1995

The Making of a New Product Development Process

William Scott Robertson

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William Scott Robertson, BJ

An Abstract Presented to the Faculty of the Graduate School
of Lindenwood College in Partial Fulfillment of the
Requirements for the Degree of
Master of Science

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ABSTRACT

The core process that almost all manufacturing organizations are built on is new product development. It is the new product development process that determines how the Technical Operations, i.e., Engineering, Manufacturing, etc., of a particular company will be organized.

In 1993, Michael Hammer and James Champy wrote a revolutionary book entitled "Reengineering the Corporation." In this book, they tell businesses to forget most of what they know about how business should run -- because it is all wrong.

They say that businesses must learn to reinvent themselves in order to compete in the ever-changing business climate of the 1990s and beyond. Hammer and Champy recommend that companies reinvent themselves by reengineering their most basic processes that dictate how the different departments work together to add value to a product.

With this in mind, this project will first show Diagraph's tremendous need for a new product development process.

Then, this project will propose a new product development process that will sufficiently meet Diagraph's needs and solve many, if not all of the Diagraph's past problems in the area of new product development.

To build the new process we will be using ideas gathered through surveys, interviews and from the published works of the leading writers and thinkers on the subject of new product development today.

A detailed analysis and critique by the author and by an outside evaluator follows the presentation of the new process along with a comprehensive appendix section containing the completed results of all of the surveys and interviews used to create Diagraph Corporation's New Product Development Process.

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COMMITTEE IN CHARGE OF CANDIDACY

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Adjunct Professor Carolyn Olson

DEDICATIONS

This Culminating Project is dedicated to my lovely wife Carey, my inspiration and motivation in life, and to my parents Chris and Betty Mangos who supported my academic growth throughout the years.

Also this project is dedicated to the spirit of positive change within an organization that occurs when enough people decide to take action. Without this kind of positive change, a company has no hope of survival in the ever-changing business environment of the 90's and beyond.

"Things refuse to be mismanaged long."
RALPH WALDO EMERSON

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CHAPTER 1: INTRODUCTION

1.1 THE BEGINNING

In 1993, Rubbermaid Corporation introduced 365 new products. That is more than one product introduced every business day for the entire year. How do companies introduce such a large quantity of new products every year in the United States? How can companies like Eastman Kodak race their new products to market in less than 6 months?

What Rubbermaid, Eastman Kodak and other successful companies have in common is the fact that they have examined and modified their new product development processes to compete in today's changing business environment.

It is important to keep in mind that this project started with a need...Diagraph Corporation's need to reengineer the way they develop new products.

This project will take you on a great journey into the larger topic of new product development as a whole and into the new way that Diagraph will develop its products in the future. But, before we embark on this journey, some background on new products and their development is necessary.

1.2 HISTORY OF DEVELOPING NEW PRODUCTS

Human invention has always been the source for new product ideas. Dr. Brian Tracy, lecturer on the subject of human potential, says that almost all people have at least one idea for a new product in their lifetime that could make them rich. So how does an idea go from someone's mind to the consumer's home?

Alexander Graham Bell invented the telephone in 1876. His channels of distribution were probably limited to his friends and family at first, but now the telephone is a mainstay of contemporary society.

The following year Thomas Edison invented the phonograph. Although this strange new product drew intense criticism at the time, entire industries were created from its development.

Many inventions followed these including: the television, the washing machine, triode oscillation used for radio transmission, fat- free cookies and crackers, the transistor, seedless grapes, portable radios, stereophonic transmission of sound and the VCR. What all these products have in common is that at one time they went through a new product development process.

We are all familiar with new products. Sometimes so-called new products are simply modifications of an earlier product design, like fat-free Chips Ahoy chocolate chip cookies.

Sometimes new products come in the form of vast new technologies that we have only begun to explore like virtual reality and digital audio and video.

The following sections will look at how products were introduced in the past both by the world at large and by my company, Diagraph Corporation.

Survival of The Fastest

Philip Himmelfarb, author of Survival of the Fittest: New Product Development During the 90's discusses four recent changes in the **marketplace** that have affected the product design and development process. The areas are: 1) The cost of research and development, 2) shorter windows of opportunity, 3) decreasing product life-cycle times and 4) reliance on time management.

THE COST OF RESEARCH AND DEVELOPMENT

Himmelfarb says that American major industry spent about $75 billion for research and development (R&D) in 1993. He adds that this is more money spent on R&D than any other country in the world. But, he also says that this is only 1.8% of the United States Gross National Product while countries like Japan and West Germany spend from 2.6 to 2.8 percent.

Himmelfarb says that executives who are quick to complain about the high cost of R&D forget that there is also a price for missed opportunities, due to lack of R&D. This is easy to do because there is no associated cost in terms of human resources or supplies. He suggests this lack of long term vision costs American companies in the international marketplace.

SHORTER WINDOWS OF OPPORTUNITY

Himmelfarb says that the "window of opportunity" is the time where the product is both available to the market and desired by that market. He says:

> There was a time when a company could be fairly relaxed about the time it took to develop a new product. There was little fear about a

> competitor getting there first. Now, it definitely is possible to miss the window just by getting to market a few months later than the competition (Himmelfarb 3).

DECREASING PRODUCT LIFE-CYCLE TIMES

Products mature much faster in the 90's according to Himmelfarb. He says that average product life-cycle times for electronics have decreased from 3 to 4 years to 18 to 24 months. This goes back to the idea of the "window of opportunity." If the manufacturer knows a product will be heading downhill in a matter of months, the manufacturer must constantly stay ahead of this cycle with new product ideas and a program of continuous improvement within that company's current product line.

TIME MANAGEMENT

Himmelfarb suggests that the increased emphasis on personal time management has caused companies to expect this same type of improvement on a corporate level. No longer can research and development projects take years or decades to complete. The other conditions listed in this section contribute to an environment where the company that concentrates on speed will indeed win the race.

How Are New Products Developed?

Now, that we have a clearer picture of the business, we can look at how American companies develop their new products from the drawing board to the production floor.

Adam Smith's Vision

In 1776, Adam Smith wrote Wealth of Nations, a book that inspired the processes of doing business that made the industrial revolution possible. Michael Hammer and James Champy address this issue in their book, Reengineering the Corporation. They say "For two hundred years people have founded and built companies around Adam Smith's brilliant discovery that industrial work should be broken down into its simplest and most basic tasks" (Hammer and Champy 2).

Smith's ideas center around a factory where pins were made. Smith remarked that a number of workers, each performing a specialized task, could make far more pins than the same number of workers each making a whole pin. Smith wrote:

> One man draws out the wire, another straightens it, a third cuts it, a fourth points it, a fifth grinds it at the top for receiving the head; to make the head requires two or three distinct operations; to put it on is a peculiar business, to whiten the pins is another; it is even a trade by itself to put them into the paper (Smith 1345)

There is no question that Smith's ideas were the cornerstone of many modern assembly practices and procedures. But Hammer and Champy assert that times are changing and American companies must wean themselves from Smith's ideas of the past in order to compete in the future. I agree with them.

It amazes me that so many companies still rely on the ideas of specialization of labor for almost all of their tasks. Take paying an invoice for instance.

If an employee goes on a business trip, the employee needs to submit a form along with documentation in the form of receipts to an Accounts Payable clerk, who in turn hands the form and the receipts to an Accounts

Payable manager. The AP manager then must call a company (located off-site) to write the employee a check while the employee waits 5-10 business days for process to run its course.

It fascinates me that different departments all go about doing business as usual and never even stop to consider why they do the things they do. I agree with Hammer and Champy that the practices of the past, while making us feel safe and secure, are not necessarily the best ways to meet our corporate goals.

For example, new product development is an entirely retroactive process in the majority of American companies. These companies see a competitive product they like in the marketplace, copy the design (making only the adjustments necessary to avoid patent lawsuits) and try to bring it to market at a lower price than the original developer in order to gain market share. This process is very safe. All the research and development dollars have already been spent by the competition. And the competitor cannot lower his price to compete because he must make up the Research and Development expense.

The very process itself is no different than Adam Smith's pin factory. One group of engineers work on the design, then pass it to another group, on so on until they all can reach some sort of agreement in terms of features, materials, cost, etc.

But, some companies like Eastman Kodak for example don't respect the processes of the past. They dare to forge a new path utilizing current technology like shared CAD databases. They engage in concurrent engineering and look at their processes beginning with the end result...the product, in mind. They always strive to improve their inter-departmental communication and they prove on a daily basis that Adam Smith's traditional business practices are inefficient and outdated.

Diagraph's History

It all started in 1893 when inventor and entrepreneur Andrew Jackson Bradley walked from his house to his paper-cutting company in the St. Louis levee district. Steamboats sat high in the Mississippi and trains sat empty, awaiting their cargo, while boxes, parcels and crates were painstakingly hand addressed by clerks using brushes and a mixture of lamp black and kerosene.

Every few feet, Bradley would have to walk off the sidewalk and out into the street to avoid piles of cargo. It irritated him. He knew there had to be a better, quicker way to mark cargo and found it. Within a few months he invented the Long Bradley Stencil Cutting Machine and founded the Bradley Stencil Machine Company.

By 1902, Stephen D. Hartog made an improvement on the original machine and joined forces with well-known St. Louis pattern maker Theodore Remmers to create the circular Diagraph stencil machine and began the Diagraph Stencil Machine Company. Even today, Diagraph sells 1,800 of these circular stencil cutting machines a year. In 1913, James W. Brigham went to work for Remmers and two years later found himself responsible for the company's sales. Fifteen years after joining Diagraph, Brigham bought it. These two pioneering companies merged in 1936 to become Diagraph-Bradley.

Growth was spectacular during World War II as everything from duffel bags to war materials required stenciling. Sales went from 75 stencil cutters per month to 500 units per month.

By the end of the 50's, Diagraph had solidified its position as the industry leader with the introduction of Roll-It-On, the first stencil roller, Rol-Flo, the first stencil applicator with a self-contained ink supply, and Mark X, the first valve action disposable marker.

In the 60's and 70's Diagraph developed a strong domestic sales organization and expanded into international markets by introducing a

duplicator product line, an in-plant mechanical label printing system and contact coding systems.

In the early 80's, Diagraph was in the forefront of integrating computer technology into the marking process. Diagraph introduced its patented Telemark large character ink jet carton printing system and Performance Series Electronic Label Printing System. (Reprinted with permission from *The Diagraph Backgrounder*)

In the 90's, the Diagraph Bar Code Ink Jet System and the PA/2000 Label Printer/Applicator system clearly established Diagraph as a leader in advanced marking technology. Company president Jim Brigham says "We are currently automating and fully integrating our sales, customer service and manufacturing systems in order to improve our ability to serve our customers." Now that we know a little about the history of Diagraph Corporation, let's look at how they bring new products to market.

How Diagraph Introduced New Products In The Past

Shakespeare said "What is past, is prologue." This simplistic statement provides a warning to those who would ignore the past and at the same time reinforces the belief that past failure can be the building block of a future success. With this in mind, I feel that it is important to look Diagraph's current new product development process in order to move forward.

When I asked Diagraph veterans about new product development, the first response I got was a snicker, then a smile, followed by a comment like "What development?" The following two examples; the Series 2 Ink Jet System and the Digital Carton Printer illustrate the tremendous need for a concrete process to facilitate new product development at Diagraph.

SERIES 2 INK JET SYSTEM

Mike Olejniczak has been with Diagraph since 1980. Mike has seen new products move through the "old" process many times from his positions as Technical Center Manager and Quality Control Manager.

He says "Diagraph has never had a written policy that tells how new products are to be designed and developed. Usually, we just see what the other guy has, make a few changes and push it through the channels." An example of this can been seen with the Series 2 Ink Jet System.

"We first talked about the Series 2 in 1986," Mike says. "I remember we (engineering) all got together with sales and they pretty much told us what they wanted. Then we put together a rough product specification list, they approved it and we were off!"

What happened next was that the two groups, sales and engineering , met many times over the period of several years making changes to design and adding features.

"But when it was all over," Mike adds, "We weren't any better off than when we started. In 1993, the Series 2 Ink Jet System was introduced with less than favorable market response. Mike recommends that Diagraph learn from its past mistakes and create a new and better process for product design. The need for a new process can also be seen when you look at another example of a new product that failed...The Digital Carton Printer.

THE DIGITAL CARTON PRINTER

Dave Loesche, a Coding Product manager remembers his experiences with the Iconotech Digital Carton Printer. The Digital Carton printer , now known as the K-D Carton Printer was touted as an alternative to traditional on-line marking systems. The Digital Carton Printer would

print custom text and graphics on blank carton stock, which could then be used to ship products.

"We underestimated the sales cycle, for one thing," says Loesche. Typically, the sales cycle for a completed purchase of a Digital Carton Printer is between 6 months to 1 year. "By that time, usually the customer has rationalized themselves out of buying it," says Loesche. "They figure they can do it cheaper, on-line with ink jet or labels."

Loesche says a number of factors contributed to the less than warm reception of the Digital Carton Printer like; 1) early skepticism from the sales force 2) deviation from the current marketing philosophy 3) Technical problems with the unit itself and 4) perceived problems with the software.

Sales Force Skepticism

The Digital Carton Printer was supposed to be released in March of 1991. The sales force went right to work , based on this date, and Diagraph received its first order for a DCP on March 15, 1991. Unfortunately, the product wasn't actually ready to ship until July of 1991. This means that Diagraph was taking orders for a product that they could not deliver.

In the electronics industry this practice is called *vaporware*, where a company promotes a product or product line heavily, then based on demand for the product, determines its production schedule, quantities, etc.

The problem with this scenario is that often times the customer does not expect to wait six or eight months for the product, and the sales relationship greatly suffers. So, it is easy to see why the sales force would be reluctant to risk the embarrassment and the headaches of supporting this new product.

Deviation from marketing philosophy

Diagraph has always recommended on-line solutions to customers' marking problems. By on-line we mean a way to identify the product using the customer's existing conveyor lines. The Digital Carton Printer was an off-line solution that didn't quite fit in with the rest of the spectrum of products according to Loesche.

"Some more thought should have gone into this product, due to the fact that it was such a change from our on-line strategy," says Loesche. "We had all these on-line systems...and the DCP, the odd duck," He adds.

Technical Problems

Contributing to Diagraph's woes was the fact that the machine itself had numerous mechanical problems. "The device which held the cartons never worked exactly right," says Loesche. These and other technical glitches like problems with the output mechanism contributed to DCP's lack of performance.

Perceived problems with the software

"Sales didn't like the idea of using a Windows-based application (at that time, Windows was still new and deemed "untested technology") to create and edit designs for the DCP," says Loesche. I was told by the Vice-President of Sales that the sales reps did not know how to use Windows," he adds. "So, I him to get some sales reps who did."

The old saying "perception is reality" really holds true in this case. The software actually had no real problems except for a negative perception by the sales reps due to the fact that it was a Windows-based application.

So we see that skepticism by the sales force, deviation from the marketing philosophy, technical problems and perceived problems with the software all contributed to the Digital Carton Printer's lackluster sales performance. But what can Diagraph learn from their Digital Carton Printer product introduction?

LIVE AND LEARN

When asked what he would do differently if he had to release the DCP again, Loesche makes 5 important points.

1) Do quality marketing research up-front.
2) Development team must be taken out of everyday routine.
3) Use outsourcing to get the job done.
4) Decide on one person to be "in charge" and empower them to lead the team.

Dave's ideas make perfect sense. "Good information and communication in the beginning of the new product development process is the key", says Loesche. He adds "The development team cannot be running around putting of fires or they will be thrown off schedule."

Loesche also recommends using all the resources available in the market by outsourcing specialty labor which typically involves a very large learning curve to master, (like lasers, for instance) in order to finish a project faster and capitalize on the window of opportunity while it is open.

The engineers on the development team, according to Loesche would be responsible for submitting a product specification, giving the project to the specialists outside the organization for the labor, then testing the work.

Finally, Loesche recommends along with many experts in the field of new product development that one person should be in charge of the entire process for a particular product or product line. The person should have certain leadership and personality traits that equip him or her to carry the project from conception to production. "Someone needs to own the process from beginning to end or there is no accountability and the project will not be finished on-time and on-budget," Loesche adds.

1.3 PURPOSE STATEMENT

The true test of an organization is its ability to design and develop new products. Diagraph Corporation of Earth City, Missouri currently has no process (in-writing) that carries a new product idea from conception to release. The purpose of this project will be to develop and document a comprehensive process that will clearly spell out all of the steps necessary to put a new product into the hands of the customer.

Since this project centers around the development of a new process, we need to look at what a *process* really is. Michael Hammer and James Champy authors of Reengineering the Corporation define a process as "a set of activities that together produce a result of value to the customer" (Hammer and Champy 35).

In Diagraph's case, the result of value will be the new product. Now that we know what a process is, we need to determine which set of activities will produce the desired result. The problem is that this set of activities is different for every company and it incorporates everything from corporate culture to reengineering to information technology.

The next two chapters will be devoted to presenting a solid body of research both in terms of the general topic of new product development and in terms of new product development for Diagraph Corporation.

CHAPTER 2: REVIEW OF LITERATURE

2.1 INTRODUCTION

Thousands of books have been written on the subject of new product development. However, since current environmental changes like reduced windows of opportunity and increased global competition have altered the marketplace so drastically, only sources from the last few years can truly be counted on for accurate information.

The purpose of Section 2 will be to give a thorough understanding of the larger issue of new product development.

First, we will look at the thoughts and ideas of many experts in the field of new product development. Next, we will look at recurring themes I found in my research of this topic. Finally, we will look at the new product development processes of two very successful companies: Eastman Kodak, and Rubbermaid, and use their ideas to build a better new product development process for Diagraph Corporation.

2.2 MAJOR WRITERS AND THINKERS

Probably the first real authority on new product development was Thomas Alva Edison. Edison, with an astounding 1,300 inventions and 1,100 patents in his name, perfected the industrial world's first new product development process in 1879. Currently, in 1994, market leaders like Sony and Microsoft use Edison's Menlo Park, New Jersey lab as a model for their new product development sites. Here are some other great writers and thinkers on the subject of new product development.

Michael Treacy and Fred Wiersema

The Discipline of Market Leaders

Treacy and Wiersema, authors of The Discipline of Market Leaders say that successful organizations excel at delivering a single type of value to their market. They say "The key is focus" (3). They suggest that companies who wish to become leaders in their market need to select one "value discipline" which could be; the best total cost, best product or best solution to a customer's problems, and then build their organization around that discipline.

Treacy and Wiersema say that theses market leaders sustain their leadership position by offering better value to their customers year after year.

Although they advocate focusing on a single value discipline, they say that "choosing one discipline to master does not mean abandoning the others, only that a company must stake its reputation and focus its energy and assets on a single discipline to achieve success over the long term" (18). They also make the statement that "no company can exist today by trying to be all things to all customers" (37).

MAJOR RELEVANT CONTRIBUTION

Three principles companies should follow to become market leaders.

PRINCIPLE 1: Keep people on-track by organizing the work in a series of well-placed challenges, each with a clearly defined outcome and a tight deadline.

Challenge	Started On	Outcome	Deadline
Write Section 2	1/27/95	Sect. 2 (finished)	2/17/95

PRINCIPLE 2: Create business structures that don't oppress.

PRINCIPLE 3: Stress procedure where it pays the biggest dividend.

Gary S. Lynn

From Concept to Market

Gary Lynn, author of From Concept to Market says that new product development takes perseverance and diligence. Although his book is targeted to budding entrepreneurs trying to sell their new products, it holds some valuable tips for product development at the organizational level as well.

Lynn says "This book will show you step-by-step how to take a concept, such as new product idea and bring it to the market" (1).

Lynn's simplistic look at new product development is a good start for a company looking to reengineer its new product development process.

For example, Lynn recommends using a Log Book or journal to document everything associated with a new project, including the designer's thoughts and ideas, so that the designer's work can be followed. This is a particularly good idea in corporations because often the design engineer holds all of the information about a new product in his head.

If anything should happen to that person (i.e.: an accident, sickness or termination), the entire product or product line could be in jeopardy.

MAJOR RELEVANT CONTRIBUTION
This book breaks the tremendously complex process of new product development down to its simplest form; an inventor, an idea and a dream of producing something of value to a customer and receiving payment in return for your efforts.

Philip A. Himmelfarb

Survival of The Fittest - New Product Development During The 90's

This book , billed as a handbook for new product development in the 1990's, "shows you how to convert from the phased, hands-off approach - still widely practiced-to the faster, multi-functional, parallel team approach than can bring smashing success for your business" (Himmelfarb 1). Himmelfarb suggests that American companies have become too sluggish in their development of new products.

He says that factors like decreasing product life cycles and shrinking windows of opportunity for new products make the "old school" approaches to new product development obsolete.

MAJOR RELEVANT CONTRIBUTION

Companies need to re-organize themselves to develop new products faster and more efficiently than the competitors to stay alive in the 90's.

Michael Hammer and James Champy
Reengineering The Corporation

This book received mixed praise and criticism when it was released in 1993 due mainly to its "radical" content. The central thesis of the book is that American companies should re-invent themselves and question everything about the way that they do business in order to realize unparalleled success. Change is very difficult to accept when one is comfortable in one's own lifestyle and the idea of reengineering is most definitely change in its most drastic form.

Another very controversial idea found in this book is the idea that you should "Question assumptions" when reengineering a particular process. They teach us that work is comprised of outcomes not tasks. They "begin with the end in mind" (Covey 99) as Dr. Steven Covey recommends in his book The Seven Habits of Highly Effective People.

MAJOR RELEVANT CONTRIBUTION

The authors list "Ways to Fail at Reengineering" in Chapter 7. Hammer and Champy allow the reader to learn from other companies reengineering mistakes, proving their contention that they honestly want companies to succeed.

John A. Hall
Bringing New Products to Market

This book is very different from the other works on new product development in that it recognizes the fact that different size companies develop products differently. Hall says "This book, in contrast, discusses the differences in product planning in various sizes and types of

companies. In it, I offer specific suggestions to the entrepreneur and the growing company, as well as to the large corporation" (Hall 1).

MAJOR RELEVANT CONTRIBUTION

Hall talks about the five categories of new products which are : The Breakthrough Product, The Line Extension, The 3 R's: Repackaged, Repositioned and Recycled, It's New for Us, and The New, Improved Next Generation.

THE BREAKTHROUGH PRODUCT

Breakthrough products are "the countless 'new' new products that result when a new technology or a new approach to an old need has been realized into a specific product or service that is demonstrably different from, and hopefully better than the product it replaces" (Hall 7).

Examples given by Hall of breakthrough products include the first personal computer, the fax machine and even the first Baseball Encyclopedia.

THE LINE EXTENSION

Line extension products are what Hall calls "the most straightforward, often mundane approach to bringing new products to market; but it is an approach that is usually profitable" (Hall 9).

Examples of this type of new product are: the large economy size, the small take-along-in-your-travel-kit size, the upgrade model and the new package, bottle, can, etc.

THE 3 R'S

A new product that is repackaged, repositioned or recycled falls into this category. Examples of repackaged products include Kool-Aid with its new plastic containers, and Nestle chocolate chips packaged in a decorative Christmas tin can.

Also, with all the hype of environmentally-friendly packaging, detergent companies can now sell you new concentrated versions of their detergents in convenient little cardboard boxes. The classic example of a repositioned product is Arm and Hammer baking soda.

Church and Dwight, the maker of Arm and Hammer baking soda have brilliantly repositioned their product as an air freshener for the refrigerator. The result was a dramatic increase in sales for what had been a stable, mature product. Examples of a recycled product include the ceiling fan, the fountain pen, and even the Victorian style of decorating homes.

IT'S NEW FOR US

Hall remarks that this approach "is used by companies usually when the company finds it necessary to meet the competition by bringing out a replica of the innovator's new product" (Hall 8). Hall warns that this approach may cause low employee morale, profits that are below normal and a constant struggle to stay alive as a company (Hall 9).

THE NEXT GENERATION

Hall lists several very specific requirements a product must have to fit into this category (9). They are:

- A new chemical, ingredient, flavor, feature or benefit that in some way makes the product taste better, work better, act faster or fill some need, real or psychological, not filled by the previous-generation product.

- A reduction in the cost of the product or an increase in the durability or the working life of the product

- An enhancement of the functional design that makes the product easier to use, set up or install-computers being a good example here.

- Must add some value factor not present in the last-generation product.

Hall's book Bringing New Products to Market was a valuable source for insight into product development while taking into account the many

different sizes and types of companies. Also, by identifying the different types of new products, the new product development team has the ability to decide which steps of the process are relevant and which are not.

Robert H. Waterman, Jr.
What America Does Right

This book was a good, general source to get a feel for what Corporate America looks, sounds and smells like in the mid-1990's. First, Waterman shatters the myth that America is falling behind in world competition. Waterman remarks that "recent research on industrialized nations shows that American workers outproduce workers in Germany and France by 20 percent, workers in Britain by 30 percent, and Japanese workers by over 60 percent" (Waterman 1).

Next Waterman says that the key strategic advantage is having the organization skills to focus on the things that motivate their own people and to anticipate customer needs.

Waterman gives a powerful argument, backed up with specific details and firsthand observation about the competitiveness of American companies. He says that companies that empower their people and change with the business environment can achieve spectacular results. With all the focus on what is wrong with America, it is indeed a nice change to read about what is right.

MAJOR RELEVANT CONTRIBUTION
Waterman does a detailed case study of Rubbermaid and their success in the area of new product development.

Philip C. Thompson
Quality Circles: How to make them work in America

Thompson tells the story of how the quality circle process used by the Japanese came to be so popular with American businesses. Next, he outlines the steps necessary to implement such a program in an American organization. Thompson says that participation in quality circles

improves job performance, morale, decision making and management-employee relations, helps spark new ideas, drastically reduces absenteeism, tardiness, lost-time, defects, turnover and accident rates, saves time, work (30).

MAJOR RELEVANT CONTRIBUTION

I found this book to be of great value in terms of giving me valuable information about how manufacturing and quality affect new product development.

Tony Husch and Linda Foust
That's A Great Idea: The New Product Handbook

This book is similar to From Concept to Market in that it is written for the entrepreneur or inventor's perspective. Tony Husch is credited with inventing and marketing the first computer dating service and Linda Foust is a San Francisco attorney, specializing in patent law. Their combined expertise renders a book that gives very valuable advice to anyone who has ever had a "million dollar" idea (Husch and Foust 3).

In terms of corporate new product development, this book is good because it forces you to break the new product development process down into its most basic steps. Since simplicity is one goal for any business process, it is a good thing to be able to eliminate the corporate bureaucracy and see new product development as in its simplest form.

MAJOR RELEVANT CONTRIBUTION

This book stresses simplicity in developing new products.

Edwin E. Bobrow & Dennis W. Shafer
Pioneering New Products: A Market Survival Guide

Bobrow and Shafer say that in their research they have found that over 80% of new products are discontinued or withdrawn from the market in

one year or less. They cite lack of market research, faulty product design and slow product development for this high failure rate.

This book draws on the examples of companies like SEARS, Coca-Cola and General Mills to give you guidelines and checklists that are designed to increase of product's chance of success.

The most valuable thing to me about this book was the argument raised as to whether a company should "pioneer" brand new products or sit back and wait for the competition to do the research and development and copy their design. This is especially significant due to the fact that Diagraph Corporation opts for the latter of the two strategies.

Bobrow and Shafer suggest that "most companies who choose a follower strategy are slowly dying and don't realize it" (Bobrow and Shafer 1). They also say that "if a company chooses to be a follower in product design, it better be innovative in product introduction and distribution" (Bobrow and Shafer 9).

It is clear that Bobrow and Shafer advocate the practice of pioneering new products rather than merely copying product designs. The rest of the book is devoted to showing you exactly how to pioneer based on your circumstances.

MAJOR RELEVANT CONTRIBUTION
Should we pioneer our own products and technology or wait for the competition and copy their designs? Makes a strong case in favor of pioneering new products .

Watts S. Humphrey
Managing the Software Process

Humphrey's book gives guidance for improving and maintaining the software development process. The original purpose of this book was to aid the Air Force in selecting software contractors, but the resulting text evaluates the strengths and weaknesses of software organizations Humphrey 17).

Although I am not writing a software development process, Humphrey's ideas about process creation and maintenance in general

provided me with many ideas which I will submit to the New Product Development Team at our next meeting.

MAJOR RELEVANT CONTRIBUTION
Many items from Humphrey's Project Plan will be adopted into Diagraph's new product development process.

2.3 OTHER SOURCES

This section covers the contributions of sources like; periodicals, CD-ROMS, On-line Research, and primary sources like the Diagraph New Product Development Survey and personal interviews with Engineers at Diagraph Corporation.

Business Week

Business Week was my most valuable periodical publication for information on new product development. Several articles are worthy of note. "A Smarter Way to Manufacture" from the April 30, 1990 edition gives valuable insight into the consequences of missing market opportunities and promotes fast, multi-functional, parallel product development. "The Brakes Go on in R&D" from the July 1, 1991 edition gives statistical analysis which justifies the cost of R&D for American companies.

Industry Week

Industry Week is a free trade publication sent to managers of manufacturing companies. I used several articles from this source including: "Tom's top ten for 1994", a list of the best management books of the year by Tom Brown, and "The Ten Commandments for business" also by Tom Brown.

St. Louis Computing

St. Louis Computing addresses small-businesses each month in a column written by Craig Palubiak. The January 1995 column entitled "Corporate Goals talks about the difference between a company's Mission Statement vs. its Goals and how important it is for every employee to understand those goals and how each job fits into the big picture.

America Online

America Online is a interactive software package that allows you to connect your personal computer to a vast network of reference and entertainment sources. I used America Online to access literature from the Library of Congress and the Smithsonian Institute in Washington, DC. as well as INFOTRAC, a database of newspapers and periodicals.

Further, I contacted the consulting firm who wrote Reengineering the Corporation and asked them to specifically address the comments made by the Wall Street Journal column (see below). They declined to comment, but they said they would be issuing a press release in mid-February.

Finally, America Online was my INTERNET connection for this project, which I used to access almost all of the articles listed in this section.

The Wall Street Journal

I used a column entitled "The problems with reengineering" to look at process development from a practical perspective. The column stated that many companies were failing at process redesign because of the basic psychological premise that people resist change. The column recommended taking "baby steps" to change an organization rather than proposing drastic changes.

Software Publisher

This unlikely source was of great value to me, especially the article "Five Steps to a successful product launch." This article gave me some

background on the advertising and public relations necessary to bring a new product to market. The idea of sending non-disclosure agreements to your target markets to stimulate advance interest in the product is a stroke of genius.

Diagraph New Product Development Survey

At the beginning of this project I circulated a survey to the 29 members of the Engineering Department, as well as the proposed members of my new product development team. The results of this survey, which I will cover in-depth in Chapter 3: Evaluation and Methods of Research, will serve as the basis for change at Diagraph Corporation.

Interviews

In conjunction with the surveys, I also interviewed each person who submitted a survey which gave me even more detailed, valuable information about new product development at Diagraph Corporation. I will cover these interviews in detail, in Section 3.

2.4 RECURRING THEMES

WHAT IS A NEW PRODUCT?

Edwin E. Bobrow and Dennis W. Shafer authors of Pioneering New Products, say "To the consumer of end user , a product or service is new, if it has never before been seen, heard of, or used" (12). This is an important idea because often a product is thought to be new only once in its life cycle when in reality, the product is new to anyone who has never heard about it. Now that we can agree on the definition of a new product, we need to know why so many new products fail.

WHY DO NEW PRODUCTS FAIL?

John A. Hall, author of Bringing New Products to Market spent over ten years helping companies with new product planning and research. In

that time, he discovered seven primary causes which he says account for 95 percent of the reasons why new products fail (Hall 19)

- A bad idea with a powerful product champion
- The solution in search of a problem
- Winging It - Going to Market with little or no good market research
- Lack of Control of all Key Elements
- Politicized Planning Process
- Failure to Hang In There
- Committee Consensus Products

Hall's lesson to companies is: Develop good ideas that fulfill real customer needs in the market as defined by thorough market research. Keep control of every aspect of your development and wait an acceptable length of time before abandoning a new product, especially in a highly-technical or specialized market segment.

THE NEED FOR SPEED

Getting to market faster than the competition is another theme found in most of my research. Diagraph's own mission statement says "We strive to build our products, faster and cheaper than our competitors."

Phillip Himmelfarb advocates fast, parallel product development throughout his book Survival of the Fittest. He says "The companies that have learned that speed is a strategic weapon will excel in the marketplace" (Himmelfarb 8).

Himmelfarb next discusses the elements of fast, parallel product development. They are:

- Utilizing formal planning for fast product development
- Engaging in front-end project planning
- Using multifunctional teams
- Empowering the teams
- Supporting the teams
- Gaining senior management support
- Freezing product features and design specifications as early as possible

- Utilizing components and processes already in existence
- Eliminating most top-down go/no-go decisions
- Ensuring continuity of team leadership
- Minimizing the bureaucracy
- Allocating time for the project
- Seeding the next projects

As you will recall, all of these ideas were also mentioned in most of the other literature about new product development in the 1990's.

THE ROLE OF MARKET RESEARCH

Every source I read about new product development stressed the importance of good market research. As you will recall from Section 1 of this project, the engineers Dave Loesche and Mike Olejniczak both cited lack of market data as a primary cause of new product failures in the past.

With this in mind, one of the goals of the team that is currently reengineering the new product development process at Diagraph, is to involve the marketing department in a greater capacity by including them in the actual development of the process itself. So far, we have had a very positive response from their department.

THE ROLE OF THE PRODUCT MANAGER

Another big theme throughout new product development literature is that **one** person must be in charge. John A. Hall suggests that a senior-level executive with full access to the president and with the power over the other departments associated with the process is the best answer (Hall 23). Hammer and Champy define this leader as "someone who doesn't make people do what he or she wants, rather someone who makes people want what he or she wants" (105).

Regardless of how this role is defined, it is clear that the person to drive a new product from conception to production will have to be willing to give up any present duties he or she currently holds and assume a completely new, full-time position as "product champion."

This person must possess: charm, charisma, character, the ability to get things done quickly and efficiently, as well as the internal connections within the corporate culture to promote his or her agenda.

THE ROLE OF CORPORATE CULTURE

The idea of Corporate Culture basically suggests that within every organization, there is an underlying social hierarchy and web of friendships and in some cases, family, which govern that organization's activities more than written policies or processes.

This is very important to know, especially when proposing change to a long-standing corporate culture. For example, Diagraph Corporation has always maintained its manufacturing facility in Herrin, Illinois. On the surface, Diagraph is a united company in the business of marking products with its line of industrial marking and labeling products.

But, if you look deeper, you can clearly see that Diagraph is divided and sub-divided into mini-cultures who do favors for each other and sometimes turn against each other.

Diagraph Corporation has employed the services of at least three consulting companies, who recommend ways to improve various aspects of their business. Every time the consultants propose good ideas and wrap up their studies in beautiful presentations and documents which hold ideas to send Diagraph's productivity to unprecedented levels. You have to ask yourself: Why don't these changes work? It is not enough to have good intentions or even good ideas about how to change an organization.

What you must have (according to every source listed in this paper) is an understanding that people don't like change. You must accept the fact that simply telling people to change does not bring about change.

The only way to change an existing corporate culture successfully is to include the entire organization in the change and that calls for increased corporate communications. Your employees must understand why the change is necessary and how it impacts them. Done correctly, this approach will build loyalty, increase morale and positive change will take place.

Now that we have looked at some recurring themes present in new product development literature, let's examine some companies who experience real success in terms of developing new products.

2.9 SUCCESS STORIES

EASTMAN KODAK

"In 1987, Kodak's arch-rival, Fuji, announced a new 35mm, single-use camera, the sort that the customer buys loaded with film, uses once, and then returns to the manufacturer, who processes the film and breaks down the camera into parts for reuse. Kodak had no competitive offering, nor even one in the works and its traditional product design process would have taken seventy weeks to produce" (Hammer and Champy 67).

Kodak boldly decided to design a new parallel development process utilizing a technology called CAD/CAM - Computer Aided Design/Computer Aided Manufacturing. This allowed Kodak's engineers to all work simultaneously on the same product while reducing communication errors because they were working from a shared database.

Kodak's new process called *concurrent engineering* is now used widely in the aerospace and automotive industries. They managed to cut their new product development time to thirty-eight weeks where it was previously sixty-four.

In 1993, Rubbermaid introduced 365 new products. That's more than one product a day, every day for the entire year. How did they do it?

Rick Margin, the vice-president of Rubbermaid's housewares division says "If I start talking about a Rubbermaid business and the person I'm talking to starts yawning in five minutes, I know I have hit a hot opportunity. The successful products tend to be boring " (Waterman 172).

Rubbermaid finds opportunity where others see an uninteresting market niche. Mailboxes, for instance have been a tremendous source of profits for Rubbermaid.

Rubbermaid's molded resin mailbox adds value to a product line most companies ignored. The Rubbermaid mail box is more durable, water-tight and has a little yellow flag that pops up when the mail has been delivered.

When people think of innovation, they probably don't think of Rubbermaid, but with 365 successful product introductions in one year and forty eight quarters of non-stop growth, they teach a lesson that many companies, like Diagraph Corporation need to learn.

CHAPTER 3: EVALUATION OF RESEARCH

3.1 INTRODUCTION

Chapter 2 gave you a comprehensive review of literature pertaining to the general topic of new product development in today's market. The goal of this chapter will be to probe the most valuable of all research sources...the minds of the performers at Diagraph Corporation.

By doing this, we can move from a general knowledge about the topic of new product development into a sharp, focused effort of looking at new product development at Diagraph Corporation.

Why is it important to hear ideas from the performers when designing a new process? Diagraph's New Product Development Process must incorporate the ideas of its performers in order to generate excitement and a feeling of ownership. Without this feeling of ownership, the chance that new process will succeed decrease dramatically.

Survey

For this research, I developed a short survey and circulated it to about forty Diagraph employees from several key departments like; Marketing, Sales, Engineering, Service, The Product Management Group and Engineering. Keep in mind that this survey was designed to deliver a sampling of popular opinion rather than a statistical analysis. The results of this survey showed the great diversity of opinions and ideas about new product development.

I discovered through my research that engineers and product mangers see things in a completely different way. In talking with members of the different Diagraph teams, I also found that Diagraph Corporation's main problem with new product development in the past has been a lack of good, effective communication between the different teams.

I further concluded that Diagraph's performers do not know how to approach the task of new product development since the process has never existed.

I began my primary research with a "skeleton" new product development process (See Fig. 1) , adapted from a meeting of all the Engineering Managers led by the Vice-President of Engineering.

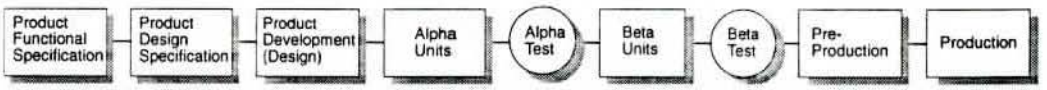

Figure 1

Next, I developed a survey that asked the participants to point out any problems with the current process, and to define the new process. The survey participants' names have purposely been withheld to provide anonymity.

Background Information

To fully understand the following sections you will need to have a general understanding of what functions each department plays in the area of new product development. The following table defines these roles as they are at Diagraph.

PRODUCT MANAGER	Responsible for bringing a new product to market.
SALES	Responsible for making customer contacts and building customer relationships.
MARKETING	Responsible for building support for the new product through the production of sales literature, advertising and public relations. Also responsible for conducting market research necessary to write the specifications for the new product.
SERVICE	Responsible for installing, repairing and supporting the new product.
VP OF ENGINEERING	Responsible for supervising the technical operations of new product development like: Engineering, Reliability and Documentation.

LEAD ENGINEER	Responsible for supervising the Engineering Team that will design and build the new product.
QUALITY	Responsible for making sure the new product meets the Quality standards of Diagraph Corporation.
RELIABILITY	Responsible for testing the new product design.
MANUFACTURING	Responsible for building the new product.

3.2 NEW PRODUCT DEVELOPMENT SURVEY

Current Problems

The first section of the survey, called *Current Problems* asked the participants to list some of the problems with the current system. Three problems that appeared frequently in the surveys were:

- Lack of a formal new product development process
- Too much bureaucracy and lack of communication
- Lack of marketing participation.

LACK OF A FORMAL PROCESS

As stated in the first two sections of this project, Diagraph has no formal new product development process. With no process written, it is virtually impossible to do the job of new product development. In the future, the employees of Diagraph must know exactly what they need to do to bring a new product to market. Or, as one Diagraph engineer stated "having something in writing that needs modification is better than having nothing."

TOO MUCH BUREAUCRACY AND LACK OF COMMUNICATION

The second large problem that appeared in many different people's surveys was the fact that Diagraph has too much bureaucracy and a dangerous lack of communication. Many survey participants cited examples of changes being made to a product only days before it went into production. One Diagraph Engineer echoed this sentiment when he stated, "Changes are made and nobody bothers to tell anybody else." This distaste for bureaucracy is very good because it shows that Diagraph employees recognize their communication problems and their own inefficiency. The key to implementing any kind of change is the actual desire to change.

LACK OF MARKETING PARTICIPATION

Ninety percent of the survey participants cited lack of marketing participation in the new product development process as the principal reason for new product failure. Several participants talked about the introduction of the IDS/2400 High-End Ink Delivery System. One engineer said, "The IDS/2400 showed us that great technological solutions do a great job of sitting on the shelf in inventory if there's no customer out there to buy them." Diagraph's new product development process must be based on solid market research to be effective.

PHASES OF THE NEW PRODUCT DEVELOPMENT PROCESS

Figure 1 shows a basic new product development process consisting of ten steps or phases. The ten phases of this process are:

- Product Functional Specification
- Product Design Specification
- Product Development
- Alpha Units
- Alpha Test
- Beta Units
- Beta Test
- Pre-Production
- Production

This section will define each of these phases, list the players involved in each phase and list the outcomes that signal the completion of each phase. The information in these sections was taken from the New Product Development Survey and from personal interviews with Diagraph employees.

Phase One: Product Functional Specification

The majority of survey participants feel that the Product Functional Specification should be the conceptual outline of the product as determined by market research.

PLAYERS

The majority of the participants agreed that Marketing and the Product Manager should write the Product Functional Specification with the help of Service and Sales (See Figure 2). Also, the Vice-President of Engineering is involved in this phase by assigning the Lead Engineer for the new product.

Product Manager	Writes the Product Functional Specification. Gives approval when he or she is in agreement as to what our requirements are and what specifications we will follow.
Sales	Writes the PFS. Gives approval when the PFS specification is completed.
Marketing	Writes the PFS. Gives approval when the PFS is completed.
Service	Writes the PFS, providing input so that the design will include features that are desirable to the servicing and support of the equipment. Gives approval when PFS is completed.
VP of Engineering	Receives the PFS. Assigns Lead Engineer to the new product. Gives approval when PFS is approved and Lead Engineer has been assigned.
Quality	Gives approval as verification of the adequacy of the requirements for the product and for preliminary consideration of the Quality Department resources required.

Figure 3

OUTCOME(S)

Most of the participants agreed that the outcomes of the first phase should be the following.

- Product Functional Specification document written and submitted to Engineering.
- Lead Engineer should be assigned by the VP of Engineering.

Phase Two: Product Design Specification

The consensus definition is that the Product Design Specification should be the technical specifications to meet the customer's requirements that must be accomplished within their pre-determined willingness to pay.

PLAYERS

Most of the participants agreed that Marketing and the Product Manager should write the Product Design Specification with the help of Service and Sales.

Product Manager	Reviews the PDS vs. the PFS and reaches compromise with Engineering as to features vs. cost tradeoff. Gives approval when ready to proceed.
Sales	Reviews the PDS vs. the PFS and reaches compromise with Engineering as to features vs. cost tradeoff. Gives approval when ready to proceed.
Marketing	Reviews the PDS vs. the PFS and reaches compromise with Engineering as to features vs. cost tradeoff. Gives approval when ready to proceed.
Service	Reviews the PDS vs. the PFS and reaches compromise with Engineering as to features vs. cost tradeoff. Gives approval when ready to proceed.
VP of Engineering	Receives the PFS. Assigns Lead Engineer to the new product.

Figure 4

OUTCOMES

Most of the participants agreed that the outcomes of the first phase should be the following.

- Product Design Specification document should be written and reviewed against the Product Functional Specification.

- Lead Engineer should be assigned by the VP of Engineering.

Phase Three: Product Development

The consensus definition is that the Product Development phase should involve developing the technical requirements from the Product Functional Specification and the Product Design Specification into a working product design.

PLAYERS

Most of the participants agreed that the Lead Engineer should hand off the specifications for each component to the appropriate discipline within his or her project team, then supervise the team members as they actually develop the product along with the Engineering Documentation associated with the product. Also, the Product Manager should be given a weekly product update.

Product Manager	Reviews and approves the prototype.
VP of Engineering	Supervises the work of the Lead Engineer's team. Gives approval when prototype and documentation are satisfactory.
Lead Engineer	Supervises Engineering Team. Builds working prototype and complies product documentation.
Quality	Approves documentation and any related Quality Department documents.

Figure 4

OUTCOMES

Most of the participants agreed that the outcomes of the Product Design phase should be the following.

- Working prototype of the new product that meets the specifications set forth in the previous phases of development.

- Engineering Documentation compiled to support the working prototype and allow the design work to be followed in the future.

Phase Four: Alpha Units

The consensus definition is that the Alpha Units phase should involve building a revision of the working prototype with all changes incorporated from the prototype review meeting.

PLAYERS

Most of the participants agreed that the Lead Engineer and his or her team should build the Alpha Unit(s) while the Reliability Department writes methods for testing them. At the conclusion of this phase, Service and Quality would have to approve the units.

Service	Service reviews the Alpha Units and provides the Lead Engineer with any information regarding the operation and support of the equipment.
VP of Engineering	Supervises the Lead Engineer and approves the Alpha Units
Lead Engineer	Leads the team that builds the Alpha Units.
Quality	Approves the Alpha Units.
Reliability	Writes the Test Methods for the Alpha Units.

Figure 5

OUTCOMES

Most of the participants agreed that the outcomes of the Alpha Units phase should be the following.

- Produce Alpha Unit(s)
- Write Testing Methods

Phase Five: Alpha Testing

The consensus definition is that the Alpha Testing phase should involve testing of the Alpha Units and a review to discuss possible product improvements as a result of this testing.

PLAYERS

Most of the participants agreed that the Reliability Department would be heavily involved in testing the units during this phase, while at the same time updating the Product Manager and the Lead Engineer of their progress. Service and Quality give their approval at the conclusion of this phase signifying that Alpha Testing was done to their satisfaction.

Product Manager	Reviews the results of Alpha Testing and works with Reliability and Engineering to improve the product.
Service	Service begins to research what it will require to support the equipment.
VP of Engineering	Supervises the Alpha Testing and works with the Product Manager to improve the product within the scope of the PFS and the PDS.
Lead Engineer	Reviews the results of Alpha Testing and suggests ways to improve the product.
Quality	Approves test results
Reliability	Conducts Alpha Testing

Figure 6

OUTCOMES

Most of the participants agreed that the outcomes of the Alpha Testing phase should be the following.

- Testing done
- Test Report produced
- Review meeting to discuss the results

Phase Six: Beta Units

The consensus definition is that the Beta Units phase should involve building of production ready units that meet the Product Functional Specification and have passed Alpha Testing.

PLAYERS

Most of the participants agreed that the Lead Engineer and his or her team would build the Beta Units. Their surveys also pointed out that the Beta Test Guidelines should be written by the Product Manager and the Lead Engineer.

Product Manager	Approves the Beta Units and writes the Beta Test Guidelines with the Product Manager.
Sales	Approves the Beta Units.
Marketing	Approves the Beta Units
Service	Reviews near-production units and makes any adjustments needed to effectively support the equipment.
VP of Engineering	Approves the Beta Units.
Lead Engineer	Supervises the team that builds the Beta Units. Writes the Beta Test Guidelines.
Quality	Approves Beta Units and Manufacturing documentation
Reliability	Writes methods for testing Beta Units
Manufacturing	Finalize manufacturing processes

Figure 7

At the conclusion of this phase, Service, Quality, Reliability, Marketing and Sales would all have to give their approval that Beta Units Phase was completed to their satisfaction.

OUTCOMES

Most of the participants agreed that the outcomes of the Beta Units phase should be the following.

- Beta Units produced
- Test Method written for Beta Units
- Customer site (Beta Site) chosen and guidelines for testing written.

Phase Seven: Beta Testing

The consensus definition is that the Beta Testing phase should involve internal testing to determine the reliability of the new product and external testing to provide customer feedback into every aspect of the product.

PLAYERS

Most of the participants agreed that the Reliability Department would test the Beta Units. Their surveys also pointed out that the Product Manager and the Lead Engineer should be responsible for conducting the external testing at the customer site.

Product Manager	Reviews Beta Test results oversees external Beta Testing
Sales	Approves Beta Test results
Marketing	Approves Beta Test results
Service	Approves Beta Test results
VP of Engineering	Approves Beta Test results
Lead Engineer	Visits customer site(s) and conducts Beta Testing.
Quality	Approves external and internal Beta Testing
Reliability	Conducts Beta Testing
Manufacturing	Approves Beta Testing

Figure 8

At the conclusion of this phase, The Product Manager, Sales, Marketing, Service, The Vice-President of Engineering, The Lead Engineer, Quality, Reliability, Manufacturing and the Production Manager would all have to give their approval that Beta Units Phase was completed to their satisfaction.

OUTCOMES

Most of the participants agreed that the outcomes of the Beta Testing phase should be the following.

- Internal Testing conducted
- External Testing conducted
- Test Report suggesting ways to improve the product before production.

Phase Eight: Pre-Production

The consensus definition is that the Pre-Production phase should involve putting into place all of the systems and processes needed to produce a quality product.

PLAYERS

Most of the participants agreed that the Manufacturing Department should be heavily involved in this phase, gathering together the accurate blueprints and structures they require to do their job in the Production phase.

Product Manager	Indicates that product is ready to move into production.
Sales	Indicates that product is ready to move into production.
Marketing	Indicates that product is ready to move into production.
Service	Indicates that product is ready to move into production.
VP of Engineering	Indicates that product is ready to move into production.
Lead Engineer	Indicates that product is ready to move into production.
Quality	Indicates that product is ready to move into production.
Reliability	Indicates that product is ready to move into production.
Manufacturing	Ensures that all systems and processes are put into place.

Figure 9

At the conclusion of this phase, The Product Manager, Sales, Marketing, Service, The Vice-President of Engineering, The Lead Engineer, Quality, Reliability, Manufacturing and the Production Manager would all have to give their approval that Pre-Production phase was completed to their satisfaction.

OUTCOMES

Most of the participants agreed that the outcomes of the Pre-Production phase should be the following.

- Systems and processes put into place.
- Production schedule finalized

Phase Nine: Production

The consensus definition is that the Production phase should be the goal of the new product development process.

PLAYERS

Most of the participants agreed that the Manufacturing Department should be heavily involved in this phase, actually building the product and distributing it to the customers for at the appropriate cost. The Lead Engineer and the Product Manager should monitor the production the new product closely and document any responses from the field technicians or our customers.

Product Manager	Calls for Product Review meeting six months into production of the new product.
Sales	Gathers field data about the product for the Product Review meeting.
Marketing	Gathers field data about the product for the Product Review meeting.
Service	Gathers field data about the product for the Product Review meeting.
Lead Engineer	Gathers field data about the product for the Product Review meeting.
Quality	Gathers field data about the product for the Product Review meeting.
Reliability	Gathers field data about the product for the Product Review meeting.
Manufacturing	Manufactures the new product.

Figure 10

OUTCOMES

Most of the participants agreed that the outcomes of the Production phase should be the following.

- A quality new product.
- A Product Review meeting that will look at ways to improve performance and lower the cost of the new product.

3.3 WHERE DO WE GO FROM HERE?

The purpose of this section was to gain insight about what Diagraph's New Product Development Process should look like according to representatives from Sales, Marketing, Product Managers, Engineering, Service and Quality.

The results of my survey show that there are no easy answers and no clear definitions, even by colleagues in the same department. Remember that my survey showed 40 different definitions of the term Alpha Units and 40 different explanations of what goes on during the Production phase of the process.

With this is mind, I decided that no one person could effectively write a process that affects so many. With this in mind, I put together a Diagraph New Product Development Process Team made up of representatives from all the different disciplines in order to facilitate better organizational communication and cooperation.

Chapter 4 of this project will give Diagraph a comprehensive, real-world process to develop new products that will be designed to decrease development time and bring Diagraph's products to market faster, cheaper and with more confidence than ever before.

CHAPTER 4: RESULTS

CHAPTER 4: RESULTS

4.1 INTRODUCTION

The goal of this section will be to present the results of my research in the form of a complete process that explains the ten phases of new product development at Diagraph Corporation.

The format of this section differs from the previous sections because Diagraph regulations state that all processes and procedures must be presented in outline form and printed on a special procedure sheets.

Diagraph. CORPORATION

PROCEDURE

SUBJECT:	Procedure No. 300-05
NEW PRODUCT DEVELOPMENT PROCESS	Effective Date: 4/1/95
	Supersedes: NA
	Page 1 of 16

I. PURPOSE

A. The purpose of this process is to show how a new product moves through the different phases of development and into production.

B. This process does not include specific requirements for individual departments outside of Engineering. The process does however, guide each department's involvement in new product development by giving "hooks," or basic start and stop messages to tell them when certain tasks should be started and completed.

C. Unless otherwise stated, all new products begun after the implementation date must follow this process.

II. ORGANIZATIONAL UNITS AFFECTED

Diagraph's New Product Development Process directly affects the following organizational units:

- Product Management Group
- Sales
- Marketing
- Service
- Mechanical, Electrical and Software Engineering
- Quality
- Reliability
- Manufacturing
- Materials Management
- Documentation

III. RESPONSIBILITY

A. The Group Vice-President of Operations and the Vice-President of Engineering will supervise the overall implementation of and compliance with this process.

B. The Lead Engineer and the Product Management Group ensure that the requirements of each phase of this process are met.

IV. AUTHORIZATION

All deviations from this process must be authorized by the Group Vice-President of Operations.

III. PROCESS

A. Phase One: New Product Proposal

1. The Product Manager works with Sales, Marketing and Service to design a document called the *New Product Proposal*, a document which includes the following.

    - Objectives for the new product
    - Acceptable unit cost
    - Quantifiable data and market research supporting the existence of a market
    - Expected annual sales volume
    - Possible competitive response
    - Expected selling price

2. The *New Product Proposal* is then submitted to the Executive Committee for consideration.

3. If the Executive Committee approves the proposal, the new product development process continues.

4. If the Executive Committee does not approve the proposal, the authors have the option of making corrections and re-submitting the proposal at a later Executive Committee meeting.

B. Phase Two: Product Functional Specification

1. The authors of the *New Product Proposal* (made up of Sales, Marketing, Service and Product Manager) draft a document called the *Product Functional Specification* .

    a. The *PFS* is a general description of what the new product should do and how the new product should look based on data gathered from the market. The *PFS* includes desirable features, speed, height, weight, width requirements, color, size, etc.

2. The *PFS* is then submitted to the Vice-President of Engineering for consideration.

3. The VP of Engineering then meets with the Engineering Team. In this meeting three decisions are made:

    a. Basic feasibility of the idea is evaluated in terms of functionality and acceptable cost.

    b. Lead engineer is assigned to the new product.

    c. Priority status is assigned and resources are allocated.

4. The Lead Engineer then meets several times with the original authors of the *New Product Proposal* (Sales, Marketing, Service and the Product Manager).

    a. The objective of this meeting(s) is for the Lead Engineer to completely understand every aspect of what the authors of the proposal intended. A model may be used in these meetings to communicate what can physically be done and at what price.

5. The *Product Functional Specification* is then revised with all the changes from these meetings.

6. The new version of the *Product Functional Specification* includes:

   - Preliminary time table for the new product
   - Target cost
   - Preliminary Annual Unit Sales Figures
   - Preliminary Pricing
   - Bullet List of Features
   - Size, Shape, and Physical Appearance

7. The *Product Functional Specification* is approved and signed by The Vice-President of Engineering, The Lead Engineer, The Vice-President of Sales, Marketing, Service and the Product Manager.

8. If the *Product Functional Specification* is approved and signed, the new product development process continues.

9. If the *Product Functional Specification* is not approved and signed, then all the parties listed above must meet and resolve any issues before the new product development process continues.

C. Phase Three: Product Design Specification

1. The Lead Engineer assembles his or her team and begins work on a document that will explain the technology that will be used to fulfill the requirements of the *Product Functional Specification*.

   a. This document is called the *Product Design Specification* and it includes:

      - Theory of Operation
      - How the new product will meet current industry standards
      - Hardware and software design specifications like:
        - Product Dimensions
        - Weight
        - Electrical, Temperature
        - Communications
        - System Limitations and Capabilities
      - Resources needed: capital, personnel, tools, supplies, consultants.
      - Design Schedule
      - Other alternatives evaluated based on cost vs. features tradeoff

2. Review Meeting(s)

   a. A review meeting is called where Sales, Service, Marketing, the Product Manager, the Vice-President of Engineering, the Lead Engineer, Quality and Reliability get together to review the *Product Design Specification* and compare it to the *Product Functional Specification*. In this meeting, a compromise must be reached between the contents of the *Product Design Specification* and the *Product Functional Specification*.

3. The *Product Functional Specification* is revised.

4. The *Product Design Specification* is revised.

5. Both the *Product Functional Specification* and the *Product Design Specification* must be signed by: Sales, Service, Marketing, the Product Manager, the Vice-President of Engineering, the Lead Engineer, Quality and Reliability.

6. If the *Product Functional Specification* and the *Product Design Specification* are approved and signed, the new product development process continues.

7. If the *Product Functional Specification* and the *Product Design Specification* documents are not approved and signed, then all the parties listed above must meet and resolve any issues before the new product development process continues.

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D. Phase Four: Product Development

1. The Lead Engineer will be responsible for:

   - Building a working prototype
   - Compiling all of the *Engineering Documentation* associated with the new product

   a. The working prototype must conform to the requirements set forth in the *Product Functional Specification* and the *Product Design Specification.*

   b. The Engineering Documentation for the new product will be defined as:

      - Engineering drawings for the new product
      - Block diagram for the new product
      - Bill of materials for the new product
      - Definition of processes document
      - Family Tree for the new product
      - Board settings and schematics for the new product
      - Product specific documentation: MSDS, special regulations

2. Review Meeting(s)

   a. A review meeting is called where Sales, Service, Marketing, the Product Manager, the Vice-President of Engineering, the Lead Engineer, Quality, Reliability and Manufacturing get together to review the working prototype and the new product documentation and evaluate them against the *Product Functional Specification.* In this meeting, the Lead Engineer presents the working prototype along with the new product documentation to the appropriate parties, who then discuss the working prototype, offer suggestions for improvement, and bring up any issues about performance, quality, etc.

3. When all parties in this meeting agree that the working prototype is representative of the specifications set forth in the previous documents, they all will *signoff* on the master *New Product Approval* document.

4. The tasks mentioned above will be completed and the appropriate signoffs will be added to the master *New Product Approval* document.

5. If any department's signoff is missing from the master *New Product Approval* document, then all the parties listed above must meet and resolve any issues before the new product development process continues.

E. Phase Five: Alpha Units

1. The Lead Engineer is responsible for producing the Alpha Units in conjunction with Manufacturing.

   Alpha Unit - A revision of the working prototype with all changes incorporated from the prototype review meeting. The Alpha Unit is almost production representative at this point.

2. The Reliability Department is responsible for two tasks.

   a. Writing the Performance Test Method.

      Performance Test Method - Testing the product to ensure that the product meets all of the requirements set forth in the *Product Functional Specification*.

   b. Writing the Durability Test Method .

      Durability Test Method - Testing the product for specified period of time under specified conditions to develop maintenance procedures and to predict product failure.

3. The tasks mentioned above will be completed and the appropriate signoffs will be added to the master *New Product Approval* document.

4. If any department's signoff is missing from the master *New Product Approval* document, then all the parties listed above must meet and resolve any issues before the new product development process continues.

F. Phase Six: Alpha Testing

1. The Alpha Testing phase is where the Reliability department conduct testing on the new product. Three things must occur during this phase. They are:

   a. Execution of Test Methods as described in the Alpha Units phase.
   b. Production of a Test Report by Life and Reliability.
   c. Review meeting(s) to evaluate test results.

2. All of the items mentioned above will be completed and the appropriate signoffs will be added to the master *New Product Approval* document.

3. If any department's signoff is missing from the master *New Product Approval* document, then all the parties listed above must meet and resolve any issues before the new product development process continues.

G. Phase Seven: Beta Units

1. The Lead Engineer will implement all of the changes made to the product from the Review meeting(s). After those changes are made (including updating all of the documentation associated with the product), the Beta Units Phase begins. Four important tasks are completed during this phase.

   a. Produce Beta Units with production tooling and processes

      Beta Units - Production ready units that meet the Product Functional Specification and have passed Alpha Testing.

   b. Life and Reliability writes the Reliability Test Method

      Reliability Test Method - Testing the product to determine the probability of operation for specified period of time under specified conditions.

   c. Finalize manufacturing processes

   d. Write Beta Test Guidelines

      Beta Test Guidelines - This document outlines exactly what Diagraph hopes to discover about the new product during the Beta Testing phase.

2. At the conclusion of this phase, all of the items mentioned above will be completed and the appropriate signoffs will be added to the master *New Product Approval* document.

3. If any department's signoff is missing from the master *New Product Approval* document, then all the parties listed above must meet and resolve any issues before the new product development process continues.

H. Phase Eight: Beta Testing

1. Internal Testing - The purpose of the Internal Life and Reliability testing is to determine the probability of operation for specified period of time under specified conditions. Three things happen during this sub-phase. They are:

   a. Execution of Reliability Test Method as described in the Beta Units phase.
   b. Production of a Reliability Test Report by Life and Reliability.
   c. Review meeting(s) to evaluate test results.

2. External Testing (Beta Sites) - The purpose of the Beta Site External Testing is to provide customer feedback as to every aspect of the product. Three things happen during this sub-phase.

   a. Diagraph installs the new product at customer site(s).
   b. Diagraph observes the product at regular intervals, recording the results.
   c. Diagraph asks the Beta customer(s) to fill out a brief survey at the conclusion of the testing, which will include questions about every aspect of the product including;

      - Was the new product effective in the purpose it was meant to serve?
      - Was the new product easy to operate?
      - Was the new product easy to maintain?
      - Were the new product instructions (User's Manual) easy to follow?
      - Were any components of the new product damaged or missing?
      - What problems, if any, occurred with the new product?

3. At the conclusion of this phase, all of the items mentioned above will be completed and the appropriate signoffs will be added to the master *New Product Approval* document.

4. If any department's signoff is missing from the master *New Product Approval* document, then all the parties listed above must meet and resolve any issues before the new product development process continues.

I. Phase Nine: Pre-Production

1. The pre-production phase is where all of the systems and processes are put into place to produce a quality product.

   - Accurate blueprints delivered to Quality by the Lead Engineer
   - Routing in place
   - Structure put into MAPIX
   - Work area laid out
   - Tooling complete
   - Production Schedule finalized
   - Forecasting
   - Finalize all manufacturing/quality processes.

2. All of the items mentioned above will be completed and the appropriate signoffs will be added to the master *New Product Approval* document.

3. If any department's signoff is missing from the master *New Product Approval* document, then all the parties listed above must meet and resolve any issues before the new product development process continues.

I. Phase Ten: Production

1. The Production phase is the goal of the new product development process. The outcome of this phase is the product itself.

2. Product Review Meeting

   a. Approximately six months into production of the new product, the Product Manager and the Lead Engineer will call a Product Review Meeting. At this meeting the participants will look at ways to improve performance and lower cost of the product. The Product Manager will ask for input from Service, Quality, Sales, Reliability, Manufacturing, etc.

VI. EXPLANATORY COMMENTS

A. DEFINITIONS

1. *New Product Proposal* - document which includes the following.: objectives for the new product, acceptable unit cost, quantifiable data and market research supporting the existence of a market, expected annual sales volume, possible competitive response and expected selling price.

2. *Product Functional Specification* - a draft of the document which gives a general description of what the new product should do and how the new product should look based on data gathered from the market. The *PFS* includes: desirable features, speed, height, weight, width requirements, color, size, etc.

3. *Model* - a physical representation of the new product constructed by the Lead Engineer from cardboard, light wood, paper, etc., that is used to illustrate various physical attributes of the new product.

4. *Product Functional Specification.* a document that expresses what attributes will comprise the new product based on market research. It includes: a Preliminary time table for the new product, target cost, preliminary annual unit sales figures, preliminary pricing, bullet list of features, size, Shape, and physical appearance of the new product.

5. *Product Design Specification* - a document that explains the technology, used to fulfill the requirements of the Product Functional Specification that includes: theory of operation, how the new product will meet current industry standards, hardware and software design specification, system limitations and capabilities, resources needed, design schedule and other alternatives evaluated based on cost vs. features tradeoff.

6. *Working prototype* - a physical representation of the new product that must conform to the requirements set forth in the *Product Functional Specification* and the *Product Design Specification.*

7. *Engineering Documentation* - Technical documents that relate to the new product that include: Engineering drawings for the new product, block diagram for the new product, bill of materials for the new product, definition of processes document , family Tree for the new product, board settings and schematics for the new product and product specific documentation: MSDS, special regulations.

8. *Product Development Approval Document* - a document , laid out in a matrix format that traces the completion of each phase of new product development by allowing each department to initial after the tasks to complete a particular phase have been completed.

9. *Alpha Unit* - A revision of the working prototype with all changes incorporated from the prototype review meeting.

10. *Performance Test Method* - Testing the product to ensure that the product meets all of the requirements set forth in the *Product Functional Specification*.

11. *Durability Test Method* - Testing the product for specified period of time under specified conditions to develop maintenance procedures and to predict product failure.

12. *Beta Units* - Production ready units that meet the Product Functional Specification and have passed Alpha Testing.

13. *Reliability Test Method* - Testing the product to determine the probability of operation for specified period of time under specified conditions.

14. *Beta Test Guidelines* - a document outlines exactly what Diagraph hopes to discover about the new product during the Beta Testing phase.

CHAPTER 5: DISCUSSION

5.1 INTRODUCTION

Chapter 4 contained the completed *New Product Development Process* document for Digraph Corporation. The goals of this chapter are to:

- Analyze the new product development process to point out its strengths
- Evaluate the new product development process to point out weaknesses.
- Discuss what must be done in the future to implement the process.

Section 5.2 will provide a clear, detailed analysis of Diagraph's New Product Development Process as a whole as well as an analysis of each phase of the process. This analysis will cover issues raised in earlier chapters and will address all of the problems with the current new product development process.

Section 5.3 will critique the New Product Development process from my own perspective and from the eyes of an outside evaluator. These critiques should point out any weaknesses or limitations with the New Product Development Process.

Finally, Section 5.4 will indicate areas where future work might extend. The goal of this section is to show that the development of the process is only the beginning of a long journey to its implementation.

5.2 ANALYSIS OF RESULTS

This section will provide a clear, detailed analysis of Diagraph's New Product Development Process as a whole as well as an analysis of each phase of the process. This analysis will cover issues raised in earlier chapters and will address all of the problems with the current new product development process.

Five Strengths of The New Product Development Process

1. PROCESS EXISTS IN WRITING

As stated in previous sections, the most significant problem with the old new product development process at Diagraph is that the process document did not exist. So it stands to reason that just writing the new product development process down is a huge step forward for Diagraph.

By documenting the process, we take all of the guess work out of new product development.

Also, Diagraph can train new employees much faster with a written process then by allowing them to make mistakes while learning all of processes and procedures on their own.

2. CLEAR AND UNDERSTANDABLE

The second strength of the new process is that it is clear and easy to understand. The goal of the new product development process team was to deliver a document that tells the story of how a product goes from an idea in some product manager's mind to the production floor.

Several people asked me why I did not write the New Product Development Process in flow-chart form like all the other processes in the company. I simply told them, "I can't understand all the other processes in the company, which means it's a pretty safe bet that most of the other employees can't understand them either." The processes they were referring to were incomprehensible flow charts that must be read with a magnifying glass because the type is so small.

The worst part is, upon reaching the end of this maze, the reader still does not know what is happening. With this in mind, my team designed a process that can be understood by every employee in the company, as it should be, since they are the performers who are expected to follow the process.

3. SIMPLE AND EASILY FOLLOWED

The third strength of the new process is the fact that it is relatively simple and easy to follow. We designed the ten-phase process in a rather linear form so that the next phase cannot begin until the proper approval has been granted in the last phase.

Several times in our new product development meetings the argument came up that we should include all of the other departments' sub-processes branching off this process so that we could honestly say that we have covered everything that happens during new product development. We decided that this would not be a good idea because a process that encompasses every last detail would be very difficult to follow, and thus would be ineffective.

4. CONCRETE PROOF AFTER EACH STEP IS COMPLETED

The fourth strength of the new process is that every phase is completely documented and can be tracked on the Master New Product Approval Document. At the conclusion of each phase, all signatures must be present on this document to advance to the next phase.

This means that a paper trail will be established so that the development of a new product can be traced and studied for future projects. Also, this system allows anyone to look at a single document and tell exactly where a new product is in the process. For example, if all of the blocks are signed under Alpha Units, and none of the blocks under Beta Units are signed, one immediately knows that the new product is in the Alpha Testing phase.

Then one can look and see how many blocks are signed under the Alpha Testing phase to determine exactly which sub-phases have occurred. For example, if the Reliability Department has signed, but the Product Manager has not, one knows that the Alpha Testing Review meeting has not taken place (or at least not to the satisfaction of the Product Manager). This makes the New Product Development Process very efficient.

5. ACCOUNTABILITY

The fifth strength of the new process is that the performers involved with new product development are accountable for their actions. Because the old process was not documented, checking to see whether approval was given to continue to the next phase was a difficult task. This situation was further complicated by poor inter-departmental communication in the form of voice mail messages, which cannot be saved and memos, which are usually thrown away.

The new process changes the ways of the past by making the performers sign their initials to the New Product Approval document signifying their consent to proceed with the process. When people know they will be held accountable for their decisions, it stands to reason that they will ensure that the product is indeed ready to proceed into the next phase of development.

Also, this accountability produces a built-in system of checks and balances within the ranks of Diagraph Corporation. For example, if the product is currently in the Alpha Testing phase of development and the Product Manager is feeling pressured by the sales representatives to push it through the system, he or she cannot ignore the Test Report submitted by the Reliability Department. Under the new process, any department can halt further development of the product by withholding their signature until the product successfully completes the phase in question. This accountability will force debate on issues that have in the past been ignored.

6. FACILITATES COMMUNICATION BETWEEN DEPARTMENTS

As you will recall from Chapter 3, lack of communication was cited by the survey participants as a significant problem with the old New Product Development Process. Also, you will recall that the New Product Development Process Team was made up of representatives from Sales, Marketing, Product Management, Service, Engineering, Quality, Reliability and Manufacturing in an effort to build stronger communication networks across departmental boundaries.

The effort was a tremendous success. Not only did the departments sit down and communicate while designing the New Product Development Process, they also began to recognize their different perspectives and started making plans in the future to get together more often and work as a team.

The new product development process facilitates good, effective communication between these departments by mandating that they meet at the completion of each phase and review the results.

This system works very much like a jury in a court of law. If all the parties cannot agree that the product is ready to proceed to the next phase of development, the new product development process cannot proceed without addressing the issues causing the disagreement. In other words, if there is any reasonable doubt as to whether the product should advance to the next phase, the development process stops until those concerns are addressed.

Strengths of Each Phase

PHASE ONE: NEW PRODUCT PROPOSAL

The New Product Proposal Phase was suggested by a member of the New Product Development Process Team and then added by a majority vote. The idea behind the inclusion of this phase was to ensure that the Product Manager, Sales and Service Departments had done all of the preliminary research needed to launch a new product.

In the past, Diagraph Corporation would go through the many steps of development to introduce a new product, only to find that the market no longer existed.

The best part about the New Product Proposal Phase is that it requires that approval of the Executive Committee before any resources are allocated for the new product.

The Executive Committee will be in a better position to accurately predict the success or failure of the new product if the authors of the New Product Proposal document do a good job of presenting a workable product concept along with quantifiable data and marketing research to support the existence of a market for the new product.

PHASE TWO: PRODUCT FUNCTIONAL SPECIFICATION

The Product Functional Specification is one of the key phases in new product development. In this stage the authors of the approved New Product Proposal document must draft a document that clearly tells the Engineering Department exactly what the new product should do and how the new product should look based on good market research.

What is good about this approach is that it forces the authors of the proposal to put all of their requirements in writing before any time or money is spent on the new product.

This means that the Marketing Department cannot come back to the Engineering Department late into development and say "I wish the new product could print at 600 feet per minute!"

If this scenario did occur the Engineering Department would say, "I'm sorry, but according to the Product Functional Specification document, the new product will not have that feature." Engineering could then add, "If you want, we can possibly incorporate that feature into a new revision of the product or maybe into a new product altogether."

This kind of thinking will keep the new product on-schedule and will eliminate the kind of surprise changes that tend to take place so late in the product development cycle.

Another strength of this phase is the fact that the Vice-President of Engineering assigns a Lead Engineer to the new product. A significant problem in the implementation of processes at many companies is that there is no one point of contact who controls the direction of the project. In other words, there is no real leader to "own" the project.

John Hall describes this leader in his book Bringing New Products to Market. Hall says, "A team builder, a person who can relate well to engineers, scientists, marketers, salespeople and manufacturers is the person best suited to head the new product development process (Hall 30)."

The concept of the Lead Engineer is not unique to Diagraph Corporation by any means, but Diagraph must learn from other companies like Rubbermaid, who introduced 365 new products in one year and Eastman Kodak, whose concurrent engineering processes of new product development are being studied by the Japanese as an example of multi-functional new product development.

The Lead Engineer must take ownership of the new product, which means doing whatever it takes to ensure that the new product will be a success.

PHASE THREE: PRODUCT DESIGN SPECIFICATION

The Product Design Specification Phase is where the real Engineering work begins. The Lead Engineer and his or her team will draft a document that explains the technology used to fulfill the requirements of the Product Functional Specification.

One strength of this phase is that it requires extensive communication between the Lead Engineer and the authors of the Product Functional Specification. The Lead Engineer must understand exactly what the authors intended and be able to translate their "wish list" into a real, workable product concept.

Another strength of this phase is that it mandates a compromise between the requirements of the Product Functional Specification and the Product Design Specification. This recognizes that there must be a trade-off between certain features and certain technical requirements within a given target cost.

In other words, if Sales wants the system to be able to run over a PC network and control several printstations on many different conveyor lines, Sales must either give up some other features or raise the target cost if Engineering concludes that those requirements are not possible within the current cost restraints.

PHASE FOUR: PRODUCT DEVELOPMENT

Product Development is where the Lead Engineer builds the working prototype and compiles the Engineering Documentation associated with the new product.

One strength of this phase is that we have defined the term *Engineering Documentation* for the Lead Engineer. In the past, the general term documentation has been used at Diagraph to mean many different things.

For example, The department that creates the user and technical manuals, training manuals and assembly procedures is called Documentation. At the same time, Engineers produce their own drawings, block diagrams and family trees that they call documentation.

Finally, the Manufacturing and Quality departments work from blueprints that they call documentation. With so many different meanings for the same term, it is no wonder that so many communication errors take place at Diagraph.

By calling the documentation at this phase, Engineering Documentation, we can clear up much of the confusion that leads to mistakes in the overall new product development process.

PHASE FIVE: ALPHA UNITS

The Alpha Units phase is where the Lead Engineer builds the Alpha Units and the Reliability Department writes the Test Methods for testing them.

The strength of this phase is that we have again clearly defined exactly what an Alpha Unit is and exactly what the Test Methods should include.

An interesting aspect of new product development terms is the tremendous diversity of opinions regarding their meaning. I have found through my research that no two performers can really give the exact definition of a term like Alpha Units.

By defining terms like Alpha Units, Diagraph can begin to communicate in the same language. The process actually serves the company as a standard dictionary of words and ideas that the performers can use to do their jobs more effectively.

Another strength is that we have laid out the requirements for completion of the phase clearly like a checklist so that there is no confusion when the product is ready to advance.

PHASE SIX: ALPHA TESTING

The Alpha Testing phase is where the Reliability department conducts testing on the new product and reports back to the rest of the new product development team.

One strength of this phase is the review meeting that must take place to evaluate the test results. Once again, the members of the team are assembled and asked to communicate their feelings, this time about the results of the Alpha Testing. When all are satisfied that the product has successfully completed Alpha Testing, they all must sign the New Product Approval document so the product can advance into the Beta Units phase.

PHASE SEVEN: BETA UNITS

The Beta Units phase is where the Beta Units are produced, the Test Methods are written and the Beta Test Guidelines are produced.

One strength that stands out during this phase is step 1-d, where the Product Manager and the Lead Engineer write the Beta Test Guidelines. This is a new concept for Diagraph Corporation. The Beta Test Guidelines idea was suggested by a Product Manager after many unpleasant experiences with Beta Testing.

The Beta Test Guidelines outline exactly what Diagraph hopes to discover about the new product during the Beta Testing phase. This is good because it would be impossible for the Product Manager to approve the Beta Testing phase without knowing that all of the objectives have been accomplished.

PHASE EIGHT: BETA TESTING

The Beta Testing phase is where internal and external testing is performed on the new product to find new ways to improve it.

One strength of this phase is the survey that is given to the Beta customers in order to get comments necessary to complete the testing. This survey serves Diagraph well by asking the customer about various issues including: Was the product effective?, Was the product easy to operate?, Was the documentation complete and easy to follow?, etc. The answers to these questions help the Product Manager and the Lead Engineer judge the overall readiness of the product and help them to see the customer's perspective.

PHASE NINE: PRE-PRODUCTION

Pre-Production is where all of the systems and processes are put into place to produce a quality product.

One strength of this phase is the Lead Engineer's role in delivering accurate blueprints to the Quality Department. In the past, no one person was accountable for making sure that the correct versions of all of the blueprints needed to build the new product were all together in one library where Manufacturing could use them.

By shifting this responsibility to the Lead Engineer, we establish a single point of contact, so that in the event that Quality needs a certain blueprint, they can contact the Lead Engineer and focus their time on other tasks needed to complete the Pre-Production phase.

PHASE TEN: PRODUCTION

The Production phase is the goal of the new product development process. The outcome of this phase is a quality new product.

A strength of this phase is the Product Review Meeting that is scheduled by the Product Manager and the Lead Engineer to look at ways to improve performance and lower the cost of the product.

This phase acknowledges that new product development is really more of a cycle than it is a process. Although Phase Ten begins, no one can ever really sign off that the phase is completed because continuous improvement of the product is necessary to compete in the ever-changing global economy.

As soon as Manufacturing takes over and begins producing the product, Engineering begins working on that products replacement. Robert Black, the President of Rubbermaid said, "We must strive to make our own products obsolete, because if we don't, someone else will."

5.3 CRITIQUE OF RESULTS

Section 5.3 will critique the New Product Development process from my own perspective and from the eyes of an outside evaluator. This critique should point out any weaknesses or limitations with the New Product Development Process.

Author's Critique

While the New Product Development Process has many strengths, a true critique of the process cannot be done unless we acknowledge the plan's weaknesses as well. This section will concentrate on the two greatest limitations with the New Product Development Process: True Completeness and the fact that it is a Linear Process.

WEAKNESS #1 - TRUE COMPLETENESS

It is important to remember when examining the New Product Development Process that we focused primarily on the Technical Operations involved with new product development.

The process fails to acknowledge the importance or even the existence of such things as marketing literature, packaging of the new product, advertising and promotion of the new product, training issues or User Manuals for the new product.

Reading the process as it currently written, you would draw the conclusion that the job of introducing a new product can be done by Engineering and the Product Manager with a little help from Sales, Service and Marketing. This is not true. James Champy, consultant and co-author of Reengineering the Corporation, says that new product development is the core process that all technical organizations are based on (Champy 60).

It is ironic that one of the New Product Development Process Team's goals became one of the processes greatest weaknesses. We tried to make the process simple and easily understood. By doing this, we also had to ignore the many sub-phases and sub-tasks that must go on to introduce a successful product. If we had included every sub-step of every step necessary to bring a product to market, we would have had a document that was over a hundred pages long and a flow chart that the employees would have to read with an electron microscope.

Obviously for The New Product Development Process to prove effective, much more work must be done. Every department must document its own processes and look at how they fit into the larger process. This weakness in the new process we developed is a necessary evil in order to communicate the vast complexity of such a previously confusing yet significant topic.

WEAKNESS #2 - LINEAR PRODUCT DEVELOPMENT

Phased, linear New Product Development processes have been used by American companies for two decades. The problem is that Diagraph had so far to go to catch up, that we absolutely had to start at the beginning, or we would have ended up very confused.

The new process is clear and effective and does hold some great advantages for Diagraph Corporation, but you have to ask, "Is it enough to compete in the 1990's?"

Phillip Himmelfarb, author of Survival of the Fittest: - New Product Development in the 90's says, "Phased product development is seductively pleasant. All the functional areas have their jobs to do, one after another, and senior management thinks everything is going well. In reality, phased product development is a disaster is disguise" (Himmelfarb 10).

Himmelfarb goes on to suggest that phased product development is too slow because each department must finish (and in Diagraph's case, sign off on) each phase before the next phase can begin. He is absolutely correct.

Again, the irony is that Diagraph's performers wanted a new product development process with increased accountability for the completion of tasks and with concrete proof that a phase had been completed. The problem is that we add a great deal of time to the development process which could delay the product's release.

Himmelfarb suggests moving to a fast, parallel system of developing new products like Eastman Kodak's concurrent engineering where many phases occur simultaneously. This speeds the new product to market and allows the company to capture a large share of the market before the competition arrives.

Outside Evaluator's Critique

A fair evaluation of the new process would not be complete without a "neutral" third-party opinion. With this in mind, I asked Tom Stephenson, an Industrial Engineer and expert in the field of new product development, for his evaluation of Diagraph's New Product Development Process.

Tom Stephenson holds a Bachelor's of Science Degree in Industrial Technology and a Masters of Science degree in Manufacturing Systems. Tom has been an Industrial Engineer at Diagraph for nearly a decade and in that time has seen many new products being developed.

STRENGTHS ACCORDING TO STEPHENSON

Stephenson states in his evaluation that the new process has four main strengths. He says that under the new process Diagraph will experience: 1) Increased productivity for Engineering, Manufacturing and Sales, 2) Reduced new product lead time, 3) Product Traceability and 4) Reduced problems in the field.

STRENGTH #1: INCREASED PRODUCTIVITY

Stephenson says that the New Product Development Process or (NPDP) will "increase the capacity of work that will flow through engineering, manufacturing and sales." He adds, "Engineering will be able to predict manpower and resources for one project and schedule the next when the completion date of the first is met."

STRENGTH #2: REDUCED NEW PRODUCT LEAD TIME

He says, "Sales will be able to commit to a reduced lead time for delivery, which is a major factor for customers in need of a product." He adds, "A salesman promising a four to six week manufacturing lead time will normally outsell a competitor with a six to eight week manufacturing lead time, even if the first product is more costly. Time is of the essence in manufacturing; time is money.

STRENGTH #3: PRODUCT TRACEABILITY

Stephenson says that the third strength of the NPDP is the fact that the path leading to the production of the new product can be tracked and documented.

He says, "If a problem occurs in manufacturing, the design engineer that actually designed the product is normally the only resource for information. If a problem occurs in the field , the reliability engineer typically is the only resource for assistance with the product performance. This NPDP will allow virtually all departments the ability to have access to pertinent information that can be applied to unforeseen mishaps.

STRENGTH #4: REDUCED PROBLEMS IN THE FIELD

Stephenson says that the fourth strength of the NPDP is that it will lead to a better quality product and thus, reduced customer problems. He says, "Under the NPDP, production will no longer be faced with finding weaknesses in design or assembly by using trial and error.

Today, if production does not find a problem during manufacturing, the product goes out and the customer finds it."

WEAKNESSES ACCORDING TO STEPHENSON

While Stephenson thought the NPDP had many strengths, he conceded that the process is not without room for improvement. Stephenson points out that the process needs to be complete to function effectively.

He calls the NPDP a road map, or a general guide to help the Technical Operations of Diagraph Corporation run more smoothly. He acknowledges the fact that many more blanks must be filled in by many other departments before we can truly tell the story of how a new production moves throughout the production cycle.

OVERALL EVALUATION

Stephenson says, "NPDP is a road map. It may not seem necessary to have this procedure for a sixty million dollar company, but in reality we must ask the question: How much of this is plowed back into the company to support poor design, procedures and quality? Industry demands that to be competitive, we must divert our resources in the beginning of a product in order to reap the profits of the final product. The competition will always be working on ways to make a better, less costly product that can be delivered one week ahead of ours and we must do the same in regards to their product. The goal is to make money and the proposed New Product Development Process will guide our way."

5.4 FUTURE WORK

This section will indicate areas where future work might extend. The goal of this section is to show that the development of the process is only the beginning of a long journey to its implementation.

Implementation

Many people have asked me "what do you plan to do with this project when your culminating project is finished?" My answer has always been, "I plan to see that this process is implemented and improved upon to foster better new product development than the company has ever seen." I see three obstacles that stand in my way of achieving my goal: corporate culture, communication and the performers themselves.

The Role of Corporate Culture

Never underestimate the power of Corporate Culture when dealing with complex systems made up of human beings. Basic human psychology tells us that people do not like change. This is a very important concept to keep in mind when you are proposing change to a system that has been in place for a number of years.

In order to implement the New Product Development Process, there must be support from the top-down. Diagraph's Executive Committee must agree that change is needed and that this process accomplishes that change before any real implementation can be done.

With this in mind, my next course of action will be to contact the Executive Committee of Diagraph Corporation and ask for an audience where I can present the ideas of the New Product Development Process Team.

The Role of Communication

If the Corporate Culture will allow the new process to be implemented, the next obstacle that could stand in the way is if the performers are expected to follow the new process without proper training.

It stands to reason that the performers cannot be expected to follow the new product development process if they do not know exactly what they are supposed to do.

This is why good communication between the New Product Development Process Team and the performers involved with new product development is crucial. Without this kind of training, the process will be doomed to fail.

The Role of the Performers

The third obstacle that could stand in the way of implementation of the new process is the performers themselves. People tend to fall back into familiar patterns if nothing is there to keep them on track. There is a very real danger that the Engineers might be so used to developing products with the old process, that the new process never really gets implemented.

Or, even worse would be that the new process is partially implemented and judged unfairly by its poor performance. To prevent these scenarios, I would suggest that the New Product Development Process Team monitor the first few new products as they pass through the different stages of development.

If the process is to work for Diagraph, the authors of the process are responsible to make it so.

In Conclusion...

I feel a great sense of relief knowing that this project is nearly complete. I also feel a great deal of personal satisfaction knowing that something I created can be used to help so many people do their jobs more efficiently and effectively.

Through this project I have learned a great deal about the subject of new product development, but there's something more. What I have really been doing all this time is showing Diagraph how to communicate in an organized, clear fashion. Many people in the halls of Diagraph call the new process, "Scott's process." This is not true. As I have said before, I only got the different departments talking. They really wrote the process.

Although I feel as if I've crossed some kind of finish line, I know that there is much more work to be done in this area before Diagraph can be like Rubbermaid and Eastman Kodak in terms of new product development.

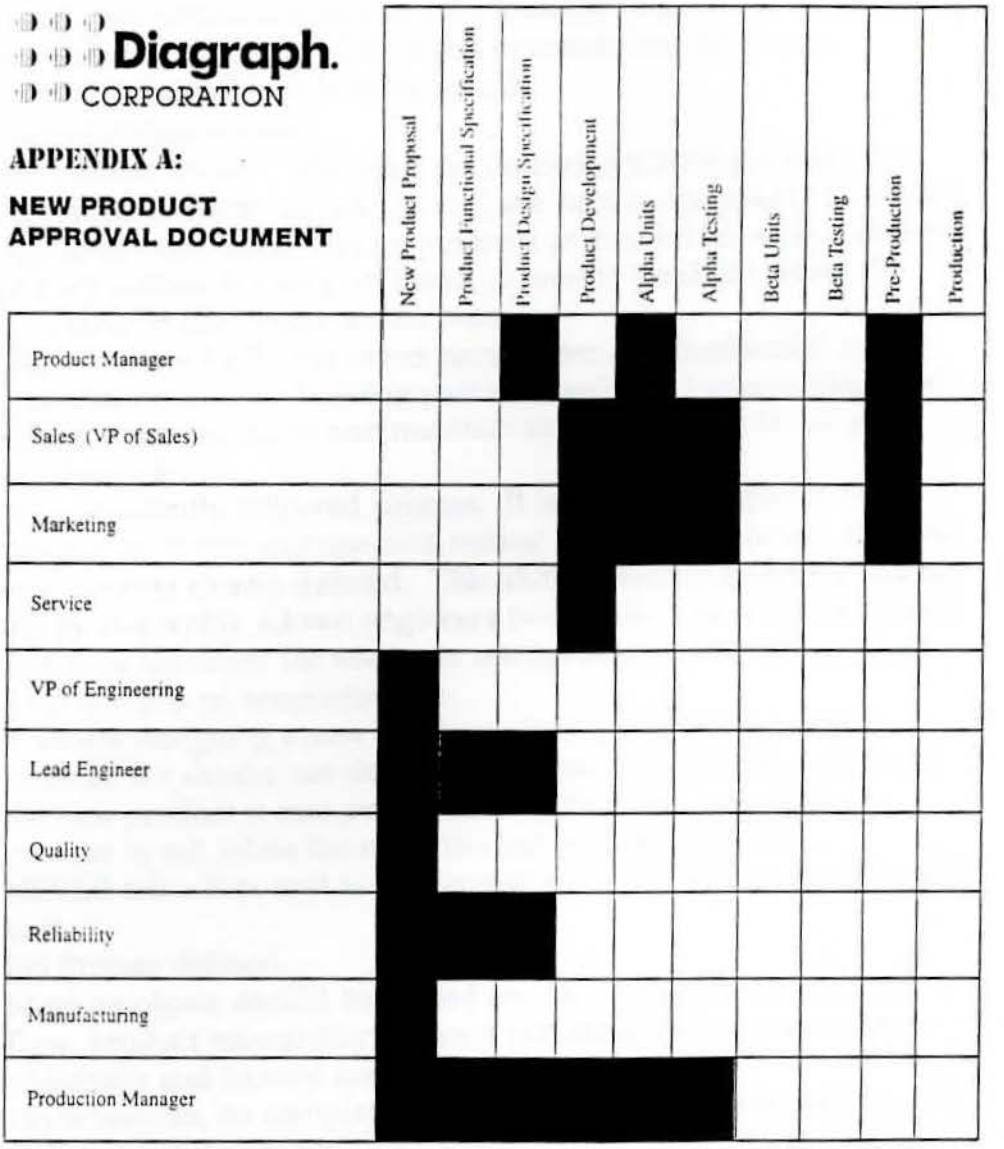
I would like to express my thanks to Lindenwood College and all of my readers for the opportunity to work on a project that has had such a positive influence on my career and my life.

APPENDICES

Diagraph.
CORPORATION

APPENDIX A:

NEW PRODUCT APPROVAL DOCUMENT



APPENDIX B: NEW PRODUCT DEVELOPMENT PROCESS SURVEY RESULTS SHEET

Current Problems

- No market specs generated and agreed to, which leads to inadequate technical specs and the inability to properly access resource requirements. This leads to scheduling problems.
- Current "process" needs more details.
- Lack of design review.
- No "central library" where all documents (including schematics, diagrams, assembly drawings, etc.) are kept in one place. If we had this library one could update progress as projects develop, add new projects relatively easily and start to modify products using the document in the library as the basis.
- I have written ECRs but never have gotten any feedback (i.e. drawing for review, drawing part number) etc. I would like to be able to check the work and maintain my own files as far as part numbers, etc.
- No consistently followed process. It is up to the engineer what services he or she will use or if testing will be outsourced. Product spec is never clearly defined. This allows product groups to change things at a whim, allows engineers to deviate from what is desired and does not allow for adequate testing other than basic testing. Also, there is no accountability.
- If we are designing a new product which replaces an existing product, we should not decide to quit building the old units until the new product is into production. In this way, we still have product to sell while the new product is in development.
- NEVER sell a Beta unit to a customer who is expecting a production unit.
- No Process defined.
- More emphasis should be placed on: process controls, material flow, product traceability, process performance, process error correction and factory communication.
- No Schedules, no complete instructions on what is needed. Delivery dates missed.
- Lack of documentation during the development cycle.
- Products not designed for easy field service.
- Too much bureaucracy and lack of communication.
- New Product Development at Diagraph suffers from (1) Having development team members fire-fighting projects. (2) Lack of specifications; both functional and detailed (3) inexperience (4) project leadership (5) lack of marketing participation.

- Not given enough time to research a product. It seems that we are too eager to push the product out the door before known problems can be fixed.
- For small projects how do we get an account number to use for purchasing parts for that specific application. (Project less than $1,000).
- I am not aware of the existence of any current new product development process. Also, it appears Diagraph lumps new product development and R & D into the same category. These should be separate. Also, "Too many chiefs and not enough indians" is another apparent problem. One guy should be coordinating the product development team, not several. Product development should be a focused team of multi-disciplinary "specialists".
- Very little manufacturing, purchasing, inventory, quality involvement in the development process. No manufacturing documentation. Inaccurate costing. Inaccurate bill of materials. Frequent design changes during production run, design not firm when released.
- Insufficient time for R&D. No deep sounding of the market current needs or precise focus on market futures.
  Late (costly) examination and testing of manufacturability.
  Marketing interaction limited to broadcasting product design specifications.
  Marketing product announcements are too early—they report the ideal rather than the actual performance capabilities.
  Lack of documentation during development cycle: what we wanted to accomplish; trials and failures; experimental statistics; what was learned; what was defined and what directions set.
  Lack of computer simulation and modeling—too much reliance on prototyping failure for development direction and capability definition.
  Beta product and testing deleted. Products jump from alpha phase to manufacturing.
  Lack of involvement of the Sales Division during development. Alpha and beta sites have come areas other than Sales.
- Under the current process, designs are driven by a sales demand to meet the level of competitve products. Most of our designs are outdated from inception. Due to the lack of a true marketing department, we are not designing to meet furture requirements, but instead designing to meet current demand. We will never achieve designs capable of capturing the level of markets required to be a 200 million dollar company delivering products that are designed to meet the current needs without the insight into into future market demands.

- We need to stop spending so much design time chasing individual salesman's design ideas that "if we make 1 of these, he'll sell 200 of them," or start taking the other 199 out of their budgets and commissions and get back to designing what the other 99% of the market demands and will buy so we can meet our schedule dates and deliver products on time.

Product Functional Specification

- Should be generated by marketing with input supplied by: sales, service, engineering, trade show visits and customer service. Also, at this point the product manager is assigned.
- At this stage, it would be advantageous to include as many people as possible in the process; Marketing, Sales, Engineering, Upper management,..etc.
- Product functional specification should be the beginning conceptual outline of the product. This should include a block diagram of major functional units within the system.
- Personnel from all departments should get together to specify the requirements. Bullet list of what customers want and what features are needed should be output from this process. Rough schedule should be made at this point as to when the project will be completed.
- Representatives from Marketing, Sales, and Product Manager write PFS in conjunction with Engineering.
- Specification of a new product by anyone (Engineer, Sales, Marketing, etc.) which should pass by the product manager.
- A true market survey or study should be done to determine what the customer truly wants. A new product should not be a wish list, defined by marketing, that incorporates all features of competing products.
- Marketing investigates and determines what functionally is required.
- Marketing and sales should ideally develop a strategic profile of Diagraph - To view its strengths, weaknesses and opportunities through the eyes of the customer. Any investment by the company must ultimately be measured by the customer's willingness to buy our product rather than that of a competitor.
- The functional specification should be based on a combination of reasons consisting of voice of the customer, competitive analysis, and sales force feedback. This should be conducted by product management and provided as food for developing a conceptual design. A project leader should be named at this point to drive the project through.

- Plenty of time given to research how the product should work or interface with another system.
- Formal document from Mkt/Sales/P.M. Engineering review with Mkt/Sales/P.M. Formal release of expectation.
- This should be 95% driven by Marketing for new areas to branch into, and 95% driven by Sales as far as existing product improvements. Project Management has little too offer at this stage except as a technical "Sanity Check".
- Little or no involvement from manufacturing, purchasing, inventory, quality.
- Voice of the customer (VOC) heard throughout the development process. Sales Managers as major drivers produces myopic results because their motivations and goals are not those of the customer. The same thing would be true if only engineers were driving product development—all products would be one-of-a-kind, perform admirably when attended by three specialists and cost a king's ransom.
  Does "cheaper and faster" drive products other than computers?
  Early consideration needed on how new product will integrate into current product offering and not dilute market share.
  Formulate and understand product objectives. Obtain sign-off throughout the company on objectives to avoid last hour rejection and non-compliance with the product roll-out and integration.
  DEFINE WHAT YOU NEED TO KNOW AND WHEN YOU NEED TO KNOW IT.
- Product Functional specs should be developed from intense marketing surveys that deliver customer requirements and that can be measured to a willingness to pay, unlike the House of Quality which produced customer requirements without producing a level of how much will the cust. pay to satisfy the requirements.

Product Design Specification

- Should be generated by engineering with input supplied by: service, production, and the product manager.
- In this stage a group that is a subset of the functional specification group that is more technically-oriented toward handling this process. In this phase, external technical help may be needed. Key people in long term strategic planning also must play some role in this phase.

- Product design specification should be the technical baseline for the design and manufacture of the product. Each functional unit as well as the system should be described and should include the following, if applicable: Theory of Operation, Hardware Design, Mechanical, Electrical, Software Design, Manufacturing and Quality.
- Engineers' process where they perhaps with a couple of others, discuss the possibility of achieving the requirements. If any of the requirements cannot be met, let the people involved in the previous process know and get their response. Revised requirements and more detailed schedule should be specified.
- I perceive this to be a description of the electronics architecture needed to satisfy the product functional specification. Various design approaches may be identified and or discussed, allowing the PFS to be modified/updated/improved.
- MUST contain all description as to how the functional spec will be achieved. The design spec should be passed by the product leader. We need a list of preferred vendors, list of deliverables for each product and structure of test method.
- Engineering designs, on paper - in a detailed fashion.
- Engineering must do their strategic homework. They must first set appropriate product objectives, prepare their people to accept and manage the new product design and development and examine whether their current forms of organization include barriers to overall product and process improvements. The starting point for planning is to establish a target set of product values. Including costs, that must be achieved for the enterprise to win a profitable share of business in the coming years.
- Detailed specifications that will be used to design the end item. Must meet the specs agreed upon during product functional spec stage.
- REALISTIC PERFORMANCE CHARACTERISTICS AND DEADLINES
- Engineering should develop the design specification. It should address as much of the functional specification as possible. This should be reviewed with the project management/marketing team to develop an understanding of the feature/cost tradeoff associated with the design. Service and manufacturing should be brought in at this point also to gain valuable input from their perspective.
- Know what the product must do, and add any "extras" to keep with the cutting edge of competition.

- This should be driven by a project "Lead" technical guy, either a systems engineer, project engineer, etc. who will interface with the functional spec. group to turn functional specs into design specs. This should be a technical systems guy who can conceptualize the system (or product) and divide it into subsystems (or components). He then, assembles his product development team and assigns the subsystems for design.
- Quality should participate in assuring design specifications meet customers expectations. Manufacturing, purchasing, and inventory should be copied on progress.
- Exert maximum effort to set REALISTIC PERFORMANCE CHARACTERISTICS AND DEADLINES. Do not release product specifications to Marketing until after Alpha testing. Budget generously and allocate resources that will actually be available. Budget for outside expertise. Select a project manager for this product with decision-making authority and leadership ability. Set compliance goals: NEMA, OSHA, etc.
  Create design team. Don't allow current levels of engineering expertise (or the lack thereof) or manufacturing capability (or the lack thereof) to limit the vision and capabilities of a new product.
- Product Design specification would be the technical spec/solutions to the customer's requirements that must be accomplished within their pre-defined willingness to pay.

Product Development

- The Product team is assembled at this point consisting of the disciplines required to complete development. Schedule is then set. First thing to do is reach closure on all unknowns through research. Determine if we can do it? If not, can we buy it? What is the mix of engineering and research?
- Most desirably modular and using rapid prototyping techniques allowing for iterative refinement. This stage produces the prototype that proves the validity of the concept; hence "The Proof of Concept Milestone"

- Product development should be the detailed design phase where the design for manufacturing is put on paper. This should include: Interface control drawings, Mechanical part drawings and Mechanical assembly drawings, Bill of materials, Schematics, Circuit Card Assembly drawings , Software Design documentation and Test documentation. During the design phase there must be design reviews before parts are made. Design reviews should be held within functional groups, but could include internal customers. For example; if a mechanical engineer is designing parts to be made in Herrin, other mechanical engineers should be at the review along with Charlie Schaubert or even the person who makes the part (I don't know if we can do that since we have union fabrication personnel). Meetings should also be held by the project/product engineer for 1 hour each week to discuss the status of each designer and to discuss problems. This helps the design group to stay focused and organized.
- Pure engineering process where the design and the allocation of personnel should be specified. Both hardware and software have to be designed.
- This should be a functional description of the hardware/software being developed. I have been maintaining this document for the IDS/SA until after completion of the Beta units. Upon completion of Beta units this document should be updated and released to the Documentation group.
- Development of the product by Engineering using the product design spec. The spec. should be so easy to understand that little to no questions need to be asked. If a spec is not possible or further questions come up, then the process should start over with the product design spec/possibly back to function spec. *Decide here if the product costs too much, if it does go back to begin ask "what functions aren't worth the $".
- Engineering physically designs the product. Marketing is active as well at this point.
- Perhaps the best approach is to concentrate on selected strategic product objectives. The technical drawings, assembly procedures and parts specifications should be accurately maintained in a timely fashion. Cost should be minimized with respect to labor (Use fasteners that require the least tools, time, and expense) & materials to maximize functionality and profit.
- I imagine that this is the prototype stage. If so, I'd recommend a product review with Sales and Product Management to compare what Eng. has come up with to what our needs are.
- Product Design of the end item with concept drawings and theories being finalized.

- Once the design specification is approved, engineering needs to determine based on capabilities and schedule what can be done in-house and what should be sourced out. The project leader should be the driver in determining this.
- A system to have mechanical and electrical engineer groups develop a system together, It's too hard to have an engineering team in Herrin and one in St. Louis working on the same product. Many electronic problems are caused by mechanical problems, so to have both, and enough people involved would save time and money.
- Bi-weekly reviews.
- The systems engineer (or whatever he's called; project lead, etc.) hands off specs for each component to the appropriate discipline within his project team (or perhaps he hands it off to a department such as software, mechanical or electrical if project teams are impractical). They design the component according to spec's as outlined by the project lead, who concerns himself more with system integration.
- Manufacturing, inventory, manufacturing engineering, and quality are team members. Product design is developed, with manufacturing processes designed to meet product specifications.
- Employ 3D modeling and schedule Finite Element Analysis of all mechanical, components. Establish incentive program for design team.

  Assess information technology needs and communicate to IS. Document all research and development. DEFINE WHAT YOU NEED TO DO AND WHEN YOU NEED TO DO IT.
- Simply developing the technical req. into a working product, again with the customers pre-defined willingness to pay for the resolution of the requirement.

Alpha Units

- A minimum of 36 alpha units should be built to test.
- Another word for Secondary Prototypes? Good for "Show and Tell" gatherings and to freeze potential clients.
- Alpha units should be models ranging from; as small a part of the design as circuit breadboards, to as large a part of the design as a complete prototype system. Before moving on to building Beta units, a complete prototype system unit should be tested. Engineering should be responsible for building alpha units but should request help from manufacturing. If the unit, or part of the unit, is similar to an existing product, manufacturing should build the product on a special engineering order.
- Cardboard version of the product. Alpha unit should not go outside of the company.

- First functional prototype. In the case of IDS/SA, the unit was demonstrated for several departments for verbal comment. Several ideas were mentioned causing us to immediately begin updates to create the Beta units.
- It should be determined if production or Engineer will build the units. The units should be built as close to the end product as possible.
- Products first production is ready to begin initial testing.
- First prototypes built with any test beds being built as well.
- Engineers build all Alpha unit in-house.
- Alpha units should be built for internal testing only. These units are basically "models" and are not to be used for customer demos or trials.
- Finding obvious bugs.
- The "Alpha Unit" of "Engineering Design Units (EDU's)" are assembled by the project lead with support from project team members if required. This unit stays in house and is evaluated by engineering, marketing, sales, etc. for a given time. This unit should be put through all the extremes of applications. After evaluation, a redesign meeting of all disciplines (proj. development, management, marketing, etc.) is held to discuss redesign issues, changes, improvements, etc. This meeting will produce an approved list of revisions to the product. The cycle repeats itself at this point. Project lead takes and spec's the revisions and communicates this to the appropriate member of the project team, who then redesigns and returns component to project lead for integration. After all revisions are made the product should then be a full-fledged beta unit, (capable of delivery to a customer if necessary). Note; on occasion, (especially with more advanced systems), two cuts at the redesign are necessary before officially having a Beta unit.
- Manufacturing will build the units with production personnel. Manufacturing engineering is heavily involved in designing manufacturing processes. Quality testing methods are developed. All are supported by the design engineer.
- Alpha units should only be for internal testing. Too often we start pushing the remaining part of the process at this point. These units should meet all the functional and design specifications with remaining work to meet manfacturability and final customer requirements.

Alpha Test

- Alpha testing should test the extreme ends of the marketing (if possible) and technical specs. The result of alpha testing should be design modifications and a higher confidence level. Alpha testing should continue up to production release.
- Better here to emphasize on Usability more than Reliability.
- Alpha testing should be testing which proves the design meets the requirements. System tests should include structured reliability testing that is planned during the product development step. Test results should be documented.
- Point out the problems that occur with the alpha unit. Get feedback from people involved.
- Internal demonstration should have been a single meeting with all departments for debate. Any concerns must be in writing by the appropriate department so that identified problems/improvements can be incorporated in a timely manner into the Product Functional Specification before Beta units are initiated. This did not happen on IDS/SA.
- Test of product by the test group. A test method should be developed by the Test Technician and the Engineer involved, using the function & design specs. for guidelines.
- Testing has begun, the unit is tested in-house. Any design changes are evaluated here.
- Written test specifications needed.
- Testing in-house of the first prototypes and test beds.
- Analyze serviceability. Begin exacting Life & Reliability Testing. Place Alpha units in test sites chosen and serviced by Sales Division. Can they find a sale if they can't find a test site for this product? Begin regulation compliance implementation.. Document installations and product performance.
- As mentioned, Alpha units should be built to perform preliminary testing. They should be used to confirm specifications.
- Finding and making solutions to bugs. This can sometimes take more time than expected.
- The test is conducted in-house. The units are prototype units which never go to the customer. Life & Reliability test the units with the design engineer.
- Only test these units internally. Don't start shipping units to customer and trade shows yet. These units should be tested by more people and longer than we currently do to determine if they meet the functional and design requirements.

Beta Units

- Enough beta units should be built to supply 2 or 3 beta test sites. There sites should test the extremes of the marketing specs only - the technical specs should have been worked out in Alpha Test.

- Units to test the appetite of the market.
- Beta units should be units similar to alpha units but should incorporate design changes based on the results of alpha testing.
- More refined version of the product.
- Second functional prototype of "IDEAL" product. I feel I have sole responsibility for the results of the IDS/SA Beta unit because I incorporated Alpha Unit comments from others responding to the Alpha demo. Why? Because a revised Product Functional specification was never generated.
- Personally, I think the Beta Units should be built from the pre-production run. The units should be identical to what is to be sold.
- Customer is located and willing to evaluate the product as a test site.
- Problems with Alpha units are fixed in the Beta units. These prototypes will resemble the finished product.
- Involve Purchasing for suppliers and inventory turn planning. Involve IE for planning and pre-production. Release marketing announcements.
- Beta units should be designed as pre-production units and configured for operating on customer premises. Should be used to demonstrate the unit's ability to meet the targeted applications.
- Rough solutions to cure bugs.
- Should be locations in the St. Louis area.
- The Beta unit is very close to the finished product. A Beta unit should require no major modifications to become the finished product (otherwise, no one did their job during the Alpha phase). This unit should be put through all conceivable application tests under full simulation or actually at a customer site. As a result of the Beta evaluation period, customer comments and further observations within the company should usually require some minor revisions. The cycle is carried out once more, albeit more quickly since revisions are minor, where revisions are farmed out by project lead to project team, etc. Upon completion of this round of revisions, the "Product " is "Finished". It is time to throw it "Over the Wall" to production. Manufacturing engineering should get involved during the Beta phase, (perhaps even during Alpha if manufacturing "Gear-up" will be significant), to prepare procedures for manufacturing in a full production mode.
- The units are built by direct labor personnel. The manufacturing engineer implements and trains in the manufacturing processes. Quality testing is implemented and component performance is measured and compared to design specifications. Design engineering is supporting and evaluating results. The units are consider to be finished and ready for field testing. Some units are tested by Life & Reliability. Service methods are developed.

Beta Test

- Beta testing should go on as long as possible (6 months would be a minimum time). Also, the Beta test site will have to get sufficient support from service, engineering and marketing.
- Better to emphasize on Reliability more than Usability testing.
- Beta testing should be similar to Alpha testing but should incorporate changes based on the results of alpha testing. Test procedures may need modification at this point. Some tests may be eliminated and some tests may be added.
- Include both in-house testing and Beta site testing. Get feedback and use them to improve the product.
- Second functional prototype demonstration for all concerned departments. Upon completion of demo, engineering should update/release: schematics, functional description, part list, interconnect cable assembly drawings, software/firmware, software/firmware documentation and test fixture with acceptance test procedure (ATP). A test fixture with an ATP should be provided to production personnel and vendors.
- Sales/Marketing/etc. should provide prime customers for Beta test. There should be a list of deliverables from the customer as well as a schedule of visits and a list of what to check on visits. How long after Beta can we make a sale?? We need to watch how many running changes we make.
- Customer tests unit, engineering routinely evaluates performance.
- Written test specifications needed.
- Beta testing will be at selected customer sites. Customer feed back is the goal of Beta testing.
- Place units at test sites found and serviced by Sales Division. Document installations and begin user documentation. Train Field Service and Training. Set performance characteristics and release them to Marketing and to Quality.
- Beta test should be set up well in advance. They should be picked based on the application, not a pre-production sale that has been promised by the sales force. It should be monitored closely by sales, service, engineering and marketing.
- Finding bugs caused by Industrial environments and coming up with solutions.
- Design and manufacturing output is compared to actual component performance and how well it meets the customer's expectations. This information is communicated to design, manufacturing, manufacturing engineering, life & reliability, quality, service. Test and service methods/instructions are finalized.

- Beta sites should be easy to develop. If the process has begun properly, these customers are already known since they were part of the marketing survey.

Pre-Production

- Pre-production is the Beta phase of production. Alpha production should be part of the Product Development cycle. In the pre-production phase, systems are installed and debugged. People trained, and the infrastructure put in place for production.
- Units that set and test the process of mass production.
- Documentation listed in product development should be revised based on testing. Documents should be released for use in production. Any special tooling should be in place in manufacturing so that manufacturing can build the product. Special methods of assembly should be communicated to manufacturing, in writing, preferably on drawings or in work instructions. Any bugs in assembly and test procedures should be resolved after final testing.
- Almost ready-to-go version. Use the feedback from beta sites and in-house quality control to complete the product.
- The process of handing Beta Unit production and test capabilities to production personnel. Supporting production with initial support/training of the test fixture and test procedures.
- Engineering involvement with manufacturing to ensure good assembly process/question answered. Believe this should occur prior to Beta. This should be on manufacturing schedule, not engineering. Engineer should actually assemble the product and get advice from the assembler. There should be a cut-and-dry deliverable for this process.
- Engineering manufactures a small quantity of units, to determine cost effectiveness and define manufacturing process.
- The product should be allowed to mature somewhat at this stage. All documentation should be developed through this stage and finalized. Production is no place for research and development. 95% of R&D should be completed and recorded by now. All pertinent data should be available to determine manufacturability.
- ECNs, structures, mfg. tooling, documentation internal & external. Training internal & external.
- Conduct analysis of outsourcing for manufacturing: raw materials; manufactured parts; partial and complete assembly; and labor. Conglomerate cost is the price to beat. Integrate MIS/MRP into process. Finalize regulation compliance. Test and troubleshoot new production tools. Prepare profile documentation and flow procedures. Inaugurate Quality procedures. Complete initial battery of Life & Reliability Testing. Complete user documentation. Train Sales, Samples and Management.

- Ironing out any last changes. This includes many changes and ECRs that should be determined by engineering, as long as cost doesn't get to high. Engineering and manufacturing need to communicate better to insure necessary changes can be made in a timely manner for production units.
- Should be built with sufficient time to resolve remaining issues, parts shortages, etc. prior to production release to be sure everything is all set prior to scheduled release.
- Manufacturing engineering takes charge, with limited involvement by the project lead. Processes are finalized and manufacturing equipment, tools, etc. put in place. Training to production personnel occurs.
- Product design, manufacturing processes, and quality methods are fine tuned. Larger lot sizes are manufactured. Training in all areas are completed.
- We need less pressure and more emphasis on developing quality manufacturing and assembly methods now and we will have better margins and fewer problems later.

Production

- Initially all process parameters are watched closely and fine tuning occurs - this could be 6 to 12 months. As the production process becomes self governing - engineering resources are freed up to develop new products.
- After a sound production process has been established.
- Production units should be built and tested according to assembly and test procedures. Production should be fully responsible for the product at this point. Engineering should be available to resolve any technical issues that arise during production.
- Support production personnel on a request basis.
- Production (manufacturing) makes units.
- Documentation consisting of computer data bases and hardcopy for engr., manufacturing, process instructions, quality assurance, should be current, use various data collection tools to allow workers to improve the processes he or she is responsible for. Techniques of problem identification, experimentation, and monitoring are becoming well known in the U.S. but have not yet achieved widespread use.
- Written specs needed from engineering to incorporate into Product Release Bulletin and Product literature.
- Starting time to go full production on meeting the customer reg. and forecast.
- Go on-line with MIS/MRP. Release and train with assembly documentation. Integrate new production procedures. Phase out old product/procedures.

- Ensure proper training on new products for all field technicians and manufacturing personnel. Small solutions to large problems can be solved with the proper training.
- Fully in production, the production manager and his manufacturing engineers run the show. Project development has run full term, and the project team should be off on another project, or disassembled to join other project teams.

Product Improvements and Fixes

- As product feedback from Beta testing, production, and field installations continues the product and process will be tweaked to accommodate the fine tuning - May have to have a separate production support group do this.
- Elements or components of the product must be produced with future possible modifications in mind.
- Product improvements and fixes should be looked at and implemented based on: need (is it really necessary based on the design requirements) safety (is it unsafe to operate without a change) cost (will the cost of doing the work to make the change be less than the savings made in making the change). If an improvement is necessary, an ECN (Engineering Change Notice) should be written. Depending on the complexity of the change, it may be necessary to go through all of the above steps (2-10) before implementing the change.
- Cases by cases. if any improvements need to be made or if customizing of the product is required.
- Categorize/prioritize unit shortcomings and provide PM with performance tradeoffs such that we can insure that fixes are appropriate/permanent. Not quick and dirty.
- ECN process - there should be some standard/criteria as to when a change requires testing.
- As more data about the product comes in, the product is constantly updated.
- Create a consistency of purpose toward improvement. Find problems by continually working on the production./engr/quality process and document (with distribution) the path we have been on. Institute modern methods of training on the job. Break down barriers between departments implement corrective action as opportunities surface. Demonstrate management commitment.
- Continuous improvements. Fixing field problems. Mfg. problems.
- Inaugurate rigorous feedback from Service to engineering. Conduct regular reviews and update procedures, documentation, training materials, tooling. Implement changes as needed.
- These should be on-going and aimed at meeting market-wide applications, not for every custom application we come across.

- Should be determined by customer's needs.
- Define problem test solutions, field test if necessary, document, ECN, release.
- Manufacturing engineering drives this, serving as the technical lead much in the same manner as the project lead did during (may require support from project lead, though) development, ie; farming out work if necessary to various disciplines, etc. However, a review and analysis period is excluded. Required mod's at this point should be relatively minor and agreed upon by mfg. engineering and production management with input sales. Any major changes should be considered as a possible new product to be developed.
- Continual improvement teams incorporating personnel from engineering, manufacturing, inventory, quality, service, and sales are formed. Teams meet on a scheduled basis and review product design and manufacturing performance. Changes are made to improve performance.
- If the process is handled properly, this step would be used to improve the product and reduce cost, not to stomp out fires.

WORKS CITED

Baker, Stephen. "A Smarter Way to Manufacture." Business Week (April 30, 1990) 110-117.

Bobrow, Edwin E. and Dennis Shafer. Pioneering New Products: A Market Surivival Guide. Homewood, Illinois: Dow Jones-Irwin, 1987.

Hammer, Michael and James Champy. Reengineering the Corporation. New York, New York: HarperBusiness, 1993.

Hall, John. Bringing New Products to Market: The Art and Science of Creating Winners. New York, New York: AMACOM, 1991.

Harris, Karl. "The Brakes Go On in R&D." Business Week (July 1991) 24-26.

Himmelfarb, Philip A. Survival of the Fittest: New Product Development During the 90's. Englewood Cliffs, New Jersey: Prentice Hall, 1992.

Husch, Tony and Linda Foust. That's a Great Idea: The New Product Development Handbook. Oakland, California: Gravity Publishing, 1986.

Lynn, Gary S. From Concept to Market. New York: Wiley Publishing, 1989.

Thompson, Philip C. Quality Circles: How to Make them work in America. New York: AMACOM, 1982.

Waterman, Robert H. What America Does Right. New York: Hunter College Press, 1983.