Continuous Improvement in the Context of Organizational Culture

by
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ABSTRACT

Midsize companies undergo major changes during the transition from a small entrepreneurial enterprise to an established institution governed by policy and procedure. Questions arise as to what happens during the transition, how it affects the company, and what if anything can be done to avoid the negative repercussions of being a large organization?

It has been my observation that companies in transition struggle with:

- Accountability, holding individuals accountable to their goals and ensuring that the individual goals are aligned with the company's goals
- Communication, facilitating communication between different levels and functions of the organization
- Systems perspective, maintaining a "big picture" view of the business, with a comprehensive, technical understanding of the interaction between parts of the organization and the external business environment

In this thesis I illustrate how Polaroid operates, specifically in the area of continuous improvement. A team was assembled to reduce the cycle of a manufacturing operation at the Chemical Operations Division (Chem Ops) by means of an alternate business improvement process. During a few days of team work, a multi-functional team addressed the manufacturing "value added" cycle time of a chemical process. The team's activities resulted in a cycle time improvement of 30 % of the total original manufacturing time for the chemical manufacturing process.

Cycle time in manufacturing operations is one measure of efficiency and performance. The reductions of cycle time of operations and functions lead directly to two major benefits:

(i) faster response rate to changes in the demand and orders, impacting customer satisfaction

(ii) resources such as equipment and manpower become available for additional products and applications.

During the cycle time reduction process, I attempted to describe the organizational culture at Chem Ops. It was discovered that Polaroid faces some significant challenges, such as the ones listed above, in creating and sustaining a successful organization.

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Chapter 1: Thesis Objectives

1.1 Thesis Statement

Many midsize companies undergo a transition when changing from a small entrepreneurial enterprise with an organic structure to a formalized institution that is governed by a set of established procedures. Questions arise as to what happens during the transition, how it affects the company, and what if anything can be done to avoid or correct the negative repercussions of growing into a large organization?

Companies that have successfully grown into large organizations, such as Polaroid, are likely to struggle with:

1. Accountability, holding individuals accountable to their goals and ensuring that the individual goals are aligned with the company's goals.
2. Communication, facilitating communication between different levels and functions of the organization.
3. System perspective, maintaining a "big picture" view of the business, with a comprehensive, technical understanding of the interaction between parts of the organization and the external business environment.

1.2 Problem Description

In the entrepreneurial firm, employees are driven to succeed because they have a sense of ownership. In relatively small and simple companies, all employees are held directly accountable for certain roles and responsibilities. However, as the firm grows, the employees' sense of ownership and incentives to remain accountable tend to decrease. This occurs because there is less of a cause and effect the relationship between an employee's actions and the impact on the outcome. It is therefore important even at early stages of the company's life to foster a culture that values accountability and/or to provide consideration for accountability in organizational design.

Communication in a small and organic company occurs on a spontaneous and as-needed basis. There is little need for a formal communication and reporting system because the employees have the luxury of physical co-location. Also, these employees typically have a better sense for what information is important to be communicated and who needs the information.

As the firm increases in size and complexity, barriers between functions and between different layers in the organization are created. These barriers tend to inhibit the flow of spontaneous communication and as a result, the need for formal reporting and communication arise. In some cases, systems to facilitate communication are not properly designed or implemented. In these cases, the barriers between functions increase to the extent of creating "functional silos," where functions hardly communicate with each other at all.

To be efficient, most modern day organizations divide work into separate functions or areas of expertise, the "Taylorist division of labor." Efficiency is a benefit of this method of work allocation, although the consequence is often over-specialization or local optimization. This occurs when one function, having the incentive to the job as well or fast as possible, causes another function to be inefficient. This typically occurs without one function realizing the impact of their actions on the other functions. In these cases, the organization lacks the ability to take a step back and look at the impact of one function on the other, or assuming the "system perspective," and designing the system for overall efficiency as opposed to local optima.

In many cases, the third factor, maintaining a system's perspective, is achieved by employing the first two factors, by either accommodating communication between functions or by setting goals for functions jointly rather than separately.

1.2.1 Case Study: Polaroid's Chemical Operations Division

The issues described above are common to any firm which transitions from a small enterprise to a large organization. During my internship, I had the opportunity to observe first-hand the operations and the challenges mentioned above, as well as those that are specific to Polaroid's Chemical Operations Division (Chem Ops).

Polaroid is an ideal organization in which to study organizational culture. The company is old enough to have a rich history of successes and failures, yet young enough that many of the original employees are still around and recall the shared history on which the company culture is based.

In 1994, Polaroid was described as one of the best companies to work for in the US [Levering and Moskowitz, 1994]. Chem Ops's culture is described by some of the division managers as one that values people, and Polaroid as a company is known for their obligation to provide a nurturing workplace for every employee. To the newcomer, the atmosphere at Polaroid is easy-going with relatively low levels of stress or confrontation, which made it possible to become "part of the family," or "Polarized."

1.3 Thesis Structure

The three issues outlined above, accountability, communication, and maintaining a system's perspective permeate the remainder of this thesis. During my internship I attempted to gain an appreciation for these problems by studying Polaroid's corporate culture. To study the corporate culture, I helped form a continuous improvement team to reduce the cycle time of a chemical manufacturing operation. Instead of the conventional business improvement process, we employed an alternative process, comprising several tools and techniques.

Chapter 2 contains an explanation of a framework that guided my thoughts about the problems and key factors present in successful organizations.

Since factors such as accountability and communication are integral to the culture of the organization, a large portion of the effort for this thesis involved the investigation of the Polaroid culture. Chapter 3 contains a brief survey of the current trains of thought relating to the study of organizational culture. (To put the partial ethnography in context, a brief description of Polaroid's history is also presented in Appendix B.) Chapter 4 contains the "heart" of this thesis; a partial ethnography, an in-depth investigation of the Chem Ops organizational culture.

Continuous improvement served as a vehicle to study the Chem Ops culture and to sense the company's response to the process of change. Chapter 5 describes a novel process that was used for cycle time reduction and presents the advantages and disadvantages of this method versus the conventional Polaroid business improvement process. Production capacity became available as a result of reduced cycle times and attention is focused on Chem Ops' strategic outsourcing decisions in Chapter 6. This decision making process is represented in a model, providing a tool for improving future make-or-buy decisions. Chapter 7 presents my conclusions and provides suggestions for future areas of research.

1.4 Specific Contributions to Polaroid

In terms of the specific contributions to Polaroid during my internship, my work can be described in two sections; cycle time reduction and the make vs. buy decision making process modeling.

1.4.1 Cycle Time Reduction

I became involved in a continuous improvement effort to reduce cycle time primarily because the Chem Ops plant manager had recently begun a plant wide initiative to reduce cycle time of business processes and manufacturing operations. The reasoning behind the drive for cycle time reduction is that if cycle time could be reduced, resources would become available for other purposes and applications. The capacity could be used to increase volumes or to integrate manufacturing into the supply chain (backward integration).

Two major goals of cycle time reduction are:

- to increase customer satisfaction through faster response to demand and orders
- to increase the plant's capacity without spending money on the expansion of existing resources

Increased customer satisfaction result from fulfilling customer needs faster. Time to market is becoming increasingly important as the average product life cycle decreases. For example, Hewlett Packard claims that about half their net revenues are derived from new products that were introduced to the market within the last two years.

Increasing plant throughput without additional expenditures are also important to Chem Ops. The Chem Ops division costs are mostly fixed because of the high capital investment for reactors and other expensive equipment. An increase in the number of kilograms of chemicals produced by the plant would therefore lead to a decrease in the effective cost per kilogram. Inventory reduction can be considered in terms of cycle time reduction too. Warehouse space is a resource; by reducing the time of inventory occupying this space, additional capacity becomes available for no additional investment.

To meet the objectives of studying Chem Ops's corporate culture and gaining an understanding of the factors that drive and constrain the rate of change in the organization, a team was assembled to focus on reducing the cycle time of a chemical manufacturing process. One of the processes was selected for cycle time reduction by surveying a number of processes and the various facilities. A number of constraints led to the consideration of Chemical A as explained in the following chapters. Chemical A is manufactured in Chem Ops' large scale production facility. It is an intermediate that is used for one of the layers in the film used for instant color photography.

A team was assembled to focus on the cycle time reduction of the manufacturing procedure of Chemical A. The team consisted of a cross-functional representation of the departments who are directly involved in manufacturing. After negotiating with the team members' supervisors, two four hour sessions separated by a week was scheduled for team activities. The activities and preparations of the team are described in detail in the following chapters, and formed the basis for this thesis. The conventional Business Improvement Teams (BIT) was found not to be ideally suited for the cycle time reduction of chemical processes. The usual period of 6 to 18 months for BIT was condensed into a few days of focused analysis. Elements from TQM and reengineering were employed in the alternative business improvement process. A detailed description and discussion of the process are presented in the following chapters.

The remainder of the cycle time reduction effort was divided into a number of tasks. I was responsible for following up and ensuring implementation of the changes resulting from the team effort. I also attempted to address the non-manufacturing activities related to the production of Chemical A. This included scheduling and materials handling. In both of these areas we identified significant opportunities for improvement, which in themselves would have been interesting and challenging topics for an intern.

A 30 % saving in manufacturing cycle time for Chemicals A was achieved as a result of the concentrated cycle time reduction team effort. The results of the team's efforts by themselves were neither revolutionary nor insignificant relative to the plant's total annual budget.

If one assumes that the resources that were made available as a result of the reduced cycle time requirements for all the batches of Chemical A was filled with the equivalent value of current production, the Chem Ops annual output would increase by $ 320,000 per year.

The real value of this team's efforts resides in the fact that this process could be repeated for all the chemical processes that are used by Chem Ops. Chemical

A's production represents approximately 5% of Chem Ops's annual output in weight.

1.4.2 Make vs. Buy Decision Making Process

After the cycle time reduction pilot program, I developed a model for the decision making process surrounding Chem Ops's purchase of raw materials. The capacity that became available as a result of cycle time reduction could be used to increase volumes or to integrate vertically. Since the demand on Chem Ops is likely to remain relatively constant over the next several years, Chem Ops could consider bringing production of some of the raw materials in-house to use the "new available" capacity.

To decide which of the raw materials to make and which to outsource, it is important to first understand the current decision making process and then to improve on it if possible. The make vs. buy decision process was outlined by interviewing a range of Polaroid employees involved in the design, scale-up and purchasing of new and old chemistry. It was found that certain issues become more important depending on the phase of development of new chemistry. It was also discovered that decisions were highly dependent on the "situation" and on parameters that are not easily quantified, such as the people involved, the type of new chemistry, and the plant's degree of capacity utilization.

The intent of my effort was to articulate the current process of make vs. buy decisions of outsourced chemicals. Gaining a clear understanding of the existing process highlighted the more critical factors in the decision making process.

Chapter 2: A Framework for Business Analysis

2.1 Introduction

Organizations, such as Polaroid, are complex and multi-faceted. How does one go about understanding what factors in organizations lead to success versus failure? In the following section, I present a framework for approaching and understanding organizational challenges and advantages.

At some point during the growth of a large organization, challenges in the areas of accountability, communication and maintaining a systems perspective are likely to emerge. To investigate these attributes at Polaroid, I used the continuous improvement program as a vehicle for understanding how a specific Polaroid division operates.

Different organizations have different needs and abilities when it comes to continuous improvement. The need for continuous improvement depends on factors such as the business environment, the type of product that is produced, and other organizational factors. Using this framework for thinking about the problems of accountability, communications and a systems perspective that midsize organizations are likely to experience, it seemed logical to focus on the organizational factors, specifically organizational culture, to understand how the organization functions internally.

The Chem Ops division faces several obstacles in their pursuit of change. To put these obstacles in perspective and to better appreciate Polaroid's situation, consider what obstacles are experienced by other companies. Most companies seek to adapt to the continually changing external environment. What factors do other firms face; do other organizations have to overcome the same obstacles as Polaroid?

To help answer these questions, I visited and studied a number of different companies' facilities. Besides visiting other Polaroid divisions, I also visited three unrelated companies; a helicopter manufacturer, a semiconductor fabrication plant, and a biotechnology medical products manufacturer. By observing operations of companies in other industries, I established a framework for evaluating the factors that affect a company's attitude towards continuous improvement.

Why do different companies approach the issue of continuous improvement in different fashions? Companies are different in multiple ways. There are, however, a number of factors that have direct impacts on how an organization approaches continuous improvement.

Factors that determine the way in which a company operates and how it improves its operations include their (i) Business Environment, (ii) Product Characteristics, and (iii) Organizational Factors (such as Culture, Design, and Size).

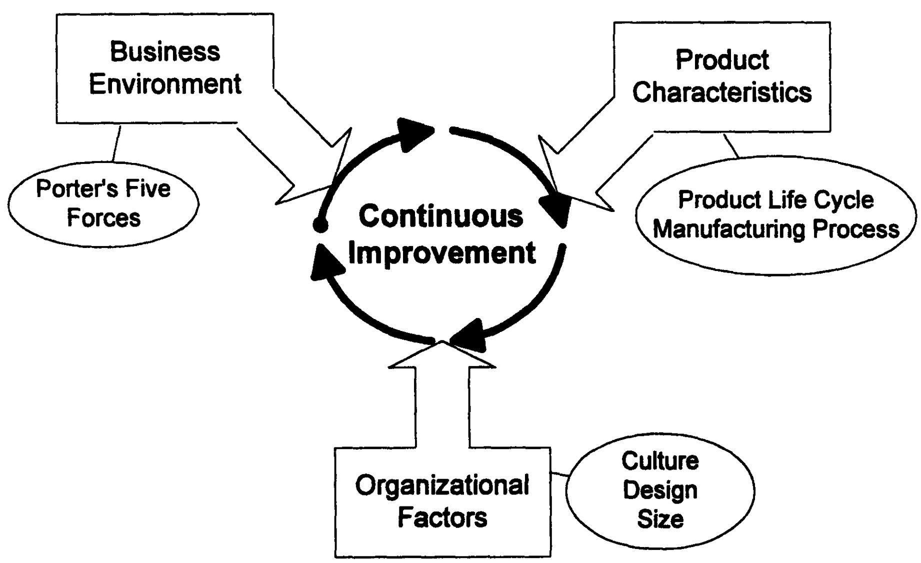


Figure 2-1: Factors Impacting Continuous Improvement

2.2 Business Environment

Business Environment refers to the factors that affect a firm's ability to compete in a specific industry. In many cases, the factors that determine a firm's ability to compete are also indicators of their attitude towards continuous improvement. Porter's Five Forces Model [Oster, 1994, p. 32] is a helpful framework for the analysis of an industry. The factors that are at play in any industry include the level of competition among firms, barriers to entry or exit, which other products are considered substitutes, and the extent of buyer and supplier power.

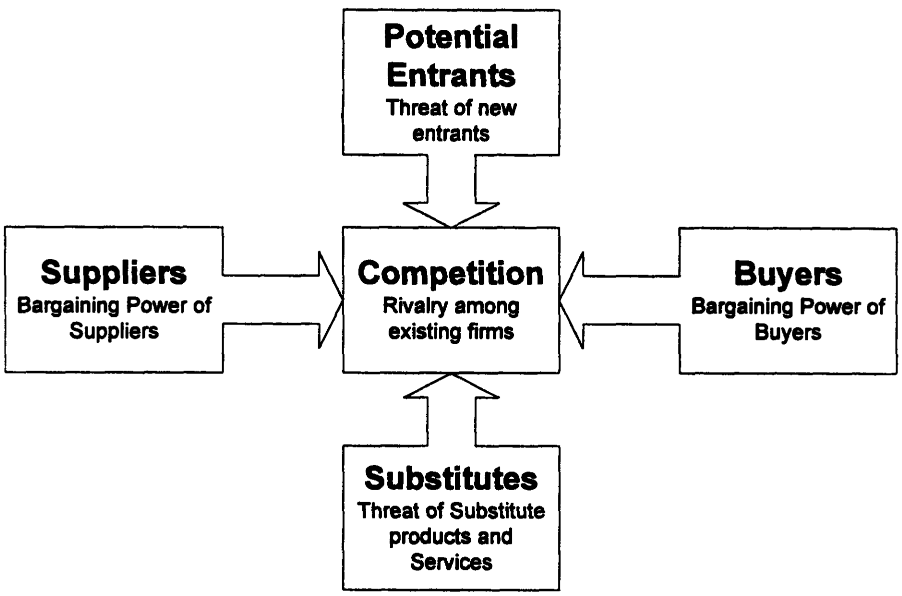


Figure 2-2: Porter's Five Forces Model

The factors that describe a market can be related to a company's attitude towards continuous improvement efforts. The extent to which the customer or government imposes regulations and specifications for the products determines how companies innovate processes. More severe regulations make it more difficult for a firm to change products and processes. For example, the Food and Drug Administration (FDA) maintains a strict policy that requires drug manufacturers to complete several phases of clinical trials before the product can be manufactured or sold commercially. As a result, one sees very little effort in the continuous improvement efforts of approved drug synthesis processes since any changes will typically require a fair amount of time and resources.

The number of competitors and the degree of competition also affects the way in which a company considers continuous improvement. When Polaroid first started producing instant photography products, they were essentially a monopoly. At this time, Polaroid had to first make the product *right*, then make it *better*. Polaroid was the first company to produce this revolutionary product; the workers still like to claim that they produce the most chemically complex product in the world. Since there were no other competitors in this market, Polaroid did not have the incentive to make the product better or cheaper as long as the customers were happy with the product and willing to buy it.

Often this phenomenon is evident when an established monopoly is challenged by a new competitor. A good example is the difference in the cost of an airline ticket for a route that is served by a single airline versus a few competitors. In cases where companies do not have any incentive to improve operations for the lack of competition, other incentives have to be found. Other incentives may be strong leadership by top management or the threat of new entrants.

It is reasonable to conclude that the nature and structure of a company's business environment (industry) does have an impact on the degree of competition, which determines to a large extent the company's attitude towards continuous improvement.

Polaroid enjoyed a monopoly status in the instant photography market for decades. Kodak entered the market with a competing product but was found to be infringing on Polaroid's patents and forced to pay a $ 950 million settlement in a lawsuit brought by Polaroid. By the time that Polaroid's patents expired, Kodak had lost interest in the instant photography market. A Japanese competitor, Fuji, entered the market and captured market share from Polaroid, forcing Polaroid to cut prices and focus on cost reduction and becoming more competitive.

2.3 Product Characteristics

The product itself has an impact on the company's approach to continuous improvement. Specific factors such as the product's (i) expected life cycle and (ii) manufacturing process have a direct impact on the nature and level of continuous improvement.

2.3.1 Product Life

The semiconductor industry has been characterized by products with short life cycles. The expected life of one generation in the semiconductor industry is about two years. In the case of short time intervals between product generations, the continuous process improvements take a different form. In the initial, or startup phase of a new generation chip, the majority of effort goes towards getting the line running and producing an acceptable yield. By the time that the process has been stabilized, the next generation product is introduced and the current manufacturing line is disassembled. Consequently, the operators and manufacturing engineers do not have much opportunity to practice continuous process improvement other than incorporating their learnings into the design of the manufacturing lines for next generation products.

Polaroid products have longer life cycles than semiconductor chips, but since instant photography is a mature industry, Polaroid maintains sales by constantly adding functionality to existing products. On average, Polaroid introduces a new camera or new features at least once per year, but since the new product introductions typically do not make the existing products obsolete, the life cycles are longer than that of a semiconductor chip.

2.3.2 Manufacturing Process

The manufacturing process also affects the company's approach to continuous improvement. Hayes and Wheelwright [Nahmias, 1993, p. 40] linked the product and process life cycles using the product-process matrix, as shown in

Figure 2-3.

In context of continuous improvement, one would expect change to be more readily achieved in the more flexible of manufacturing processes. Changing a rigid continuous manufacturing process would be expensive and requires significant effort. In continuous flow manufacturing operations, the equipment is typically designed to operate within a certain range of a set of parameters.

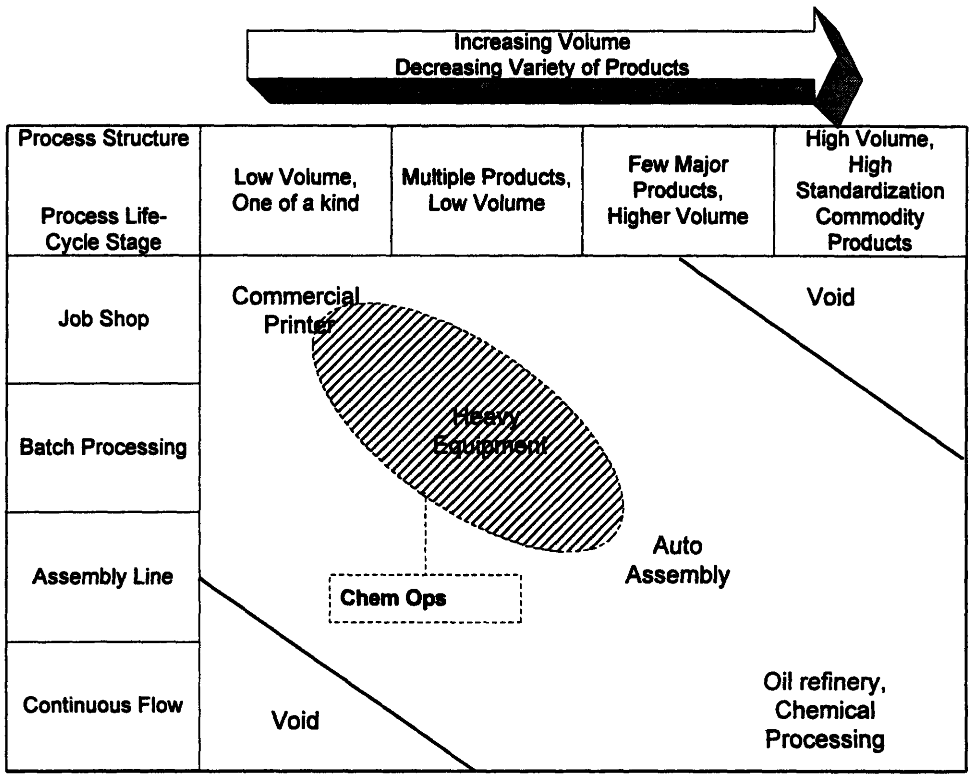


Figure 2-3: The Product-Process Matrix

Equipment is designed to produce one product with slight variations at most, incorporating only a small number of variables, such as the quality of the feed streams and ambient conditions. The continuous manufacturing process is less flexible and therefore requires more time to implement change.

Discrete part manufacturing in the job shop configuration is the most flexible of manufacturing processes. Production is in relatively small lots, and the shops are designed for maximum flexibility. The job shop manufacturing process would lend itself to continuously improving operations if a large variety of products had to be manufactured, since configurations would have to be changed instantly and with minimal effort.

Batch processing falls somewhere between continuous flow and job shop manufacturing with flexibility. Equipment trains can be rearranged and a range of different "recipes" can be manufactured. For example, the biotech industry typically produces small batches in fermentation vessels. The equipment is designed and used exclusively for the manufacturing of one or two products and is therefore regarded as inflexible.

Chem Ops manufactures multiple chemicals in relatively small batches. Some of the equipment and vessels are arranged in fixed configurations, similar to assembly lines. Certain chemicals are demanded in large volumes, requiring several batches (a "campaign").

Chem Ops is characterized by batch processing, although elements of both continuous and job shop type manufacturing processes are observed. Batch processing does allow flexibility to process a number of chemicals, as long as the chemistry is compatible with the processing equipment. Different chemicals require processing at different conditions (temperature, pressure and acidity) for which the equipment has to be designed.

Chem Ops can also be described to some extent as a continuous manufacturing and job shop line process. A significant consideration for Chem Ops is that most of the chemicals that are manufactured are dyes. The dyes lead to a coloration of the metal and gasket materials, making it difficult if not impossible to clean equipment after manufacturing certain dyes. It is common practice to dedicate a train of equipment to the manufacturing of one of the dyes. When Chem Ops dedicate an equipment train to a certain chemical it may be described as a continuous manufacturing process. On the other hand, Chem Ops make several orders consisting of one batch only, like the job shop manufacturing process.

2.4 Organizational Factors

There are countless ways to talk about internal factors that contribute to the success of a company. Since this thesis covers topics of accountability, communication and maintaining a systems perspective, the following section will include three factors; (i) the organizational culture, (ii) the organizational design, and (iii) the size of the organization.

2.4.1 Organizational Culture

Continuous improvement is also impacted by the workforce's prevailing attitude towards change. The organizational culture contributes to the workforce's attitude, and is a function of many variables, including the average age and tenure with the organization, the company's culture, leadership, economic atmosphere, etc. Continuous improvement is valued more when the prevailing attitude and values change.

3M, Hewlett-Packard and L.L. Bean are well known for organizational cultures that promote innovation and change [Bart, 1994]. In these companies, creativity is important in the way that people think, and change is part of the way in which they do business. Creating an atmosphere of innovation and change is not an easy task. It is the result of creative leaders and employees that appreciate the value of change.

As described below, organizational culture is a product of three factors:

- the company's founders and leadership
- the industry and business environment
- the broader societal culture.

The influence of the company's leadership is visible in every culture. Leadership has direct and indirect impacts on continuous improvement. Leadership is a direct impact on change when management designs policies and procedures that determine how continuous improvement is practiced. Leadership impacts the prevailing attitude toward continuous change by their espoused values. A management team that values innovation and change indirectly fosters an atmosphere and culture that promotes change.

In continuous improvement as well as any other form of change, change has to come from the top of the organization. The company's leadership has to initiate and encourage continuous improvement. At the very least, the company leadership has to foster an atmosphere that is amenable to change. Some companies argue that their work force is "empowered" and change is initiated by anyone who sees the opportunity and has the drive to change. Even in these cases however, change is from the top down, since management typically has to proclaim the workforce "empowered". For example, the helicopter manufacturer performs a series of Kaizen projects in their quest for continuous improvement. In a Kaizen team, the team has full authority to try anything within a generous budget. A team member explains:

> *"Our motto here is that 'fast and dirty is better than slow and fancy'. When we as a team decide that the configurations of a set of machines have to change, we walk out onto the floor, point at the machine and where we want it to be moved, and it is done, right away. Once [the team] agrees to do something, we don't waste time and money drawing details of what it would look like in ideal situations, we simply go out there and do it. The Kaizen teams are fully empowered by top management and receive special priority."*

Organizational culture is the glue that holds the organization together, culture dictates the way in which the members of an organization deal with each other and how they adapt to a changing external environment.

2.4.2 Organizational Design

Bureaucratic organizations have difficulty maintaining and sustaining an atmosphere of continuous change. Excessive hierarchies, lengthy decision making and oppressive procedures all contribute to the stifling of innovation and change. These problems can be found in small and large organizations, but the more successful innovative corporations flourish under conditions that have [Bart, 1994]:

- tight reward systems that link performance objectives to employee evaluations
- detailed, specific performance objectives
- formal procedures for generating new ideas and solving problems.

In these organizations, peripheral formalities such as allowing employees to set their lunch hours, free coffee and open parking are abolished. In return, the employees are "expected to get the job done".

Even successful organizations struggle to maintain the thin line between too much control and not enough control. Many seek ways to relax or reduce (but not eliminate) the firms' formal controls. At the same time, they seek to increase the level of informal controls, which is based largely on trust and personal contact between superiors and subordinates. "Order without rigidity" represents an ultimate objective. These settings encourage creative thinking and lead to an increased awareness of continuous improvement.

The measurement and reward system deserve special attention when the topic of organization design is discussed. Since metrics and rewards are means of extrinsic motivation, the manager has to take the effect of these systems on desired employee behavior into careful consideration. What is measured and is rewarded will to a large extent drive employee behavior. A classic example of rewards that bring undesired results is the case of piece rate compensation; where the more pieces the employee produces, the more she is paid. The employee has incentive to work as fast as possible and to crank out products non-stop. This, however, will also probably lead to low quality products and a selfish behavior that impacts his co-workers and the plant's performance.

Another area of consideration is whether the workforce is organized in team based vs. functional roles. Functional roles enhance the level of expertise in each department whereas the team based approach enhances communication between functions and leads to team members acquiring multiple skills. Polaroid's 11-X (Helios film manufacturing) division is an example of a team based organization. Each area of the plant is operated by a team. The team consists of 6 members, and team roles rotate between members. Whereas each member has a specific field of expertise, such as electric, process, or mechanical, each member also has the training and knowledge to perform a minimum level of any one of the other roles. Rather than the conventional operating mode in which the operator calls the maintenance department when a machine breaks down, the operator in this case is able to fix small problems himself or with the help of a fellow team member. In cases with more severe problems where higher levels of expertise are required, a roving expert will assist the team.

A critical issue in the design of organizations is the matching of decision rights with the holders of knowledge. In this context, the holders of knowledge are those employees who are best able to make specific decisions based on their expertise and access to information. However, often the holders of knowledge are constrained by their supervisors' approval. The formal control mechanism provides checks and balances to ensure that employees do not make costly mistakes or abuse their authority. The cost of checks and balances is frequently a less efficient organization with regards to making decisions.

2.4.3 Organization Size

Continuous improvement is a response to changes in the external environment. Small firms (fewer than 500 employees) are better able to adapt to changes in the external environment for several reasons. For one, small firms typically have not yet invested significant amounts of money and time in any specific systems. Quite likely, small firms have no formal procedures or policies for many of their activities. Since specific behaviors in response to certain situations are not set by precedent or dictated by policies, the employees are more flexible in how they react to a change in the external environment. Different situations will lead to different responses by different employees and often allow small firms to be more responsive.

As a company grows to a size in which control becomes diffused, rules are created to standardize the way it operates. Once standards and systems have been created, implemented, and accepted, employees have little incentive to change or challenge existing operating procedures. As a result, policies become more difficult to change and since policies are not able to "foresee" the changes in the external environment, these organizations have more difficulties in adapting to change.

To create change, employees have to be motivated. Bart (1994) states:

> *"...In small firms, much of the motivation is in the form of psychic rewards. It's a lot of fun being part of a small firm that is trying to buck the system and establish new norms. There are also strong feelings of affiliation that come from associating with the leaders, who are often cast as larger than life entrepreneurs, innovators and corporate visionaries. These rewards carry a lot of charm and appeal. It is no wonder critics often challenge large firms to recreate this atmosphere..."*

Similarly, communication between different functions in a small organization is presumably easier to achieve because employees are likely to be physically co-located and hopefully not inhibited by a hierarchical structure.

2.5 Summary

The framework presented above is useful as a perspective on the different drivers and factors impacting a company's approach to continuous improvement. The three major factors described above, the business environment, the product and process characteristics and the organizational factors, all affect the value of continuous improvement to different organizations.

My interest in this study is the ability of large firms to overcome obstacles in the areas of accountability, communication, and maintaining a systems perspective. The focus of this thesis is on the internal structure and culture of operations.

The organizational culture receives a fair amount of attention in this thesis, and the culture at Polaroid's Chem Ops division served as a helpful example for understanding the complexity of the dynamic interactions in organizations.

Chapter 3: Literature Review of Corporate Culture

My intent in this thesis is to understand the factors that impact Polaroid's operations and extent of success in the market. The factors that are identified as a result of the study include accountability, communication, and maintaining a system's perspective. Since these factors are integral to organizational culture, a large portion of the effort for this thesis involves the investigation of the organizational culture at Polaroid's Chem Ops division. In the following section, a brief survey of the current lines of thought relating to the study of organizational culture is presented. In the following chapter, the Chem Ops organizational culture is described.

3.1 Culture in Organizations

Defining "*organizational culture*" is not easy since it is a socially constructed concept. It is a way to refer to the patterns that seem to organize thoughts and behaviors of groups and organizations. We learn about culture naturally by being a part of a group or a society. The same culture may be described in several different ways by different observers based on different experiences and observations.

Schein [1985, p. 9] defines culture as:

> *"a pattern of basic assumption - invented, discovered, or developed by a given group as it learns to cope with its problems of external adaptation and internal integration - that has worked well enough to be considered valid and, therefore, to be taught to the new members as the correct way to perceive, think, and feel in relation to those problems"*

Culture is the shared patterns of thought, belief, feelings, and values that result from shared experiences and common learning. It functions to solve two basic problems facing members of an identifiable group:

- survival in and adaptation to the external environment and
- integration of its internal processes to ensure the capacity to continue to survive and adapt.

Others have elaborated on this claim, stating that there are three origins of organizational culture [Ott, 1989, p. 75]:

1. The broader societal culture
2. The nature of the business and what environment it finds itself in
3. The beliefs, values and basic assumptions of the founders and leaders.

Polaroid is an ideal organization to study organizational culture since the company is old enough to have a rich history of successes and failures, yet young enough that many of the original employees are still around and recall the shared history on which the company culture is based.

Culture performs the function of defining boundaries between the members of the organization and the non-members. Culture also acts as an implicit control system that prohibits certain behaviors and prescribes others. It provides members a way to understand events and symbols; thus it acts as a powerful force of organizational behavior.

In the following chapter, I attempt to describe the culture governing the Chemical Operations (Chem Ops) group. I also make observations about the differences between what I consider to be the Polaroid culture and the Chem Ops culture as a division of Polaroid.

3.2 Thoughts on Research Methodologies

Describing an organization's culture is dependent on the methodology used by the observer. Ott [1989, p.51] states:

> *"How one looks at the organizational culture largely determines what it is".*

Ott also presents the arguments for and against several research methods. Two schools of thought depend on analysis and study of organizational culture. One uses the logical-positivist, quasi-experimental methods to describe organizational culture and the other emphasizes qualitative methods in the description of culture.

The logical-positivist, quasi-experimental designs and approaches were dominant during previous decades but are almost universally rejected by contemporary students of organizational culture [Cook and Campbell, 1979, pp. 10-14, Van Maanen, 1982, p. 13]. The disenchantment with traditional quantitative quasi-experimental designs revolves around the lack of comparability across studies and the failure of quantitative studies to achieve much predictive validity. The studies also tend to evolve into high levels of technical sophistication which leave the publications and results incomprehensible.

Conversely, proponents of the logical-positivist quasi experimental perspective argue that qualitative methods cannot yield valid or reliable results. Researcher objectivity is problematic in organizational research in general. Experimental and quasi-experimental designs claim to provide protection against the researcher-induced biases, such as values, feelings and perceptions. For all practical purposes, qualitative studies can seldom be replicated and statistical confidence levels cannot be established for their findings. Also, argue logical-positivists, if the studies' confidence levels are not known, they are not worth doing.

The truth is that organizational research is biased by the researcher regardless of the methodology used. A hypothesis and the use of logical-positivist quasi-experimental research designs predetermine what will be looked for, how it will be looked at and, therefore largely determines apriori what the findings and results will be. All organizational research involves judgment calls and decisions that may influence research outcomes.

The researcher's definition of organizational culture determines in part what methodology is appropriate. If it is defined as espoused beliefs and values, tools such as questionnaires, inventories and interviews are used. If, on the other hand, organizational culture is defined as basic underlying assumptions, the use of quantitative tools such as questionnaires by themselves will yield misleading results.

Furthermore, research strategies have to be appropriate to what and why it is being studied. In this, Polaroid's organizational culture was studied to understand how the process of continuous improvement has developed and how the company's culture impacts the process of implementing change. Since the time span of the entire project was limited to six months, and since rigorous qualitative studies would require more time than was available, it was clear that I would need a combination of approaches for my research.

Ott [1985, p. 103] refers to the increasing use of multiple research methods or "triangulation", a research method that combines qualitative and quantitative methodologies. Triangular studies supplement participant observation and archival searches with a variety of qualitative research methods. Examples include the use of interviewing and content analyzing newspaper and business journal articles, speeches and sequences of verbal interchanges and feedback sessions. Many researchers believe that triangulation increases the richness and reliability of qualitative organizational research [Ott, 1985, p.104].

During this internship, an attempt was made to adhere to Van Maanen's principles of qualitative research. The primary principle of organizational research is "firsthand inspection of ongoing organizational life" [Van Maanen, 1982, p. 16]. Qualitative methods are best suited for seeking a thorough description of a limited sphere and, since this study focused primarily on Polaroid's chemical operations division, qualitative methods were therefore most appropriate.

Other principles of qualitative research as described by Van Maanen are:

- Analytical induction; patterns are to be built from specific data and are not used to confirm preexisting theories or hypothesis.

- Proximity; all events and things must be witnessed firsthand. Pure qualitative research methods would therefore not include interviews, surveys or questionnaires.
- Ordinary behavior; research is to focus on routine and uninterrupted activities. The observer has to guard against research activities impacting routines. The observer has to be "transparent" and data collection should be unobtrusive.
- Descriptive focus; The purpose of the research is to describe the culture, not to explain or predict it.

The description of organizational culture in terms of the basic underlying assumptions is a substantial undertaking. To complete a thorough and accurate description of the basic assumptions requires at least four elements [Ott, 1985, p.120]

- a lengthy involvement with the organization
- unrestricted access to employees and records
- the presence of an objective outside perspective
- the use of multiple data-collection strategies

Three combinations of researcher roles and methodological strategies can be employed to satisfy these requirements:

1. Participant observation with the identity of the researcher being concealed and ethnographic research strategies being employed. This method is impractical because not many researchers could remain in an organization for a long time with a concealed identity without losing their outside perspective.

2. Participative observation with iterative interviewing, conducted jointly by an outsider who has a clinical perspective and key insiders. This method may be ideal in cases where the researcher has (i) plenty of time and (ii) has been asked by the firm to help. In my case, both the limited time span prohibited iterative interviewing and the researcher was not specifically asked to "help" the division decipher their organizational culture.

3. Participant observation with the identity of the observer revealed, using quasi-ethnographic research strategies. The ethnographic perspective of the observer gives priority to description, explanation has only secondary importance [Van Maanen, 1982, p. 16].

3.3 Summary

This chapter described two predominant views on the study of organizational culture; the logical-positivist quasi-experimental methods and the qualitative methods. It became apparent that both views had arguments for and against and that the situation should dictate the mode of study.

I used the method of triangulation in my study of the organizational culture at Polaroid' Chem Ops division since it appeared to be most suitable for my goals and circumstances. Elements from the various research methodologies described above, such as interviews, proximity, and archival research were all used in my description of the Chem Ops culture. The following chapter contains the results of the six month period of observations and study at Chem Ops.

Chapter 4: The Chem Ops Culture

Polaroid's Chem Ops division served as a sample in my investigation of organizational culture. My observations and findings here are two-fold, some relate to midsize organizations in general, and others appear specific to the Chem Ops division. In this chapter, I provide a description of the culture at the Chem Ops division. This partial ethnography forms a basis for identifying and addressing the factors that hinder or promote the effort to change and improve internal business processes and operations.

The factors that were identified seem common to other organizations as well. The major focus fell on accountability, communication and maintaining a systems perspective. These factors are important to midsize companies in transition from a small organic enterprise to a large institution with established formal governing policies and operating procedures.

4.1 Background

To discuss the culture at Polaroid, let me first define the scope of the organization. In this chapter, the culture of the white and blue collar workers of a Polaroid subdivision, the Chemical Operations Division, will be addressed.

Polaroid is made up of a number of different divisions and sub-divisions which are all individual microcosms and they all differ in their cultures.

4.1.1 Company Level: Polaroid Corporation

Polaroid is currently in a transition. The company has dominated the instant photographic market for decades. Polaroid considers itself to be a photographic imaging company. Lately, the company's traditional markets have been changing. Instant photography has alsways been a major cash generator, but sales growth in the US has recently slowed down (see Figure 4-2). Sales in emerging markets and developing countries like Russia, China and India are still expected to grow.

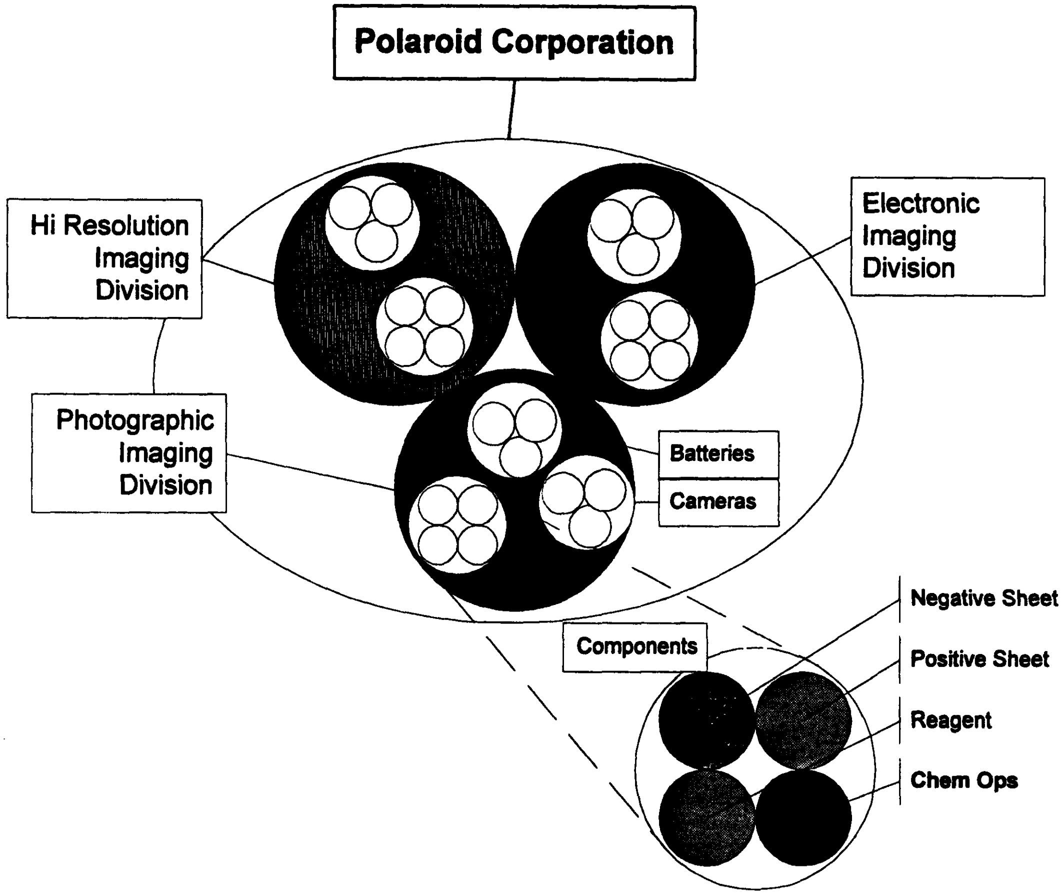


Figure 4-1: Microcosms of Culture at Polaroid

Polaroid's instant photography products have become standardized and undifferentiated. Recent product introductions are characterized as incremental product innovations. At the same time, improvement efforts were focused on reducing cost and improving manufacturing processes.

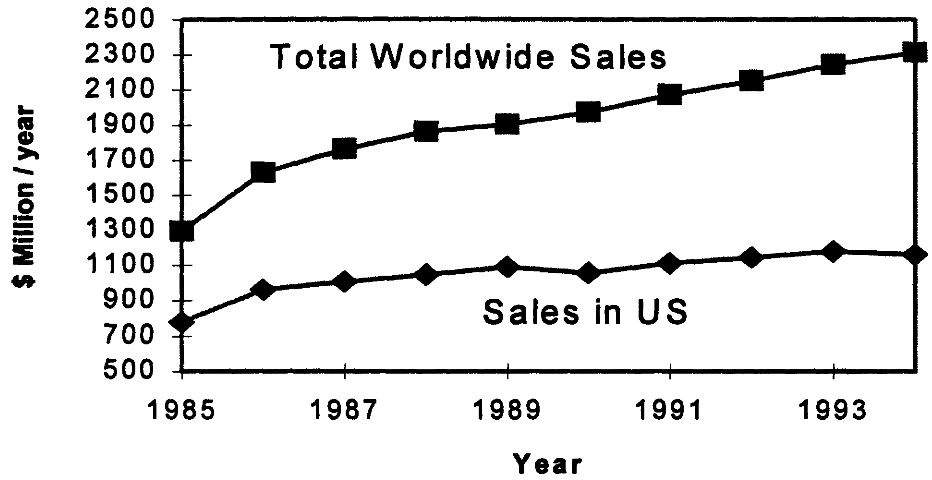


Figure 4-2: Polaroid's Net Revenue (1985-94)

Polaroid has entered the specific phase of industrial innovation as defined by Utterback [1994, p.95], who claims that there are three phases of innovation: the fluid phase, the transitional phase, and the specific phase. The specific phase of innovation is described in Table 4-1.

Instant photography is Polaroid's cash generator. To keep the product pipeline filled, Polaroid is attempting to grow predominantly in two new business areas; Digital (or Electronic) imaging and Graphics Imaging (high resolution printing). These new areas of business are expected to grow and become Polaroid's future sources of revenue as the instant photography market declines.

4.1.2 Divisional Level: Photographic Imaging

The Photographic Imaging Division is Polaroid's oldest and most mature business unit. This division manufactures cameras, batteries and film. The division consists of several plants and facilities. The plants are located in the US (Massachusetts) and abroad (Netherlands, Scotland and India).

Table 4-1: Specific Phase of Industrial Innovation

Innovation	Incremental
Products	Mostly undifferentiated, standard products
Production Processes	Efficient, capital intensive, rigid, cost of change high
R&D	Focus on incremental product and process technologies
Plant	Large-scale, highly specific to particular products
Cost of Process Change	High
Competitors	Few, classic oligopoly with stable market shares
Basis of competition	Price
Organizational control	Structure, rules and goals
Vulnerabilities of industry leaders	Technological innovations that present superior product substitutes

Source: Utterback, 1994, p. 95

Polaroid's business model is two-fold. In the consumer market, customers typically purchase Polaroid cameras serially, as features from new product introductions render older models obsolete. Film packs (containing the batteries) are sold repeatedly and provide a continuous stream of revenue and profit.

Chem Ops is part of the film assembly operations. The dyes and chemicals used in the film is manufactured by the Chem Ops division. The positive and negative sheet consists of paper coated with multiple layers of organic chemicals and dyes as illustrated in Figure 4-3.

4.1.3 Subdivisional Level: Chemical Operations

Chemical Operations (Chem Ops) was started in the early seventies to produce chemicals for instant photographic imaging. Until this point, Kodak had been a sole supplier for all of Polaroid's negative. Competitive pressures and monopoly supplier power forced Polaroid to set up their own negative producing facility in

New Bedford and Polaroid built the Waltham Chem Ops facility to meet the demands of the New Bedford plant.

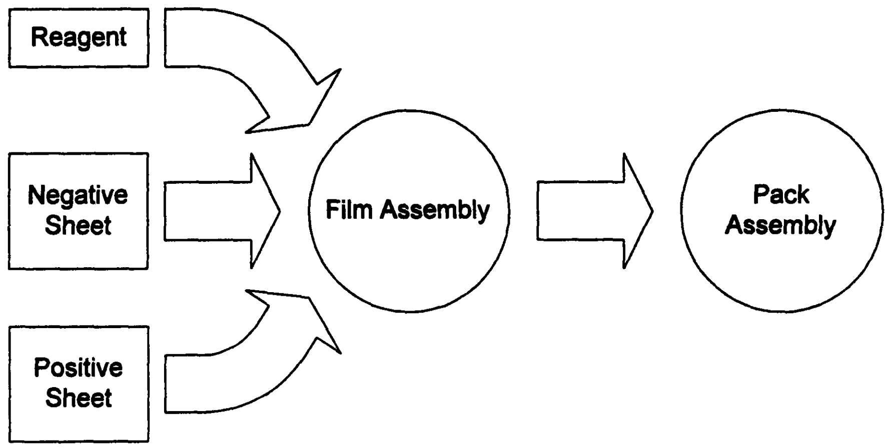


Figure 4-3: Film Assembly Process Flow

According to an employee who had been with Polaroid since Chem Ops was founded, the company was entering unexplored territories. Until then, Polaroid had never manufactured specialty and complex chemicals on a large scale.

> *"Chem Ops was on a mission to supply the new SX-70 project with chemicals, Chem Ops had something to prove and the air was charged! The people at Chem Ops were driven and enthusiastic."*

In those days, Chem Ops had the atmosphere of excitement and the can-do spirit prevailed for several reasons.

First, Chem Ops was central to the company's success. A seasoned operator claims that Chem Ops received much attention in the beginning. A manager explains that

> *"We had the support and resources to make things happen, no matter what it took."*

Secondly, Polaroid was operating in a different market and competitive environment. Another veteran comments:

> *"In those days Polaroid devoted its resources to making it work, no matter what"*

If the SX-70 product succeeded, Polaroid would succeed. If the product did not succeed, Polaroid's outlook would be bleak. A manager remembers:

> *"Things were different in those days, there was no pressure from the outside to focus on safety, environmental concerns or competition."*

Another manager believes that the external environment has played a huge role in the changes at Chem Ops:

> *"Rather than being reactive to the requirements of law enforcement agencies such as OSHA and the EPA, Chem Ops could afford to be proactive. This luxury allowed Chem Ops to run the business according to their own optimal rules, rather that those imposed by a regulating agency."*

And thirdly, personalities contributed to the general culture of the division in the beginning. One such person that shaped the culture in the division is Richard E. Brooks. In setting up of the facility and consequently in his role as plant manager, Brooks had a profound impact on the division's culture. According to a former Brooks subordinate:

> *"He expected hard work from all of his employees, he changed roles and responsibilities by, for example, insisting that chemical engineers become supervisors rather than operators (traditionally engineers did not take operating roles in the plant, they were more hands off and technically focused."*

Brooks also led by example and challenged the status quo, he changed the nature of the business by leading the division into an unusual venture.

In response to corporate management's demands to lay off numerous production workers, Brooks instead chose to find work for the excess production capabilities in custom chemical manufacturing. He was able to locate a client for the production of pharmaceutical chemicals and consequently enabled the division to operate at full capacity without the expected layoffs, and finding in it the most profitable product of that year (Brooks left Polaroid to successfully start and operate his own firm that produced custom chemicals and intermediates, until today a lucrative business [Chemical Week, 1986]).

Most of the Chem Ops employees who have been around since the division was founded like to claim that

> *"the people were willing to do whatever it took to get the job done and to be successful."*

In talking to the veterans, it is not uncommon to hear of a junior level engineer or an operator that spent three nights in his office to complete his project before going home. The culture described by the Chem Ops veterans has changed considerably in their opinion. In the following section, I describe the current Chem Ops culture.

4.2 The Chem Ops Culture

I follow Ed Schein's conceptual framework and describe the culture at Polaroid using three levels of analysis.

The first level concerns artifacts. Artifacts describe the material and non-material elements that can be observed in the organization. Artifacts include documents, the physical layout of buildings, dress codes, language, "war stories", organizational charts, performance measures, and so forth.

The second level of analysis concerns espoused values. These are the reported beliefs and values people in the company say they follow.

The third level of analysis attempt to describe the basic underlying assumptions held by most if not all the members of the organization. This level describes the taken-for-granted beliefs which people operate under, beliefs that have moved from the conscious to the unconscious. Underlying assumptions guide the behavior of the members in the organization.

4.2.1 Artifacts

Chem Ops is described by some as "a fun place to be", a place where people seem happy and proud. A big blue banner at the entrance proudly displays the Chem Ops motto:

"It all starts here"

This reminds visitors that the fine organic chemicals that are synthesized here are unique to Polaroid and are the building blocks for a vast array of Polaroid products.

Across from the blue banner, stands the division's unofficial mascot, a bright pink (plastic) flamingo. The flamingo is perched on a patch of neatly trimmed dark green grass. Some fish swim back and forth in a small pond formed by a gully in the stretch of grass between the offices and the warehouse. An avid angler working in the plant keeps the pond stocked with fish. The fish disappear along with the water in the pond during dry seasons.

<u>Location</u>

Polaroid's corporate headquarters are located in Technology Square on Main Street in Cambridge, Massachusetts. The administration and other staff functions are housed in a cluster of four high-rise buildings. Some of the original Polaroid buildings are located diagonally across Main street from Tech Square. These buildings house the R&D functions and a pilot chemical manufacturing facility. The Polaroid library and Land Art Gallery are also located in these buildings.

The major US manufacturing facilities are located at several sites within an hour's drive from Cambridge. Most of the film manufacturing and assembly occurs at the Waltham facility. Camera assembly is located at a separate facility. Chem Ops is located on the top of the hill at the furthest end in the rear of the Waltham facility.

Sounds

A predominant artifact at Chem Ops is not sight, but sound. "Easy listening" radio is played over the intercom network all day long. Nobody really knows who decides which station is played, *"it has always been like this"* (thank goodness we're not in Texas, it could have been country music). Everywhere one goes in the offices, the plant, inside, outside, even the bathrooms, the sounds of Elton John or Whitney Houston are heard -- "And I will always love you". The music permeates the entire facility, from the moment one arrives until the time one leaves. Fortunately, volume controls are provided in the offices to adjust the volume of the music, although it is never entirely absent.

On weekends, when the plant operators are the only employees at work, the radio station mysteriously changes from soft rock to hard rock. Everyone in the plant jams all weekend long. When the cat is away the mice will play.

Office layout

Chem Ops' office layout is described as "a maze". As a result of several unanticipated demands for space, the offices evolved into an intricate mesh of hallways and corners. Three main hallways run parallel to each other connected by several alleys that reach under and over obstacles such as offices and emergency power generators. There is no apparent order to the way buildings are numbered at Polaroid. Buildings seemingly grew out of nowhere and were apparently numbered on a first come first serve basis.

Use of Space

Most departments are clustered in groups. There are typically between five and twelve employees in a department, yet departments are divided into the various plants, resulting in a matrix organization. The offices have mostly single occupants, except for the offices of interns and a few of the "young ones" (those with less than 10 years of seniority). Many of the department heads have offices in a common hallway on the second floor, away from their subordinates. The "management hallway" also houses the plant manager's office. A large group picture of the department heads and a former manager decorates this hallway. everyone in the poster is smiling and the poster is autographed by all the people appearing in the picture.

A Mac or a PC can be found in almost every office. The offices vary in decoration and neatness. There is no dominant model or theme other than the fact that they are Spartan. The plant manager boasts the most hideous furniture in the division, lime green couches and other fixtures last seen in the mid 1950's. Valuable pieces of original art, prints and photographs are scattered randomly throughout the buildings at Polaroid. These serve as visual reminders of the Polaroid products: high quality photographs that capture beautiful moments.

Some offices are locked at night, but for the most part, one can easily navigate through buildings and offices when no one is around.

Recycling

Many things are recycled at Polaroid's Chem Ops division. In the offices for example, bins are placed next to the copiers and printers for misprints and waste paper. Much of the division's paper is recycled. In the cafeterias, aluminum cans and glass bottles are collected in a large wooden box. The income from the cans is donated to charities. Some hazardous and toxic materials are collected and sent to a recycler, others are recycled and reused on site. A large part of the Chem Ops operational expenses are the solvents used in the reactions and product purification. For economical as well as environmental reasons, the solvents are recovered and separated in a set of distillation columns in the plant. A mixture of several solvents enter the stills and based on the boiling point properties of the components, the solvents are separated, stored and reused.

Parking

The parking lot encourages early arrival since it operates on a "first come, less walk" principle. It is located two hundred of yards away from the plant at the bottom of a hill. Management is not given reserved parking. A special parking lot is provided for those with medical concerns and disabilities. Motorcyclists have the privilege parking next to the office. The few cycling commuters lock their bikes to the perimeter fence.

Documents

Polaroid publishes several weekly and monthly news letters. Two publications are widely distributed at Chem Ops, *Polaroid Update* and *Polaroid Resource*.

Polaroid Update is a bi-weekly news letter that announces news from all the divisions, "published for the employee-owners and other members of the Polaroid community." *Polaroid Resource* is a bi-annual news letter with information on environmental issues and programs affecting Polaroid and its neighbors in the Waltham area.

Demographics

In 1995, Polaroid employed 12,104 employees worldwide. 7,224 employees are located in the US. Of the 7,224 US employees, 72 % are male and 81 % are Caucasian. The Chem Ops Division employs 283 people of whom 86 % are male and 92 % are Caucasian. As a reference, the 1990 US census data indicate that the national population breakdown is 48 % male and 80 % Caucasian.

Polaroid Corporate Demographics, 1995
(Total Number of Employees: 7224)

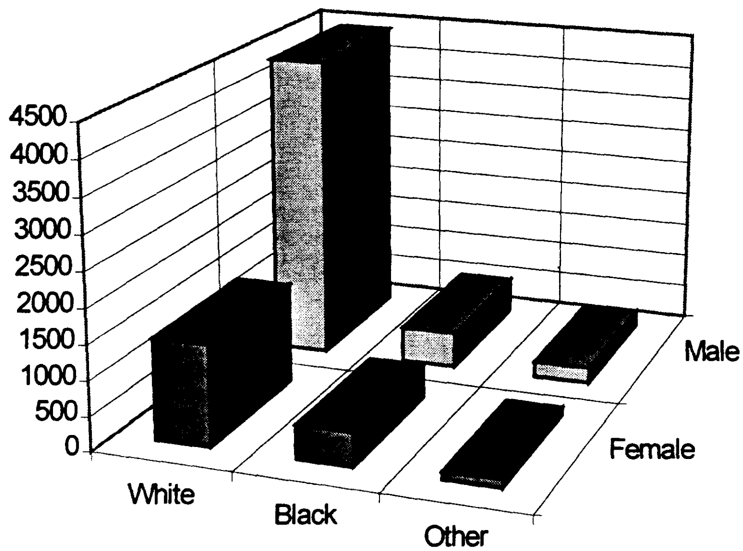


Figure 4-4: Corporate Demographics

Chem Ops Population by Race, 1995
(Total of 283 Employees)

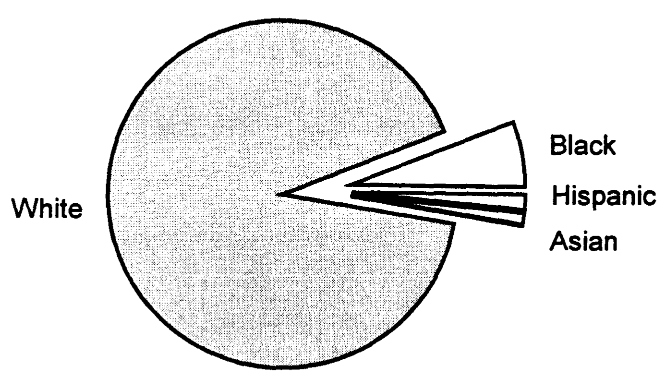


Figure 4-5: Chem Ops Population Racial Make-up

Education

Polaroid manufactures technically and chemically complex products and the company's success depends to a large extent on the quality of its technology. As a result, the company employs many chemists and engineers from elite universities. In the Chem Ops division, 53 % of the 283 employees have post high school educational experience.

Chem Ops Population by Education Level, 1995
(Total of 283 Employees)

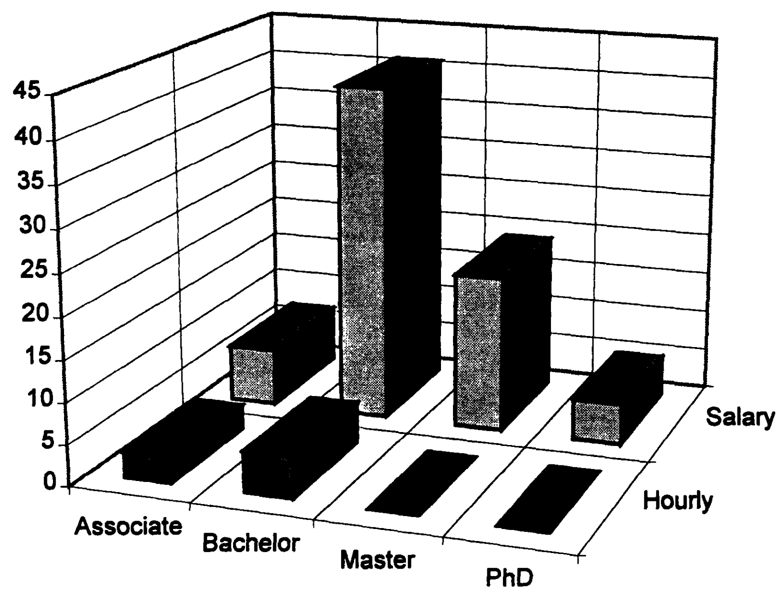


Figure 4-6: Education at Chem Ops

Tenure

As can be seen in Figure 4-7, the average age is around 46 years and the average tenure with Polaroid is 17 to 18 years. The average age of the Polaroid workforce has increased steadily over the years, as indicated below.

Year	Average Age	Average Seniority
1985	42.13	13.05
1986	44.06	15.67
1987	45.98	17.59

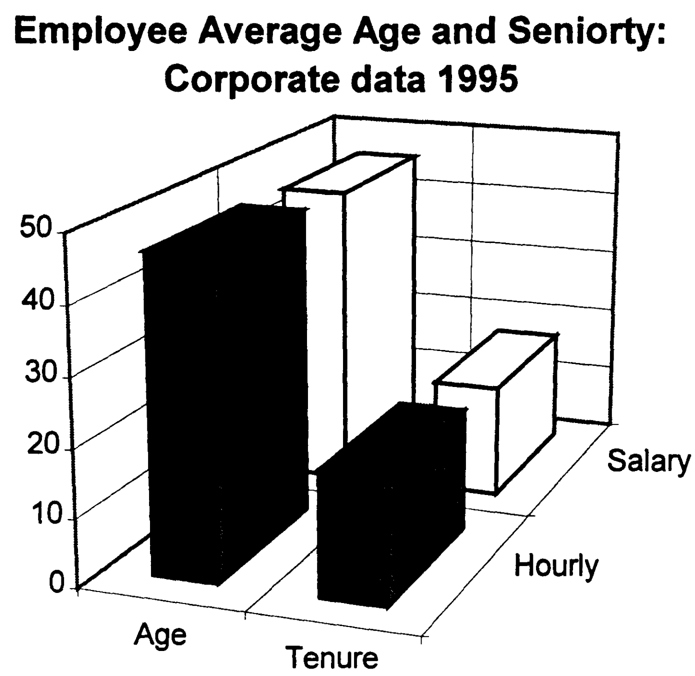


Figure 4-7: Age and Tenure, Corporate Data

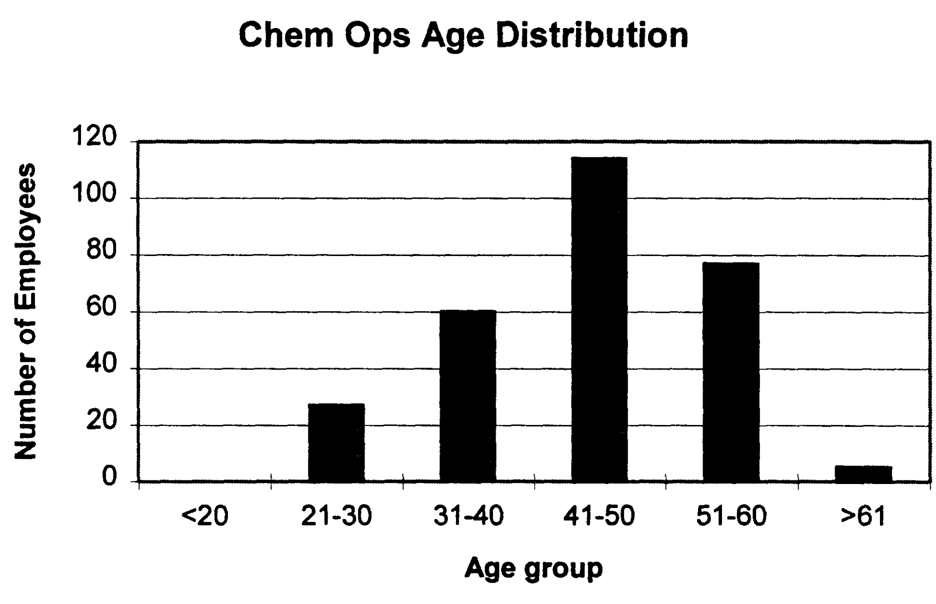


Figure 4-8: Age Distribution, Chem Ops

Dress

Employee dress codes at Polaroid vary depending on the employee's rank and function. Managers and administrative personnel dress more formally than the engineers and chemists. Operators wear overalls and other protective clothing in the plant. The operators' first names are printed on their shirt pockets.

Facilities

Chem Ops operates on an around-the-clock three shift schedule. All plant operators have lockers located in the change room. Since many of the dyes leave permanent stains on clothing and car seats, the plant operators typically shower after their shifts before leaving for their homes. Employees are also free to use the workout and game room. A set of weights, a stationary bike, and a stairmaster are provided for those who wish to exercise. Many operators play in table tennis matches on their breaks.

4.2.2 Espoused Values

Espoused Values: Corporate Management

During recent years, Polaroid's former chief executive officer, Mac Booth, initiated an "Internal Visioning process:"

> *"transform the way we work to ensure Polaroid's success as a global competitive company".*

The CEO intended to balance the vision of Polaroid in the external world with the vision of Polaroid's internal environment.

As part of the visioning process, the upper management described the Polaroid culture that is necessary for success. The culture as described by the managers represents, in my view, the company's *"Espoused Values"*, values that the managers believe are and should be held by Polaroid employees. The descriptions of Polaroid's culture and people according to corporate management are listed in Table 4-2 and Table 4-3.

Table 4-2: The Polaroid Culture as Described by Management

Values	Attitudes
Respect and dignity of the individual	Sense of responsibility
Integrity, truth, honesty	Orientation to action
Ownership	"Can do" attitude
Excellence, high standards	Job security vs. employment security
Innovation, creativity, change	Merit vs. entitlement
	Leadership, participation and followership
Beliefs and Assumptions	**Behaviors**
Learning as an organization	Balanced focus (Long vs. short term)
Broad business acumen	US/International focus vs. Cambridge
Commitment to customer, understanding their needs	Functional focus vs. view/cross functional focus
Clarity of purpose	Competitive focus
Sense of urgency	Alignment around decisions
Openness to change	Clarity of roles and responsibilities
Employees flexibility	Standard ways of doing things
Direct, honest communication	Information availability
Being accountable	Balanced internal communication
Balance of self & organization's interest	Single solution advocates vs. alternative analysis
Teamwork and partnership	
Empowerment vs. control	
Value of diverse workforce	
Reward and recognize performance	

Table 4-3: The Ideal Polaroid Employee as Described by Management

Personal Characteristics	Human Systems
Self Awareness	Acquisition, attrition
Flexible	Career Planning
Achievement oriented	Training and Development
Influential	Rewards and Recognition
	Succession Planning
Leadership Skills	**Core Competencies**
Technical	Who has them?
Managerial	How are they developed, acquired and retained?
Business Acumen	
Visionary Leadership	

There seem to be as many Polaroid values as there are employees. Their descriptions differ depending on whether one asks a manager or a person working in the plant on the floor. Most managers claim that Polaroid is *"all about people."* The corporation is said to value people and their contributions. Some say that Edwin Land was ahead of his contemporaries when he formulated a personnel policy that aimed at not only making a profit, but also enhancing the skills and interests of the employees.

An excerpt of Polaroid's personnel policies [PP-101] states:

> *"We have two basic aims here at Polaroid*
>
> *One is to make products which are genuinely new and useful to the public - products of the highest quality at reasonable cost. In this way we assure the financial success of the Company, and each of us has the satisfaction of helping to make a creative contribution to society.*
>
> *The other is to give everyone working for Polaroid personal opportunity within the Company for the full exercise of his talents; to express his opinions, to share in the progress of the Company as far as his capacities permit, to earn enough money so that the need for earning more will not always be the first thing on his mind - opportunity, in short, to make his work here a fully rewarding, important part of his life. These goals can make Polaroid a great Company - great not merely in size, but great in the esteem of the people for whom it makes new, good things, and great in its fulfillment of the individual ideals of its employees."*

Edwin H. Land
Founder, Polaroid Corporation

Espoused Values: Chem Ops Managers

When asking employees about the Polaroid culture, one does not hear the same answer from any two people. The employees' views about company's culture vary from person to person, depending on their backgrounds and positions in the organization. One also finds that the culture differs depending on the time period being discussed. A manager claims:

> *"Chem Ops has changed in the same way as the world has changed: we have moved away from managing technical expertise to a role of leadership."*

Whereas some managers believe that the division is doing the right things to stay in business, others do not agree. One manager who has spent over 20 years with the company says:

> *"The ratio of politics to substance is much higher than other companies I had been with."*

The feeling among managers is that the Chem Ops division may not be doing as well as it had in the past, but that the division will still be around for quite a while. Lately, division managers talk about feeling pressure from the corporate purchasing department. One corporate executive believes that the chemicals produced by Chem Ops can be produced for much lower cost if they were outsourced to a lower factor cost country like India. The managers at Chem Ops believe that Chem Ops should be evaluated by factors other than the price of chemicals. Chem Ops management argues that they provide valuable services to the rest of the company, such as the ability to rapidly scale-up complex organic chemistry.

> *"As a result of the increased pressure from corporate management, the employees in the division regard themselves as isolated from the rest of the company."*

One of the managers believes:

> *" Chem Ops people are loyal to the division, we have a sense of pride, and we are not well understood by the people outside the division."*

When talking about their division, Chem Ops people love to say:

> *"We are like one big family."*

Chem Ops employees regard themselves as separated from the rest of the company, not necessarily by choice. Physically, Chem Ops is in fact isolated. The buildings are perched on the top of the hill at the furthest end in the rear of the Waltham facility. Some Chem Ops managers believe that the division is a neglected part of the company;

> *"People outside the division do not want to know anything of Chem Ops, all they want to know is that the product is made right and that it is made on time, that is all they want to know". The belief that Chem Ops is not well understood and valued by the corporation is confirmed by the apparent absence of Chem Ops alumni in the ranks of corporate executives."*

Chem Ops employees believe that they perform a very important function in the operations of Polaroid, even though the people on the outside may not fully appreciate their contribution. They believe that their role should not be taken for granted, since the business of fine and complex organic synthesis is not one that is easily acquired. One manager describes the complexity of their operations as:

> *"Chem Ops is like flying a 747 only a few yards above ground. It is possible, but mistakes are very costly."*

Espoused Values: Chem Ops Employees

Like any other place of employment, the members of Polaroid's Chem Ops division are made up of a diverse range of people. Yet people tend to believe that certain characteristics describe most of the employees.

Whereas the view of the managers and salaried employees are generally positive, there is an obvious separation between the salaried and hourly employees. White collar workers refer to themselves as "we" and to the blue collar workers as "they" and vice-versa. An example of the separation is a middle manager that would say:

> *"They [the blue collar workers] don't listen."*

The degree of animosity and distrust between the blue collar workers and management is relatively mild. However, the blue collar workers are more willing to express their dissatisfaction with the status quo in private. Blue collar workers appear to be distrustful of management's motives. In private, they accuse managers of being *"out of touch"* and *"making decisions in a vacuum."*

Management diplomatically acknowledges a problem and is quick to provide explanations or propose solutions. Blue collar workers in contrast assign blame to management and feel that the situation is out of their control. One manager claims:

> *"We have reduced middle-management and empowered our workers, we stress educational training".*

When the workers were asked about this statement, they responded that the incentive systems is *"unfair"* and the training is a way for management to get them to do *"more work for the same pay."*

When asked to describe the Chem Ops type of person, the managers will say:

> *"Our people are caring and they have respect for each other."*

A higher level manager claim that most Chem Ops people are *"hard working and bright."* Yet the people closer to the daily operations of the plant feel that

> *"People are good [at their jobs], but not creative."*

Another manager says:

> *"I have seen the culture of hard work here at Polaroid, but not the one of no waste."*

<u>Espoused Values: Outside Divisions</u>

Many Chem Ops employees believe that the other Polaroid divisions do not appreciate their contribution and that the corporate management *is "out of touch with reality."* Similarly, they also have opinions about the other divisions. Marketing seems to get most of the blame for the corporation's past failures. Polaroid experienced a failure in the introduction of the Polavision "movie" camera in the mid-1970's. After performing extensive marketing studies, the camera was introduced around the same time that magnetic tape video players (Beta and VHS format) were gaining popularity. Since Polavision did not have sound, the market did not respond favorably the Polaroid product. The manufacturing side of the house still believes:

> *"Polavision was technically a success but the product was poorly marketed."*

Another example, the Captiva camera, was designed to use a smaller format film.

> *"Nobody is interested in buying a camera that takes such small pictures, who would want pictures that small?"*

The camera did not do well in the market and many Chem Ops employees believed that marketing was responsible.

4.2.3 Basic Underlying Assumptions

The Evolution of Culture

The Chem Ops employees have sensed a change in the culture over the years. Many of the employees have been with the company for 30 years or more, and they often compare the past to the future. The culture of the past is characterized by:

> *"a bunch of wild and gung-ho men who did anything and everything to make complex organic chemicals on time and on spec."*

Some say that it was not unusual for an engineer to spend days and nights on end at the plant to monitor a chemical process. In the beginning, the focus was less on price and efficiency than on successfully synthesizing chemicals. Chem Ops was on a mission to prove to the rest of the corporation that they were able to produce the goods.

That was then. Today it is said that the company must respond to pressures from three external forces: (i) safety standards and liabilities, (ii) environmental regulations (iii) competition.

The increased pressure has contributed to the different culture we see today. The tone today is characterized by many of the hourly workers as:

> *"I am just putting in my time so that I can get paid and go enjoy my real life, the one away from work. Not that I don't do an excellent job, I do my job very well and deserve my pay, just don't ask me to do anything extra unless there is some OT [overtime pay] in it for me."*

Confrontation

A manager summarizes the problems at Chem Ops as:

> *"People here don't resolve issues, problems are accommodated and enabled".*

An example of this phenomenon is the layoff procedure that Polaroid used in previous rounds of "belt-tightening". Like other companies, Polaroid realized they had to cut cost by reducing weekly hours, rotating employees to perform various tasks rather than hiring additional help and reducing overhead expenses. In some cases, cost cutting also implies a reduction of the workforce and a round of layoffs occurs.

During a layoff, it makes sense to eliminate non-essential jobs and try to retain the more competent and talented employees.

Before changing their policies, Polaroid had a unique approach to layoffs. Because of the high regard for people and their personal well-being, Polaroid designed the layoff policies to accommodate the more senior employees. One of the plant operators explained the situation:

> *"During the early eighties, layoffs were imminent at Polaroid. The 'non-essential' jobs were identified. If the job happened to be held by an employee with 30 years of tenure (or seniority), then the employee had the right to go elsewhere in the corporation, find a job that matches his/her skills, and 'bump' the person holding that particular job at the time. Theoretically, any employee could bump any other employee providing his/her skills match the job, as long as the one doing the bumping has more tenure. Laying off one person could therefore affect several other employees."*

The impact of this policy is quite visible. During this period, the safety records for Chem Ops were the worst they had ever been. As can be seen in Figure 4-9, the total number of accidents increased significantly during 1984. It so happens that Polaroid experienced a layoff during 1984.

Managers and hourly employees alike believe that the high number of accidents was a result of people moving into new positions. Low worker moral characterized those periods and probably also had an indirect impact on the high accident rate. Workers were constantly looking over their shoulders in anticipation of being "bumped". Many employees were constantly worrying whether they had enough tenure to outlast the bumping process. Whereas some pressure may motivate employees, too much pressure provokes anxiety and lead to dysfunctional organizational behavior.

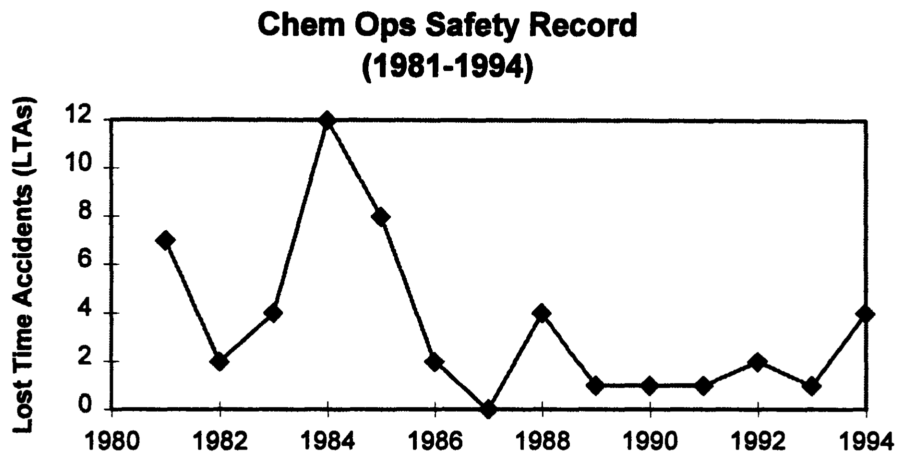


Figure 4-9: Chem Ops Safety Record (1981-1994)

The layoff policies have since been revised. If a job is eliminated now, affected employees are placed in a labor pool for a few months, during which they are paid a portion of their normal salaries. Before any recruitment from the outside can be made, the labor pool has to be considered.

Functional Silos

On the surface there is little difference between management and the hourly workers. Both enjoy a decent salary to afford cruises, a house and a cabin in New Hampshire, education for their children, etc.. Many of the operators are savvy business owners, evidenced by the successful businesses that they operate on their own time, such as a retail store in Harvard square, an antique dealer, and a home builder/contractor.

Beneath the surface however, a division between management and hourly workers is apparent. Consider the language of both groups. The *"they"* syndrome prevails and each group sees the other as *"overhead"*, *"lazy"*, *"incompetent"*, and even *"devious"*. Whereas this separation may not be as prevalent or dysfunctional as in other organizations, it does characterize the Chem Ops culture.

Hints of the underlying separation between management and hourly workers become apparent from the office layout. The department managers' offices are located on a common hallway on the second floor. The hourly plant workers occupy a room within the plant, and the shift supervisors' offices are located in the office building adjacent to the plant. Keeping the plant workers close to the plant makes practical sense, but it also marks the beginning of a barrier that separates the blue collar workers from the white collar workers and the managers. The physical barriers are symptoms of the non-visible barriers which inhibit communication and cooperation between various functions. These barriers lead to the formation of "functional silos," which will remain as long as offices are separated between functions, management and plant personnel.

Insofar as mistrust between management and hourly workers do exist, the hourly workers have the freedom and encouragement to speak out about things of which they do not approve. At each of the Quarterly Business Meetings (QBM) the challengers or *"ballbreakers"* emerge. They are the ones that are rude and loud at the QBMs or other divisional meetings. There is a sense of pride among operators associated with being labeled a ballbreaker. Most hourly workers are polite, yet very straight forward and forthright when it comes to discussing events or policies that may (however remotely) affect their pay, overtime hours or job descriptions.

The QBMs are intended to serve as a vehicle for communication between the plant workers and the corporation's activities, i.e. management. Management has a chance to tell the employees if goals had been met or not, what the forecasts look like, and what else is going on in and outside the division. The hourly workers have a chance to vent their frustrations and frustrate management. This forum may or may not be the ideal way of discussing concerns. This channel of communication opens four times per year.

4.3 Summary

As illustrated above, Chem Ops is a complex organization with an intricate organizational culture. During a six month internship, one can expect to only scratch the surface of a culture based on a long history of events. Given the complexity and dynamics of organizational culture, the observations of an outsider during the same or a different time might lead to different conclusions. The views of the various subcultures are entrenched and seen as almost structural in nature.

I found the Chem Ops culture is indeed one that values the contributions of individuals and fosters a familial environment. This fact, combined with the fact that the division is old enough to have an established culture, yet young enough that many of the founding employees are still around to recall the past, made Chem Ops an ideal place to study organizational culture.

In this chapter I focused on the problems that Chem Ops and Polaroid in general are facing to continue its successful history. This chapter may therefore seem to dwell on negative elements of the Chem Ops culture. Indeed, there are many other positive elements of the Chem Ops culture that were not discussed here primarily because they do not relate directly to the issues that I have chosen to address.

Chapter 5: Continuous Improvement

Continuous improvement served as a vehicle to study the organizational culture as well as the company's behavioral response to the process of change. Instead of using the existing business process for continuous improvement, an alternative process was designed and used. The new process embodied a number of different approaches to continuous improvement and I found it to be more suitable for the purposes of cycle time reduction.

The new approach is presented below, and the outcome of the team effort is described. The advantages and disadvantages of the approach are also discussed.

5.1 Cycle Time Reduction Team

As part of the continuous improvement programs at Chem Ops, I formed a team to reduce the cycle time of a chemical process. At the beginning of the meeting, a team charter was defined and accepted by the team:

> *The purpose of this process review is to reduce the manufacturing cycle time of [Chemical A]. We aim to reduce the time spent on non-value added process steps, while remaining safe, quality oriented and environmentally responsible.*

As the team leader/facilitator, I performed many of the preparatory tasks. The team comprised eight employees who were selected from the Chem Ops Division as described below. The team met for two four hour sessions plus a follow up meeting lasting an hour. Several changes were implemented as a result of proposals from the meetings and a cycle time reduction of 30 % was achieved.

Since much of the time in the manufacturing of a chemical is dictated by laws of thermodynamics, mass and heat transfer, the team did not expect much improvement in the chemical synthesis cycle time. The value of the team's efforts becomes more apparent when an efficient process for continuous improvement is applied to the other chemical and business processes.

If the format of the team's cycle time reduction approach was found to be successful, management had the option to repeat this process for some of the other "major" chemicals and business processes. Specific attention was paid to the process of the continuous improvement effort. The details of the meeting and its format are discussed in detail below, since it varied significantly from the conventional Business Improvement Team format. The learnings from the effort are presented and discussed, and some suggestions for future teams are offered.

5.2 Elements of the Meeting Format

5.2.1 Attendees

To study the manufacturing process of Chemical A, I assembled a multi-functional team. I asked each of the department managers which employee in that department would be most knowledgeable about the production of the specific chemical we would be investigating. The department managers ultimately appointed the employees whom they saw fit, given the demand on employees' time as well as their specific knowledge of Chemical A.

The team was composed of members from various departments or functions that encounter the manufacturing process. The team consisted of the following members:

- Process Engineer
- Chemist
- Operator
- Supervisor
- Analytical Lab Supervisor
- Instrumentation
- Distillation technical specialist.

Additionally, a Human Resources department team member who was trained in facilitating meetings helped to kick the meeting off and I acted as team leader/facilitator. As an intern, my role was one of a process consultant [Schein, 1987], although I was able to contribute to (or at least understand) the technical discussions.

5.2.2 Timing and Agenda

The team met for two sessions. Each session lasted four hours. There was one follow-up meeting of one hour, for a total of 9 hours. As can be seen from Figure 5-1, the first hour of Session I was spent on getting started, and the remainder of the meeting was spent on the analysis of the manufacturing process. One of the participants was designated as the timekeeper and it was his job to keep track of the time spent on analysis and breaks. The meeting was divided into 45 to 60 minute sessions with intermittent 5 to 15 minute breaks. The pauses occurred at natural breaks in the flow of the process analysis and/or when I felt the team was losing focus or gridlocked in disagreements.

5.2.3 Preparation

Before the team was assembled and the meetings commenced, I spent some time becoming familiar with Chemical A's manufacturing process. To learn about the process, I worked with the operators in the plant for a few weeks. Working with them accomplished two goals:

- To become familiar with the terminology and equipment that are involved in the manufacturing process
- To get an idea of the time involved to perform certain tasks.

I then created a cross functional map of the chemical manufacturing process that would eventually be used during team meetings.

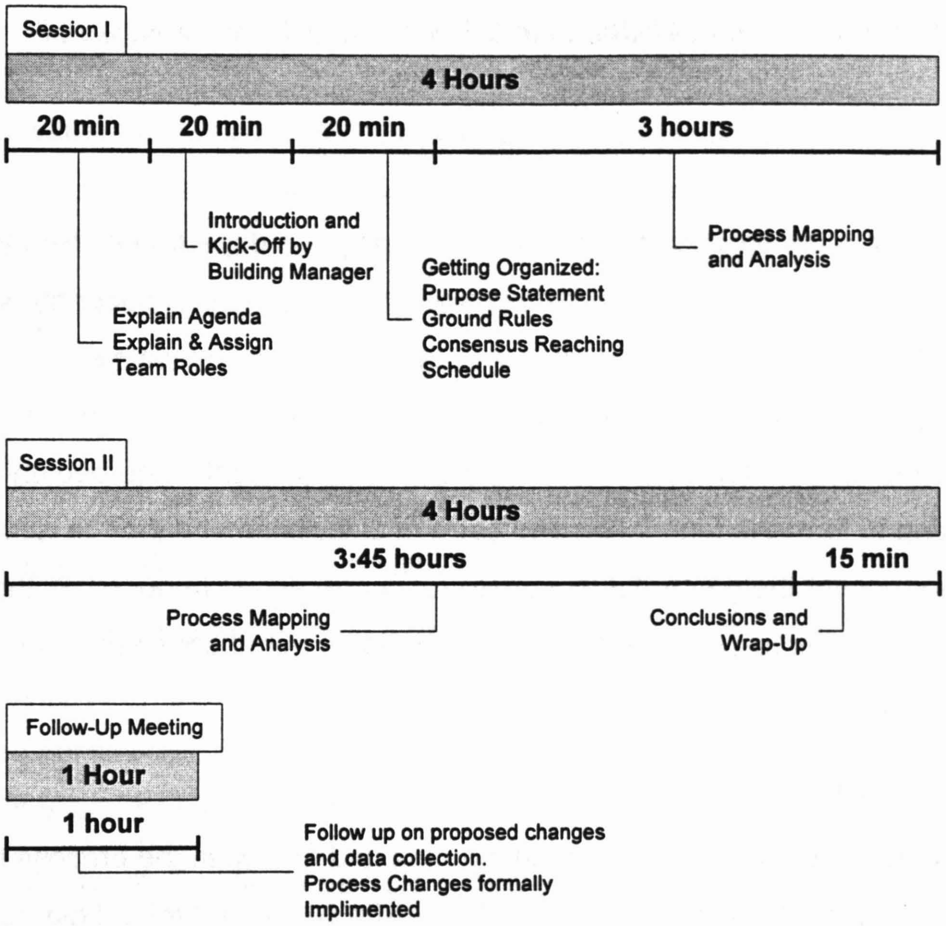


Figure 5-1: Agenda and Time Allocation in CTR Meetings

In a facilitation role, I was responsible for arrangements such as refreshments, scheduling the meetings, and reserving a conference room.

5.2.4 Introduction

Several management gurus claim that change has to come from the top. In *Reengineering the Corporation* [Champy and Hammer, 1993, p.102], the authors emphasize the importance of management's commitment to a project for motivation of the team members. With this in mind, the Building Manager was invited to say a few words to put the cycle time reduction effort in perspective. During a motivating introduction the manager cited some examples of previous successes accomplished by other teams, helping to establish a sense of purpose.

5.2.5 Facilitation

The facilitator as an employee in the Human Resources department. She first laid out some ground rules and to help create an atmosphere of cooperation, mutual respect and focus. Other roles included helping to dissipate any potential problems, such as conflict between team members, and ensuring that everyone had the chance to participate. It was important to be present in the beginning of the meeting to form the foundation and basis of discussion and then to remain present to monitor the general atmosphere for cooperation. In our case, the meetings appeared to be under control and the team members seemed to work together well.

5.2.6 Team Leader

My role as team leader was to lead the meeting and to help in the process of investigation and discovery. In a sense, I played a consultant role. I did not have the expertise or ability to solve the problem single-handedly. The answers to reducing cycle time reside with the team assembled in the room. It was my job to draw these answers out into the open where they could be discussed further, analyzed and implemented if necessary. Schein [1987] states that a process consultant should focus on exploration, inquiry and diagnosis as a tactic of intervention. This means that a team leader should make as few assumptions as possible about what the problems and solutions might be. The tactical goal is to get information without behaving like an expert and to get the team to think the matter through for themselves. Questions were asked to encourage the team to diagnose the process thoroughly, such as:

> *"Can you describe what is going on?"*
>
> *"How do you see the problem?"*

"Is there anything that can be done to avoid this problem in the future?"

Schein warns the consultant not to make action interventions until he feels that the team is ready to think about alternatives. In the intervention, the consultant begins to share his own perceptions of what may be going on but any suggestions should be proposed in terms of multiple possibilities. Questions are asked to introduce the team leader's perception, while being careful to do this only once the team is ready to consider and accept alternatives. Examples are:

"This may be a silly question, but can this or that be done?"

"Is it possible to do this or that?"

The initial role of the facilitator is exploratory and diagnostic. When the team is ready to consider other options, the role shifts to action alternatives. Managers who are familiar with the problem will typically have strong ideas about what the problem is and how to solve it.

Ideally, the facilitator should be from a different group or division, someone who has the ability to grasp the technical concepts. This person should not be involved with the day to day operations surrounding the problem and should have few or no preconceived notions about the possible problems or solutions.

5.2.7 Participation

The majority of the "air time" went to those who were most familiar with the technical detail of the manufacturing process. The process engineer and the shift supervisor were most intimate with the manufacturing process for this chemical. The team members were all from different departments within Chem Ops, rank and title in the organization did not appear to be a factor in the level of participation. The chemist and the lab supervisor contributed frequently to the discussion and together the team came up with several ideas for potential gains in cycle time.

Some of the team members, however, could have participated more but did not. These team members were either not as familiar with the process or simply chose not to say anything. The team leader and facilitator had to pause frequently to solicit the input from less active team members

5.2.8 Note taking

Volunteers were recruited to keep notes as the meeting proceeded. It was more efficient to distribute roles to those who were not expected to be central to the discussions. In our case, the lab supervisor and the distillation expert bothwere appointed to take notes. In their notes, the particular step of the process was noted, the comment or question, and the person assigned to follow up on the item was noted. By delegating the note taking task, I was relieved from the burden and could focus on moving the discussions forward.

5.2.9 Format

Before the meeting, the cycle time data for the previous 15 batches of Chemical A was collected and plotted to get an idea of the variability of the cycle time. Initially, we intended to use this data during the meeting to discuss the reasons for long delays and ways to eliminate their "root causes." However, once the meeting was underway, it became apparent that the data from past history would not be very useful in the cycle time reduction because:

- There was not time to pause at every step to consider or discuss the reasons for delays;
- The team members were not equipped to discuss batch histories since they did not have first hand knowledge of events that tool place years ago;
- I played the role of process consultant and as the team leader, I should not have predisposed assumptions regarding the nature and solutions to the problem. It was up to the team to understand and solve the problem.

At the outset of the meetings I emphasized that "we are looking forward, not backward." This cliché seemed to help to keep the focus on the process as opposed to assigning blame to departments and people.

We found that removing history from the meeting may have helped team members cooperate with each other.

5.2.10 Snacks

Cold soda and cookies were arranged for the meetings. This may seem like a trivial point, but it was important to make the meeting as attractive as possible to the attendees and four hours is a long time to sit through anything. Some of the attendees went out of their way to help improve the process. Since it was not part of a regular routine (this was the first team assembled from the plant to tackle cycle time of a manufacturing process), the snacks went a long way as a symbol of thanks and appreciation for their efforts.

5.2.11 Cross-functional Mapping

The process description for the manufacturing of Chemical A includes hundreds of actions and tasks as described in the procedures. Since the process is long and complex, a tool was needed to avoid confusion during the discussion of the process. We used a cross-functional map to illustrate the process and guide the discussion during the meetings. A cross-functional map looks similar to Gantt charts used for scheduling activities. The horizontal side of the matrix indicates a progression in time. The vertical side is divided into different functions or elements of the process. The matrix is then used to illustrate the flow of work and interaction of one function with another.

5.2.12 Implimentation Meeting

An implementation meeting was scheduled for three weeks after the last cycle time reduction team meeting. The purpose of the implementation meeting was to finalize the changes that were to be made to the manufacturing process of Chemical A. During the cycle time reduction sessions, several suggestions were made to change the process, but in many cases, the team did not have the information or data to decide if the decisions should be implemented. In these cases, action items and questions were assigned to one or two of the team members for the window of time after the cycle time sessions but before the implementation meeting. The team agreed that three weeks would be enough time to develop the information needed to make decisions.

5.3 Outcome and Results

5.3.1 General Issues

As a result of the two four hour sessions, a list of 45 questions was generated. Each question was assigned to one of the team members for further investigation who reported their findings to the group at the implementation meeting.

Some of the questions raised included:

- Can the acetone recovery be performed in a different vessel than the one used presently? If so, the cleaning and rinsing step can be eliminated.
- What is the crystallization temperature of the final chemical intermediate? Will a faster cooling profile (changing the programmed cool down from 11 to 6 hours) result in a homogeneous crystal structure?
- What is the reason for the sub-micron filtration step after the phase split? Historically, the filters have not been removing any contaminants that would impact final product quality. If this step can be removed, the chances of a plugged-up filter and the hazard of cleaning the filters can be removed.
- To get a water content sample, the agitator is turned off and the operator has to wait a half hour before the water rises to the surface layer. Can a different test be used on a sample of the homogeneous mixture?

5.3.2 Filter Removal

One of the process steps involved filtering the intermediate through a one micron filter. The filter not only slowed down the transfer time of the intermediate, but occasionally it plugged up, which meant that the filter box had to be opened and the filters replaced. Replacing the filters was a time consuming task. It was also hazardous since the operators were exposed to flammable solvents. When plugging problems occur, it usually results in the filters being replaced several times during the transfer. The cycle time increased by an average of 8 to 30 hours per batch as a result of plugging problems.

The filter removed a slime-like material but the analytical tests did not indicate exactly what was being removed. The slime was neither product nor contaminant. The filter step was added a few years ago to deal with a contamination problem, which had since been solved by other means. The team decided to eliminate the filter step. Later it was found that the first batch of Chemical A produced without the filtration step yielded a normal batch of Chemical A.

5.3.3 Acetone Recovery

Currently, one of the reaction vessels is used for the recovery of acetone, one of the solvents used in the process. The recovery process simply involves the separation of acetone from a mixture of acetone and another, higher boiling temperature organic solvent. To separate acetone from the mixture, the mixture is heated up to a few degrees F above the boiling temperature of acetone. The mixture remains at this temperature while the acetone is "boiled off," i.e. the acetone undergoes a phase change from liquid to vapor, the vapor leaves the vessel through the overhead line and is cooled down below the boiling temperature to condense in another vessel. When most or all the acetone has been separated out of the original mixture, the temperature will start rising towards the boiling temperature of the solvent. At his point the heating process is halted and the recovery completed.

Since a reactor vessel is used for the manufacturing as well as the recovery of solvents, the vessel has to be rinsed and cleaned after each use. The cleaning procedures take a few hours, and this time adds up to be significant, especially when several batches are produced in a campaign.

To avoid the time required for cleaning between solvent recovery and reaction, several courses of action can be taken:

- Outsource the recovery of acetone to an environmental recovery provider. This alternative has obvious cost implications that have to be considered, and Chem Ops are also under environmental constraints to recover a certain fraction of the solvents on-site.
- Use a different vessel for the recovery of solvents. This option is only feasible if other vessels are available for use when Chemical A is manufactured. However, the plant's production scheduling procedures are currently mostly manual and does not consider which vessels are used for which processes. It is therefore difficult to know whether or not other vessels are available until the week of production.
- Accumulate the acetone solvent mixture in a storage vessel until the reaction step for a number of batches has been completed, thereby decreasing the number of "changeovers" for a given number of batches. There are several considerations for this proposed solution; large enough storage capacity is not available and the cost of installing such capacity is not justified.
- Reduce the time needed for the changeover between reaction and recovery. There may be room for improvement in this area by installing automatic jets and sprays inside the reaction vessel. Certain vessels are manually cleaned which takes considerably more time.

5.3.4 Summary of Results

Historically, the average time to synthesize a batch of Chemical A is 130 hours. The potential for reducing cycle time based on the ideas that were being investigated were estimated at 40 hours (including 8 hours for the filter removal). This implies a 30% reduction in the manufacturing cycle time of Chemical A. Several changes were implemented in the batches of chemicals preceding the cycle time reduction sessions. In each case, the quality of the final product was carefully measured to avoid any adverse effects of the changes on product quality.

5.4 Evaluating the Meeting Format

Polaroid employs Total Quality Management (TQM) principles in its continuous improvement efforts. The format of continuous improvement has traditionally taken the form of Business Improvement Teams (BIT). BIT teams meet once a week for one to three hours for a period of three to eighteen months. When comparing the formats employed above for cycle time reduction to that of the BIT, several differences become obvious:

Table 5-1: Comparison of BIT Format to Cycle Time Reduction Format

Similarities
The teams have the objective of improving a business process by focusing on a specific set of metrics, e.g. reduce variability, reduce number of defects or reduce cycle time of a process.
Employ TQM principles, the seven step process.
The teams are composed of members from multiple disciplines and areas of expertise.
Differences
CRT's are quicker The CRT meets over a short time span, a few weeks compared to BIT's that last over 6 months.
CRT's are less expensive Total time required for employees is 10 to 20 % of total time required for typical BIT.
CRT's are more efficient Since employee time is dedicated to the team for the duration of the meetings, there are lower startup costs and fewer distractions, and a high degree of focus and concentration.
CRT's are more effective Since fewer meetings need to be scheduled, there is less chance of absenteeism over the span of the project. Teams are more effective when critical team members are present.
BIT's monitor implementation Since BIT stretch over larger time spans, the ability to track and monitor implementation of long lead time projects is possible.

Both approaches to continuous improvement have advantages and disadvantages. From my experience, the format used for cycle time reduction was more efficient than the BIT, but allowed less opportunity for gathering data and following up on the implementation of the proposed changes.

Given that Chem Ops has the opportunity to reduce the cycle time of many of chemical products and business processes, it seems more practical to utilize the alternative approach than the BIT format, based purely on the duration of the program.

An Approach to Continuous Improvement: Episodic Kaizen

A widely used format for the process of continuous improvement is the episodic Kaizen method. *Kaizen* is the Japanese word for improvement [Goehle-Sternbergh, 1995]. Masaaki Imai popularized the idea of kaizen in his book [Imai, 1986], where he described how to practice continuous improvement and create a culture that will support this practice. Imai's definition of Kaizen is

> *"Kaizen means improvement. Moreover, it means continuing improvement in personal life, home life, social life and working life. When applied to the workplace, kaizen means continuing improvement involving everyone -- managers and workers alike"*

Episodic Kaizen has its foundations in the Toyota Production System. A simplified definition of episodic Kaizen is a practice where multi-functional teams, relieved of their normal production responsibilities, gather for a limited number of days to study and implement an improvement project. The formal episodic Kaizen events are scheduled periodically, depending on the size of the plant, resources available, etc.. For example, Johnson and Johnson's Medical Instruments division held a Kaizen on an average of once every six weeks [Goehle-Sternbergh, 1995], whereas the helicopter manufacturing plant mentioned earlier pride themselves on completing about 200 Kaizens over the span of a few years.

5.5 Summary

The approach that was devised for the cycle time reduction of chemical A was based in part on the principles described by the Episodic Kaizen method. Our approach differed in that the team was not dedicated to the project for the entire duration of the project, since team members had daily responsibilities that precluded their absence for more than a few hours at a time.

The approach resulted in positive gains in cycle time reduction of the manufacturing process of Chemical A. From the feedback of team members, this approach was generally regarded as more efficient and effective at continuous improvement than the once-a-week meeting format of BIT's.

The most significant value of this effort was the chance to reflect on the existing business practices, and to improve where possible and appropriate. This was the first of hundreds of other processes that could be addressed for cycle time reduction. Ideally, this team's learnings will be incorporated in the following improvement projects, leading to a more effective continuous improvement program and more responsive operation.

Chapter 6: Decision Making Process

6.1 The Consequences of Cycle Time Reduction

The reduction of cycle time of business operations and manufacturing procedures enables an organization to do more with existing resources.

When Cycle Time ⇩ , Then Available Capacity ⇧

Additionally, cycle time reduction leads to advantages such as reducing non-value added activities and reducing variability. At Chem Ops, the reduction of cycle time means that the newly available resources can be used to make more chemicals. This chapter is intended to better understand and improve the decision making process that leads to make vs. buy decisions.

There are three ways to utilize the "newly available" capacity:

- If demand from current customers exists, increase the production of current products
- Find ways to increase demand for other products, from current or new customers
- Integrate operations forward (into similar business as that of current customers), or backward (into supply chain).

Chem Ops could continue to make the same products at larger volumes if their customers demanded more products. However, based on forecasted demands, the existing demand for chemicals will probably not increase significantly over the next several years.

The Chem Ops division has a charter to supply chemicals to internal customers only, i.e. supplying the chemicals for the manufacturing of Polaroid products. The internal customers have demanded chemicals for the manufacturing of new Polaroid products, such as for imaging systems for improved instant photography products. Chem Ops has also gained demand from additional internal customers, such as chemicals that are used for the Helios high resolution medical imaging products. New Polaroid products have not provided significant new demands on the chemical manufacturing resources.

If the increase in demand from new business or products does not satisfy the available capacity, Chem Ops could integrate their existing production in either the forward or backward direction. For example, in the forward direction they could perform some of the operations that are currently being performed by their customers. They could consider activities such as the mixing of chemicals, the recovery of solvents used in the coating processes, etc..

In the case of backward integration, Chem Ops could consider making some of the chemicals that are currently purchased from suppliers. The division purchases a significant amount of chemicals and solvents on an annual basis and the cost of the raw materials is significant in the overall operating cost structure. The cost for raw materials is one of the largest single line items in Chem Ops' annual operating budget.

6.2 Integrating into the Supply Chain

The issue of integration involves a large set of variables. Like most decisions, the decision process involves quantitative as well as qualitative criteria. Quantitative decisions are driven by data such as cost, yields, and resource allocation. Qualitative decisions include questions such as whether the new business is aligned with Chem Ops' core competencies or not. In this thesis, backward integration was more relevant that forward integration and only backward integration was therefore considered in the decision making process.

The remainder of this chapter focuses on the decision making process involved in bringing new chemistry into Chem Ops. These decisions are termed *make vs. buy* decisions. Should Chem Ops integrate into the supply chain (make) or should they continue to purchase the materials from outside suppliers (buy)?

New chemistry includes the development of new products by the Polaroid research staff, as well as products that have previously been manufactured by Chem Ops' suppliers.

6.3 Articulation of the Current Process

This section describes the typical product development process. Depending on the product, the make vs. buy decisions are made at various phases during the development of a product, ranging from the inception of the chemistry to full scale production. A typical new product follows the path of development illustrated in Figure 6-1.

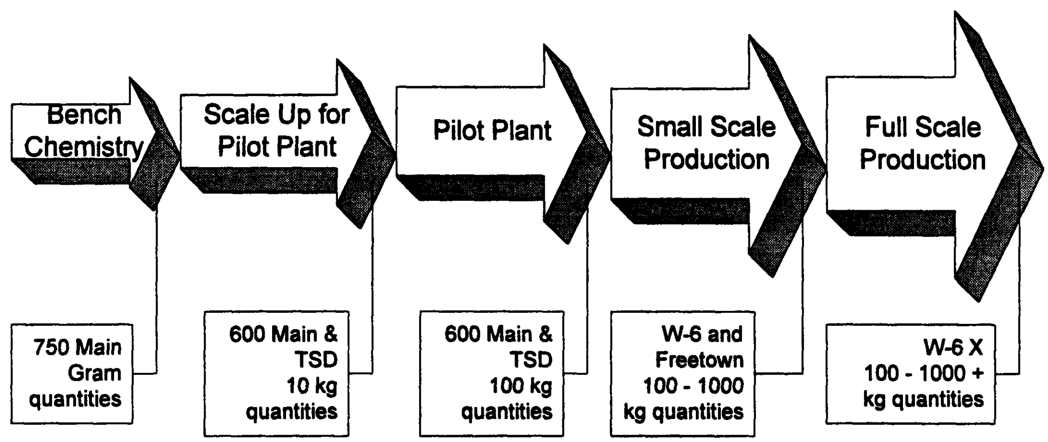


Figure 6-1: Chemical Development Cycle

A "molecule" is typically designed at the chemical development laboratory at Polaroid's Cambridge facility located at 750 Main Street. At this scale, the raw materials used to synthesize the molecule is obtained in one of three ways as illustrated in Figure 6-2.

The majority of the chemists' needs are supplied by chemical supply houses. Since only gram quantities are required for experiments, the scientists are able to purchase the chemicals from supply houses like Aldridge or Fischer. These supply houses charge a premium because they are providing the service of stocking of a very large variety of chemicals that can be shipped in the matter of days. The prices for chemicals from supply houses are not suited for orders of large or production scale quantities.

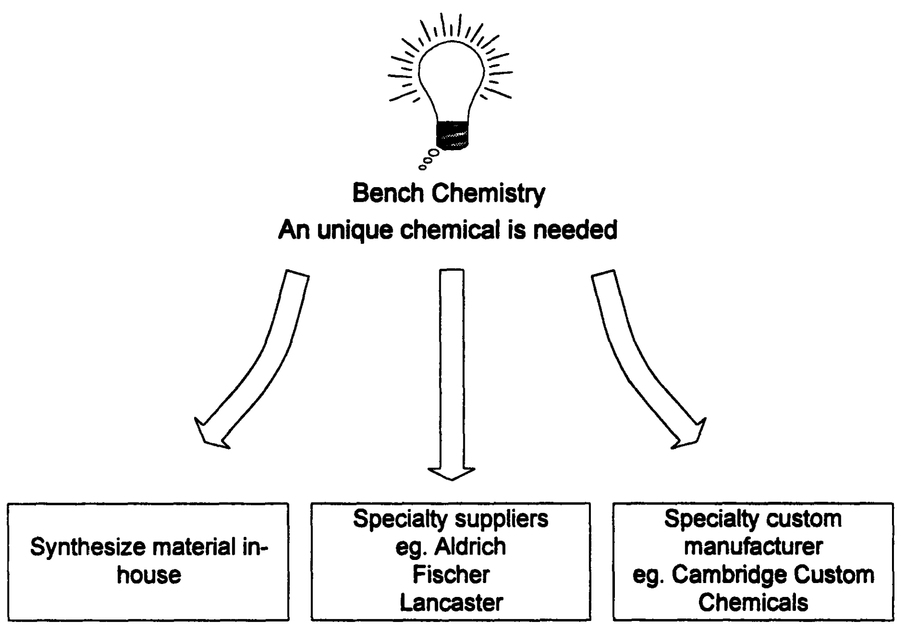


Figure 6-2: Purchasing Decisions During Chemical Development

In some cases however, even the chemical supply houses do not carry a certain material that a Polaroid chemist needs. The chemical would then be either synthesized by one of the Polaroid chemists or a specialty custom chemical manufacturer would be approached. In either case, the price of obtaining chemicals in this way is high, because:

- Scientists are highly paid professionals with very specific skill sets
- Since the quantities involved are small, the price per gram is relatively high, i.e. no economies of scale are achieved.

The purchasing department becomes involved at this phase for two reasons. The first reason occurs when the chemists are not able to locate the chemicals easily from catalogues, or if the chemicals needed have never been synthesized elsewhere, the purchasing department will help to locate a firm that would consider making the chemical. The second reason for purchasing to become involved in this phase is to monitor the development of new chemistry. The negotiations and the understanding of technical issues involved in contracting an outside firm to manufacture chemicals on a large scale require lead times in the order of years. The purchasing department therefore has to look ahead several years in the case that a chemical is outsourced to custom chemical suppliers.

If the chemistry developed in the lab appears to have application in Polaroid's product, the development process leads to the next phase; from bench scale to pilot scale. The quantities of chemical produced is increased from the gram range to the kilogram range. During this phase the plant chemists and Technical Services Department become involved to determine how the synthesis can be controlled at scales larger than that of flasks and crucibles. The purchasing department continues to monitor the progress. If the chemistry makes it to this phase, the probability of "having a future" in a Polaroid product increases.

Purchasing initiates a search to locate outside firms that are able to manufacture this chemical. The purchasing department uses the following tools to locate chemical suppliers:

- Industry knowledge from previous experience.
- Catalogues and trade literature
- Patents; authors, licensees
- Distributors and brokers (e.g. a specialty chemical supplier/distributor has in the past disclosed their suppliers if the volume becomes significantly large)

In the next phase, the chemistry is advanced to the pilot plant. The pilot plant contains similar equipment to the larger scale facilities, except at much smaller scales. The goal during the pilot plant phase is to test the "recipe" that was developed in the previous phases, and to work out any "bugs". The pilot plant personnel strive to find easier and less expensive ways to synthesize the chemical, but their first priority is to develop a robust recipe that will become deliverable to the manufacturing plants.

After the product recipe had been developed in the pilot plants, it is handed over to the manufacturing plants. The small and large scale production facilities differ in size as well as types of equipment. The chemical is allocated to one of the four production facilities based on the product recipe (which determines the type of equipment required) and the demand for the chemical (which determines the size of the equipment required). From this point forward the recipe will change to accommodate changes in:

- the facilities (new equipment is installed)
- the regulations (changes in environmental or safety regulations)
- demand (if the demand increases significantly, the batch sizes may change)
- quality (additional separation or isolation steps, or additional analysis or inspections during the synthesis)
- yield (continuous improvement)

The chemicals produced in the production facilities will continue to be manufactured until the product matures or the marketing department takes the product off the market.

There have also been cases where chemicals already in full scale production were outsourced. Occasionally the chemical synthesis was found to be too complex or unsafe. At times, the chemical was found to be made by other suppliers at lower cost or higher quality. In other cases, the plant capacity simply became constrained and some products had to be outsourced. Recently, the decisions are also subjected to environmental constraints. The regulating bodies allocate permits to produce certain amounts of specific chemicals. All the Chem Ops plants require environmental permits to manufacture types and volumes of chemistry. When a new chemical is introduced to the plant, the Environmental Protection Agency (EPA) and the local environmental agencies have to approve the type and quantity of chemical to be made.

6.4 Decision-Making Process

The make vs. buy decisions surface throughout the chemical development phase. Different issues arise during the course of product development and at each phase a decision has to be made whether Polaroid will make the product in-house, or buy the chemical from an outside firm.

Although the decision to outsource a chemical can be made during any of the phases, Chem Ops has a strong interest to develop the process to at least the pilot phase. Reasons cited include:

- Chem Ops' core competence is "rapid scale-up". If a chemical needs to be scaled up from bench scale to production scale fast, Chem Ops managers believe that keeping the chemical in house is the fastest method, because the chemists, development and pilot plant departments form a more seamless team than would be possible with an outside vendor. As one manager put it:

  "We have found that the entire scale up process is much faster if we can give our suppliers a 'complete package' and the avoid the high cost of development".

- Proprietary nature of the chemicals. Some of the chemicals are still in the process of being patented, and keeping the chemicals in-house will better protect Polaroid's intellectual property.
- It increases Polaroid's leverage in negotiations with potential outside suppliers, since Chem Ops has a better understanding of the cost of making the chemical.
- It decreases Polaroid's risk in "hold-up" situations. If the supplier of a strategic chemical fails to produce either the desired quantity or quality of the chemical, Polaroid is better able to ramp-up production in-house. If Chem Ops can produce the chemical in-house, the supplier's "monopoly power" is reduced and the risk associated with arbitrary price hikes from suppliers is decreased.

Even though Chem Ops has an interest in seeing chemical development through the pilot scale phase, the decision to make or buy can be made during any of the development phases.

<u>Other Purchasing Rules of Thumb</u>

- *"We can't do everything"; Chem Ops has to make decisions regarding which chemicals to manufacture and which to buy from other parties*
- *For the fastest time to market, give the supplier a "good package", i.e. Chem Ops should complete the chemical process development through the scale-up phase before turning the process over to suppliers.*
- *Manufacture those chemicals that are known for technical difficulties, (such as undetermined impurities). Chem Ops is in a better position to troubleshoot processes because they are close to the downstream customers and the feedback loop is shorter and faster.*
- *Chem Ops is better able to respond to customer needs than outside suppliers. When customers demand short lead times and fast ramp-up of chemical processes, Chem Ops have the flexibility to shift priorities and meet the most critical customer demands without charging a premium.*

6.4.1 Levels of Decision Making

For every chemical that is developed or manufactured at Polaroid, a set of issues will surface. The decision making process may differ from one chemical to another, but at some point or another, the same issues are addressed in each case. For purposes of clarification, the decision making process has been divided into three groups, or levels, according to the phase of the chemical's development status.

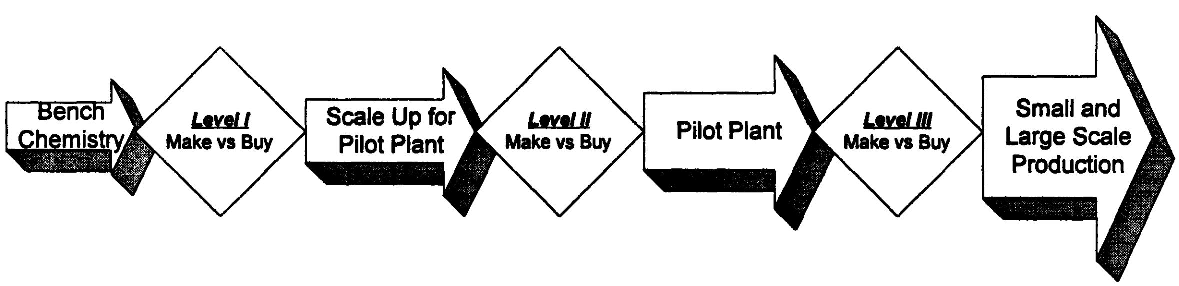


Figure 6-3: Levels of Decision Making

The following section describes the issues that are addressed during each of the levels of the decision making process. The "Make or Buy" column indicates the opinions of the purchasing department and the people involved in the product development process.

Table 6-1: Make or Buy?

Situation	Make or Buy?
Level I	
The chemical is proprietary in nature and Polaroid has an interest to protect their intellectual property (i.e. the patent is still pending etc.)	Make.
The chemical presents significant safety or environmental consequences (foul odors, toxic, explosive.)	Buy (if possible).
The chemical is part of a train of new chemicals and Chem Ops is able to manufacture only a certain number of the new chemicals due to capacity constraints.	Strategic outsourcing: Make the chemicals that are most important to keep in house for some of the other reasons.
Level II	
An outside firm produces the desired chemical as a by product of a process (of consistent quality.)	Buy, firms have to spend money to dispose of by-products and are likely to have reasonable terms.
An outside firm produces the desired chemical for a number of other firms as well.	Buy, especially if the chemical is produced and used by many other firms (commodity.)
The new chemistry requires Chem Ops to make a significant capital investment in equipment or other resources.	Buy, ideally if another firm can be found that has already made the investment in capital.
The environmental regulating agencies will not issue a permit to manufacture this chemical at the Chem Ops facilities, due to neighborhood proximity and chemical hazards.	Buy from a manufacturer who is permitted to make this chemical.
The new chemical is critical to the quality of the final product. The chemical is applied directly to the final product and inspection at this stage is not robust.	Make, if the quality of a chemical critical to final product performance and the quality is difficult to monitor.

Situation	Make or Buy?
Level III The selection of chemical suppliers favors the following criteria in the order listed: • Polaroid has established a relationship from previous successful agreements. • The firm has a reputation for quality and on-time delivery.	
• The firm's manufacturing facilities are local to Chem Ops.	• To avoid communication problems as a result of time zones, lower currency risk etc.
• The firm has a particular expertise, such as handling extremely explosive or toxic materials • The supplier has a lower cost structure than competitors. • The supplier does not require additional investment (which would be charged to Polaroid in amortized payments and limiting contracts)	
• The supplier is considered a "minority owned" company.	• As a matter of policy, Polaroid awards a portion of annual business to minority owned businesses.

As can be seen from the Level III decision process, the basis of awarding business to outside firms is not necessarily cost. In an ideal world with perfect competition, Polaroid would have a choice among equally qualified suppliers, but in many cases, a limited number of suppliers compete for the same business.

6.4.2 Single-Source or Dual-Source?

Two trains of thought exist regarding Chem Ops' purchasing policies. If two reliable and reputable suppliers are able to manufacture a chemical for Polaroid, should Chem Ops choose one for the entire demand or split the order between the two suppliers?

Polaroid would prefer to "dual-source" chemicals for:

- Economic reasons: When the level of competition is higher, the suppliers have an incentive to keep the cost low
- Reliability reasons: If one supplier fails to deliver on schedule (as a result of a disaster, or if the shipment is destroyed in transit, for example), the other supplier could possibly ramp up production to alleviate the temporary shortage.

However, Polaroid purchases chemicals from a "single-source" for reasons:

- Variability reasons: Even though two suppliers may use the same procedures and raw materials, variability is introduced by using two suppliers. When the chemicals have very tight tolerances on critical chemical characteristics, the engineers would typically prefer a single source to reduce variability.
- Volume reasons: Since Chem Ops may need relatively small quantities of certain purchased chemicals, outside suppliers insist on guaranteed volumes as incentives to agree to produce small quantities.
- Relationship reasons: The trust gained through previous experiences lead to efficiencies and learning in the long run.

The decision to single or dual source therefore ultimately comes down to an array of factors, and depends on the degree of competition among suppliers and the negotiations between the engineering/manufacturing and purchasing functions.

6.5 Summary

My intent in this chapter was to articulate the current process of make vs. buy decisions of outsourced chemicals. By gaining a clear understanding of the existing process, the most critical factors in the decision making process were highlighted.

Several functions, such as manufacturing, R&D and purchasing, are stakeholders in the make vs. buy decision. Each function has an incentive to promote their own interests and therefore negotiate with each other to advance their own interests. This negotiation process does not necessarily lead to the optimal decision for all parties as a whole. To arrive at a mutually beneficial decision, the articulation and communication of each function's interests are crucial. When all functions have more information about the other factors involved, the probability of a globally optimized decision increases.

Outsourcing decisions differ from one chemical to the next and ranges in complexity from simple to very complicated decisions. Each chemical has to be considered and the factors have to be weighed against each other on a case by case basis. Ideally, all functions should have an understanding and appreciation of the factors contributing to the make vs. buy decisions.

Chapter 7: Conclusions and Recommendations

7.1 Conclusions

7.1.1 General

The study of Polaroid and observations from other companies taught me that large organizations face tremendous challenges. All large companies undergo a transition at some point during their growth. The transition marks the transformation of the company from an organic and reactive enterprise to that of the established organization with a set of formal business processes and procedures. During these transitions, organizations face many hurdles. I have identified three to be of great importance:

1. Accountability, holding individuals accountable to their goals and ensuring that the individual goals are aligned with the company's goals.
2. Communication, facilitating communication between different levels and functions of the organization.
3. System perspective, maintaining a "big picture" view of the business, with a comprehensive, technical understanding of the interaction between elements of the organization and the external business environment.

These hurdles are all integral to the company's organizational culture. The problems are complex and not easily solved. Issues aren't resolved with heuristics or magic formulas. The problems are specific to the organization and therefore require individual analysis.

What factors should be addressed in the analysis of an organization and what tools are to be used? The framework for analysis presented earlier in the thesis was helpful in guiding the analysis of organizations. The major components of the analysis are the business environment, the product characteristics, and the organizational factors. Of the organizational factors, the organizational culture component is critical and relevant in addressing the issues mentioned earlier.

The study of Polaroid's organizational culture led to conclusions that are specific to the company and industry. Some of the issues that I found to be important are:

- Organizations have to find ways to rejuvenate their cultures
- Change has to be initiated from the top down
- Middle management buy-in is critical to implement change, this is done by setting clear goals, using reward/recognition as a motivator, creating an atmosphere of competition
- Lack of communication between functions leads to *functional silos*, which leads to sub-optimal decision making and less cooperation and teamwork.

Culture changes continuously, it evolves from the time that an organization is formed until it is dissolved. Since the external business environment is always changing and at an increasingly rapid pace, it follows that the organizational culture has to change with time. As an industry becomes more competitive, the organizational cultures have to change to adapt to the new environment. The problem is that cultures are difficult to change. Humans resist the notion of change and the same is true for organizations. To compound matters, larger organizations tend to respond to changes in the environment at a slower pace than smaller, more agile organizations. This phenomenon occurs, in part, as a result of the time required for information to reach all members of the organization and, in part, because of the increased complexity.

Several theories claim to know the secret of how an organization goes about continuously renewing or rejuvenating its culture. Crisis seems to be the initiator for change in an organizational culture. A crisis from the external business environment, such as a major disaster, a takeover attempt, or a new competitor will typically lead to quick change since all employees perceive the crisis as a threat to their future livelyhoods. Crisis is obviously not an ideal initiator of change since the organization falls victim to circumstance and has little control of the situation.

A more effective initiator of change may be "creating the illusion of a crisis". Some organizations promote and hire people with strong leadership skills to "light a fire under the sleepy organization". These leaders create the illusion of a crisis by setting high standards, changing the organizational structure and status quo, and threatening job security with layoffs.

The leader of an organization has the responsibility to not only initiate and support change, but also to ensure that the middle management layer is "on board". This process of getting subordinates to buy into the leader's ideas is important and differs from one leader and organization to the next. Generally the leader spends most of his or her time selling ideas to subordinates and colleagues. After making an attempt at answering questions and allaying fears, it is the leader's responsibility to help the subordinates set high yet attainable goals. Beyond that point the role of the leader becomes the management of change, monitoring progress, and removing hurdles from the process of change.

Whereas the process sounds simple and straight forward on paper, it should be obvious that only leaders with exceptional interpersonal skills and an ability to balance his/her commitment to the employees with the goals of the organization can be successful in changing an organizational culture.

Large organizations typically divide functions into departments that develop and promote a high level of expertise. Unfortunately, in many cases, the departments tend to become self sufficient to the point that a lack of communication exists between different functions. The *functional silo* problem is addressed by facilitating communication between divisions and functions.

Employees are cross-trained in different responsibilities, rotated through different functions and locations and responsibilities are allocated to teams rather than individuals. To avoid the development of a barrier between managers and subordinates, companies encourage management to spend part of their time walking around the plant and talking to employees. In many cases the physical barriers between the white and blue collar workers are removed by physically co-locating management with subordinates and various functions together. Another action of organizations with continuously changing cultures is the recruiting of employees from diverse countries and schools.

7.2 Directions for Future Research

Stemming from the learnings and interests that evolved over the course of the internship, some of the areas of research that I would have pursued had there been more time is:

- The designing and implementation of metrics; understanding how one creates an accurate and amenable system for the measurement of performance
- The scheduling and/or materials handling procedures since these areas present opportunities for significant savings for relatively small investments.

Appendix A: An Overview of Polaroid's History

This appendix contains a paper which I wrote in May 1995 for a class at MIT dealing with the development of the instant photographic industry in the US and Polaroid in specific.

A.1 Introduction

The instant photography industry has been virtually dominated by a single company since its inception: Polaroid. This paper reviews how Polaroid as a company developed, and how the instant photography industry evolved. The paper also discusses the role of Polaroid's founder, Edwin Land, and the impact that he had in shaping the company's structure and operation, and eventually the industry.

The development of the instant photography industry is described using Schumpeter's classical model of technological progress [Ch. 3, 1939]. The three stages of development are defined as:

- Invention - the conception of instant photography
- Innovation - cultivating a market, building a new organization
- Imitation or Diffusion - other producers promote widespread use.

A.2 The Beginning of Polaroid

Edwin Herbert Land identified the use of polarization to control the brilliant light from automobile headlamps in 1927. At the time, pedestrians in big cities were killed daily when crossing busy streets in blinding auto lights. While in New York, Land perceived an urgent need to control the light of the scene, and he imagined the phenomena of polarization saving thousands of lives [Wensburg, 1987, p. 45].

In 1932, Land dropped out of Harvard to start the Land-Wheelwright Laboratories. The research areas were to include ideas such as the development of a fuel cell (a self-contained power source intended for farms with no electricity), a polarizing automobile **headlight system**, stereoscopic movies, and hundreds of other schemes using polarized light. Kodak was Land's first customer by placing a $10,000 order in November 1934 for polarizing **camera filters**. It was around this time that Land made a dramatic introduction of "Polaroid" glass to the American Optical Company, promising that their new **sunglasses** would be made of Polaroid.

In January 1936 at the Waldorf-Astoria in NY, Polaroid hosted its first press conference. At the conference, Land stunned the audiences with three-dimensional movies, using Polaroid lenses to create the stereoscopic effects.

After much effort and much funding, Polaroid finally failed to be accepted by the automakers, partly due to opposing headlight patents. The other reason was that styling and horsepower sold cars at the time, safety did not. People did not want to be reminded that cars were dangerous. Polaroid's 3-D movie film was well received by the general public, but also failed to be commercialized on a large scale. One of the Warner brothers, from Hollywood, Harry, just did not see the big deal about 3-D. It was later discovered that Harry Warner had a glass eye and that 3-D would never be a big deal to him [Wensburg, 1987, p. 45].

By 1940 Polaroid had accumulated a number of brilliant scientific faculty, but the existing product lines had mediocre if not bleak futures. In 1941, Polaroid started bidding on and winning several Navy contracts. A "Position Angle Finder", a device for finding the elevation of an airplane above the horizon was built, and sunglasses were transformed to military goggles issued to ski troops, pilots, and factory workers. With the onset of the war, Polaroid evolved from a manufacturing company back to a research company. Research and development for the military became their primary activity, in areas such as optical ring sights, rangefinders, guidance systems and infrared sensors. Land and other Polaroid scientists developed Vectographic images, where two images appeared as a single scene with the illusion of depth, shape and amazing realism. Vectography became a part of planning almost all invasions, including the battle of Normandy.

Vectography had taken Land further into the world of photographic chemistry, and by 1943 Polaroid had assimilated enough technology and background in photography to alter the course of the company. During a vacation in New Mexico, Land's three year old daughter, Jennifer, innocently asked why she could not see the pictures that they had take earlier in the day [Wensburg, 1987, p. 45]. Land's answer to her question was the beginning of a new industry: *instant photography.*

A.3 INVENTION: The Beginning of an Industry

At the time, Polaroid was still deeply immersed in government projects, but Land realized that the war would end eventually, and that the end of the war would mean canceled contracts for Polaroid, and leaving the Polaroid scientists and staff unemployed. Land wanted to be ready for the end of the war slump. While continuing to direct Polaroid's effort to government projects, Land had a small part of the research lab dedicated to the development of a self-developing camera.

After the end of the war in 1945, Land directed the majority of his staff to the SX-70 camera project. As the prototype evolved, Polaroid recognized that their capabilities were geared to research rather than manufacturing. Polaroid decided that outside suppliers would be used for manufacturing initially. Eastman Kodak agreed to supply the negative, and Samson United, also from

Rochester, NY, was contracted to build the camera. Polaroid would use their resources for film assembly, which comprised a negative sheet and a positive receiving sheet, joined at a common pull tab.

In the film assembly area, Polaroid managers studied the movements of the women's' hands as they rolled film like socks and tucked them into foil bags. By carefully studying their motions, the routine and redundant actions were automated as far as possible.

A.4 INNOVATION: The Development of the Industry

Schumpeter defined innovation as "the setting up of a new production function" [Schumpeter, 1939, p. 87], and that innovation "is embodied in a new firm founded for that purpose" [p. 93-97]. Instant photography was an invention by Land, but the innovations were the result of both Land and Polaroid. Polaroid's products evolved from black and white film to eventually include color, the peel-apart film became single-step, no-waste pictures, and the bulky bellows type cameras became slick plastic encased cameras.

The innovations that allowed Polaroid to become what it is today are described below:

Product Innovation

Polaroid was a leader in **product innovation**. Besides having a brilliant scientific staff, which comprised the best from Harvard and MIT, Land also employed and trained liberal arts students (many from Smith College) to become some of Polaroid's most valued scientists. And then there was Land.

Land held over 530 patents, second only to Thomas Edison in number. Land was considered to be a genius, he took nothing for granted, accepted no common knowledge, tested the cliché, and treated conventional wisdom as an oxymoron. Land continuously pushed the scientific staff in his personal "Back Lab" (behind his office) to explore new chemistries, continuously coming up with ground-breaking technology that could be applied to Polaroid products. Land's Back Lab was considered a pilot facility dedicated to erasing problems. As a consequence, Polaroid was continuously introducing new products and improvements of existing products (see Table A-1 for Timeline).

Land tended to introduce products to the public with a bang, and high publicity events like world trade shows, press conferences, and the famous Polaroid shareholder meetings. During the presentation of the very first peel-apart film, for example, Land gave a quick talk about his interest in photography.

He then jumped right into the demonstration by taking a picture of himself, waiting a minute for development, without saying a word and while the audience held their breath in anticipation. Finally he peeled the film apart, and left the audience dazzled with a life size image of his face. Land also had a way of entertaining the press with fascinating displays of technology. New Polaroid product introductions were well publicized by the press and through marketing efforts.

Table A-1: Product Introductions After 1950

Year 19'	Major New Products
50	Pathfinder
51	Speedliner
52	Highlander
54	Panchromatic Film
56	Black and White Film
57	Transparency Film
58	Polapan 200 Picture Roll
60	900 Polaroid Electric Eye
63	Polacolor Film Type 48
	Colorpack Camera
	Polaroid Land Filmpack
64	Polaroid Automatic 100 Land Camera
66	Swinger Camera Line
68	Big Swinger
	Model 360
	Colorpack II
70	Foldingpack 700 Series
	Big Shot
71	Square Shooter II
	Colorpack Type 88
72	SX-70
73	Packfilm Type 105
	Model 195 Pack Camera
74	Polacolor 2
	Zip, Super Shooter
77	Polavision -Instant movie camera
....*	
80- 90's	Conventional 35 mm film/cameras
	Video tapes
	Floppy disks
	Pomogranate (Video Printer)
	Spectra
	Palette -Instant slides-computer Graphics
	Digital Scanner
	Desktop image printers
	Autoprocess - 35 mm slides from film
	Onestep flash camera
	Procam
	Helios Laser Imaging
	Disposable 35 mm Cameras
	Joshua/Captiva

[Hayashi, 1976]* Not a complete list

Decision Making: It is worth noting at this point that the decision making power within Polaroid resided mostly with Land. While the firm was in the organic form, Land maintained a flexible organizational structure with an informal information flow and centralized decision making. Communication flowed vertically and horizontally and a flexible structure allowed Polaroid to adapt to the rapidly changing environment quickly.

It worked well for Polaroid also because the decision power resided with the one person most capable of making the decision. Land was the only person in Polaroid that had knowledge of the entire camera, it's chemistry and operation. He was criticized for not allowing other individuals to acquire a broad knowledge of the process. The reasoning for this behavior was rooted in the fact that secrecy was crucial in the photographic industry (considering the threat posed by Kodak).

As the firm grew and the processes became more complex and Polaroid integrated its processes backwardly, some of the decision making power was decentralized. The decentralization gave plant managers the authority for quality control, and process innovation.

<u>Process Innovation</u>

In a speech at MIT, Land articulated two broad aims of the company:

to make worthwhile products genuinely useful to the public

to make a worthwhile work life for every member of the company [Polaroid Personnel Policy PP-101].

The two aims as outlined by Land actually conform nicely to the two types of innovation found at Polaroid, or any other manufacturer for that matter as explained in *Mastering the Dynamics of Innovation* [Utterback, 1994]:

- Product innovation
- Process innovation.

It was clear that Land and upper management, teamed with the scientific and marketing staff, were responsible for ensuring product innovation. It was their duty to put useful and worthwhile products in the customers' hands, and it was in the interest of the firm to release a new product to the market on a regular basis to ensure a steady flow of revenue and match the changing customers' changing needs. On the other hand, it was the responsibility of all other employees to innovate in their own areas of expertise, which meant improving the firm's daily operations.

The system of centralized decision making in product innovation, and decentralized decision making in process innovation appeared to be successful as long as Land was around. Land possessed the knowledge and vision that guided Polaroid's product lines and marketing efforts. While Land was in charge, it appears that the science and technology drove Polaroid's products. By exploring the wonders of chemistry, Land created products that the consumer adored. How much market research had been done before most launches was not clear. (Polaroid did make use of market research by test marketing of the Polavision product in Florida, among others).

A.5 IMITATION AND DIFFUSION: Eastman Kodak Enters the Market

The sequence of events as they relate to the interaction between Polaroid and Kodak is striking. As mentioned above, Kodak was one of Polaroid's first customers for polarizer camera filters. With the introduction of the instant camera and film, Kodak became a key supplier of negative to Polaroid. At the time, Kodak held a monopoly position on the manufacture of film in the US, and Kodak constituted Polaroid's only supplier of negative. Polaroid believed that Kodak took advantage of their monopoly position and enjoyed a healthy profit on negatives.

Being in a monopoly situation, Kodak was in a position in different technologies. There was a time in the 1940's that Kodak actually considered financing Polaroid, "but Kodak executives dismissed the whole thing as a toy" [Forbes, Sept. 15, 1974. P. 75]. In the subsequent years, Polaroid managed to create and grow a new market and industry. Kodak's chairman in 1969, Vaughn, acknowledged at the annual shareholders meeting that "for those customers who want rapid results and single prints, in-camera processing has obvious appeal" [Eastman Kodak Annual Report, 1970].

Polaroid had bought black and white film from Kodak for several years until it developed its own manufacturing capabilities in manufacturing. When the Land color cameras were launched, Polaroid again contracted Kodak to supply their color negative from 1963 through 1975. This time, Kodak enjoyed even higher profit margins on color films.

To avoid the costly dependence on a single supplier (and prospective competitor), Polaroid undertook backward vertical integration into manufacturing negative for its SX-70 camera. In 1969, Polaroid signed a five year contract with Kodak to guarantee the supply of color negative. A licensing agreement was also signed to allow Kodak to manufacture film that could be used in Polaroid cameras after the five year term. The five year period secured enough time for Polaroid to vertically integrate into the manufacture of color film.

Being Polaroid's key supplier of color negative, Kodak had gained the technical expertise in the area, and Kodak publicly indicated an intent to enter the instant market under Polaroid's licensing agreement. In 1975, one year after Polaroid had reached feasible capacity in their new color film production line, the Kodak contract was terminated. During this time, Polaroid was aware of Kodak's intent to enter the market, and Polaroid made the strategic move of differentiating the SX-70 camera models.

In 1976 Kodak introduced a camera line and film that was incompatible with Polaroid products, in direct competition of Polaroid's products.

Six days after Kodak's new camera launch, on April 27, 1976, Polaroid filed suit against Eastman Kodak for infringement of twelve of its patents relating to the art and technology of both camera and film. Judge Zobel issued her final Memorandum of Decision nine years later on September 13, 1985, announcing an overwhelming victory for Polaroid and for Land. Kodak was enjoined to stop manufacturing and distributing their cameras and film. Kodak appealed the court's decision, and the appeal was denied. Kodak was finally forced to buy back their 16 million instant cameras, and pay substantial damages to Polaroid ($925 million [Edelman, 1991]).

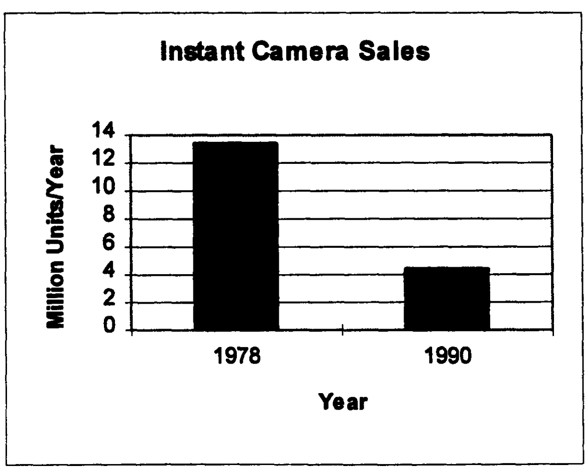
A.6 Signs of a Mature Industry

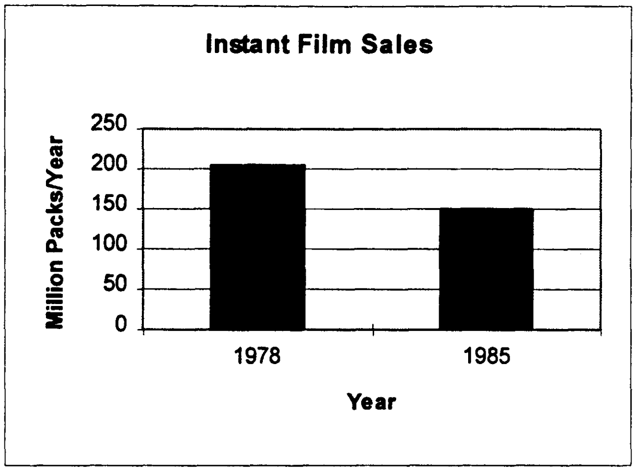
In a talk to our class on February 23, 1995, Al Lenhard described a mature industry as being "baroque". One way of telling whether an industry is becoming mature is to pay attention to the new product introductions. If the "new" products are characterized by features only, or "bells and whistles", the industry becomes "baroque", or ornate.

It is safe to say that in 1995, Land's instant photography is baroque. If one looks at the past few decades, very little about the camera and film has changed. The camera and print quality have changed, but the basic concepts and chemistry have remained the same. Polaroid's latest instant cameras are new only in the sense of new features.

The Captiva, or Joshua camera uses a smaller print and has a tidy storage compartment for convenience. Earlier this year, Polaroid released a "talking" camera. The "new" camera has an on-board microchip *that will tell a joke, or say "cheese"* before the picture is taken.

Another way of determining whether an industry is in the mature phase of the business cycle, is to look at annual sales. Polaroid's sales of instant cameras and film dropped dramatically since 1978 [Rifkin, 1991].





One might hazard a guess that the market for one step cameras is saturated in the States. Polaroid has continued to maintain sales in world wide markets. Some Polaroid execs estimate that film pack sales have been flat at 180 million/year for the past four years, and that "the Captiva camera will bring sales back up to record levels by 1995" [Sacramento Bee, July 26, 1993].

Polaroid is taking advantage of new and emerging markets that are opening up around the world. Countries like Russia, India, and China lack infrastructures that accommodate one-hour photoshops and Polaroid offers a unique advantage in remote areas.

The emerging markets offer a terrific opportunity for cash generation. However, this avenue for growth can not sustain Polaroid indefinitely. What future is awaiting Polaroid? How is Polaroid positioned to deal with the rapidly changing market place?

A.7 The Future of "Instant Photography" and Polaroid

What is instant photography today? The industry has evolved from Land's black and white invention to an industry that includes technologies like electronic and digital imaging. As technology in the imaging area improves and proliferates, Polaroid stands to face increasing competition from not only the yellow giant, Kodak, and but also other film companies like Agfa and a host of hi-tech imaging companies. Computer companies like Apple and Canon, electronic companies like Sony and Xerox have made their intentions clear regarding their entrance into the imaging market.

Polaroid has recently established two areas of business in addition to the traditional instant photography business:

- High Resolution Film (Helios brand name)
- Digital Imaging.

The traditional business of instant photography is the cash generating engine that drives the new areas of development and Polaroid appears to be making a conscious effort of diversifying into other business areas. The patents that have protected Polaroid from the onslaught of competitors like Kodak and Fuji expire in less than two years. It is unclear what Polaroid can do to protect their core business.

The Helios product has had a slower than expected entrance into the Hi-Res film markets [Byrns and Hardman, 1993] and digital imaging cameras have successfully been introduced. The question remains whether Polaroid is able to compete in a completely different market environment, with new and strong competitors and less protection in the form of patents than they enjoyed in the past. The jury is still out ....

Appendix B: Research Methodology

As a change agent, one can play the role of either an insider or an outsider. With each role, a number of pro's and con's are associated. At the outset of my six and a half month internship, I decided to play the role of an insider for the reasons explained below.

The term *Convert* is used to describe an insider. A convert becomes part of the organization and adopts the values of the members of the organization. In contrast, a *Martian* describes the change agent who comes in from the outside, similar to the role of many consultants. Some of the advantages to being either a *Martian* or a *Convert* are listed in Table B-1 below.

B.1 Diary

The following section contains an outline of my activities during my internship. A Gantt chart of the activities is also presented in Figure B-1.

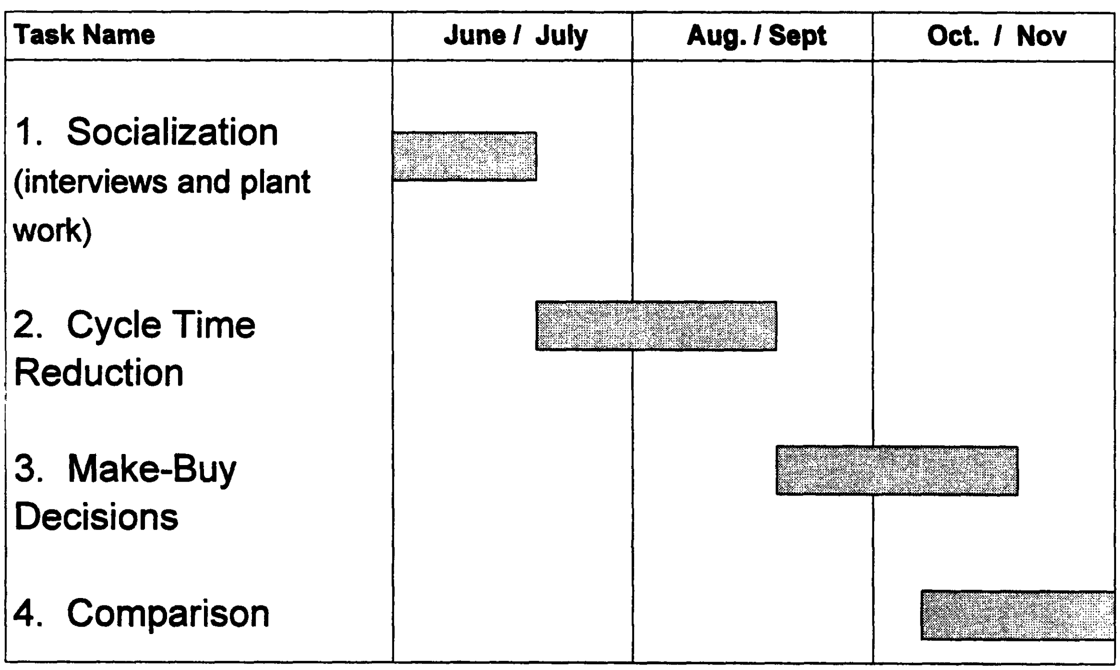


Figure B-1: Internship Schedule

Table B-1: Pros and Cons of the Convert and Martian as Change Agents

<u>Convert</u>

Pros

If employees are fearful of broad and sweeping change, they may feel less threatened by the presence of an insider who has demonstrated himself as a stakeholder. A stakeholder presumably cares about the organization and its impact on the other stakeholders of the organization. Employees may therefore be more open to discuss their real motives and values.

A change can be more effectively implemented because the workers know and trust the insider already. The insider knows his/her way around the organization and has identified where the critical powers reside in the organization and has a better idea of what needs to happen to implement change.

Cons

If change involves an action that inflicts pain on the fellow members, (such as reducing the size of the workforce) it may be more difficult for the insider, since he/she may have developed emotional ties with employees.

<u>Martian</u>

Pros

If the outsider has been recruited by higher level managers, the change agent will typically enjoy the support of the higher level managers and therefore have access to many resources and information, including other employees who may have no choice but to cooperate.

It may be easier to recommend harsh or sweeping change if the outsider is not a stakeholder of the organization and would not be affected by the proposed change.

Being an outsider from a reputable organization, such as MIT, lends credibility to the change agent's recommendations and proposals.

Cons

The recommendations of consultants and outsiders are soon forgotten unless a "champion" inside the organization takes on the responsibility to implement the proposed changes.

B.1.1 The Initial Weeks, Interviews

I intended to assume the role of an insider in affecting change, but as a newcomer I first needed to learn about the organization and its culture. I spent the first few weeks interviewing a number of Polaroid employees. The interviewees included members from corporate management and staff, plant management, supervisors and operators. A list of questions was used to guide the interview (included in Appendix C: Interview Questions About Culture). The interviews helped me to gain an initial impression of the Polaroid culture and how it had changed over time. This is similar to what Schein [1985, p.119-121] advocates in his work. The ethnographic study of Polaroid's organizational culture (presented in Chapter 4) leans heavily on the learnings from the interviews and my subsequent experiences in the company.

B.1.2 Socialization

During the subsequent weeks I was immersed in the daily operations of the organization. I spent three weeks working on the floor with the operators from two shifts, one day shift and one night shift. Since it soon became obvious that the Polaroid culture consists of many work subcultures, or "microcosms", I wanted to know how the operators on one shift differ from the people on another shift. During these three weeks I tried to live the operators' lives. I worked side by side with them, we had our meals together, and I even took naps when they did (during the night shift).

The work involved mostly manual labor and the conditions required wearing protective *tyvek* overalls (affectionately called *bunny suits*) and breathing apparatus. We used the *drum-crusher* to loosen the solids in raw material drums. The drums were opened and lined up in front of the reactor manhole (an opening in the top of the reaction vessel). After weighing the drums, two or three of the operators would lift the 175 lb drums and empty them into the funnel attached to the reactor's manhole. Daily chores included the scraping clean of vessels and drier trays, taking samples of a reaction intermediate by lowering a cup attached to a rod into the reactor, taking the sample over to the analytical lab, waiting for the lab results, washing drums out, monitoring reaction temperatures and pressures, and waiting.

B.1.3 Cycle Time Reduction

The plant manager had recently begun a plant wide initiative to reduce cycle time of activities in the plant. He hoped to apply the concept of cycle time reduction to many aspects of the division's operations, including the manufacturing of the chemicals and intermediates and non-manufacturing operations. Because the process we used would be the first of many cycle time reduction efforts, this project was intended as a pilot program. The learning from this teams' effort would contribute towards developing a methodology that could be applied to other chemicals and aspects of operations.

The capacity that became available would be used to increase volumes or to integrate manufacturing into the supply chain (backward integration).

The two major goals of cycle time reduction are:

- to increase customer satisfaction through faster response to demand and orders
- to increase the plant's capacity without spending money on the expansion of existing resources

Increased customer satisfaction results from fulfilling customer needs faster.

Increasing plant throughput without additional expenditures are also important to Chem Ops. The Chem Ops division costs are mostly fixed because of the high capital investment for reactors and other expensive equipment. An increase in the number of kilograms of chemicals produced by the plant would therefore lead to a decrease in the effective cost per kilogram. Inventory reduction can be considered in terms of cycle time reduction too. Warehouse space is a resource, and by reducing the time of inventory occupying this resource, additional capacity becomes available for no additional investment.

I spent two weeks determining which process should be selected for cycle time reduction by surveying a number of processes and the various facilities. A number of constraints led to the consideration of Chemical A. Chemical A is manufactured in Chem Ops' large scale production facility. It is an intermediate that is used for one of the layers in the film used for instant color photography.

The team was assembled to focus on the cycle time reduction of the manufacturing procedure of Chemical A. The team consisted of a cross-functional representation of the departments who are directly involved in manufacturing. After negotiating with the team members' supervisors, two four hour sessions separated by week was scheduled for team activities. The activities and preparations of the team are described in detail in Chapter 5.

The remainder of the cycle time reduction effort was divided into a number of tasks. I was responsible for following up and ensuring implementation of the changes for resulting from the team effort. I also attempted to address the non-manufacturing activities related to the production of Chemical A. This included scheduling and material handling. In both of these areas we identified opportunities for improvement.

B.1.4 Make vs. Buy Decision Model

During my internship I also tried to gain an understanding of the decision making process surrounding Chem Ops purchasing of raw materials. The study of the make vs. buy decision making process is a consequence of the cycle time reduction effort. As mentioned above, the capacity that became available as a result of cycle time reduction could be used to increase volumes or to integrate backwards. Since the demand on Chem Ops is likely to remain relatively constant over the next several years, Chem Ops could consider bringing production of some of the raw materials in-house to utilize some of the newly available capacity. To decide which of the raw materials to make and which to outsource, it is important first to understand the current decision making process and to then improve on it if possible. The make vs. buy decision making process was outlined by interviewing a range of Polaroid employees involved in the design, scale-up and purchasing of new and old chemistry. It was found that certain issues become more important depending on the phase of development of new chemistry. It was also found that decisions were highly dependent on the *situation* and on parameters that are not easily quantified, such as the people involved, the type of new chemistry, and how *full* the plant is at any given time.

B.1.5 Comparison

During the final part of the internship I spent three weeks visiting some of the other local Polaroid divisions and other manufacturers, such as a helicopter manufacturer, a semiconductor fab, and a biotech company. I did so for both general education and to develope an understanding of how other organizations go about continuous improvement. Since the team activities described in this thesis differed substantially from Polaroid's conventional continuous improvement methodology, it was useful to know how other methods could be employed to further improve the processes.

Appendix C: Interview Questions About Culture

Founding

When was Chemical Operations founded?

Describe the events that occurred and the people involved in the beginning.

Who was involved?

What were they like?

What were some of the critical problems?

What were some of the beliefs and values that evolved?

Personal Experience

Describe an event that had no ready solution and that challenged the existing norms and values at Polaroid.

How did the people feel about the event?

Who acted in response to the event?

What did they do?

Did the response work?

Role Models

Who has been the one person you most respected during your time here at Chem Ops?

What are the traits you most admired?

Values and Beliefs

Describe the values and beliefs of the people at Polaroid.

Re: empowerment, diversity, innovation,

Appendix D: Selection of a Chemical Process

D.1 Constraints

A central part of this thesis was the cycle time reduction for the manufacturing of a chemical process. Chem Ops makes hundreds of different chemicals and intermediates every year. Ideally the cycle time reduction format that was used for Chemical A would be applicable to the other chemicals manufactured at Chem Ops. The continuous improvement team format described in this thesis was an alternative to the existing team process. If the team format was found to be more effective or efficient, then elements of the alternative format could be adopted in future continuous improvement teams that focus on other chemicals or business processes.

The selection of the first chemical process therefore deserved some consideration. In the next section an outline of the reasoning that led to the selection of Chemical A has been included.

In the selection of a chemical process for cycle time reduction, ideally one would select the process that presents the largest potential gains. The potential gains can be estimated by any of several simple parameters, such as:

- Does the production of this chemical contribute significantly to the plant's revenue or income?
- Does the production of this chemical require a significant number of work hours per batch?
- Do the operators and engineers who are familiar with the process regard this process as one with room for improvement or potential gains?
- Is the process for the manufacturing of this chemical significantly complex, i.e. does it require many process steps?

Timing was also a constraint. It was preferred to perform the cycle time reduction effort in the middle of a campaign (*campaign* is used at Polaroid to describe the production of a chemical in a series of batches.)

Performing the cycle time reduction team effort in the middle of a campaign has advantages:

- the operators and engineers are familiar with the process since it is fresh in their mind
- questions regarding the process that are raised during the team meetings can be answered by observing and measuring a batch in the ongoing campaign
- opportunity is provided to implement, monitor and measure the proposed changes

The span of the internship occurred during the second half of 1995, whereas the plant produces most of the high volume chemicals during the first half of the year. The manufacturing process used for the synthesis of Chemical A met matched most of the requirements mentioned above, and was selected as the subject of the team' cycle time reduction focus.

Without a timing constraint, one might use additional criteria in the selection of a process. One such criterion comes from the *bottleneck theory* (also called the *Theory of Constraints* [Goldratt and Cox, 1992]). A plant can be considered as a set of resources, such as reactors, dryers, distillation columns, and work force. In principle, one of the resources is responsible for limiting the plant's overall capacity.

Typically, the most constrained resource, called the *bottleneck*, is the resource that is and should be most utilized. Once the bottleneck operation has been identified, the cycle time reduction effort should focus on the process that uses a significant amount of the bottleneck's time. If the cycle time of this process is reduced, the bottleneck is relieved and the plant's effective capacity increases proportionally, until another resource becomes the bottleneck. If the distillation column used for the recovery of solvents is the bottleneck, one should reduce the cycle time of those chemicals that require significant amounts of solvent recovery.

D.2 Overview of Chemical A

The chemical process that was addressed by the team has been altered for reasons of confidentiality. The value added chain, the chemistry, and the process flow diagram are presented in simplified form below.

D.2.1 Value-Added Chain

Chemical A is an intermediate in a series of chemical steps that eventually becomes part of a Polaroid instant photographic image, as is presented in Figure D-1. The raw materials are received by the materials handling department and stored as raw material inventory. The raw materials are then reacted to form Chemical A. Chemical A is reacted with other raw materials and intermediates to eventually produce the finished product. The finished goods are shipped to other Polaroid divisions, where it is coated onto sheets with a number of other chemicals. The coated sheet is then shipped to the film assembly department where the final product is assembled before being shipped to the customer and end user.

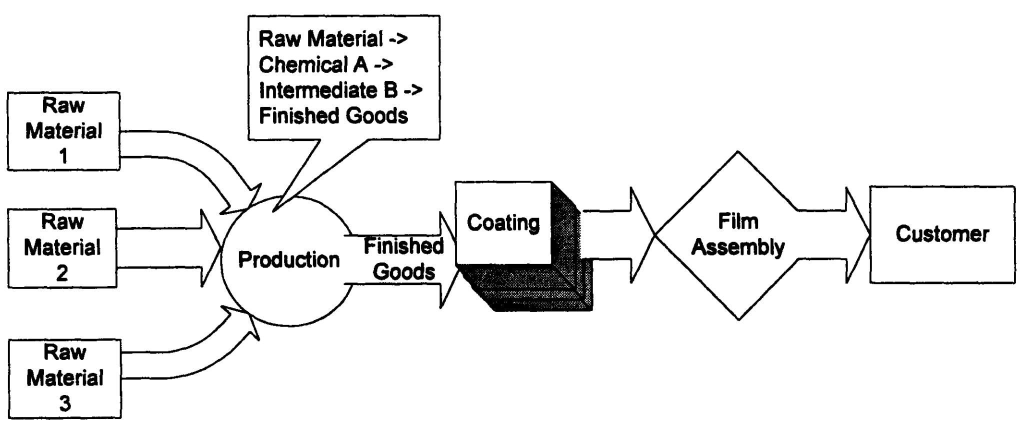


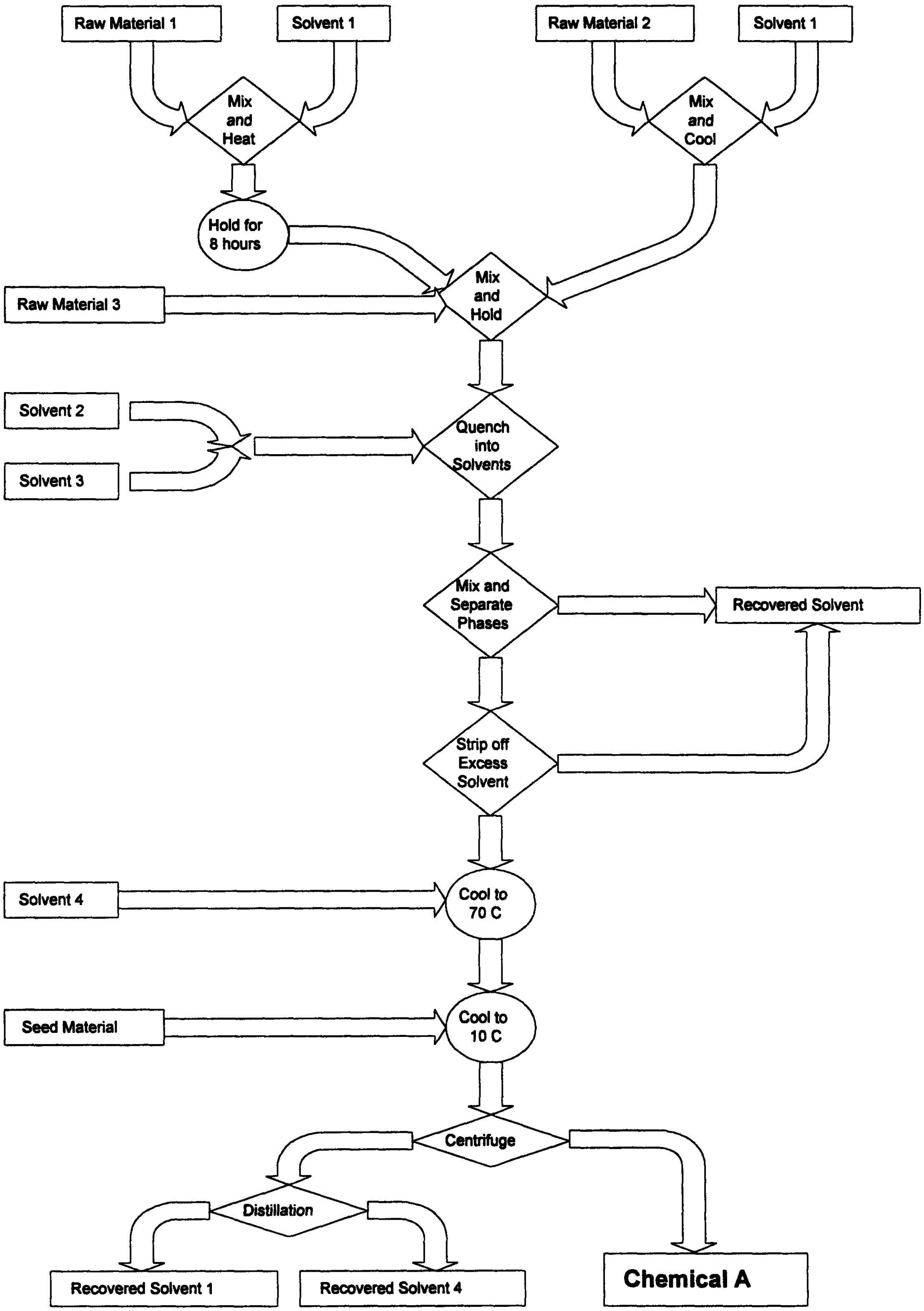
Figure D-1: Value-Added Chain of Chemical A

D.2.2 Process Description

Chemical A is the result of several process steps. A simplified process flow diagram is presented in Figure D-2. Several solvents are used during the reaction and recovered. Some of the solvents are recovered on site and the remainder is shipped out to environmental reclaimers. Most of the raw materials are purchased from vendors. The raw materials and solvents are mixed in different vessels and then combined to react. The reaction mixture is then quenched into a vessel of solvent, where two layers are formed. The remainder of the process steps is for the isolation of the product from the solvents and byproducts.

The two layers are separated by means of a visual phase cut, i.e., the bottom layer is transferred into another vessel until only the top layer remains. The excess solvent is then removed (stripped) by boiling the mixture. After adding another type of solvent, the mixture is cooled slowly to cause a crystallization. A seed material is added to initiate the crystallization process. The product crystals are then washed with more solvent in a centrifuge (a high speed rotating drum filter to separate solids and liquids), where any impurities are removed. The final product is then scraped from the centrifuge walls and packed into lined drums. After sampling the drums, the product is shipped to a warehouse where it is stored until needed for use in other reactions.

Figure D-2: Chemical Reaction Flow Diagram



Appendix E: Glossary of Terms

Language is an important aspect of organizational culture. In some cultures, the same words have different meanings. Language evolves as a culture develops, and the significance of certain words and phrases are learned only by observing and experiencing the culture first hand. The following list contains a small sample of the words and phrases that are used in the Chem Ops culture.

Blue collar workers, The employees performing physical labor in the plant. This group includes the operators, supervisors, maintenance and support functions as opposed to **White collar workers**, who are engineers and administrative staff (personnel, accounting and managers.) The two groups affectionately refer to each other as **grease monkeys** and **pen-pushers.**)

CDL, Chemical Development Lab, the R&D facility in Cambridge. Most chemistry manufactured at Chem Ops have their origin in this department.

Cost Center, All products delivered to customers are charged at predetermined transfer price, which is allocated to direct and indirect costs (as opposed to **Profit Center**)

Customers, The Polaroid divisions to whom Chem Ops deliver chemical products (Also called **outsiders**)

End-User, The consumer, the person purchasing the camera and film for their own use.

Exempt, Employees who are compensated based on annual salary (Non-exempt describe the hourly wage employees, this group includes operators, maintenance functions and custodial staff)

Go on break, Operators are entitled to intermittent breaks. During the day they will go hang out in the "room", or outside if they smoke. At night they kick their feet up and have "catnaps" in offices or in the cafeteria.

Henry Perkins, A British Scientist from the 1800's who did much work in the area of dyes and organic chemistry. The Chem Ops division was named after Perkins.

Microcosm, Chem Ops is a microcosm of the Polaroid population in terms of culture. The cultures are similar yet has unique characteristics.

Not Invented Here (NIH), The term used to describe a close-mindedness to ideas that were not originated from within the organization. R&D from Cambridge is accused of not being open to ideas from operations for improving the process and product.

Package job, When a load from the filter press or the centrifuge has been completed, the tasks of packaging the material usually requires a few operators to drop the material from the equipment and another to catch the load in a drum, where it is tied up in plastic bag, samples are taken and the weight is recorded.

Professional employees, Personnel that have at least a college education, including those with advanced degrees.

Profit Center, Divisions that have their own profit and loss responsibilities, they normally operate more independently of the parent company.

Rapid Scale-up, A new chemical product is scaled up from bench scale to pilot scale to production scale quantities. Chem Ops claims that they can do it quickly or rapidly. Whereas rapid scale up intently reduces the time to market of new products, a consequence of this strategy is that Chem Ops may manufacture a product without really understanding the chemistry behind it.

Richard E.T. Brooks, Original Chem Ops plant manager who was instrumental in the founding of Chem Ops and the expansion of W-6X. After failing to persuade Polaroid to supply more chemicals to the outside, Brooks left Polaroid to start ChemDesign, a specialty chemicals company that was recently acquired by Mills Chemicals, a subsidiary of Bayer, Germany.

Scale-up, When a product has been developed in Cambridge R&D, it is scaled up to 20 gallons or so in a pilot facility. It then can be scaled up to 50-100 gal in W6, which is enough to supply initial commercial demands.

Sunshine Dyes, Opacification Dye, it blocks out the light while the negative is developing, and becomes clear when the development process is complete.

Supervisor, Oversees the plant operations and personnel of a certain plant for a certain shift, e.g. one for each shift for 6, 6X.

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