.3

To illustrate some of the steps in the process a Type F Program will be used as an example. F Programs have a development cycle of 12 – 18 months from <PD> to Job#1. The Pre<PD> work begins at an event that is shown on the TPWP as Kick Off, approximately five months earlier. F Programs are niche product versions of existing products, which have a discrete level of interior and exterior change. Minor chassis tuning is permitted. The longest lead time for production tooling can be 12 months, and the product is launched outside of normal Job#1 timing.

Clearly defined program goals and operating guidelines must be communicated to the team. Management must then empower the team to make the decisions within the boundaries of the program on such issues as affordable targets, timing, theme decision, etc.

Weekly team meetings are essential. Suppliers and dedicated members attend and present their status reports during pre-arranged times. Weekly commitments and planning focus the team on the sense of urgency needed to complete a Go Fast program. A series of gateway reviews at major milestones of the program are essential. It is recommended they be held off site to minimize outside phone calls and other distractions. A design review with all team members prior to initial release can ensure a sound design.

The clay is approved at Theme Decision <TD> which is the combined <PD>/<PI>/<TD> milestones. No discretionary program content changes are allowed after this combined milestone. The program timing cannot tolerate the conventional "Build, Test, and Fix" scenarios. Therefore, the latest proven technological tools should be used. Caution must be exercised so that new technology claimed to be off the shelf is not used.

Type F program requires the maximum amount of simultaneous development. The team should be encouraged to take calculated risks by completing more tasks in parallel.

Design alternative should be evaluated on a PUGH Matrix or equivalent process to compare alternatives such as cost, weight and fuel economy implications, as well as customer needs, against the proposed decision. Go Fast Process also recommends avoiding "ground up" prototype builds for SP, and CP builds should be done at the assembly plant. The design aid bucks should be provided to the assembly plant to assist development tooling, assembly and painting processes.

For testing, the DVP&R should be coordinated to minimize the use of dedicated vehicles. Conduct all non-destructive testing first on shared prototypes.

The team must ensure that the manufacturing technology is appropriate for the capacity planning volume involved in an F program. For example, there must be a proper balance between the use of hard and soft tools and automated assembly versus the use of less costly manufacturing methods. This applies to dunnage design, assembly fixtures, and guages, etc.[26]

It should be noted that C/D and E type programs will use similar techniques for reducing cycle time.

5.4.3 *Go Fast Process Enablers and Inhibitors Identified*

To ensure the success of Go Fast Process, as was done in CTC & WCT, a set of enablers were developed to facilitate the flow of information and improve the efficiency of the product development system.

1. The team must receive a PPS from Senior Management outlining team authority.
2. The number of management reviews are limited.
3. A small dedicated team and collocated core team defines the program content.
4. The deliverables of <PD>, <PI>, and <TD>, are combined at <PD>.
5. The deliverables of <PR>, <TC>, and <PC>, are combined at <PR>.
6. The deliverables of <SO> and <LR> are combined at <SO>.
7. There is an extremely high degree of parallel development of the component and the assembly tools.
8. Use of sophisticated Engineering tools.
9. The number of new tooled parts is limited and the manufacturing technology is appropriate for the financial planning volume/ capacity planning volume.
10. Outside engineering support may be high (45% to 90%)
11. There is a very high vehicle c/o content.
12. There is minimal new part impact on carry over vehicle content.

Go Fast Process did prove to be very successful for Ford. For C/D type programs the 1994 Mustang, 1992 Aerostar, and 1992 F-series were examples of programs that met their objectives and delivered the product in the 31 – 42 month time frame. For the E type program, the 1993 ½ Explorer Limited and 1992 F-series

---

[26] Ford Motor Company. (June 1, 1995). "Go Fast Process Guide". Ford Motor Company Publications.

"Lightning" met their 25 to 27 month implementation time line.

Even with the success of these programs, the overall Go Fast Process was not widely implemented throughout Ford. Some of the inhibitors to its acceptance were the fact that the team had to accept higher amounts of risk in order to achieve the program timing and objectives, e.g., qualitative judgements instead of actual test data, the use of CAE for signoff, limited testing, concurrent tooling and design, etc. The process was also limited in the scope. For any long lead tooling required, the process would not work. This was a significant issue with the supplier base since many were structured around high volume long lead tooling intervals.

As described previously, Go Fast Process was used for smaller content programs to accelerate timing. For the large main stream programs World Class Timing was used. As mentioned in section 5.3, the goal of WCT was to reduce cycle time down to 43 months. Once again, improvements were made to cycle time, through efficiencies found among collocated cross functional teams but Ford was still well behind the competition. In 1995, Toyota was at 36 months on average in their product development cycle time. Ford in comparison was still above 40 months on average. In response, Ford made some drastic changes, in 1995, under what is known today as Ford 2000. Ford 2000 involved a major restructuring of the Product Development Organization and an implementation of a totally revamped Product Development System called Ford Product Development System or FPDS. The theory behind Ford 2000 was that a major paradigm shift was needed in the way Ford developed its products. By reorganizing its people and implementing a new process, it was hoped that many of the old ways of doing business would be erased and the new process would be immediately embraced.

5.5 *Ford Product Development System (FPDS)*

FPDS was developed based on experience with how Ford actually conducts Product Development rather than on an idealized concept of how it should be working today. The goal of FPDS was to reduce cycle time by 25%, reduce warranty, reduce resources and reduce investment while delivering more vehicle programs and improving cash flow. FPDS and the new organization went through some extreme growing pains and today the process and organization is still dynamically evolving.[27]

5.5.1 *Background to FPDS*

FPDS is not a timing plan or milestone chart, but rather a process leading to deliverables. FPDS saves time by building on the experience of World Class Timing. The majority of the process is composed of best practices from actual WCT Programs with only selective areas of the process that are substantially new.

The strategy behind FPDS is that everyone is considered to have a Job#1. Not only does the team have program milestone commitments to make Job#1, but each team member also has his or her daily commitments to their fellow co-workers. The key to achieving those commitments is discipline, dedication, understanding and honoring downstream implications of each one's part of the work, and finally personal integrity in each one's commitment, not good intentions.

FPDS uses the Work Break Down Structure which is a task based structured approach to organizing work. There are basically four fundamental tasks: 1. Defining product and process; 2. Designing product and process; 3. Verifying/build/produce product and process; and 4. Managing the program.

FPDS in summary concentrates on improving the People, Process, and Technology.

---

[27] Ford Motor Company. (June 10, 1998). "FPDS Process Overview". Ford Motor Company Publishing.

1. *People* – The people improvements include the continual emphasis of system thinking, having a consumer headset (voice of the customer), using teamwork, and continual learning through training plans such as Ford Training and Education Program (FTEP). FTEP includes 8 courses: QFD, System Engineering Fundamentals, Experimentation, Robustness – Parameters Design and Tolerance Design, Reliability, Process Control, 8D, and Failure Mode Effects and Analysis (FMEA).

2. *Process* – The process involves benchmarking the "Best Practices" within the company and among the competition. Utilizing these best practices along with the technology tools. The goal of FPDS process is to use a structured process to eliminate rework.

3. *Technology* – The new technology consists of C3P, which stands for Computer Aided Design (CAD), Computer Aided Manufacturing (CAM), and Computer Aided Engineering (CAE) and Product Information Management (PIM). PIM refers to the means by which the company catalogs, stores information, and exchanges the information. C3P is a critical tool set for improving our predictive engineering capability and achieving a industry leadership position

5.5.2 *Description of Process*

The FPDS product development system consists of 15 review points including J#1. Table 5.4 graphically shows the process. Further explanation is given below.

Event	*Timing*
1. Kick Off - <KO>	
2. Pre Strategic Intent - <PS1>	Pre-Program
3. Pre Strategic Intent - <PS2>	Pre-Program
4. Strategic Intent - <SI>	41 months
5. Strategic Confirmation - <SC>	36 months
6. Proportions & Hardpoints - <PH>	33.5 months
7. Program Approval - <PA>	30 months
8. Appearance Approval - <AA>	25.5 months
9. Product Readiness - <PR>	19 months
10. Confirmation Prototype - <CP>	14.5 months
11. Change Cut-off - <CC>	8 months
12. Launch Readiness - <LR>	4.5 months
13. Launch Sign-off - <LS>	3.25 months
14. Job#1 Achieved – (J1)	0 months

Table 5.4

Kick Off - <KO> - Annual Process data collected and given to the initial Pre <SI> program.

Pre <SI> - Pre-Strategic Intent. This event occurs 50 – 41 months before Job#1. In Pre <SI> target setting takes place. Design concepts are created and evaluated.

Compatible targets and assumptions are completed during this phase.

Strategic Intent - <*SI*> - At Strategic Intent, all program direction is established. Strategies for product, market, manufacturing, supply, design and reusability confirmed. Major customer and corporate wants and regulatory compliance plans confirmed. Compatible vehicle level target ranges and product assumptions are established and consistent with Affordable Business Structure. New technologies are identified and program logistics confirmed, e.g., timing, work plan, resources and facilities.

Strategic Confirmation - <SC> - At Strategic Confirmation initial attribute prototype and confirmation prototype plan is developed. Vehicle level targets are committed. Powertrain line up selected. All suppliers are selected and part of team.

Proportions & Hardpoints - <*PH*> - At Proportions & Hardpoints all proportions and selected hardpoints are frozen. The program parts list is also complete.

Program Approval - <*PA*> - At Program Approval, all targets become objectives. Program Design Verification Plans are complete and the AP and CP prototype plan is established. All suppliers at this point are committed and the final budget is approved for Job#1.

Appearance Approval - <*AA*> - At Appearance Approval, the interior and exterior appearance is approved. Appearance related end item targets become objectives.

Product Readiness - <*PR*> - At Product Readiness, there is a full vehicle analytical sign off, all objectives can be met. Confirmation Prototypes (CP) are ordered and production launch plans are confirmed.

Confirmation Prototype - <*CP*> - The Confirmation Prototype are produced from surrogate production tools.

Change Cut-off - <CC> - At Change Cut-off preliminary engineering sign off is completed on the CP durability testing. Engineering confidence that objectives will be met declared. Suppliers at this point commit to supply Part Sample Warrant (PSW) parts to 1PP builds.

Launch Readiness - <LR> - At Launch Readiness all parts are 100% PSW'd. Final Engineering Sign-off is completed with the exclusion of engine certification.

Launch Sign-off - <LS> - At Launch Sign-off all the assembly tools and equipment have been tested and are ready for production.

Job#1 Achieved – (J1) – At Job#1 production begins.[28]

5.5.3 *FPDS Enablers and Inhibitors Identified*

Since FPDS was derived from WCT many of the same enablers previously listed are common to both processes. What then differentiates the two systems? The following is a comparison of the two systems.

The following is a comparison of FPDS vs. WCP:

1. Suppliers roadmap to achieve quality operating system (QOS) deliverables vs. no roadmap
2. Increases communication vs. teams had stand alone plans
3. Provides focus on event start dates vs. end date focus
4. What if analysis to manage program changes vs. no what if
5. Identifies critical path vs. no identification
6. Instills discipline vs. no discipline
7. Two development prototype phases vs. four development prototype phases
8. Extensive use of simulation analysis of subsystems vs. subsystem analysis only on prototype vehicles
9. Six separate timing templates (ranging from 18 to 42 months) for varying size programs vs. a single 43 month development process
10. Six separate time lines, for vehicle content changes, and six separate time lines, for powertrain changes, vs. a single plan for both content and powertrain

FPDS does have enablers that are specific to this product development process. These enablers pertain to the simulation tools used in determining program staffing, prototype build quantities, and the analytical engineering tools. Ford uses a Resource Management System (RMS) that determines staffing requirements for each of

[28] Ford Motor Company. (June 10, 1998). "FPDS Process Overview". Ford Motor Company Publications.

the major programs and a Ford Automotive Operation (FAO) Predictor model to determine the number of prototypes required for each program. Ford C3P includes the Engineering simulation tools that are used to draw and model all the new parts and subsystems. These powerful tools allow the engineer to perform Finite Element Analysis (FEA), dynamic checks of the inter-related parts and subsystems, and full vehicle virtual digital buck prototypes.

In addition to the simulation tools, Ford is also upgrading its various systems that support the new product development system. One of these systems, for example, will allow for a production level bill of materials to be produced for the initial prototype vehicles. This system will not only confirm the correctness of the production bill of material but will also improve the quality level of the prototype build event. All of these new simulation tools and new support systems are not without their problems. Many of these new tools are still plagued with software glitches that currently are making them an inhibitor to the process. The following is an example of some of these inhibitors:

1. The C3P tools are plagued with software bugs.
2. The C3P tools were not able to perform some of the simulation that they were originally sold as being capable of performing.
3. The C3P tools are not compatible with the previous CAD system.
4. The C3P tools and many of the new systems are not very user friendly.
5. Engineers and suppliers are not experienced with the new systems.
6. Engineers and suppliers do not always use the new systems.
7. Engineers are making more changes during launch since it is easier to cut through the bureaucracy.
8. Incorrect predictor models can cause shortages of prototype vehicles.
9. Simulation tools are still not able to replace all of the actual vehicle tests.

These inhibitors are causing delays in some of the current FPDS Programs, but the future does look promising for this technology once it has been fully developed. So what then are the true enablers and inhibitors that are keeping Ford from making dramatic reductions in its product development cycle? The following section will try to capture many of the lessons learned from the various Ford product development systems.

5.6 *Lessons Learned*

In the early 1980's, prior to CTC, a group of Ford Executives met to discuss and document what are the true inhibitors that were plaguing their system back then and ironically many of them are still applicable today.

Prior to establishing the CTC product development process in 1980, Ford established a team, consisting of upper and middle managers, to determine some of the root causes that were inhibiting the product development system to reduce cycle time. It is ironic that many of these issues documented back then are still plaguing product development systems today.

Identified Problems and Root Causes – Yesterday and Today:

Yesterday

1. Roles, responsibilities and authority are not team oriented, not clearly defined communicated and mutually agreed upon.

- Responsibilities are vague and left open to interpretation.

Today

Ford is using collocated cross functional teams today for its major programs with clearly defined roles and responsibilities. But, for many of the smaller programs, many times the roles and responsibilities are not clearly defined and cascaded to the entire team.

Yesterday

2. Late and non-representative prototype vehicles and design aid bucks disrupt the product development, manufacturing, and assembly process which compromises the final product.

- There is not a consistent plan within product development for defining and building each prototype phase.

Today

As described previously, Ford is implementing the system where production BOM's will be produced for each of the prototype vehicles that are built. This system ensures that the vehicles are representative. The current issue with this new system is that it is not user friendly and many of the Engineers do not know how to use it or use it incorrectly. This lack of knowledge of the system therefore causes significant delays, due to the time required to get accurate information loaded.

Yesterday
3. Late management changes are made with general awareness of costs and that timing implications are disruptive to the process.

- Inadequate front end planning and execution.

Today

Ford is still plagued with late management changes. Instead of being on a downward trend, what is actually happening today is that they are increasing at a greater frequency, due to Ford's new "Consumer Headset" approach. With the introduction of Ford's new Spirit of Ford consumer focus, the push is for all employees to become more sensitized to the true needs of the customer by conducting personal interviews. What is taking place is that many of the Executives are pushing ideas that came out of these Single Point Marketing interviews, instead of relying on this direction coming out of Sales and Marketing. Besides creating late changes, another problem with this approach is that many times the direction dictated is not backed by any sound business case.

Yesterday
4. There are too many cost reduction changes.

- Too many changes at six months before job #1.

Today

Cost reduction efforts are hotter than ever. Within the last 4 years, Ford Executive Management has established significant cost reduction targets yearly for each vehicle line. Even before the new products are introduced, targets are set to go after once the new product is in production. The pressure to reduce costs is so great today that many repercussions are beginning to appear in rework, warranty, and customer dissatisfaction.

Yesterday
5. Inadequate pre-program work prior to prime program approval resulting in too many changes.

- Present workplans, which are used to guide pre-program, are inadequate.

Today

On many of today's FPDS programs, unrealistic time frames are specified at the beginning of the project, due to incomplete buy in from the rest of the team. Many times the Vehicle Program Plan's (VPP) are not developed with input from the entire team thus leading to unrealistic dates that were never committed to by team members. Another harsh reality within Ford today, is that once a detailed VPP is developed for the entire vehicle, further subsystem work plan overlays are never developed. It is also rare to see critical paths base-lined for the programs and tracked on an ongoing basis.

Yesterday
6. Lack of emphasis on upstream timing events prior to 29 months results in "snowplowing" or overloading the downstream phases and thus inhibits feasibility prototype, and development actions.

- Lack "clear" upstream product assumptions supported by management with clear, timely direction provided to all involved activities.

Today

Ford does a fairly good job today, for the large main stream programs, in identifying all the program assumptions. Where Ford lacks the discipline is in the area of the smaller content programs, where many times, the program assumptions are incomplete or incorrect.

Yesterday

7. "Work elements" leading up to major timing events are not clearly defined, understood, communicated or accepted and the effect of failure to do work elements is not understood by or well communicated to all activities.

- Program assumptions are not timely, clearly defined, understood, communicated & accepted.

Today

The ongoing opinion among the Engineering community at Ford is that FPDS has unrealistic timing events. The inflexibility of the timing dates also causes the deliverables to be incomplete or, in some cases, in error. Part of the problem is due to the new tools being used, as described earlier, and part is due to unrealistic expectations put forth to the project team.

Yesterday

8. Lack of understanding, responsibility, and accountability to meet all timing events.

- Lack of effective timing control system.

Today

As described earlier, the strategy behind FPDS is that everyone is considered to have a Job#1. Not only does the team have program milestone commitments to make Job#1, but each team member also has his or her daily commitments to their fellow co-workers. FPDS is very good because it continually emphasis this commitment and accountability.

Yesterday

9. Lack of adequate human/mechanical system/process to identify, communicate and coordinate required product definition.

- Lack of understanding of the significance of early identification or the process for obtaining identification.

Today

As with CTC, WCT, and FPDS the product definition starts with the development of a detailed system QFD. In reality, this tool is rarely used by the project teams. Typically the team jumps into the project without doing a thorough job of fully defining the total project. Ideally what should happen is that all customer requirements must be thoroughly defined and then these requirements must be transferred into a complete vehicle specification.

Yesterday
10. Production suppliers for all commodities are not involved in Phase I prototypes and subsequent phases.

- Prototype supplier is not known at the time of prototype build or is not requested to participate.

Today

This issue still persists with programs today. Ford has done a better job in bringing on board long lead, full service suppliers but overall there is still room for improvement. This is especially true for the smaller programs and lower volume programs. Much time is wasted in trying to negotiate with the high volume manufacturers to support the smaller niche market projects.

As you can see from the 10 documented root causes that plagued programs in the past are the same issues that plague present programs today. Still the question needs to be asked, what are the enablers to reducing cycle time?

5.7 *Summary*

What appears to be happening with Ford's product development system is that its evolution has reduced cycle times, but primarily the reductions have come from technological advancements. What is still inhibiting the process seems to revolve around the people side of the equation. Planning, communicating, discipline in using the process and tools available.

The means by which FPDS is addressing the people side of the equation are the following:

1. All corporate resources are fixed; only changes that maintain system balance are permissible.
2. All the slack is out of the system.
3. Smoothed workloads.
4. Reinforcing need for standard process consistency.
5. Synchronizing functional groups and support organizations to optimize program team performance.
6. Reducing implementation variability by program teams by:
   - focusing on first time capability with the design which eliminates the need for rework
   - building on Best Practices within a standardized process
   - facilitating team to team learning
7. Clarifying roles and responsibilities through use of explicit process sheets.
8. Management's awareness that resources and support activities need to be provided on time to the program.
9. The use of corporate knowledge.
10. Never starting a design like a clean sheet of paper, reusing design concepts.
11. Provide book shelved technologies and utilize this technology as needed.
12. Empower the project teams.

If Ford can continue to improve its technology tools and can continue to nurture discipline amongst its employees with realistic timing goals, the results will become evident in the improved cycle times.

Now we will turn our sights on to what another high volume mass marketer is doing to address the issue of faster cycle times. The goal of observing others is to find clues to improving issues within ourselves.

Chapter 6 – The External Search

The research in this thesis now turns its attention to what another high volume mass marketer is doing in the area of improving cycle time. The company analyzed in this research was Xerox.

6.1 *Xerox*

There are many similarities to Xerox's history and that of the American automobile manufacturers. Xerox went through many of the same type of customer disappointments as that of the American automotive industry in the late 1970's and early 1980's. Poor quality, unexciting products, high prices, etc., were just some of the problems.

6.2 *The History of Xerox*

Xerox embarked on an ambitious program in the early 1980's to regain its eroded leadership in the copier industry – an industry it virtually created with the introduction of its model 914 in 1959. During the 1970's, Xerox customers had become disappointed with Xerox quality and service and the company lost significant market share to domestic and Japanese competitors.

In the 1980's Xerox established the "Leadership Through Quality" strategy. Customer satisfaction had become the first corporate priority in 1987. All this appeared to have paid off with Xerox Business Products and System's wining the prestigious "Malcolm Baldrige National Quality Award" in 1989, the nation's highest award for quality.[29]

[29] Menezes, Melvyn A.J., Serbin, Jon. (1991). "Xerox Corporation: Customer Satisfaction Program". Harvard Business School Publishing, Boston, MA 02163. 9-591-055, Rev. January 12, 1993.

Xerox categorized the copier industry into three product markets:

1. *Low-volume market* – This is classified as 5,000 or less copies per month and the machines cost less than $4,000.00. The competition in this area was Canon, Sharp, Xerox, Mita, and Ricoh.
2. *Mid-volume market* – These copiers designed to make up to 100,000 copies per month cost between $4,000 and $60,000.00. This market, which had the highest overall growth in 1989, was where Xerox had always earned the most revenue and profit. The competition in this area was Canon , Mita, Ricoh and Konica.
3. *High-volume market* – These copiers cost over $60,000. The competitor in this area was Kodak.

The copier market was extremely competitive, with 23 companies battling for market share. However, Xerox was the only full line supplier with products ranging from the low end of the low volume to the high end of the high volume. Based on total number of unit placements, Canon was the market leader, followed by Xerox and Sharp. In terms of revenues, Xerox was the market leader with a high market share in the higher priced mid and high volume markets, which also provided significant service and supplies revenues.

Xerox with its monopoly culture, its large bureaucracy, and its forays into new businesses, had difficulty responding to the new competitive pressures in its flagship copier business. Costs and product prices were higher than the competition's, quality and perceived quality had declined, and market share and return on assets had fallen to alarming levels.

Beginning in the 1980's, Xerox undertook a number of initiatives to respond to the increased competition and the company's declining market share. The company was restructured and developed a philosophy emphasizing quality, led by Chairman and CEO David Kearns. He instigated a strong quality movement, in the belief that quality would drive costs down and that getting it right the first time would eliminate costly repairs and replacements and would prevent the unnecessary breakdowns that drove customers away.

In the 1990's, Xerox's vision for customer satisfaction was "100% of Xerox's customers are very satisfied with our products and services through the elimination of defects and errors in our work processes and the achievement of world-class benchmark quality and value in our products and other deliveries to the customer".

Xerox Strategy for the 90's
- Build from current strengths
- Lead and shape technology and market
- Drive office productivity with new customer values
- Deliver products that meet environmental needs

Xerox developed a new line of copiers known as the Lakes Project. The Lakes Project is a digital document platform.

Xerox basically changed the value proposition for their customers through Platforms, Centreware, Re-engineering the business processes, and improving pre and post sale support.[30]

6.3 *The Product Development Process*

Time-To-Market (TTM) is Xerox's new product development process. It was developed from benchmarking the industry best practices and the development of a new comprehensive business architecture. A major paradigm shift took place in the areas of Engineering and Manufacturing. For example:

The paradigm shift in design involved

- Common standard architecture
- Scalable performance – take machines up or down in capability

The paradigm shift in manufacturing involved

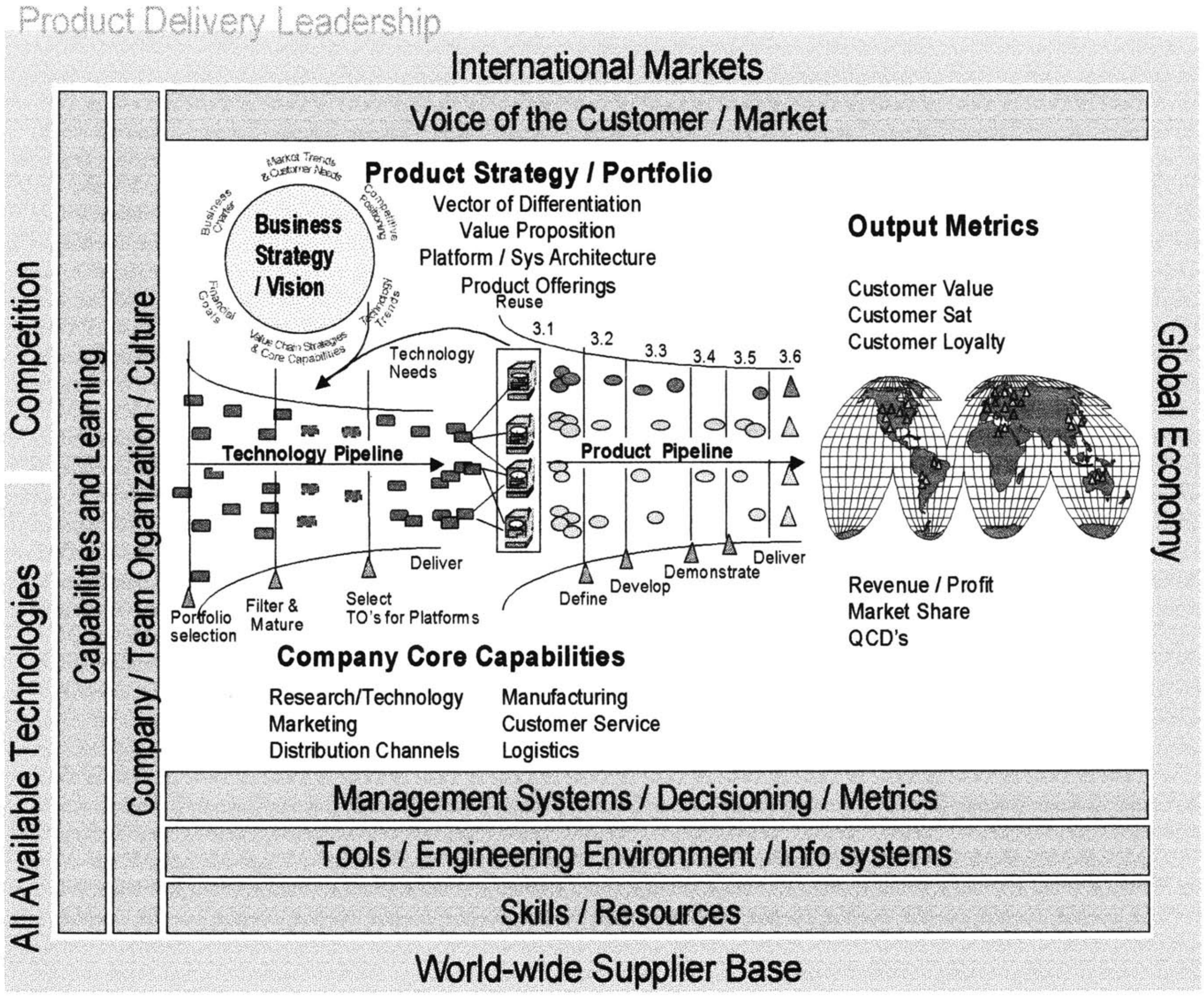
- Build to plan/ship to order
- No warehouse
- High level assemblies
- Standard hardware/components

The TTM process emphasizes breakthrough improvements in technology, improving the program teams knowledge and skills, and improving the commitment of

[30] Menezes, Melvyn A.J., Serbin, Jon. (1991). "Xerox Corporation: Customer Satisfaction Program". Harvard Business School Publishing, Boston, MA 02163. 9-591-055, Rev. January 12, 1993.

management.

Xerox's new business architecture consists of the following in Graphic 6.1:[31]



[31] Graphic is from Presentation to System Design and Management Class by Dr. John F. Elter, Vice President Xerox Corporation. October 2, 1998.

To develop new products today, Xerox uses voice of the customer (VOC), Benchmarking, and QFD. The engineers take on a systems approach to their product development system and therefore act systematically knowing that all things are connected. The theory is that decisions effect all elements of the value chain.

The strategy behind Xerox's new product development process involves developing a flow of platform variations. The definition of platforms is different then in the context of the automotive industry. Platforms in Xerox's product development culture consists of subsystems. They chunk the various systems of the copier and classify them as platforms. There is variation off each of these platforms. The goal is to be able to take the various chunks and create customized systems for their customers. Xerox's product development system therefore tries to develop streams of proven platforms, i.e. book-shelved technology which can be incorporated into multiple product offerings.

Xerox's product development process focuses on what they call the velocity of products moving through the pipeline based on variations enabled through the flow of new but proven platforms. This so called Product Development Pipeline consists of the following phases:

1. Propose
2. Define
3. Design
4. Demonstrate
5. Deliver & Delight

As the product evolves from concept to customer, it must pass through various phases of the project. The exit criteria is established by the team and management up front. The exit phases consist of the following:

1. Proposals
- Proposals approved
2. Define
- Defined and Technology ready
3. Design
- Design ready and proven
4. Demonstrate
- Production ready

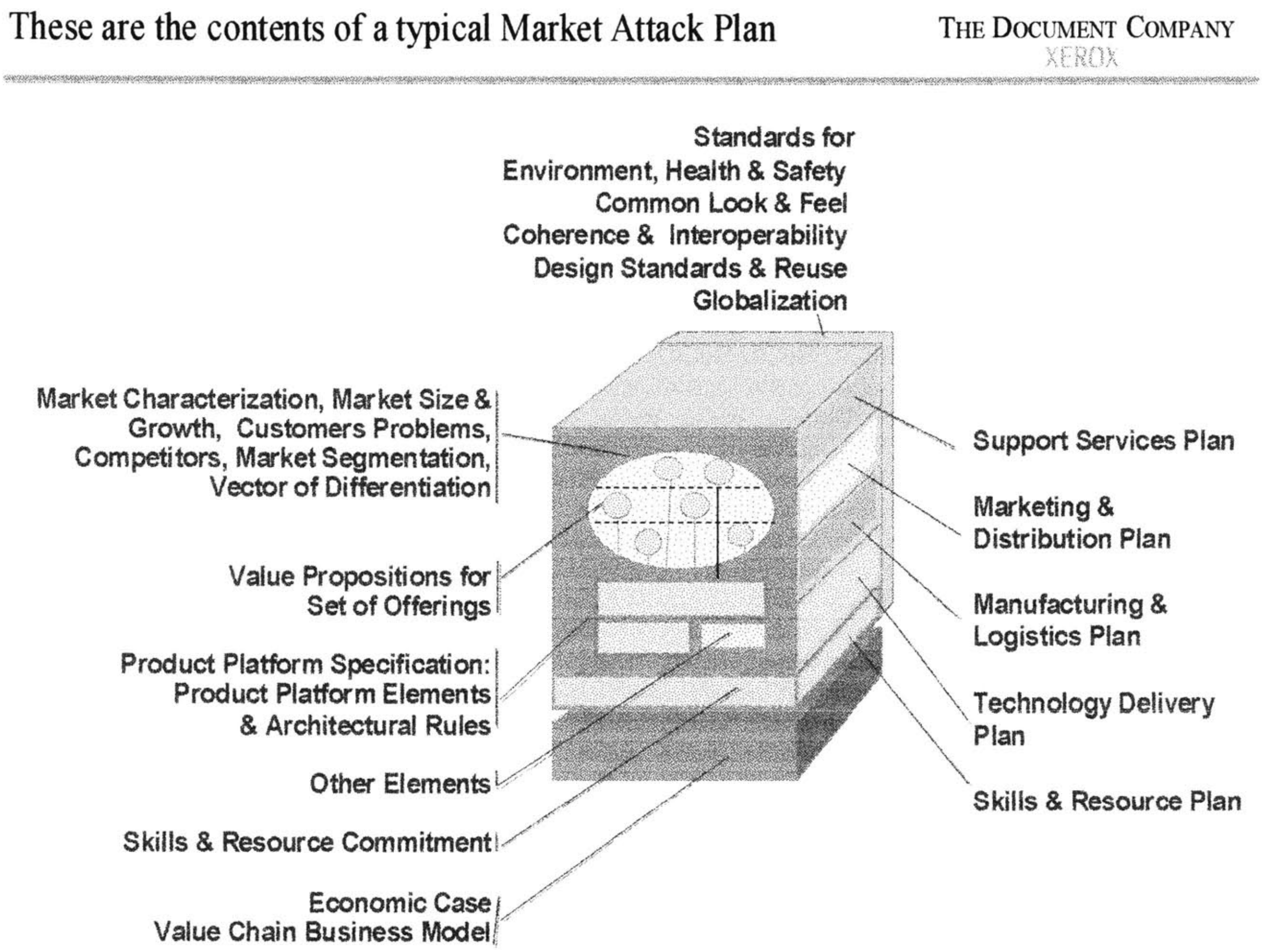
6.4 *Why Xerox's System Works – The Enablers*

Xerox has been very successful with their TTM process. They were able to recoup much of their market share while significantly reducing product development cycle time. Some of the keys to why TTM is successful are:

1. It identifies and uses industry best practices.
2. There is a common development process throughout the company.
3. Heavy emphasis upfront on determining what the market needs are and then defining the product strategy vision and market attack plan.
4. Continuous customer feedback throughout the entire TTM process.
5. Mature platform technology.
6. Empowerment of the program teams.
7. Education of the employees.
8. Knowledge transfer is captured and applied to improve productivity and performance over time.
9. Executive management and program teams work together to deliver the right products at the right time.
10. Ongoing design reviews, which are attended by across company management.

Xerox basically revamped all their processes, from engineering tools, to developing new ways, to get voice of the customer, management philosophies, to new launch processes.

What seems to make their system really work, is the upfront preparation that is done by the entire organization. At the front end of the TTM process, a detailed Market & Product Strategy Vision (MPSV) is developed. The MPSV is a high level definition of the target markets and market segments. The charter is established for the Market Attack Plan (MAP). The MPSV also completes a strategic level market situation analysis. The MAP is shown in Graphic 6.2.[32]



[32] Graphic is from Presentation to System Design and Management Class by Dr. John F. Elter, Vice President Xerox Corporation. October 2, 1998.

For each market segment that Xerox goes into has one of these MAP's performed. In each one of the MAP's, the Project Team will create multiple variations of product by mixing of proven platforms

One other important enabler in the Xerox product development system, is the roll the Executive management plays. Not only do they set direction and commit resources, they stay involved. One interesting feature that Xerox management does, is to sign a contract with the program team. This contract fully empowers the team.

Xerox has been successful in revamping its product development system and also achieving significant cycle time reductions. The company was successful in the fact that it addressed both the technical side and the people side of the process.

From the analysis of the Xerox system it should be pointed out that there is a significant difference in one aspect between the two consumer products, that is styling. For Xerox, the aesthetics of the product do not play as big a part in the final selection by the customer. In contrast, the styling of the automobile can be one of the most important contributors for a customer selecting the product. Not only does an automobile have to fit and function with high reliability and quality, but it must also be appealing to the customer. For the automotive manufacturers this styling aspect can add another important dimension that has to be taken into consideration when developing a new product. This extra dimension can and does affect the product development cycle time. Thus it is important to note this one major difference between the two products.

Next, we go back into the Ford system and find out what the employees themselves see as the inhibitors and enablers.

Chapter 7 – Ford Employees Describe the Enablers

To get a better understanding of what the inhibitors and enablers are, part of the research centered around personal interviews with the employees. A total of 20 individual interviews were performed along with a single focus group interview. The strategy used for the interviewing process was to get a good cross section of the product development community. Individuals therefore were chosen from each phase of the product development system. Activities interviewed included the following:

1. Sales and Marketing
2. Chief Program Engineers
3. Program Management
4. Designers
5. Prototype Build Coordinators
6. Test Engineers
7. Release Analysts
8. Service Representatives
9. Suppliers
10. Purchasing

For the focus group interview, a total of eight engineers from various component and vehicle system areas were interviewed.

7.1 *Structure of the Interviews*

Prior to conducting interviews a list of interview objectives was developed to help structure the interview and extract the key information. The internal interview objectives were the following:

1. Document shortcomings with current product development system.
2. Document shortcomings with previous product development systems.
   - Concept-to-Customer
   - World Class Timing
3. Document why programs had problems:
   - Manpower
   - Communication
   - Process
   - Tools
   - Part Failures
   - Timing
   - Budget
4. Document what went right on programs.

5. Determine how often Milestones were met.
6. Determine areas where timing could have been compressed.
7. Verify program constraints.
8. Determine how often projects were delayed.
9. Determine how often projects were completed on time.
10. Determine how often projects were started on time.
11. Determine how team was organized.
12. Determine how information was communicated to the team.
13. Determine team makeup.

Once the objectives were determined, a standard interviewing form was developed and Individual one hour interviews were held with each person.

The focus group interview was similar to the individual interviews. The focus group interview lasted approximately two hours and was basically a free flow of questions among the group.

7.2 Data Analysis

Once the interviews were completed, all the data was compiled and all inhibitors and enablers that were extracted were grouped through the use of an affinity diagram. The affinity diagram is a means of structuring detailed data into more general conclusions.[33] It is often used for providing initial structure in problem exploration.

After the data was analyzed through affinity diagrams, all of the inhibitors documented were placed in an Ishikawa diagram, or fishbone diagram. Ishikawa diagrams are a tool to help find root causes. The process uses the 5 Why concept that was developed by the Japanese. Use of the 5 Why technique allows investigators to dig further into to the true root causes of a problem by continuing to ask Why.

With an explanation of how the interviews were structured, we now look into the results.

[33] "The Language Processing Method - A Tool for Organizing Qualitative Data and Creating Insight". (1995). Published by the Center for Quality of Management.

7.3 *The Interviews*

As mentioned previously, the people interviewed were those that are involved in the various aspects of a typical project.

During the interviews, it was apparent that most of the people were extremely frustrated with the current product development system. Comments by many of the individuals were that FPDS was not realistic with the dates, decisions were continually made late in the program, especially in the area of the design studio, and late management changes were common. The general feeling was that Ford did not have a good predictor of what the customer truly wanted. There was a lot of "Single Point Marketing" that was taking place within the organization, especially at the Director level. The term Single Point Marketing refers to the process by which decisions are made from comments of a single customer instead of mass customer consensus. It was felt by the group, that Ford's desire to become so customer focused, with the "Consumer Headset", that Executive Management is pushing decisions that in some cases do not have a sound business case. Resources and time are spent developing these proposals when in the end, they were never truly viable or that they did not represent a real market opportunity.

The inability to accurately predict what customers really want is a major issue noted among the group. Inability to clearly define the market opportunity with what the customer needs and wants, leads to unclear objectives for the team. What is taking place is that decisions are made late out of the design studio due to nebulous direction given by the Sales and Marketing activity. When that side of the organization was interviewed, frustration was also observed. The individuals from Sales and Marketing who were interviewed, admitted that their forecasting tools were weak. They stated that part of the inability to forecast is due to the long cycle time for products to be developed. The lag in development time causes the Sales and Marketing activity to be hesitant in making firm forecasts. Therefore it is the chicken and the egg scenario. It is clear that without an accurate customer specification upfront, all bets are off on what the actual program will produce, when it will be complete and what it will cost.

We will now explore in more detail the results of the interviews through the use of an affinity diagram.

7.4 *Affinity Diagram Results*

The Affinity Diagram was developed from a decomposition of the results of each of the interviews. The analysis concentrated on the inhibitors that were noted.

The inhibitors were primarily grouped into six categories. The categories included Marketing, Upper Management, Program Management, Engineering, Support Activities/Services, and Process & Systems.

Marketing was the first category of inhibitors. As described previously, Ford Marketing is weak in the area of forecasting tools and predictor models. Some of which is driven by the slow process but mainly it is due to not having adequate tools. Currently Ford does not have any marketing tools to predict option popularity or pricing. Marketing does not have a good means of correlating customer satisfaction to option content. A good example was when Sales and Marketing requested a change in tires from Continental to Michelin, on the Navigator vehicle. When asked if they could specify why Ford needed to change to the more expensive tire, the requester could not offer any data relating to the satisfaction or quality improvements for the customer. Basically their tools were described as "Crystal Balls". The majority of forecasting came from the many years of experience with the veterans but the down side was that it was based off of the past and therefore not forward sighted.

The result of not having an accurate up front forecast leads to unclear project objectives. All new program actions are initiated at Ford through what is called a

Program Direction Letter (PDL). The PDL encompasses all of the program assumptions. These include changes in every subsystem of the vehicle, and financial business case. If customer needs and wants are not explicitly determined and translated into the program assumptions, the project team will not be able to accurately deliver the new product.

Upper Management was the second category documented under the affinity diagram. In the category of upper management some of the inhibitors noted were lack of support, late changes or changes made without a true business case, and lack of "True" empowerment to the project team.

What the lack of support comment referred to was that Executive Management must take a larger role in the project through monthly Program Steering Team (PST) meetings and periodic design reviews. Their involvement should also be there to guard against late program direction changes as well as to rally support of the other areas of the company when help is needed to solve problems. The consensus among the surveys was that when an Executive personally sponsors a project, the likelihood of its success in meeting its timing commitments and budget, rises dramatically. This does not mean though that this person must micro-manage the project. The team must be empowered to establish its own budgets, timing work plan, and staffing requirements.

Program Management was the third category documented under the affinity diagram. Program Management's role in the process is to not only manage the program but to champion the initial PDL. From the survey, one of the common issues noted was that the assumptions were not clearly defined. Without clear assumptions, which are basically a list of all the changes that will take place on the vehicle, the program can be incorrectly staffed, improperly budgeted, and ill planned. This then leads to confusion in objectives, assignments, and the overall work plan. The inhibitors therefore noted in the surveys was that PDL's were incomplete or incorrect, VPP's were not developed, programs were not properly staffed, and objectives and deliverables were not clearly defined.

Engineering was the fourth category and included both Engineering and Design. From the survey, feedback on what the inhibitors were ranged from lack of knowledge of the technology and systems, and the engineers amount of time spent on one project, to being understaffed, overworked, and inexperienced.

The engineering lack of knowledge pertaining to the C3P technology, the systems such as WER's, GPIRS, GPLUS, etc., or the tools such as QFD, DOE, DFMEA, PFMEA, etc. Another issue with the tools, is that even though an engineer may think he or she knows how to use them, many times the heavy workloads and tight schedules override the discipline of applying them. The efficiencies taken out of an engineer's schedule many times involves the deletion of one of these analytical tools and thus relying on judgement calls.

Another important observation, was that many engineers are rotated in and out of the project before its completion. This not only disrupts the flow for the rest of the team but also creates discontinuity for the particular system that the engineer was working on. The common consensus was that team members must be committed to the project and remain with it until its completion.

Some additional inhibitors noted in the engineering category were the fact that many felt they were understaffed and overworked. Part of this could be due to lack of planning, inexperience, lack of knowledge, etc.

Support Activities and Services were the fifth category documented. Support Activities and Services included all activities that support the process (e.g., purchasing, testing, finance, etc.), and suppliers.

Support Activities noted in the survey included purchasing. The inhibitors noted within purchasing include late sourcing, low volume programs being stuck using high volume suppliers, and smaller low volume niche market programs that are not supported. Late sourcing has always been a frustration amongst the engineering community at Ford. The issue is even more complicated when the program needs fast response from the vendors but due to long drawn out price negotiations the program suffers. One engineer, during the interview, mentioned that the issue gets even more complex when you are working on smaller low volume niche market programs. Many of the high volume suppliers do not like to deal with lower volumes due to the low margins and additional work that may be associated with it. Ford has over the past 5 years significantly reduced its supplier base to only high volume suppliers. In reference to the low volume part requirements, one purchasing employee was quoted as saying, "If they want the high volume programs they're going to have to live with supporting the low volume programs".

An additional inhibitor was the fact that purchasing does not have the resources to fully support every program. What happens is that the major programs are supported and the smaller ones live with the results. When in many cases the smaller programs require greater purchasing support due to the speed and special circumstances associated with low volume production in a high volume company.

The inhibitors noted in the area of testing and test support services were lack of resources, limited or overworked test facilities, inadequate instrumentation, or dependence on seasonal testing. I will start with the latter first. Most of the vehicle programs today within Ford are still dependent on doing their final sign off's on actual vehicles in extreme hot and cold environments. This typically means that the programs must test the vehicles in northern climates during the winter and in the southern climates during the summer. With this requirement, what takes place is that all programs are on the same schedule. That is the same schedule to use similar facilities, test engineers, and test equipment. For new programs that are not in the typical yearly cycle plan, this can result in significant delays due to prior commitments on all the other programs.

The inhibitors associated with Finance concern the approval of the program budget. During the development of the PDL, Finance plays a critical role in the development of the programs business case. Once the PDL is complete and the program is approved, final expenditures throughout the program are approved by Finance. If the Finance activity does not take an active roll in the program, expenditure approvals may be delayed due to added scrutiny. The program team therefore needs a dedicated financial analyst to help expedite approvals.

Inhibitors associated with the Suppliers has already been discussed. The overall issue is that the supplier base is typically highly capitalized with expensive high volume equipment. Any changes required by low volume programs can cause significant disruptions to the regular high volume production runs. Suppliers typically are very hesitant to want to produce these low volume runs. Especially if Ford's Purchasing activity doesn't allow price increases to take on the added risk and disruption.

Process inhibitors include items such as requiring "no risk" signoffs, inflexibility in moving key timing events, excessive management reviews, etc.

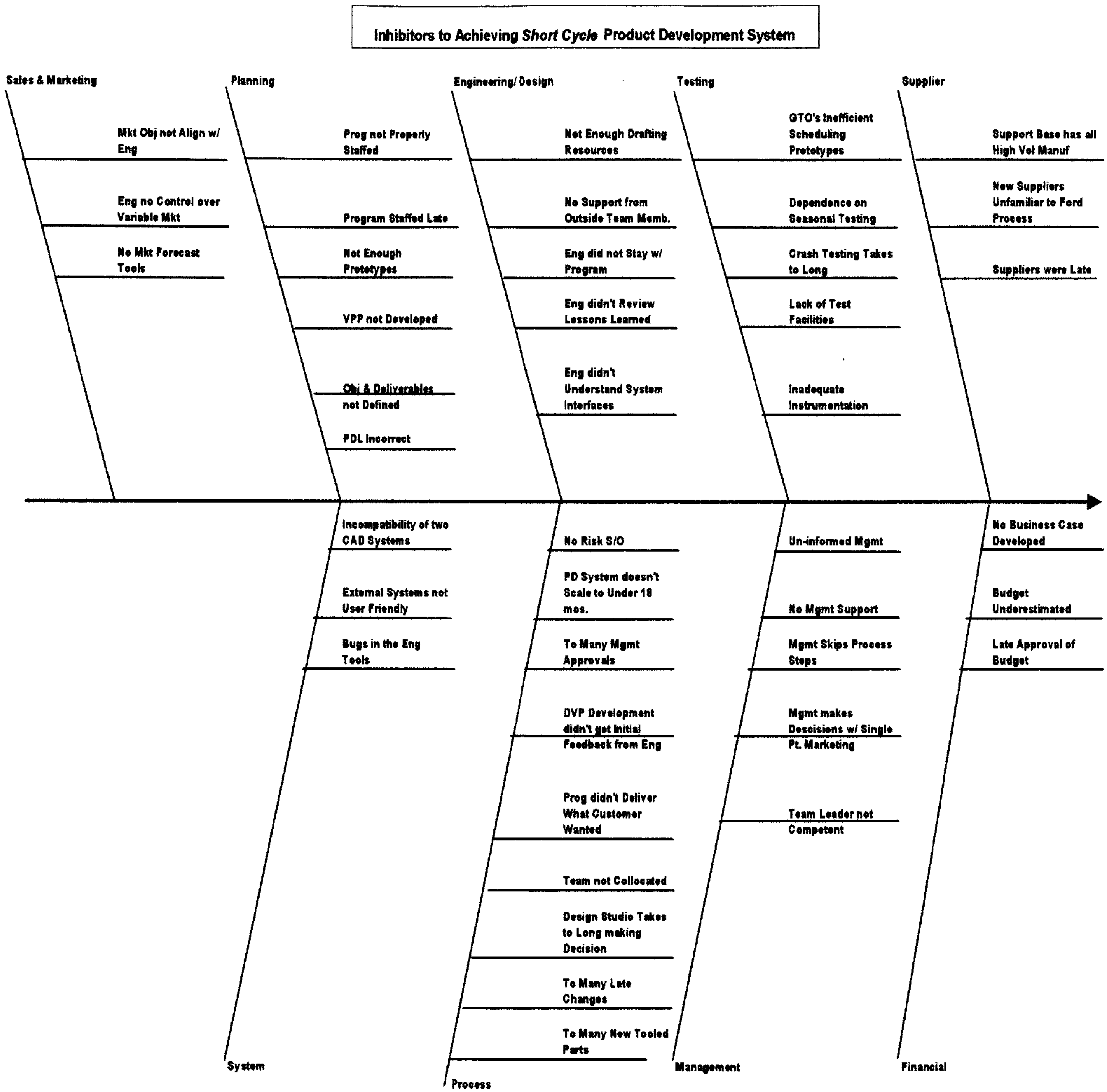
The System inhibitors were discussed previously and involved issues such as the systems not being user friendly, bugs in the engineering tools, and multiple CAD systems.

To further investigate the inhibitors, Ishikawa Diagrams were developed for the various categories. The following section will explore more of the root causes and suggest some possible enablers.

7.5 *Ishikawa Diagramming*

An overall system Ishikawa Diagram was developed from the decomposition from the surveys and the Affinity Diagram, see Graphic 7.1. Similar to the Affinity Diagram, each branch of the Ishikawa Diagram categorizes the major inhibitors that surfaced during the interviews. The categories include: Sales & Marketing, Planning, Engineering & Design, Testing, Suppliers, Systems, Process, Management, and Financial.

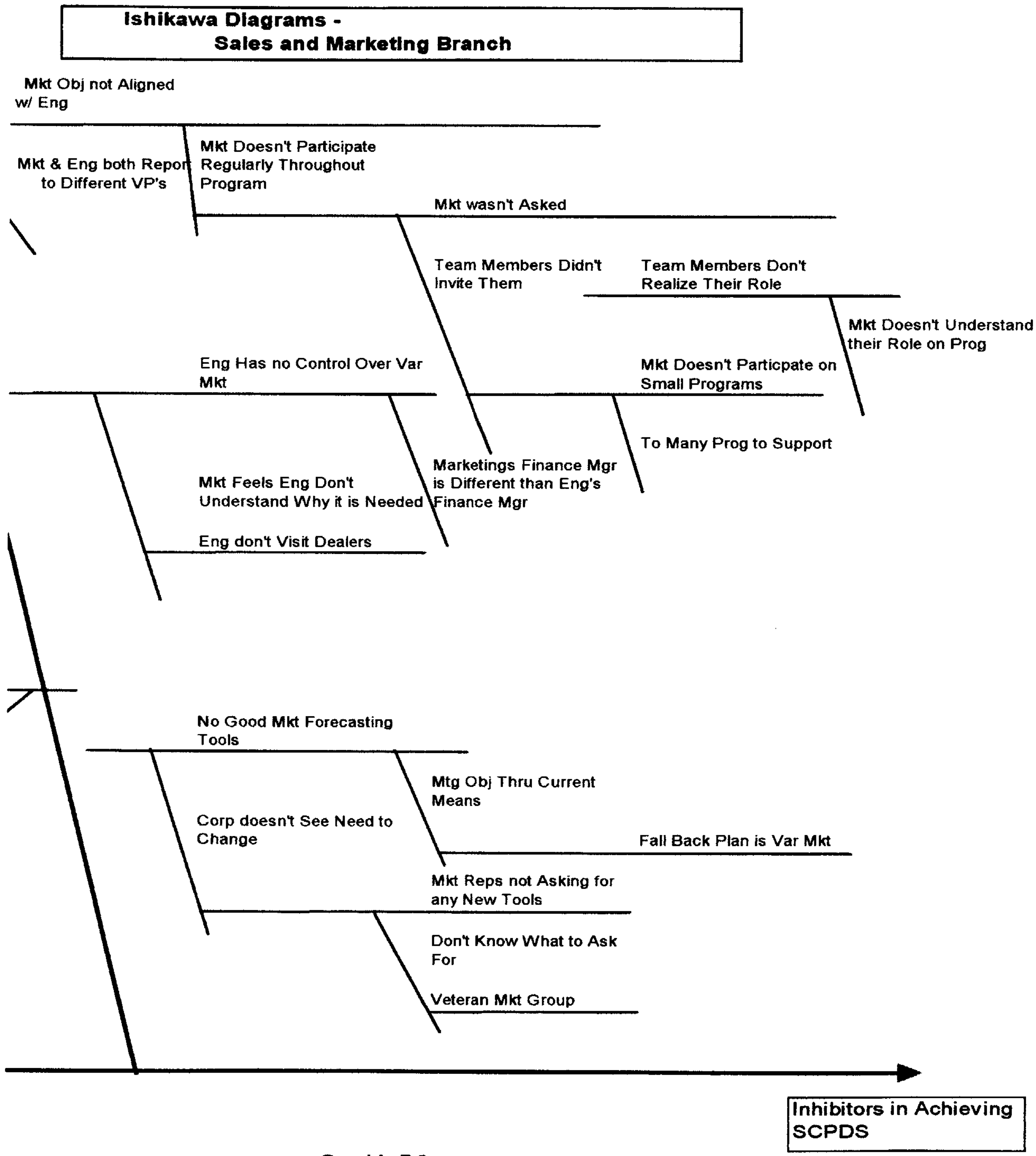
After each branch of the diagram, conclusions were drawn to try and capture the key inhibitors. Following the conclusions, there are some suggested enablers that were captured from the surveys.


Inhibitors to Achieving Short Cycle Product Development System
Sales & Marketing
Mkt Obj not Align w/ Eng
Eng no Control over Variable Mkt
No Mkt Forecast Tools
Planning
Prog not Properly Staffed
Program Staffed Late
Not Enough Prototypes
VPP not Developed
Obj & Deliverables not Defined
PDL Incorrect
Engineering/ Design
Not Enough Drafting Resources
No Support from Outside Team Memb.
Eng did not Stay w/ Program
Eng didn't Review Lessons Learned
Eng didn't Understand System Interfaces
Testing
GTO's Inefficient Scheduling Prototypes
Dependence on Seasonal Testing
Crash Testing Takes to Long
Lack of Test Facilities
Inadequate Instrumentation
Supplier
Support Base has all High Vol Manuf
New Suppliers Unfamiliar to Ford Process
Suppliers were Late
Incompatibility of two CAD Systems
External Systems not User Friendly
Bugs in the Eng Tools
System
No Risk S/O
PD System doesn't Scale to Under 18 mos.
To Many Mgmt Approvals
DVP Development didn't get Initial Feedback from Eng
Prog didn't Deliver What Customer Wanted
Team not Collocated
Design Studio Takes to Long making Decision
To Many Late Changes
To Many New Tooled Parts
Process
Un-informed Mgmt
No Mgmt Support
Mgmt Skips Process Steps
Mgmt makes Descisions w/ Single Pt. Marketing
Team Leader not Competent
Management
No Business Case Developed
Budget Underestimated
Late Approval of Budget
Financial

Graphic 7.1

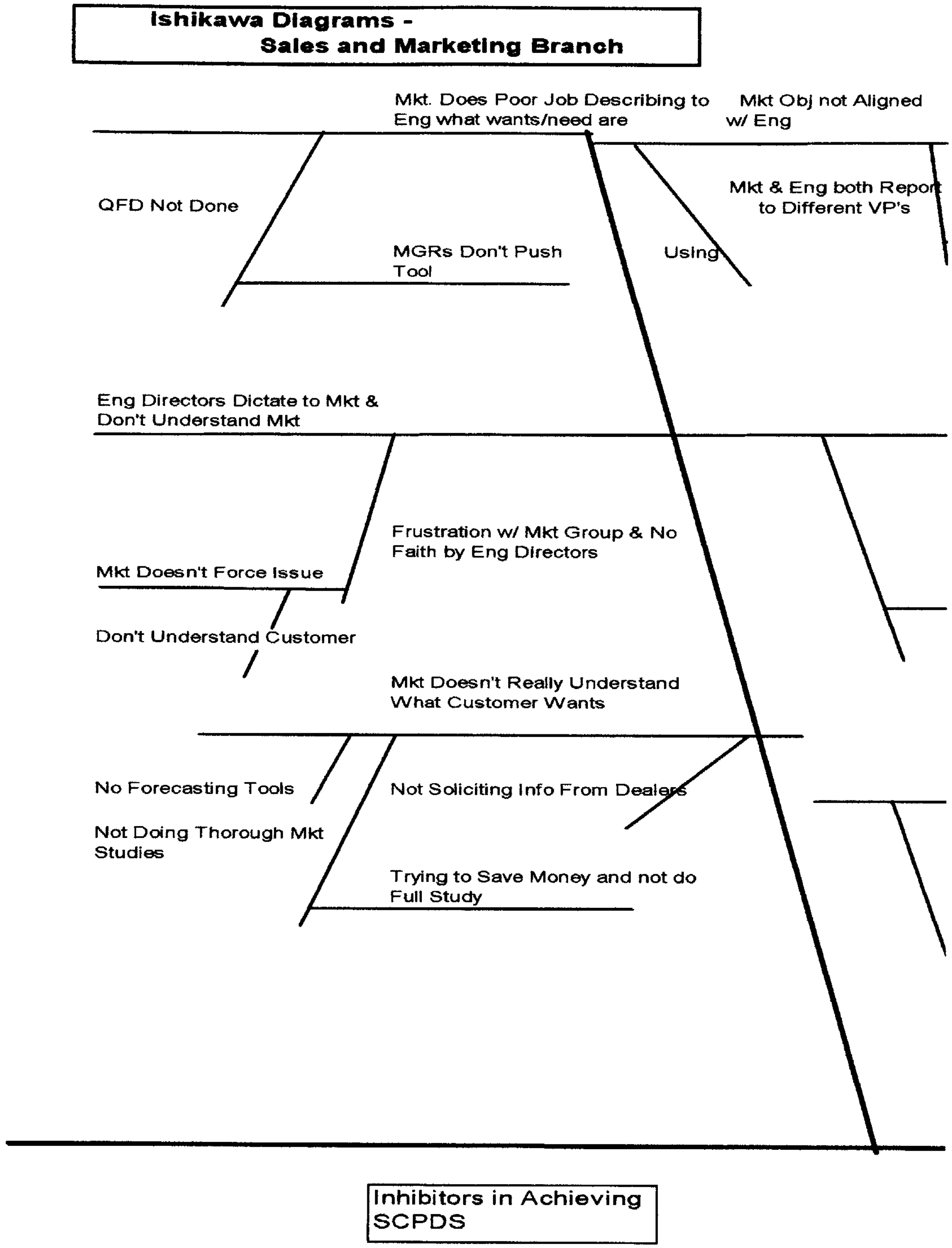
7.5.1 *Sales & Marketing – Ishikawa Branch*

The Sales and Marketing Branch is shown in two Graphics 7.2 & 7.3.



Graphic 7.2

7.5.1 *Sales & Marketing – Ishikawa Branch Con.t*



Graphic 7.3

Sales and Marketing Ishikawa Branch – Conclusions:

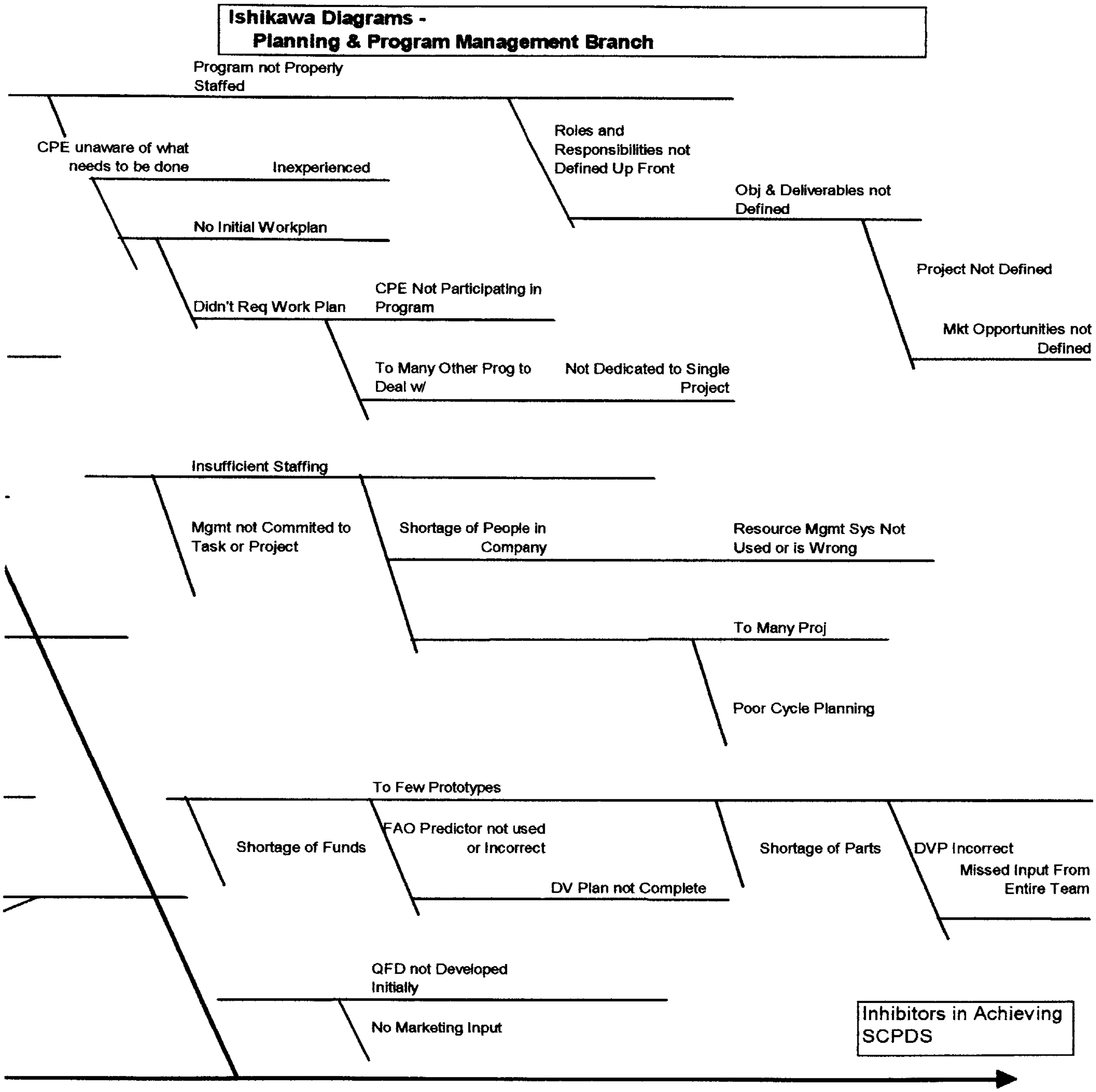
• Marketing's only equity in the program is upfront and downstream. There is very little association during the vehicle development.
• Marketing uses variable marketing budgets to convince customers to take product he or she doesn't want.
• Ford Marketing tools for predicting customer wants are insufficient.
  - Problems are in forecasting trends
  - Problems are in forecasting option take rates

Suggested Enablers:

• Force the system to use the Quality Function Deployment tool to help brainstorm customer wants and needs. This tool will also help to convert these wants and needs into Engineering parameters.
• Utilize Marketing's input throughout the development process.
  - Marketing can continually confirm Voice of the Customer
  - Keep program and product aligned with the wants and needs of the end customer.
• Align objectives between Engineering and Marketing, e.g., profit margins, market share, return on sales margins, etc.
• Assign dedicated Marketing person for the life of the project.
  - They can be used to conduct initial customer wants.
  - Direct QFD development.
  - Conduct customer design reviews.

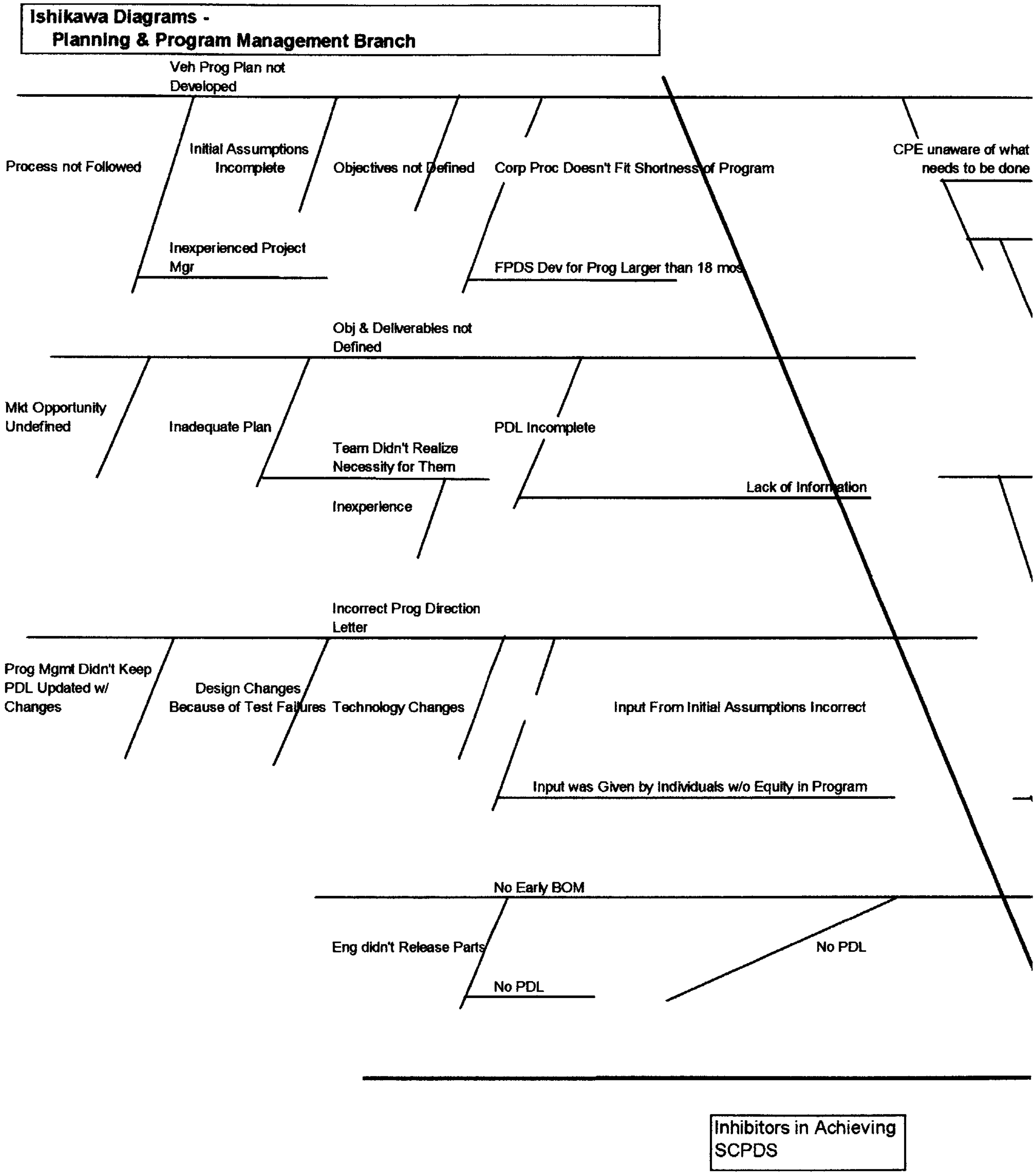
7.5.2 Planning and Program Management – Ishikawa Branch

The Planning and Program Management Branch is shown in two Graphics 7.4 & 7.5.



Graphic 7.4

7.5.2 *Planning and Program Management – Ishikawa Branch Con.t*



Graphic 7.5

Planning and Program Management Ishikawa Branch – Conclusions:

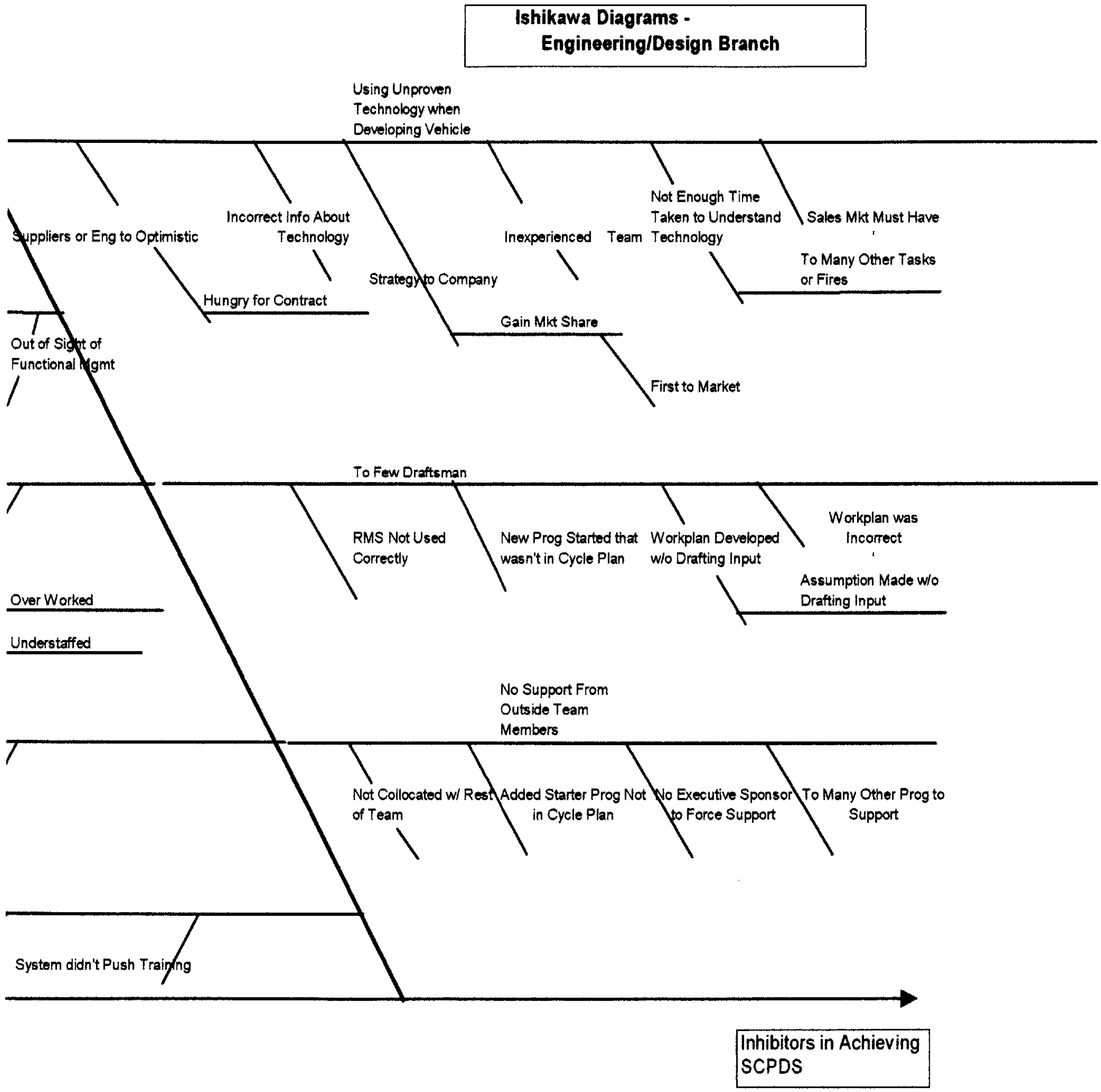
- PDL must be complete, accurate, and thorough. The PDL initiates all other work.
- Insufficient staffing can be caused by:
  - Lack of executive sponsor
  - Roles and responsibility not defined.
  - PDL incomplete.
  - RMS tool doesn't work or isn't used.
- Objectives not defined due to lack of clearly defined mission.
- FAO predictor model should be used but a sanity check needs to be made.

Suggested Enablers:

- Accurate and complete assumptions and financials must be developed for the PDL and be issued before any work starts.
- Development Verification Plan (DVP) must be developed at the beginning of the program with participation from whole team.
- Perform a QFD for every new program.
- Executive sponsor should be required with each new program.
- Clear cut objectives and deliverables defined and cascaded at the beginning of every program.
- Metrics must also be developed at the beginning of every program.
- Organizational chart is required with each new program.

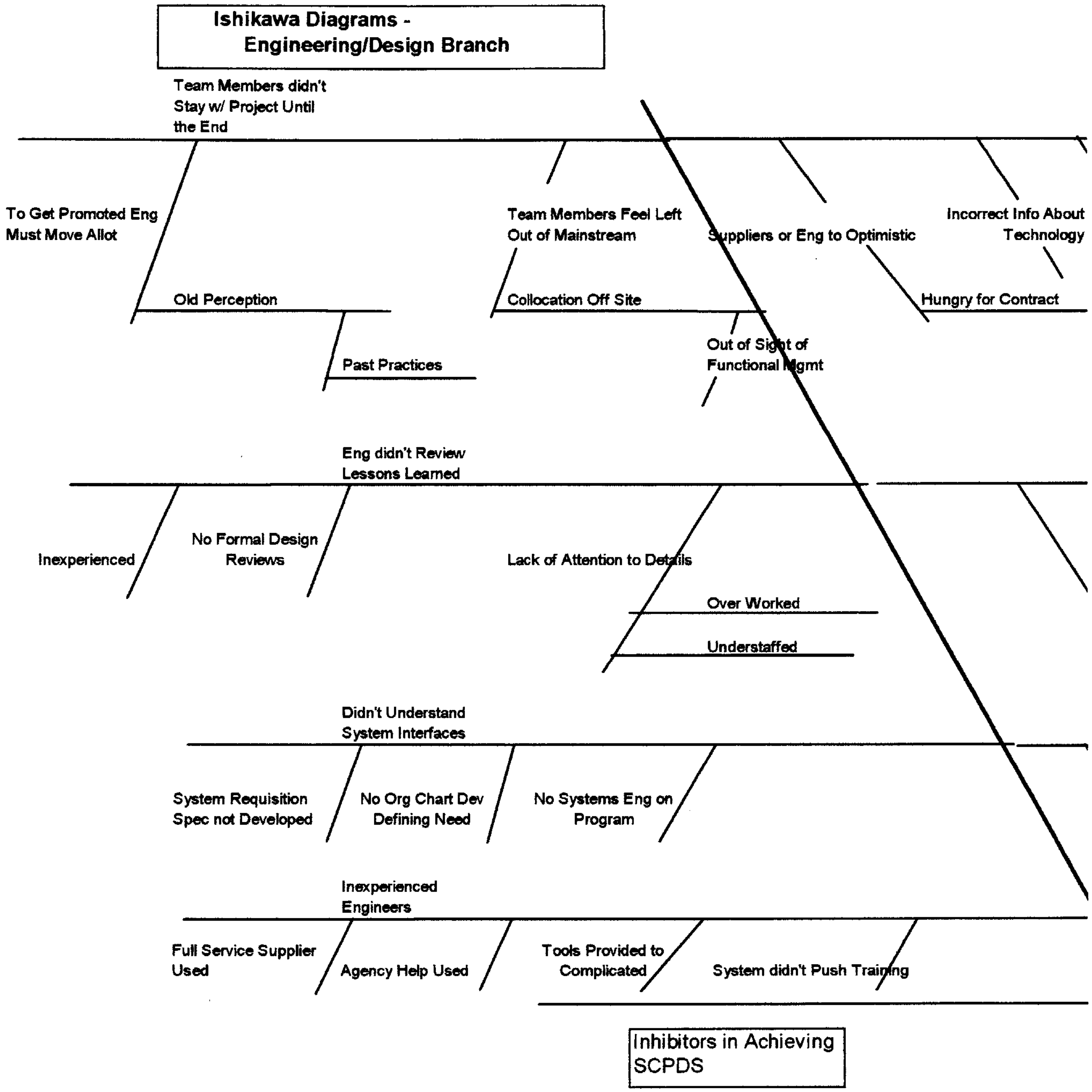
7.5.3 Engineering and Design – Ishikawa Branch

The Engineering and Design Branch is shown in two Graphics 7.6 and 7.7.



Graphic 7.6

7.5.3 *Engineering and Design – Ishikawa Branch Con.t*



Graphic 7.7

Engineering and Design Ishikawa Branch – Conclusions:

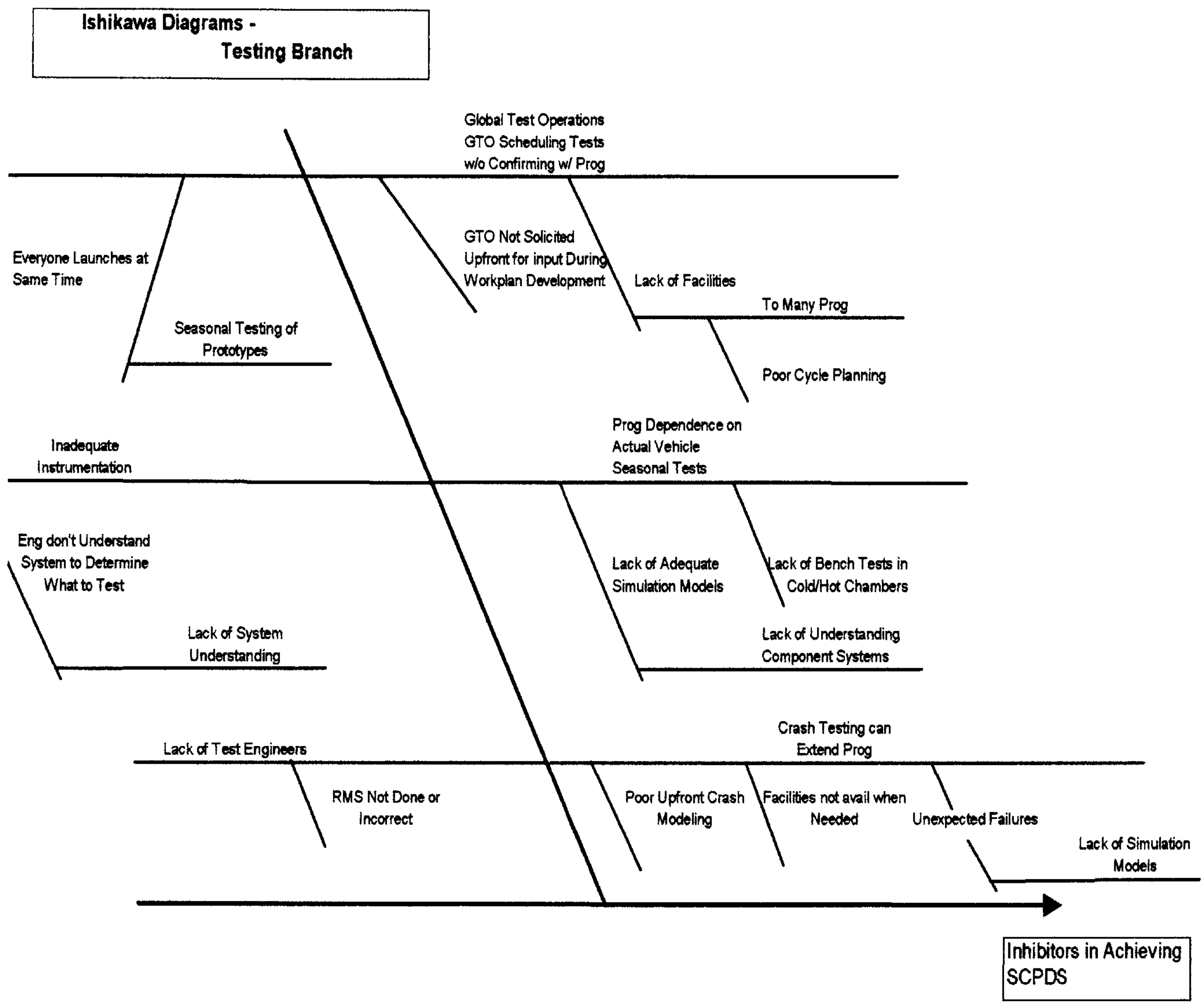
- Short cycle programs must be careful to not use unproven technology.
- Organizational charts should be developed showing system interfaces so that entire team understands what their individual systems will affect.
- Projects require that core team stay with the project from conception to launch.
- Adequate staffing must be in place at the start of a project.
- Executive sponsor needs to get resource commitments from the rest of the organization.

Suggested Enablers:

- The entire organization must be willing to support the core program team when required.
- The program must strive to use as many carry over components as possible.
- Team members will remain with the program until the product enters production.
- Short cycle programs must use on the shelf technology.
- Design reviews need to stress the importance of the subsystem interfaces.
- Project Manger must stress the importance of the lessons learned data base.
- Program Managers (i.e., CPE) should be given the authority to give performance reviews for his or her team members.

7.5.4 *Testing – Ishikawa Branch*

The Testing Branch is shown in Graphic 7.8.



Graphic 7.8

Testing Ishikawa Branch – Conclusions:

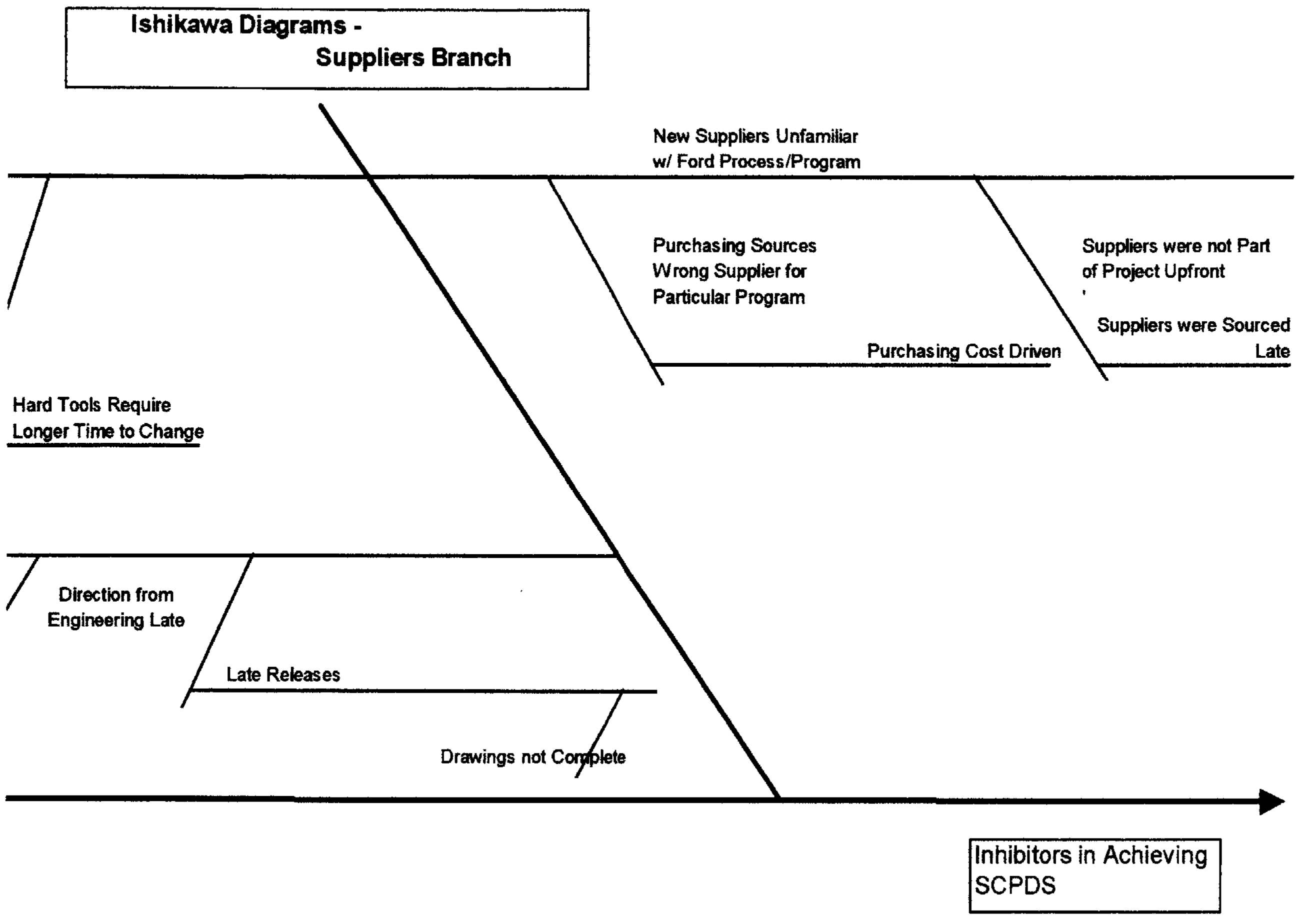
• Test facilities are typically overworked due to too many programs having the same schedule.
• Test activity needs to provide input into the VPP.
• Accurate modeling and simulation must be done on components.

Suggested Enablers:

• Consult with Global Test Operations (GTO) on test facility readiness and the ability to support program during the initial phases of the program. Meeting should be held prior to developing the DVP.
• Program needs to assure that there are enough test engineers to support program.
• Use multi-test vehicles. (e.g., concurrent testing)
  - Use more than one test at a time when possible.
  - Perform destructive prototype tests last so that vehicles can be used for other testing.
• DVP verified with Test Engineer, Test Activity, Prototype Build Group, and Instrumentation Group prior to being approved.
• Pursue improved modeling techniques which can help eliminate actual vehicle tests.
• Better cycle planning for queing tests at test facilities. Development Engineers need to participate in the planning process.

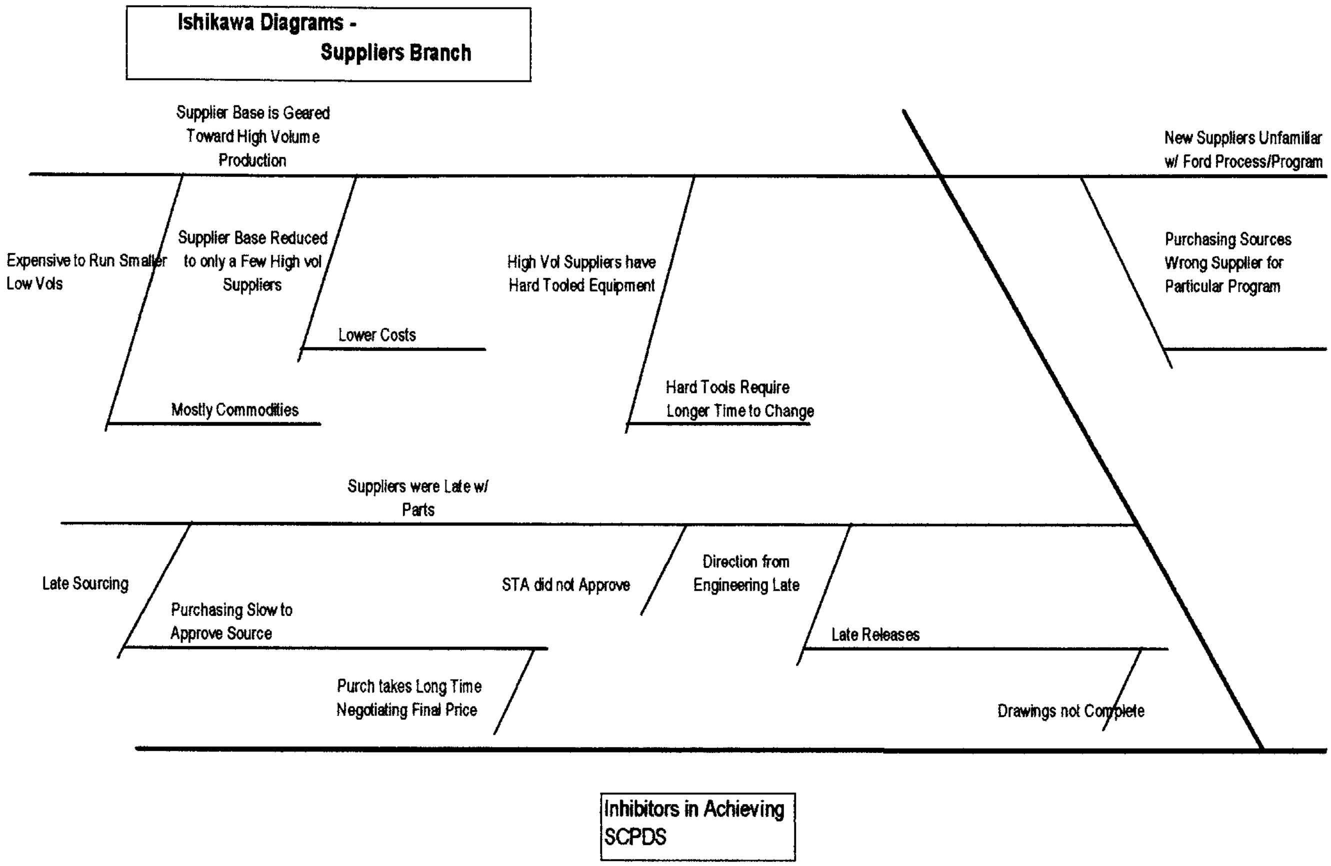
7.5.5 *Suppliers – Ishikawa Branch*

The Suppliers Branch is shown in two Graphics 7.9 and 7.10.



Graphic 7.9

7.5.5 Suppliers – Ishikawa Branch Con.t



Graphic 7.10

Suppliers Ishikawa Branch – Conclusions:

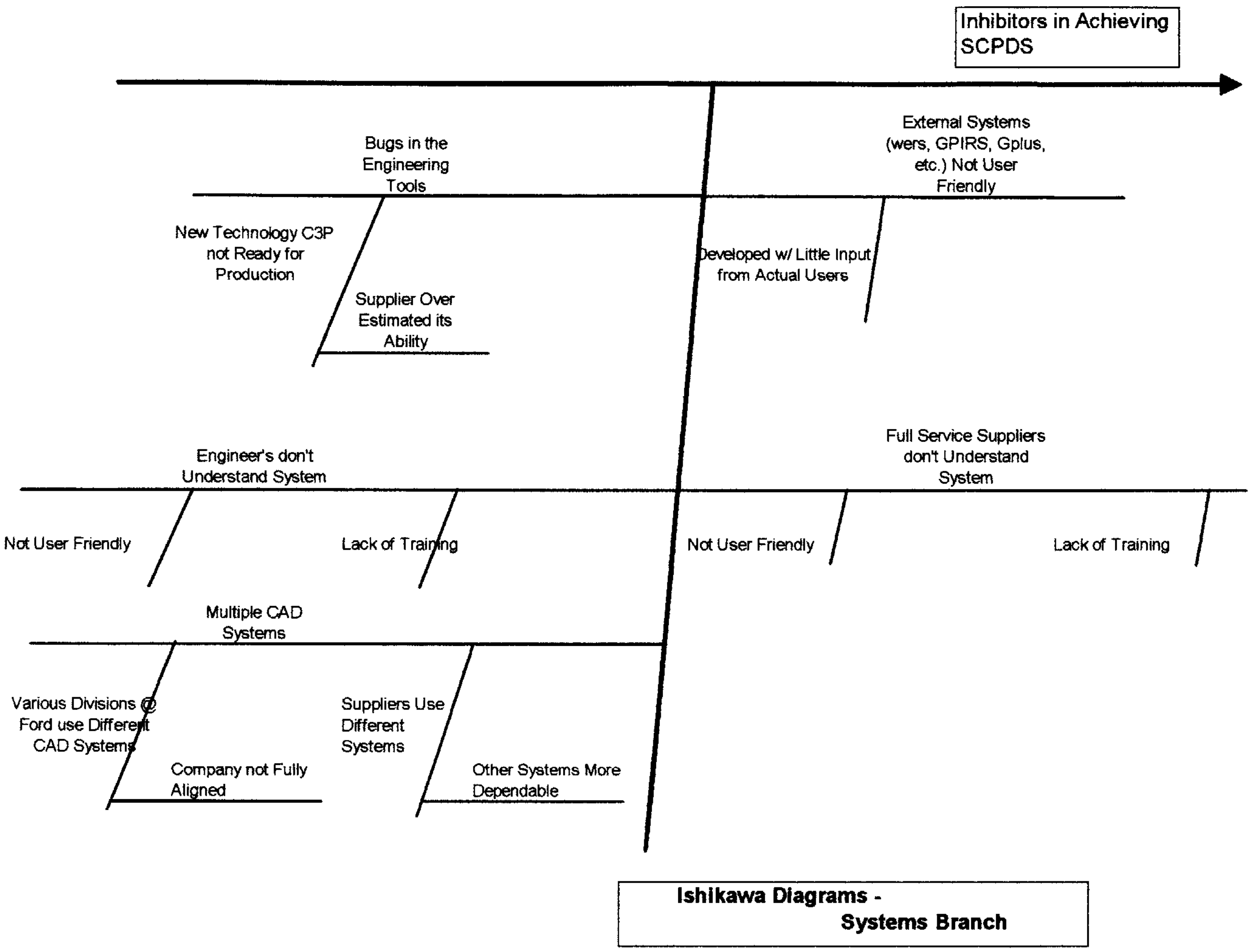
- For low volume requirements additional suppliers should be allowed to quote on program.
- High volume suppliers need flexibility to modified their commodity parts.
- Source programs suppliers early.
- Engineers should fully understand suppliers capability.

Suggested Enablers:

- Early sourcing of suppliers is mandatory.
- Suppliers need to participate in the VPP development.
- Engineering and Purchasing must communicate each others requirements.
- Purchasing to participate on an ongoing basis during all program development phases.
- Engineering and Purchasing must understand the suppliers capability and manpower.

7.5.6 ***Systems – Ishikawa Branch***

The Systems Branch is shown in Graphic 7.11.



Graphic 7.11

Systems Ishikawa Branch – Conclusions:

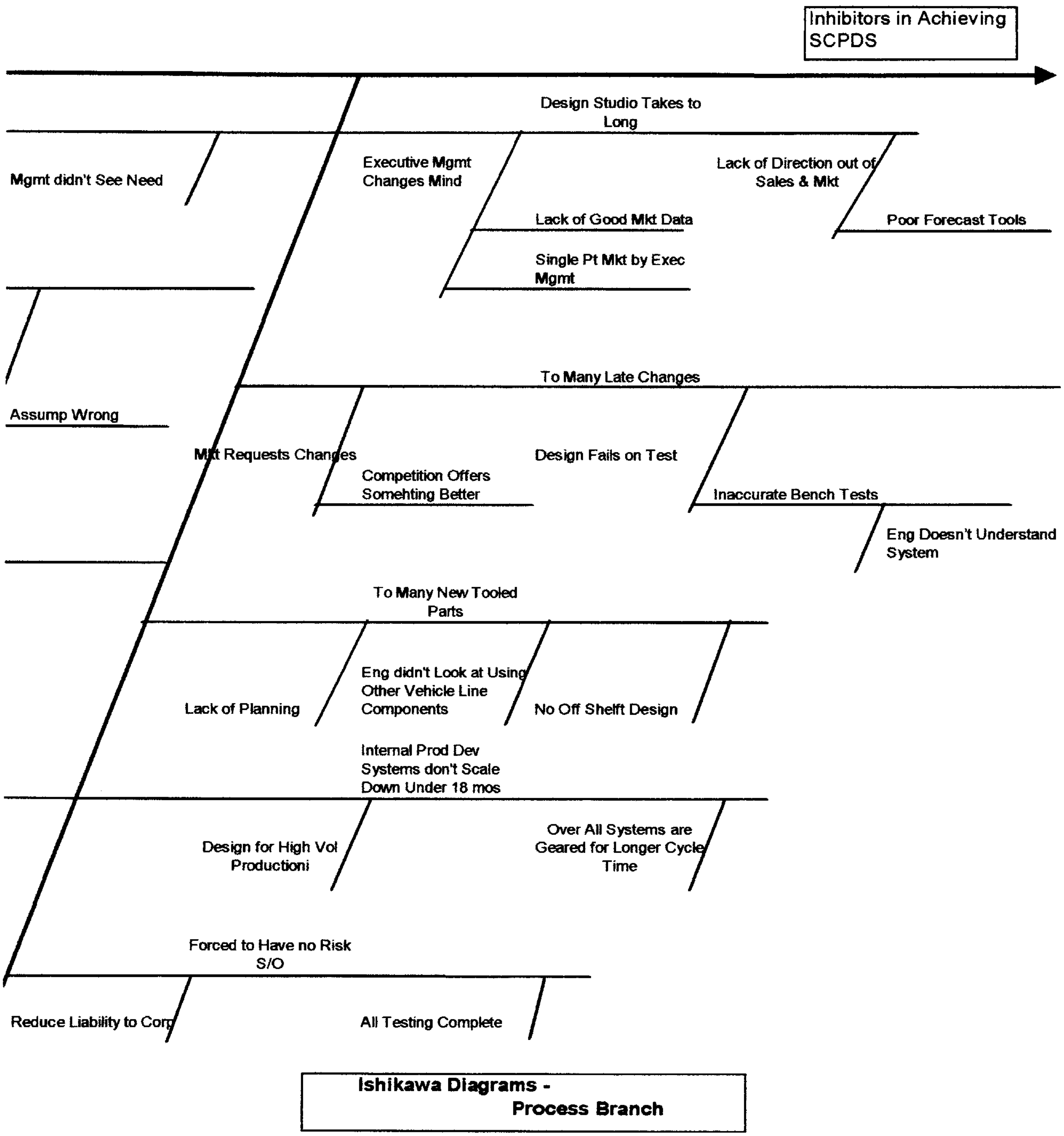
• External systems not user friendly thus engineering and other users resist using them or use them incorrectly.
• Team needs systems training before the program gets to far along.
• Team members must understand C3P tools.

Suggested Enablers:

- Conduct training, for engineers and other team members on company systems.
- System specialists should be assigned to each of the groups as a coach.
  - They can be used to problem solve and teach members of the group on how to use systems.
- Engineers need a minimum of the introductory courses in C3P.
- Suppliers on the program should have knowledge of the C3P tools.
- Suppliers must be proficient in the use of the internal Ford systems.

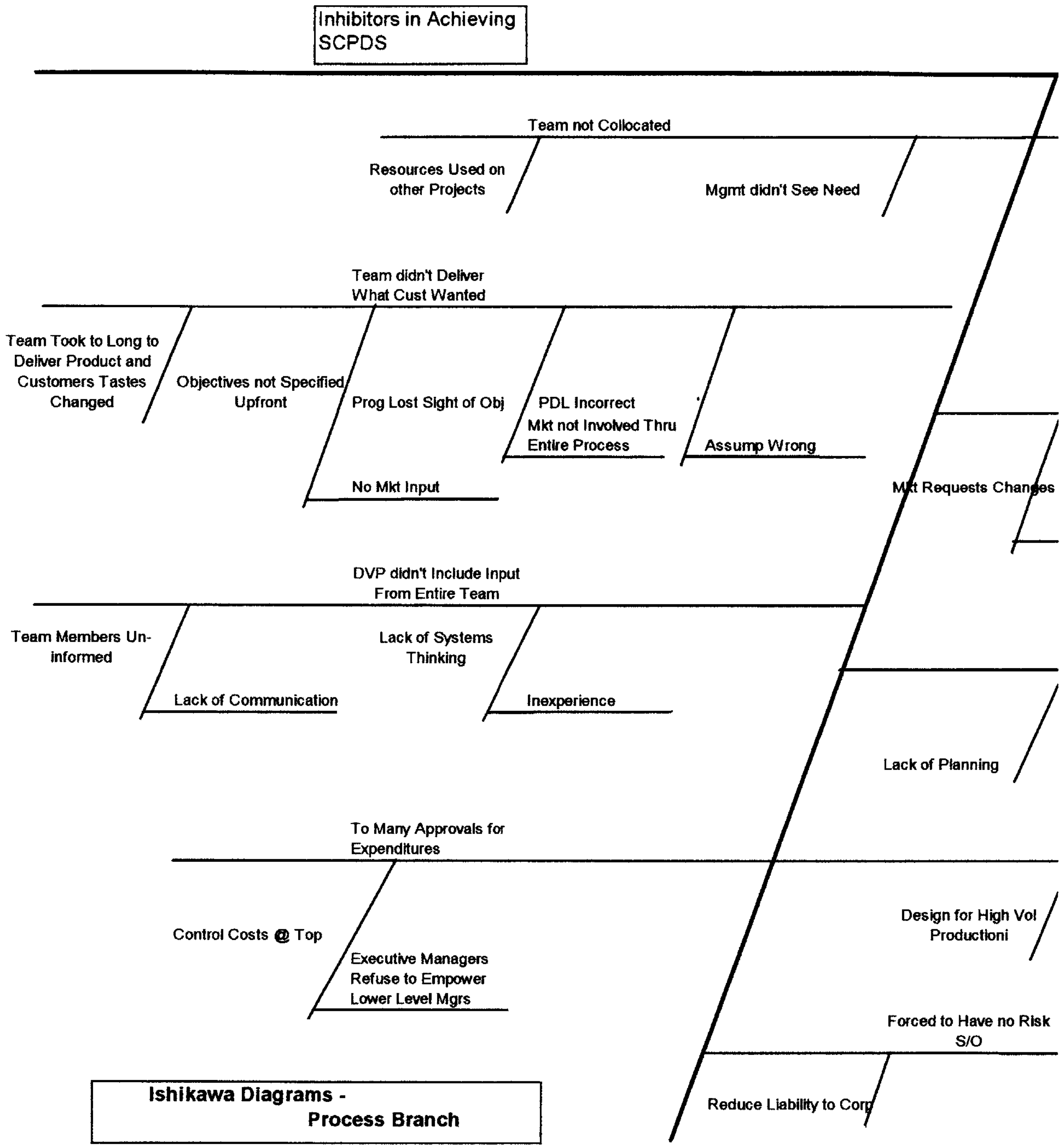
7.5.7 Process – Ishikawa Branch

The Process Branch is shown in Graphics 7.12 and 7.13.



Graphic 7.12

7.5.7 Process – Ishikawa Branch Con.t



Graphic 7.13

Process Ishikawa Branch – Conclusions:

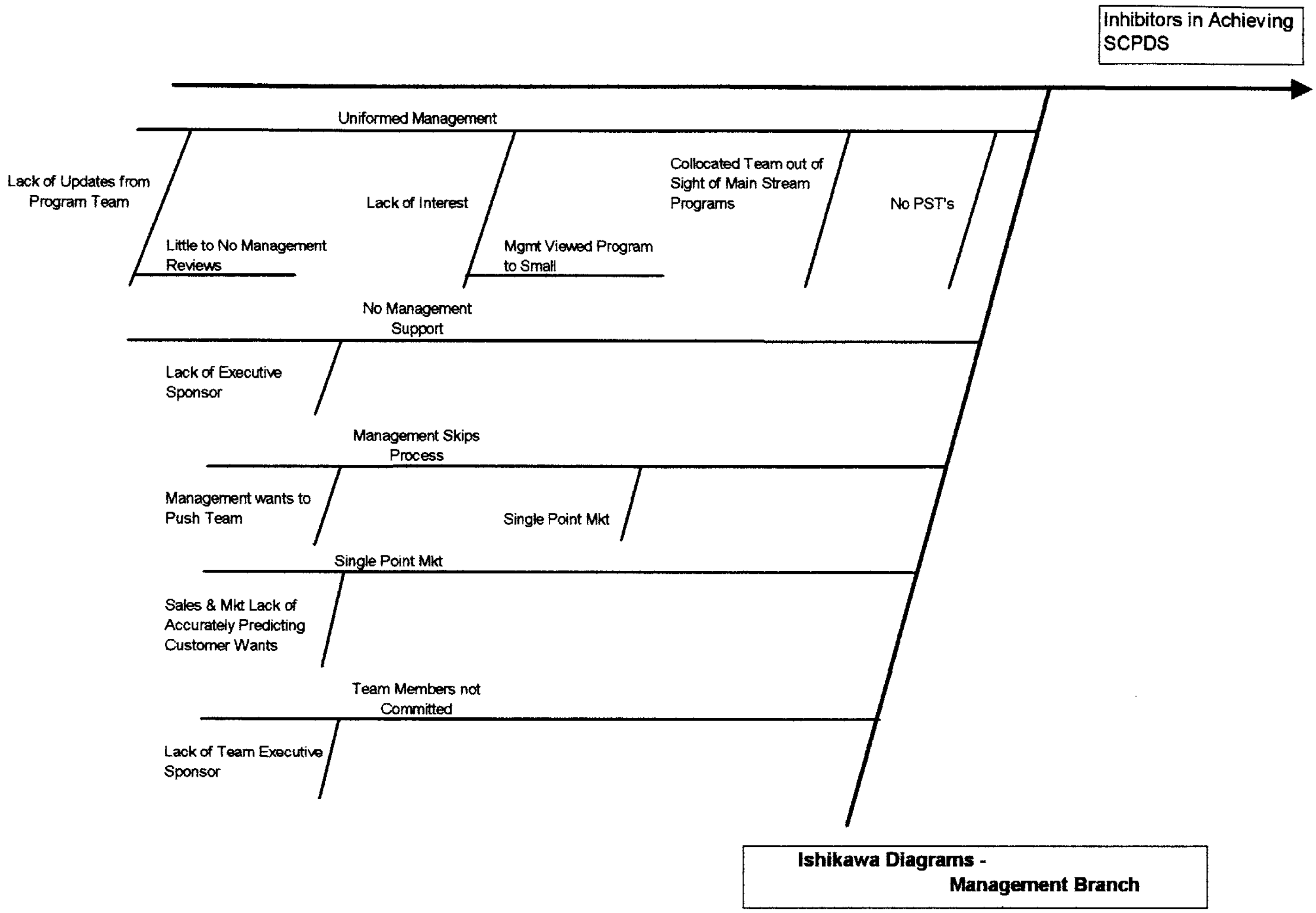
- Cross functional collocated teams are more productive then teams that are not collocated and cross functional.
- All team members (core team specifically) need to participate in the development of the QFD, VPP, DVP, and affected DFMEA's.
- Minimize new tooled parts by using off the shelf carryover parts.
- Empower project team to manage their own budget.

Suggested Enablers:

- Use collocated cross functional teams whenever possible.
- Avoid using new tooled parts whenever possible.
- Freeze the design as early as possible and do not allow late changes.
- Develop PDL, DVP, VPP, etc., with the entire core team.

7.5.8 ***Management – Ishikawa Branch***

The Management Branch is shown in Graphic 7.14.



Graphic 7.14

Management Ishikawa Branch – Conclusions:

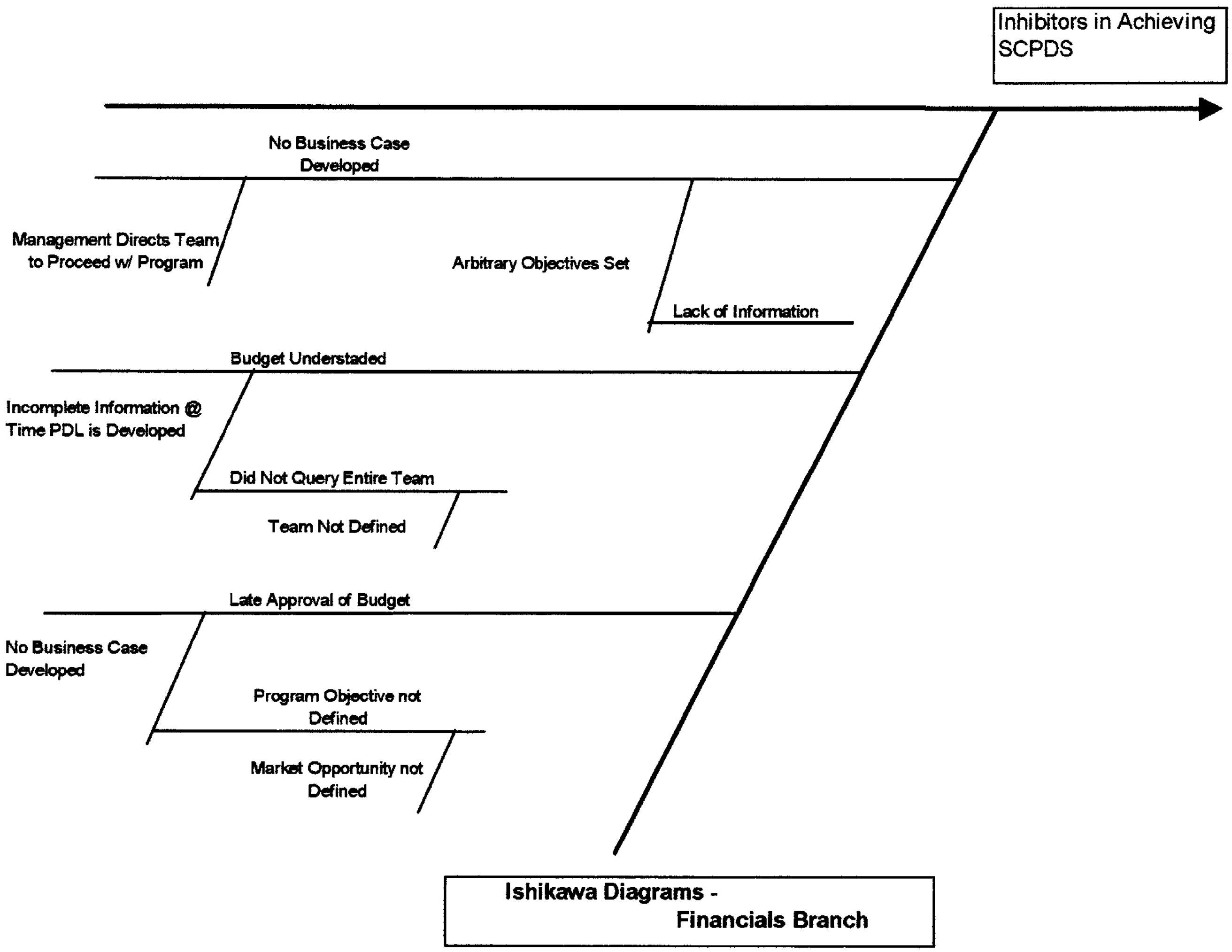
- Management Design Reviews are critical for keeping management informed of the project status. It also offers a fresh eyes view of the project.
- The general opinion amongst most of the survey participants felt that projects that have Executive sponsors are typically more successful than those that don't.
- Every means should be used to ensure the full process is followed.

Suggested Enablers:

- Executive sponsors are critical to the team's success in meeting dates and budget goals.
- Regular design reviews should be held for the team and management.
- The product development process should be flexible enough to allow the team to customize it to the needs of the project.
- Once the process has been defined for the program, stick to it.
- Management should emphasis the criticality of holding delivery dates.
- Management should acknowledge the accomplishments of the team when key timing events are met.
- Hold weekly and monthly meetings as needed amongst the team, assembly plant, and suppliers, and management.
- At the start of a program, project managers need to establish team objectives, stretch targets, reporting structure, and individual performance objectives.

7.5.9 *Financials – Ishikawa Branch*

The Financials Branch is shown in Graphic 7.15.



Graphic 7.15

Financials Ishikawa Branch – Conclusions:

• Each new project must be accompanied by a financial business case to assure the teams hard work is not wasted.
• Management must be knowledgeable about the project and technology prior to establishing financial stretch targets.

Suggested Enablers:

• Management needs to empower the team to develop the business case.
• Financial stretch targets must be realistic.
• Budget objectives need to be communicated to the entire team.
• Finance and Program Management must work together to develop budgets and stay within budgets.

7.6 *Summary*

As you can see from each branch of the Ishikawa Diagram there were many excellent enabler ideas suggested from the individual interviews. The Ishikawa Diagram had 9 distinct branches but if one were to reduce them to their basic root causes they would fall into one of three categories. As previously mentioned in Chapter 4, these categories were identified as relating to the three P's, People, Process, or Planning. Once again, it is apparent that these three categories truly capture the essence of where the root causes lie in reference to the Inhibitors or Enablers to achieving shorter cycle product development.

In order to validate many of the enablers identified, the research now turns to an actual real life case study where many of these enablers were used and the results were quite impressive. The project was the 2000 Model Year, United States Postal Program (USPS) Explorer Carrier Route Vehicle (CRV), which involved the development of an entirely new delivery vehicle for the U.S. Postal Service in under one year. In Ford's normal FPDS process time line, this type of project would typically have taken a very large engineering team around 3 years to accomplish. But through the use of the many of the enablers identified and a small offsite highly motivated cross functional collocated team accomplished the impossible in only one year.

What this team accomplished was so significant that the team was singled out recently as the High Performance Team of the Year within the Ford organization.

The next chapter will examine the means by which this team was able to successfully achieve such a fast cycle time.

Chapter 8 – Case Study Validation: 2000 USPS Explorer CRV

The 2000 Model Year United States Postal Program Explorer Carrier Route Vehicle Program delivered a vehicle to the U.S. Postal Service in less than 1 year. In comparison to a normal FPDS process, this would have taken 3 years. This doesn't mean that the program didn't have issues. Rather it is a lesson of how a small committed collocated cross functional team when given a specific objective can achieve the impossible. Yes, this team did re-write the rules at Ford.

8.1 *History of the Program*

In August 1998, the United States Postal Service approached Ford Motor Company and Utilimaster Corporation with an offer to bid on a large fleet order of 10,000 units to replace their aging delivery Jeeps. Within one month, Ford and Utilimaster presented a joint proposal to design and develop a new right hand drive flex fuel explorer chassis with an all new aluminum body. After being awarded the contract in September of 1998, the team set out to design and develop an all new Carrier Route Vehicle. What transpired was that Ford and Utilimaster completed its first prototype in five months, and six months after that they delivered the First Article of Inspection. The 500th unit will be delivered to the U.S. Postal Service by January 14th, 2000. A total of 75 new tooled parts for the chassis and over 500 new body, interior, and electrical new tooled parts for the body were released. In that one year, Ford tooled up its assembly plant, St. Louis Assembly Plant, and Utilimaster built and tooled an entirely new body assembly plant.

For Utilimaster and Ford this was a significant accomplishment. Both companies prior to this point had never worked together on a project of this magnitude. Beyond the design issues that arose on the project, there were many cultural issues that had to be resolved between the two companies. Both companies had significantly different means by which they managed and developed new products. As mentioned previously, the project was not without its problems. At one time or another, the problems faced by the team included all of the inhibitors associated with people, planning, and or process.

So how did the team succeed in finally delivering a high quality product to the customer in under a single year?

8.2 *Enablers that were Instrumental to Achieving Short Cycle Time*

The 2000 USPS Explorer CRV program accomplished something within Ford that normally takes up to three years to accomplish through FPDS. The revised chassis with the all new body went from concept to final customer in less than 12 months. The management teams of both Ford and Utilimaster not only had to develop a new product, but had to resolve the issues of how to constructively work together, plan, and communicate. Between the two companies the 3 P's had to be addressed, People, Planning, and Process.

As a way of summarizing the enablers listed throughout this paper and a means by which to describe why this project was able to reduce cycle time, all the enablers that were identified are now listed below in one of 3 categories, Planning, People, or Process. Those that were of particular influence in accelerating the 2000 USPS Explorer CRV program will be discussed in further detail.

The enablers to short cycle product development are as follows:

People:

1. *Keep team member destiny in the hands of the project leader. The project boss rather than the functional boss should evaluate the team members.*
2. *Insist on 100% assignment to the team. Core team members cannot be part time members and they must be dedicated to the project 100% and also stay through the entirety of the project.*
3. *Place key functions on board from the outset of the project. All core and supporting team members must be in place at the start of the project, this includes everyone, e.g., Engineering, Purchasing, Marketing, Manufacturing, Suppliers, Quality, Service, etc.*

4. *Live together. Team members should be collocated.*
5. *Remember the social element by celebrating team accomplishments as well as provide humorous awards for setbacks. This is not to say setbacks shouldn't be taken seriously, but the key is for the team to stay unified under trying times.*
6. *Allow outsiders in. Principle vendors, distributors, and customers should be allowed to participate on the team.*
7. *Raise the productivity of the engineering staff. Allow Designers to design and Engineers to engineer by eliminated non-value added meetings and assignments.*
8. *Top management support is important throughout the process. Top management can assure that the teams are properly staffed and budgeted. They can provide assistance in resolving various system and process related problems and assure that no late changes are allowed.*
9. *Client consultations throughout the entire project. Where possible, allow the customer to provide direct input on the project.*
10. *Communication. The team must maximize their communication during the entire project. Communication is critical within the group and to members outside the group.*
11. *The entire organization must be willing to support the core program team when required. When technical issues occur outside the scope of the core project team, immediate assistance must be provided by those expert's, knowledgeable within the company.*
12. *All plans whether it's the overall work plan or test plan, need to be reviewed with all affected parties. For example, the DVP should be verified with Test Engineering, Test Facilities, Prototype Build Group, and Instrumentation Group prior to being approved.*
13. *Empower the project team. This empowerment includes the ability to establish the overall work plan, budgets, staffing levels, program metrics, and approval chain.*
14. *Team members should have knowledge of the company's development process, internal systems and engineering tools. In order to provide assistance to the team, an expert in these areas could be temporarily assigned to the project.*

Planning:

1. *Project performance tracking metrics must be identified after the VPP is complete. The development of the metrics should include input from the project team and once finalized they should be cascaded to the entire core team and all external support groups.*
2. *Technical issues need to be assessed up front in the project. Timing implications need to reviewed as well as the team's expertise.*
3. *Detailed project planning needs to be completed before the start of the program. The project manager must insist on a VPP with a base line critical path defined, all subsystem timing overlays also need to be defined and completed.*
4. *Parallel development of the component and the assembly tools. Once the VPP has the critical path identified, those supplier and assembly plant tools and equipment that have long lead times must be procured, where possible, in parallel with the design.*
5. *Accurate and complete assumptions and financials must be developed for the PDL and to be issued before any work starts. All affected areas of the organization must be solicited for their assumptions.*

6. *Part of the project planning is to consult with Global Test Operations (GTO) on test facility readiness and the ability to support program during the initial phases of the program. Synchronizing all the functional groups and support organizations to optimize program team performance is critical.*
7. *Freeze the design as early as possible and do not allow late changes.*
8. *At the start of a program, the manager of the project must establish team objectives, stretch targets, reporting structure (organizational chart), and individual performance objectives. These items must be cascaded to the entire team.*
9. *Develop PDL, DVP, VPP, etc., with the entire core team.*
10. *Eliminate the need for seasonal testing. The program plan should pursue the use of Environmental chambers.*
11. *The program plan must strive to use as many carry over components as possible.*
12. *Start the development clock when risk is manageable.*
13. *Benchmark the competition.*
14. *The manager of the project should strive for smoothed workloads amongst all team members.*

Process:

1. *Organize and document a repeatable design process*
2. *Conduct design reviews at critical milestones; conduct progress reviews when the business needs information. Ongoing design review's should be attended by management from across the company.*
3. *Give priority to product (over function) in the organizational structure.*
4. *Early problem identification and quick troubleshooting response by the team is critical.*
5. *Focus on value added functions.*
6. *Apply computer aided engineering up front in the project. Utilize as much simulation and modeling analysis as possible.*
7. *Force the system to use the QFD tool to help brainstorm customer wants and needs. This tool will also help to convert these wants and needs into Engineering parameters.*
8. *Short cycle programs must use on the shelf technology.*
9. *Lessons learned. Engineering must be sure to utilize the corporate knowledge base especially on what's been learned on other projects.*
10. *Use multi-test vehicles. Optimize the use of the prototype vehicles.*
11. *Engineering and Purchasing must review and understand the suppliers capability and manpower status.*
12. *Suppliers must be proficient in the use of the internal Ford systems.*
13. *Use collocated cross functional teams.*
14. *Once the process has been defined for the program, stick to it.*
15. *Employ systems engineering focus throughout the process.*
16. *Reducing implementation variability by program teams by:*
    - *focusing on first time capability with the design which eliminates the need for rework.*
    - *building on Best Practices within a standardized process.*
    - *facilitating team to team learning.*
17. *Never start a design like a clean sheet of paper, reuse design concepts.*

Many of the enablers mentioned were instrumental in helping the 2000 USPS

Explorer CRV program significantly reduce its cycle time. Lets now take a more focused look into what some of these program specific enablers were.

8.2.1 *2000 USPS Explorer CRV Program Enablers*

8.2.1.1 *People*

The project team played a crucial role in achieving a fast cycle time. At the start of the program, Ford Management dedicated a team of five engineers on the project. The five engineers included an Electrical Engineer, a Powertrain Project Leader, two chassis Engineers, and a Body Engineer. Besides the core team of Engineers, the project also had a dedicated project management person, three Supervisors and a full time Chief Program Engineer. The team was also supported by a contract design house and prototype build shop, ACI Carron. In addition, the team was supported by personnel from Marketing, Manufacturing, Quality, Purchasing, and Service. Besides the Ford team, there was a small team of body engineers from Utilimaster, the aluminum body manufacturer.

The entire Ford core team was collocated offsite at ACI Carron. This offsite collocation helped the team in several ways, it reduced many of the distractions that take place within the main engineering center, which allowed the team to focus, it placed the engineering team along side of the designers, and the team was also located next to the prototype build area. When design or build issues took place, the engineering team was able to quickly address the concerns, since they were collocated on site.

What helped the team deal with the tough schedules, the many obstacles that took place, and design challenges presented to the group, was the fact that the team had been part of the establishing the schedule and targets upfront. Long hours were put in by the team for setting up the VPP, the budget, the test plan, and the team metrics.

This empowerment of the team and the ability to personally set the schedule helped unify the team and when the obstacles were faced, the team drove hard to resolve them. The problems faced on the program, the offsite collocation, and the daily face to face contact truly unified the team. The camaraderie was present almost from day one. Since the management staff and engineering group were located in one room there was a continual open flow of information and discussion. There was such close interaction amongst the group that at times it was unclear who had responsibility for what. One manager was quoted as saying, “everyone backed each other up and the work just got done, regardless of whose actual job it was”.

Even though the program was considered a small project, due to the low volume, the team was assigned a Chief Program Engineer (CPE). Having a CPE dedicated to the project also helped keep the program focused and on track. When technical issues were beyond the scope of the project team, the CPE was able to quickly acquire the needed resources within the corporation to help resolve them. The CPE played a critical role of keeping the rest of the Executive Management informed of the teams progress. The CPE also used these updates to give the team members personal credit for their various accomplishments which was a true morale booster for a team that had to be moved out of site from the rest of the organization.

Another enabler that needs to be mentioned in the category related to People was the fact that the team had ongoing involvement with the customer throughout the development process. Regular monthly visits were held with the customer to review the progress of the project. These customer visits helped develop a relationship with the customer and also was important for the team to see their enthusiasm for what was being developed.

8.2.1.2 *Planning*

One of the key differences between the 2000 USPS Explorer CRV Program and the many other programs and projects within Ford, was the fact that the team was given a very explicit vehicle specification from the customer. This specification defined in significant detail what was expected of the vehicle in fit, form, and function. The team was therefore given clear cut goals and objectives on what needed to be accomplished. The customer specification also provided for accurate and complete assumptions to initiate the project through the corporate PDL process. This customer provided vehicle specification was the basis for the PDL, VPP, DVP, and project metrics.

Besides the customer specification, there were also some additional corporate requirements that were added to ensure that the vehicle would meet the corporate quality standards as well as safety standards.

What the vehicle specification provided was a means by which the team determined the readiness of the product. It either met the requirements in the specification or it didn't. The team was able to stay on track because the program content would not change. The program was focused on delivering what was called out in the specification. There was no worry of management making any late changes.

Another means by which the team established targets for the vehicle, was the use of benchmarking the competitors product. This was quite simple since there was only one type of vehicle to review. Fit and functional data was taken and targets were set in addition to the specification. The goal of the team was to meet or exceed all of the current vehicle attributes in reference to ride quality, fit, engine performance, comfort, and operator ergonomics.

8.2.1.3 *Process*

In order to deliver a new CRV to the customer within one year, the team had to use as much carryover hardware as possible. The body was all new but was constructed out of off the shelf aluminum extrusions with the exception of the roof, hood, and dash panel. These three items required developing new stamping dies and molds. In order to meet the timing, parallel design and manufacturing, of the tools, took place.

The team used many of the FPDS milestones but found that the majority of them had to be combined so that the time schedule could be kept. In order to meet the FPDS milestones the team established various mandatory meetings to review program status and issues. These meetings included a weekly half day Engineering meeting, a weekly body supplier meeting, and a weekly assembly plant launch meeting. In addition to these weekly meetings, the management staff held monthly customer design reviews to provide status and gather additional customer insight. From the corporate side, there was two major design reviews held with upper management to provide updates to the program status. Since the team was collocated there were many impromptu meetings that took place to discuss and resolve issues.

In order to successfully meet all of the deliverables at each milestone, only the value added work was performed. There wasn't anytime for rework or mistakes. The team had to focus on first time capability. In order to accomplish this, the team used as much analysis as possible through CAE, Failure Mode Effects Analysis (FMEA), and Design of Experiments (DOE). The team included a dedicated manufacturing engineer so that any assembly issue was addressed early in the process. The detailed vehicle specification provided by the customer was helpful in that it helped the team focus only on what was specifically requested. Any upper management design direction given out in the reviews was always controlled by the wording of the specification. Engineering to an exact customer specification for each vehicle subsystem was dramatically different than what was typically the case within Ford. In many cases, the work completed in the subsystems was derived from general design direction dictated in the PDL. The PDL is developed from a list of assumptions which were translated from the requests out of Ford's Business Planning Office and Sales and Marketing. The direction out of these offices are typically very clear from an overall all vehicle systems perspective but are more vague within each subsystem. There is generally a lot of room for error when assessing what exactly the customer expects from each subsystem. Once again, this would be a clear argument for the advantages of using the QFD tool. In essence for this project, the customer provided vehicle specification was in fact the typical outcome derived from a QFD analysis.

One other area in which time was removed from the process was in the area of prototype testing. As mentioned previously, the team did not have time to run consecutive iterations of prototype builds. All the slack was taken out of the system. There was only enough time to run one round of testing. The core team along with the test activities within Ford developed a very detailed Design Verification Plan (DVP). The development of the plan included verifying test facility readiness. The plan also optimized the testing performed on each vehicle. For example, the crash vehicle, which in many cases is non-functional, was in this program an actual running vehicle. The team conducted a series of non-destructive tests prior to finally crashing testing the vehicle. The use of multi-testing on each vehicle in a optimized fashion allowed the team to reduce the size of the prototype build and shorten the test window.

8.2.2 2000 USPS Explorer CRV Program Inhibitors

As eluded too earlier, the 2000 USPS Explorer CRV Program was not without its problems. Still today the program is having to deal with technology issues such as a reliable high mileage flex fuel pump. The program did not fully understand the capability and readiness of this technology in the area of alternative fuel use. Along with the technology readiness, the program had to deal with many issues associated with low volumes. The chassis was a derivative off of the current Explorer therefore any changes required, specifically for this program, either affected the main program, which resulted in significant cost penalties, or could not be changed due to the high volume tools inflexibility to modify these parts. Many times the project team was requesting, from the high volume suppliers, changes that caused disruptions in their way of doing business. The program in many cases was stuck paying significant premiums and in some cases had to convince a reluctant purchasing activity to take on a low volume supplier.

In addition to the chassis related supplier issues, the Ford team had to deal with a new aluminum body supplier, Utilimaster. The all new body was the significant change for this vehicle, therefore Utilimaster played a critical role in the project. Since both companies had not worked together, many problems arose due to the two different business cultures and philosophies. Ford basically had their structured high volume systematic approach of designing and testing vehicles versus Utilimster's low volume relatively unstructured approach to designing and testing of vehicles. At the start of the project, these differences did hinder some of the progress on the project. Once work began on the project, the Ford team immediately found that Utilimaster did not have a formalized program management methodology at tracking programs or managing engineering changes. This resulted in Utilimaster underestimating staffing requirements, failing to track the progress of the project, and lacking discipline to time and control changes. Ford on the other hand, had to learn to be more flexible with delivery dates and expectations. This is not to intended to say that Ford compromised the eventual outcome of the product but did mean that it had to look at new ways to achieve the final end product. What therefore took place overtime, was a new evolution for both companies. Ford learned how to be more flexible in certain areas while Utilimaster learned how to design a product in a more structured and disciplined approach. Even with the adversity faced by both companies, in the end the differences were worked through because each company had a single guiding objective and that was to deliver a product which met or exceeded the fit, form, and function called out in the customer specification.

In summary, the Ford project team had to deal with many obstacles due to the extremely compressed schedule, resistance to change among the high volume suppliers, technology readiness, and philosophical differences with the body partner. Through using many of the enablers noted in this chapter, the team was able to overcome many of the problems and finally deliver a Final Article of Inspection, which is the 1st production unit built, in less than 12 months.

8.3 *Customer Approval*

The Ford and Utilimaster team were awarded the contract and began the project in late September of 1998. A single batch of 12 confirmation prototypes were built between February and March of 1999. A full and complete vehicle test plan was run between March and July of 1999. Many design issues were found and corrected throughout this testing, and on August 30, 1999, the first product vehicle was delivered for final inspection to the customer. The United States Postal Service spent two full days statically and dynamically testing the vehicle. The outcome of each check in every case met or exceeded their expectations. The results were so positive that an Engineering

Manager for the USPS was quoted as saying, " I want to have Ford as our supplier for life".

8.4 *Summary*

As shown in this research, there are many enablers that can impact program timing. There is much interaction in a project between the planning that takes place, the process used, and the people executing the plan. To deliver a product to the customer, when he or she wants it, as well as totally satisfying that need, is something that every mass marketer strives for. Each one of the three P's does play a critical role and must be executed well. There are many inhibitors that exist in each of these categories that impede progress. What the manager of the project and the team members must understand is that these things do exist. That in order to reduce timing, it is imperative that we study and learn from the past. The enablers in each of the three P's must be identified for each new project. Every new project will come with its own set of inhibitors but understanding and addressing these right up front will prepare the team for dealing with them.

The team must have well thought out and clearly defined objectives prior to beginning a project. It is management's responsibility to understand the obstacles that impede the progress and its their responsibility to properly analyze and meticulously plan the project. As described earlier, it is critical to get buy in from the team. This buy in and commitment can begin immediately in the process by soliciting input from the team upfront. A committed highly motivated team can break down many walls. It is critical therefore to create an environment that promotes team work and continually fosters this drive to bring the project home.

What I have learned through this research and hopefully have presented to the reader is that Product Development System is a road map and the human element is the means by which the product is transported successfully and expeditiously from theory into physical reality. Achieving a faster cycle time requires understanding the task before you and having a solid understanding of what's worked in the past. It's a fine line between success and failure and maybe the only luck in life is that born out of the human desire to accomplish what was deemed impossible. So, with this I propose that the only limits to reducing cycle time are truly those that we impose in our own minds!

Appendix

A. *Glossary*

3P's – People, Planning, and Process
AA – Appearance Approval
C3P – CAD, CAM, CAE, & PIM
CAD – Computer Aided Design
CAE – Computer Aided Engineering
CAM – Computer Aided Manufacturing
CC – Change Cut-off
CEO – Chief Executive Officer
CMVSS – Canadian Motor Vehicle Safety Standards
CP – Confirmation Prototype
CPE – Chief Program Engineer
CPV – Capacity Planning Volume
CRV – Carrier Route Vehicle
CTC – Concept to Customer
DFMEA – Design Failure Mode Effects Analysis
DOE – Design of Experiments
DVP – Design Verification Plan
DVP&R – Design Verification Plan & Report
FAO – Ford Automotive Operations
FCT – Fast Cycle Time
FMVSS – Federal Motor Vehicle Safety Standards
FPDS – Ford Product Development System
FPV – Financial Planning Volume
FTEP – Ford Training and Education Program
GPIRS – Global Prototype Inventory Requisition & Scheduling
GPLUS – Global Product Letter Universal System
GTO – Global Test Operations
J1 – Job# 1
KE – Key Events
KO – Kick Off
LR – Launch Readiness
LS – Launch Sign-off
MAP – Market Attack Plan
MPSV – Market & Product Strategy Vision
NAAO – North American Automotive Operations
PA – Program Approval
PC – Program Confirmation
PD – Program Definition
PDL – Program Direction Letter
PDS – Product Development System
PFMEA – Process Failure Mode Effects Analysis
PH – Proportions and Hardpoints

PI – Program Implementation
PIM – Product Information Management
PPL – Program Parts List
PPS – Powerful Product Statement
PR – Product Readiness
PS1/PS2 – Pre Strategic Intent
PST – Program Steering Team
PT – Powertrain
QFD – Quality Function Deployment
QOS – Quality Operating System
RMS – Resource Management System
SC – Strategic Confirmation
SCPDS – Short Cycle Product Development System
SI – Strategic Intent
SO – Sign Off
SP – Structural Prototype
TD – Theme Decision
TGW – Things Gone Wrong
TPWP – Total Program Work Plan
TQM – Total Quality Management
TTM – Time To Market
USPS – United States Postal Service
VOC – Voice of the Customer
VPP – Vehicle Program Plan
WCT – World Class Timing
WER's – World Wide Engineering Release

References

Adler, Paul S., Mandelbaum, Avi, Nguyen, Vien, Schwerer, Elizabeth. "Getting the Most out of Your Product Development Process". Havard Business Review, March-April 1996.

Ancona, Deborah, Kochan, Thomas, Sculley, Maureen, Van Maanen, John, Westney, D. Eleanor. (1996). "Managing for the Future – Teams in Organizations". ISBN 0-538-85880-X. South-Western College Publishing, Cincinnati, OH.

Chambers, Craig A. "Transforming New Product Development – Organizations that carry out successful team – based R&D follow nine best practices". Research Technology Management. November-December 1996. Industrial Research Institute Inc.

Deming, W. Edward. (1982). "Out of the Crisis". ISBN 0-911379-01-0. Massachusetts Institute of Technology, Center for Advanced Engineering Study, Cambridge, MA 02139.

Eisenstein, Paul, A. "Wheel Wise:Creating Their Niche". World Traveler Magazine. September 1999.

Ford Motor Company's 1998 Annual Shareholder Report.

Ford Motor Company. (1988). "Program Control Process – Concept to Customer". 3rd Edition. Ford Motor Company, 20000 Rotunda Drive, Dearborn, MI 48121.

Ford Motor Company. (April 20, 1992). "A World Class Timing Overview – Participants Guide". The Emdicium Group, Inc., Bingham Farms, MI.

Ford Motor Company. (June 1, 1995). "Go Fast Process Guide". Ford Motor Company Publications.

Ford Motor Company. (June 10, 1998). "FPDS Process Overview". Ford Motor Company Publishing.

Goldratt, Eliyahu, M. (1997) "Critical Chain". ISBN 0-88427-153-6. The North River Press Publishing Corporation, P.O. Box 567, Great Barrington, MA 01230.

Graphic is from Presentation to System Design and Management Class by Dr. John F. Elter, Vice President Xerox Corporation. October 2, 1998.

Menezes, Melvyn A.J., Serbin, Jon. (1991). "Xerox Corporation: Customer Satisfaction Program". Harvard Business School Publishing, Boston, MA 02163. 9-591-055, Rev. January 12, 1993.

Phadke, Madhav S. (1989). "Quality Engineering Using Robust Design". ISBN 0-13-745167-9. P T R Prentice-Hall, Inc. A Simon & Schuster Company, Englewood Cliffs, New Jersey 07632.

Shiba, Shoji, Graham, Alan, Walden, Dave. (1993). "A New American TQM – Four Practical Revolutions in Management". ISBN 1-566327-032-3. Productivity Press, P.O. Box 13390, Portland, OR 97213-0390.

Shtub, Avraham, Bard, Jonathan F., Globerson, Shlomo. (1994). "Project Management – Engineering, Technology, and Implementation". ISBN 0-13-556458-1. Prentice-Hall, Inc., A Paramont Communication Company, Englewood, Cliffs, New Jersey 07632.

Thamhain, Hans J. "Managing Effectively in Technology Base Organizations". Engineering Management. Wiley Series in Engineering and Technology Management. Chapter 12.

The Economist. May 1997.

"The Language Processing Method - A Tool for Organizing Qualitative Data and Creating Insight". (1995). Published by the Center for Quality of Management.

Waldon, David. "Evolution of Customer Focus and its Challenges". Chapter 7 of new text book draft. Permission granted by Author, September 1999.

Winston, Wayne L.. (1997). "Practical Management Science – Spreadsheet Modeling and Applications". ISBN 0-534-21774-5. Wadsworth Publishing Company, 10 Davis Dr., Belmont, CA 94002.

Womack, James P., Jones, Daniel T., Roos, Daniel. (1990). "The Machine that Changed the World". ISBN 0-89256-350-8. Rawson Associates, Macmillan Publishing Co., 866 Third Avenue, New York, NY 10022.