Helios: The Final Chapter at Polaroid

An Interactive Qualifying Project Report

Submitted to the Faculty of

WORCESTER POLYTECHNIC INSTITUTE

In partial fulfillment of the requirements for the

Degree of Bachelor of Science

By

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Date: June 4, 1999

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Acknowledgments

I would first like to thank Professor John Wilkes for his assistance, advice and understanding throughout the project. Next, I would like to thank my contact at Polaroid, Don Foster. Don took time out of his very busy day to help me with many aspects of my project. He familiarized me with the background of the project and with what was happening around him during the time of chaos which the plant was in at the time.

Don was not the only person to help with the completion of the project. I would like to thank the three groups who previously completed projects dealing with the Helios project and NB6. Without them, my project would not exist.

Also a special thanks to my family for helping me as they always do.

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1.0 Introduction

This project completed the four study series of Polaroid's Helios Project sponsored by Don Foster, a senior engineer who was recruited to the project during its R&D phase, he stayed involved with it until his retirement which was shortly after the technology was sold by Polaroid. This was partly a case study of the unraveling of the Helios product development project at Polaroid, and partly an attempt at theory testing using cognitive styles. This was the be the final step in testing Don's theory of how the cognitive distribution among contributing technologists evolves in response to the changing task environment, created by the product development cycle, as a product matures. However, a stable production environment was never created long enough to be studied, thus the study goal has changed to one of just predicting who could work best in the turbulent environment of NB6 during the end of the project.

The focus of the study is the NB6 plant, located in New Bedford, MA. This is the second time that a cognitive styles distribution study has been done dealing with the NB6 facility. The first study (Heath and Smith, 1996) dealt with the opening of the plant by its "startup team" in the mid 1990's. This study dealt with the conversion, sale of, or threatened closing of the NB6 plant due to Polaroid's divesting the Helios technology, abandoning it as a possible new core technology. By abandoning it as a possible new core technology, Polaroid put the future of NB6 in doubt. Once the favored son, it was now an orphan.

The prior three cognitive styles distribution projects used procedures that were based on easy access to the technical staff on the 8x10 design team, the 14x17 redesign team (and a fair amount of cooperation), all arranged by Mr. Foster himself. With the

start of this project it was known that Polaroid was no longer eager to see the Helios team studied. Therefore, it became very difficult to use all of the invasive types of measures employed in the previous projects. There was also little trust left on the part of the staff due to the constantly changing atmosphere of NB6 so "studies" were likely to be viewed with suspicion. However, Mr. Foster reported that at least some employees were ready and eager to "vent" their feelings and share their observations.

The original study plan included one hour interviews with many of the current employees behind closed doors in order to do a in-depth case study analysis of reaction by technical and operation groups to this turbulent task environment. As part of that interview cognitive style data was gathered so that the distribution of the employees could be compared with that of the distribution of employees who opened the plant and filled out the cognitive indicators in the previous studies. As explained later in this project report, it was not possible to complete the project as initially planned, but a good approximation was possible. I did as much as possible to test the theory within the limits of available data, while describing the situation that emerged at NB6.

As noted, the original study design was based on interviews, but it has since evolved into a survey approach, with 2 survey's fielded to his coworkers by Mr. Foster, one to serve the case study aspect of the study, and the other to measure cognitive styles. The second one will also provide a point of connection to the prior studies tracing the evolution of the Helios project from R & D stage, to the redesign stage, and on to the large scale production stage.

At the present time it is hard to describe the condition of the Helios project since it is essentially over at Polaroid but is continuing elsewhere. It was expected that by the

time of this fourth project, NB6 would be a mature production plant. Thus, studying it's staffing now and comparing it to the earlier study of the plant's staff at opening would have been a worthy but straightforward research effort. But due to the lack of success of the Helios project, NB6 was not at the mature production stage this year. Hence, all of the preexisting predictions suggested by prior research teams was worthless. This project will describe what is left behind at Polaroid's NB6 plant after Helios and what the most likely cognitive distribution at NB6 would be today based on theory. The theory being tested is no longer that offered by Don Foster five years ago. He has no idea what to expect now, and it is findings gathered elsewhere by Boynton et al studying student teams at WPI, which was the basis for my predictions.

With the change in circumstances it may be difficult to see what is left to study. But by looking at what has happened, and what is left of the team assembled to open NB6 to do the final steps of the Helios project, an interesting story emerges. Truly, it has become the story of the rise and fall of the Helios project at Polaroid, where the engineers claim a great technical success, yet management decides to abandon the project altogether and take a $1 billion loss. Why? Who miscalculated, when and how? To some extent we have a post mortem case study. However, in addition to NB6 employee perceptions of what has happened, this analysis of Helios is informed by some very interesting cognitive data gathered by earlier research teams that suggests that there were early warning signs. Clues about what went wrong and why, can be found both in the way within the 14x17 redesign team was created and later, in the way NB6 was staffed. Management seems to have misjudged the nature and magnitude of the task and sent the

wrong signals out a few times. Polaroid may have recruited the wrong people to Helios at key moments as a result.

Attempts to get the management side of the story were not successful. Phone calls were not returned, no interviews were offered, and the company was understandably reluctant to be placed under such scrutiny at that time. Still, one is left with a suspicion that the time frame was too short and that missing the narrow window of opportunity caused the problems that laid the Helios project low. Timing issues in which management tried to phase things in too rapidly, given the challenging nature of, and existing state of the technology and the limited market for the Helios products could have turned a belated technical success into a financial failure. The overhead of running a plant that is not yet needed, built too soon and at too large a scale, could threaten even a healthy company. Polaroid was not healthy at the time of Helios. This project was carried out with normal operating on investment funds, but rather on the basis of a one time cash infusion. When the investment fund was exhausted, it was gone forever.

This project moved from being a descriptive case study to a comparative analysis and finally conclude with some grounded speculation about why the Helios project was not a success for Polaroid. The story of the Helios technology itself is far from over. Still, any future Helios imaging system film medium research or production will not take place at NB6 or anywhere else in Polaroid. Other companies have bought it and numerous NB6 people are moving to a new plant in NH. This was started by a Polaroid Helios refugee to serve the graphic arts market. This new plant seems to be the emerging center of activity for Helios in its reincarnated form.

In summation, the current project focuses on how the social and organizational setting of the NB6 production facility set-up by Polaroid, in a period of organizational change, impacted the outcome of the Helios project. From a Polaroid perspective Helios must be considered a failure, but on the technology side those involved claim that success was attained by being able to create this new product and setting up a process for producing it in quantity at a high level of quality. Whether or not there was a ready market in place when they got done with their part they do not consider their responsibility.

The Helios technology itself is probably catching on and will bring profit and honor to other companies that will benefit from Polaroid's 1 billion-dollar investment in Helios. Polaroid itself may not survive what it considers to be one of its greatest investment errors. The people who created Helios are now divided between those who have left the company to stick with the concept, and those who have stayed with the company and left the Helios project. I will attempt to predict, based on cognitive theory, who did which and what the resulting cognitive distribution among the engineers on the technical staff at NB6 should be. I'll start by fully laying out what the situation was at NB6 when things started to unravel, and Polaroid gave up on the project. What the task environment was like and who can function under those conditions is key to the predictions to be made.

In particular I examined the widespread belief at NB6 plant that they did nothing wrong and management failed them, giving up too soon. I suspect that there was a window in which the technical people had to deliver this product and get NB6 paying for itself or the plant would have to be divested and for some reason management decided

not to tell the NB6 staff what was on the line. Did the technical people deliver too late? Were the managerial demands and expectations realistic? Who miscalculated, how and when? It is possible that the 14x17 team was too late to get to market and NB6 were therefore built too early to pay for itself given the slow buildup of the market for Helios film based products.

A key factor contributing to the completion of this project was the assistance of Don Foster. He was the man who originally suggested the paradigm cycle and the product development cycle analysis. He was the inside contact who provided access to the other teams in the past. For this project he is a full partner in research design, as well as the prime interpreter of internal events. All of the studies that Don has been apart of have dealt with the Polaroid sites that he has worked at. For the ten years the WPI Helios research project has been shaped by his career decisions.

2.0 Overview

This project will complete the four study series of Polaroid's Helios project. It is the second to focus on the high volume production facility in New Bedford, MA., called NB6.This plant was designed to manufacture the new carbon based Helios film "medium" (black and white), though it has since been put to other uses. Helios is the name given to the imaging technology process that uses laser etching to form a picture that is of better quality than a normal x-ray. There are various artistic applications, but the major market was expected to be in medical imaging since it is a black and white (grayshade image). (See appendix for technical description provided by Polaroid)

The first size image that Polaroid began with was the 8x10 inch size. This seemed to be the best low competition market to enter while perfecting the process. The 8x10 R&D team was studied inadvertently by Boynton et al. in their 1988 study of R and D and design teams, including both student and corporate teams. Due to the fact that the typical chest size x-ray is larger, Polaroid later formed a 14x17 inch development team. This team was assigned to perfect the process for a highly competitive imaging market while increasing its size and changing the imagers configuration to fit the space taken by existing x-ray imaging machines in a lab of this kind. The 14x17 team was the focus of the second mechanical design group study carried out by Campbell and Convent (1994). The third project was completed by Heath and Smith in 1996 and dealt with the start up (or implementation) team that opened NB6. NB6 was an experiment for Polaroid organizationally as well as technologically. This was the first time that Polaroid had used an organizational arrangement that was highly decentralized, heavily automated and

aggressively cross-trained. This led them to blur the lines between production, support, engineering and management.

The recruitment process for the NB6 staff was elaborate and unique within Polaroid, with the existing staff taking the time to review role playing exercise results in selecting each new member of the NB6 team. About two out of every ten applicants received an offer for a job at NB6. The idea behind this process was to produce a loyal, stable, committed and talented team with minimal turnover. Flexibility and interpersonal skills were key criteria for an offer to come work at NB6.

The focus of the startup team project was supposed to be a comparison of the cognitive distribution of the mechanical design team (the 14x17 team) to that of the manufacturing engineering group assembled as the plant implementation team. There was a theory about how the members of an R and D team and a mature manufacturing production team would differ but no one had studied the transitional stages of second generation design revisions (14x17) and a plant start-up (NB6). The theory about whether they would differ and how, was highly speculative. Further access to these teams was dependent on the career movements of our main contact, Don Foster, who was admittedly seeking out the parts of Helios he was attracted to and found challenging. This suggested that redesign and start-up might really be very similar task environments. Observers had expected him to leave NB6 when the facility was running smoothly, a mature, stable and predictable process of production. He was the type of person that we thought would be too bored at this job if he stayed longer.

However, NB6 was never to reach maturity and stabilize. Technological turbulence and shifts in managerial and corporate philosophy combined to bring about the

sale of the Helios technology to another company. NB6 was now an orphan, without a mission at Polaroid. Hence, the production people had to learn how to produce a variety of products to justify this very expensive (high overhead) high volume facility, when it was not fully committed to producing what it was designed to produce, the Helios film medium. However, they still needed to produce the Helios medium for the buyer under terms that left them running at a loss unless production costs could be cut or quality requirements reduced to minimize wastage. The pressure to innovate, change and adapt the system remained in place at NB6, four years after it was up and running.

This situation coincided with rumors about the sale of the plant and the possible failure of the company, the actual divesting of other units and facilities, seemingly sold to keep the company afloat until a new product could be marketed. Morale was impacted, the unique organizational setup was undercut and made more traditional. Continuing turbulence caused many to leave and seek other employment options. Most of the people who had been attracted to the Helios concept had migrated to two companies, one in NH and the other in NJ. The prevailing uncertainty is a main reason why this project is under such time restraints and must be completed this academic year.

So, the story line of this 4th study deals with the last gasp of the Helios effort at Polaroid, and the conversion of NB6 to other purposes. The details of this topic will be further explained in the overview. There will also be an effort to "finish" the cognitive profile series began as a way to study the product development cycle. I will be trying to do as good a job as possible (under the circumstances) at estimating the cognitive profile of at least the engineering and managerial components of the NB6 plant. These were the groups that are most consistently present as one goes from the 14x17-team design team to

startup of NB6, and then conversion to other uses. Distinguishing those who stayed on and those who came in as replacements for those who left will be the new focus of the cognitive part of the study.

In its final form, this study was based on the results of 2 surveys. The first dealt with some sensitive topics about conditions at Polaroid in general and NB6 in particular. Some NB6 people were eager to "vent", yet others were reluctant to say anything. The original purpose of the first survey was to look at the present group of employees at NB6 to see how they interpret and feel about what is happening around them. This provided an interesting story about a production environment during such a turbulent time in Polaroid's history, in short it was to be their story, a case study about the prevailing conditions and a description of the task environment.

The second survey was designed to avoid all controversy and thus involves taking a methodological risk. It adopts a new indicator of cognitive style that is still experimental. However, it is unobtrusive and can be done without have to administer the test in person, unlike the cognitive styles administration method used by Heath and Smith. Our contact sized up the situation and decided that there would not be enough cooperation to allow for comparable data collection. He did feel that this indirect indicator could be used and that its trial results in a Gillette R&D lab suggested that it was promising. Further validation work already planned would reveal whether an acceptable proxy had been used in the final Helios study at Polaroid.

This will end up being a summary project, focusing on how the social and organizational setting of production in Polaroid, during a period of organizational change, impacted the outcome of the Helios project. From a Polaroid perspective it must be

considered a failure. However, the technologists involved have succeeded in creating this new product and a process for producing it in quantity at a high level of quality.

The technology itself will bring profit and honor to other companies that will benefit from Polaroid's 1 billion-dollar investment in Helios. Still, Polaroid may not survive what it considers to be one of its greatest investment errors. The people who created Helios are now divided between those who have left the company to stick with the concept, and those who have stayed with the company and left Helios. I attempted to predict, according to the data based on cognitive theory, who did which, after fully laying out what the situation was at NB6 when things started to unravel, and Polaroid gave up on the project.

In particular, I examined the widespread belief at the NB6 plant that they did nothing wrong and a new management "without vision", gave up too soon. I wonder if, from the perspective of management, there was a window in which the technical people had to deliver this product and get NB6 paying for itself or the plant would have to be divested. Did the technical people deliver too late? Were the managerial demands and expectations realistic? Who miscalculated, how and when? It is possible that the 14x17 team was too late to get to market and NB6 was therefore built too early to pay for itself given the slow buildup of the market for Helios products. Without printers in the field there is no clear reason to buy the film produced at NB6.

Clearly something went wrong, and as a management engineering major doing a technology and society project in which the social shaping of technology is supposed to be the subject, I want to see where the fault lies. Based on the story about what has happened from an inside contact, and a survey to see how broadly those visions and

perceptions of the situation are held, I was able to draw some conclusions. However, double checking the employee perception of what was done, when and why, required an interview with top management. A limited attempt to contact higher management was made, to no avail. Hence, I fairly represented the management perspective myself. There is probably some sort of information on management's dilemma that is not being looked at. A clear effort to be balanced is being made and an article on things at Polaroid did recently appear in a local magazine and will be drawn from as appropriate. Certainly this article lends credibility to the comments of those at NB6 critical of management that the current leadership is orientated toward marketing rather than technological innovation and is not even willing to maintain existing production and storage facilities, but wants to sell assets and outsource as much as possible. This is a major change in the Polaroid Corp. culture. In this paper, I will be starting with the company and its founder and try to make the contrast between the past and where they seem to be going now at Polaroid.

2.1 History of Polaroid

Over the years Polaroid has had a history of making groundbreaking technology work. The founder of Polaroid was Edwin Land. As a young man, Land was first introduced to the idea of science when he first saw a polarizer that would take the glare off of a tabletop. From that day forth he was a man who was determined to lead the race to invent new technology that would be useful in everyday life. Five years after seeing this polarizer, Land began extensive tests of a new polarizer that could be used to help dim the headlights of cars. For years after that Land worked on a design to make the original polarizer more effective. With this development, he received the first 535 patents of his career, paving the way for many more to follow in the area of light polarization. Land's total of 535 recorded patents is second only to Thomas Edison in the annals of the US patent office. Land then received contracts from General Motors, American Optical, and Eastman Kodak for the rights to use the polarizer that he had developed. In 1937, Land sold the first shares of stock for his new company, known as Polaroid.

In late December of that year, Land first developed the concept for instant photography. He wanted to see whether or not a process that would faster than the laboratory based photographic method of the time was possible. In 1948, the first Polaroid Model 95 cameras went on sale. As time went on, the development of the instant camera resulted in continuous improvements of picture quality. Instant Color photography followed the development of color photography quite closely.

Following the continued success of the instant camera, Polaroid decided in the early seventies to invest large amounts of money in the development of an instant movie camera, to be called Polavision. Polavision was a very difficult project and in the end a

technical breakthrough, but a marketing failure because it was competing with the just-emerging consumer video recording products. Polavision could have been a significant success 10 years earlier, but because Land was focused on the new SX-70 photography, the Polavision technology sat on the shelf in R and D for too many years, it missed its window of opportunity. The development of this product took close to ten years once it was seriously undertaken. Polaroid decided to write-off Polavision just after perfecting it. Land had considered this his "pet" project, during the last few months of the Polavision project, Land fought hard to try and keep it as a product, but in the end the board of directors made him write off the rest of the inventory for the Polavision in 1979. Some say that he waited too long in getting it out to the public (wanted it to be perfect) and missed a chance to market test the idea before the video camera appeared. In any case, this was a major disaster for Land, because it was his personal project, so he had invested a great deal of personal time in it. Until he was able to leave this technology behind and admit that he missed the opportunity to make the niche in the market that he wanted, Polaroid could not seriously pursue other investment possibilities.

For many years Polaroid was the leader in the market of instant photography and the plan was to become the leader in the new market of instant movie cameras and have another 10 year lead on the competition. The new video technology not only cut off the line of development Polaroid was pursuing in movies, but signaled the entry of digital technology into the imaging business more generally. The invention of the VCR and spread of other videotape devices were a threat to Polaroid's core technology and overall existence as well. When still color pictures and color-moving images became comparable in cost, there would be fewer and fewer applications for the existing instant photography

system. The cam-corders were still very expensive, but the handwriting was on the wall, Polaroid needed a new core technology.

During this time many different side projects were underway, but none had really developed into being ones that could help Polaroid move to another market and maintain its stature. Due to the Polavision losses there was little money for investment as well. However, funds soon became available, as a long standing lawsuit Polaroid brought against Eastman Kodak for copyright infringement of instant photography was finally resolved. The lawsuit first went to court during the late 1970's, however no verdict was reached till 1985. At that time the US district courts ruled that the patents held by Polaroid were infringed and that Kodak should leave the market and pay Polaroid for any lost profits.

This was a major advantage for Polaroid due to the fact that the court ruled that they had the dwindling market for instant cameras all to themselves without competition, and they could now invest in new R&D. The verdict of this court case gave Polaroid a large sum of money, nearly 1 billion dollars, the largest patent infringement award ever. Of greater significance, this was the chance to take a step toward a related new technology that they had yet to seriously develop as their response to digital video technology. Would they "fight" or "switch"?

After the leaving Polaroid as chairman, Land started a pure research organization called The Rowland Institute, only 1-mile from Polaroid. Hence, there were a variety of smaller projects that had been in the works on the fringe of Polaroid to be examined and saw which had the greatest promise as a new "core" technology for the company. One of these projects was the Helios Project.

2.2 The Helios Project

2.2.1 The Helios Image Printer

At first the engineers of the original Helios group had envisioned Helios technology as being the next step in x-ray imaging technology. The basic idea of Helios is to use a laser beam to etch the image of what was desired onto a black and clear or transparent medium (this had not yet been specified). In short, they were trying to replace "wet" x-ray lab processing with a "dry", "instant" imaging technology which was what Polaroid had a reputation for doing in other fields.

The first problem that the engineers had was how to use the laser in a way that would produce an image better than that of the basic x-ray, which was a reasonably mature and largely perfected technology. Others companies in the film industry (such as 3M) had tried, and failed, to do laser etching, but fancy chemistry in multileveled coatings on film media is something Polaroid people knew a lot about, and the prototype system showed promise.

The first production size image that Polaroid decided to work with was 8x10 inches. The reason for choosing this was to try to make a size suitable for the doctor's office or a hospital radiology lab with a moderate level of quality. This was to get experience rather than a lot of money. Only 5% of the medical imaging market was 8x10, so this was not going to be a visible threat to established competition. The highly competitive, high end, demanding market was for the 14x17 chest size images. They would ultimately need to enter that very quality sensitive market when the technology was developed enough to be competitive. The busy high-volume hospital and clinic x-ray departments would require a whole different size and shape of medium as well as larger

sheets of the film medium. The time that was needed to get 8x10 working reliably was longer than they had anticipated, thus causing trouble with getting on to the 14x17 project which had a chance of actually making some money. In the end the lagging 8x10 and new second generation 14x17 projects were run concurrently, with some 8x10 people being reassigned to the scale-up and as time went on, more and more people were assigned to the Helios project, both image system and medium devlopment.

The make-up of the medium that is used for the Helios camera is very clever in design. It is something that has never been done successfully before, therefore there was really no precedent as to what direction to head with the design and make-up of the medium. A black and white picture (with all shades of gray) is really made up of many small dots. The trick is to "punch holes" in the carbon layer above the vinyl carrier, and remove different amounts or percentages of the carbon based on the intensity of the laser beam. In this case, the covering layers were to be stripped away and the final carbon layer re-coated with a stabilizer to make a permanent image. So, the more intense the beam the more carbon gets "stuck" to the peel away layers and removed in nice neat microdots.

Actually it is more complex than that, and there are really six layers of varying thicknesses that compose the medium. The laser then enters the first few layers interacting in various ways, finally making an imprint on the medium that shows up as being the picture produced, when the over-layers are removed.

The 14x17 machine was going to be very expensive and might have to be sold at a loss, but this was not that unusual for Polaroid. They would gladly give away a camera if you had to come to them and them alone for the film, and had been selling instant cameras at a loss for years. The money would have to be made on the selling of the

medium used in the imager. This can be looked at in the same way as Gillette sells their razors. They way that they market their product is by pretty much giving away the razors, while making the money back many times over on the blades. Hence, the medium would have to be produced cheaply yet be reliable and result in a stable archive quality image as part of a medical record for Polaroid to make money on the systems as a whole. The extra time and effort spent on developing production prototypes for the medium worked out in the end, as the medium was finally developed in such a way that it could compensate for problem in the imager and could still be produced in large quantities at low cost.

2.4 NB6 – Polaroid's Full Scale, High Volume (Helios) Film Production Plant

The study site for this project will be the New Bedford #6 plant located in New Bedford, Ma. and part of the Polaroid corporation. The last full-scale production plant built by Polaroid from scratch was NB1, and that opened 20 years earlier. NB6 or the High Resolution Medium Manufacturing Facility was built in 1991 as new home for the carbon based Helios medium production system. It would be a vastly scaled up version of the Waltham plant that had produced the medium to feed the 8x10 system then in use. The value of the plant has been variously quoted as being close in the 100's of millions of dollars

One major thing that sets NB6 apart from other production plants of this scale was Polaroid's experiment with a new organizational structure as part of the opening of their facility. Prevailing notions of how to organize a plant as to sustain high innovation levels suitable for this new technology had changed in the 20 years since NB1 was built. Many companies in today's business environment have changed their organizational structure in order to be more adaptive to an ever-changing business world. A more basic reason for

the lean, highly automated NB6 layout was that to make Helios pay, Polaroid had to be efficient in medium production. Polaroid had "upfront" money to invest in plant, compliments of Kodak , but had to keep operating costs low so as to make up losses on etching devices in film sales price. It had to be cheaper (than it looked) to produce. The change would cause the company to create a small, "elite", well paid but cross-trained work force. In effect, management was prepared to delegate authority to the NB6 team if it was elite, select, accountable and a predictable fixed cost. They could indulge in lots of training and see their salaries rise the more things that they knew how to do, but they were to be on salary, not hourly wages. Tradesmen, such as plumbers and fitters, would have a second production function, production people would understand the safety and maintenance tasks, engineer would do quality control, etc., but the size of the entire staff would be small, $1/3^{rd}$ of the size of the workforce that opened NB1. The idea was to minimize turnover and maximize team loyalty, interdependence and esprit de corps.

The selection process was a grueling day long set of role playing and teamwork exercises with about 1 out of every 5 candidates being selected by their coworkers to join the plant workforce. Their decisions were typically based on how they tackled problems and interacted with one another. The process was costly in time by the rest of the staff, but viewed as an investment, a hedge against heavy turnover in the future with attendant training costs.

The salary issue was resisted by the production staff operators, who were fearful of the unpaid work time during the understaffed start-up period. This feature of the NB6 plant was finally dropped by management. However, a relatively decentralized system was established in which each person had a certain dollar figure they could spend on their

own authority, and larger amounts they could spend by going to a committee of peers without seeking management's approval. The lean NB6 team was soon considered a privileged group at Polaroid, part of the future, the prototype for the new Polaroid Corporation to follow, as well as the next technology "leap" the company would make. The fate of Polaroid was placed into the hands of the NB6 staff. Everything else was considered to be holding operation, to buy time and provide resources to make the transition to the new core technology.

2.5 Development of Helios at Polaroid

Polaroid is known for its risk taking in the technology of new products, and Helios is in the tradition of converting wet imaging technology to dry for which the company was known. However it was truly an effort to create a new core technology using a new film material and etching process using light in a new form.

As noted earlier, Helios was not only the small fringe project under development by Land and Polaroid, there were several clever technological projects under which management viewed as having the potential to repeat the success of the instant camera, including Helios. It is not clear why Polaroid management bet so exclusively on the Helios, but they did. In 1982, there were 5 people working on the Helios project at the Cambridge, MA. plant. That team worked on the basic chemical and technical features of the Helios process. As the development of the Helios continued there were more people assigned to the project. After the technical group proved that the concept was feasible in 1986-87, the project had grown to the size of 15 people. In 1988, the Helios project took

major strides because in that year Polaroid had won the court case against Eastman Kodak for an amount close to $900 million.

With a confident hold on the instant camera market and new funds, Polaroid selected Helios for development out of the as yet unproven projects. There were two especially promising projects that Polaroid had in the works; the Helios laser etching project, and a magnetic storage medium project that still needed more development. Polaroid chose to invest more time and money in the Helios printer for the medical market. Later commercial art would emerge as a second potential market with less demanding technical requirements and large demand for the new medium if sheets larger than 14x17 were available. Perhaps top management felt that Polaroid was not in the magnetic (digital) business but rather in the imaging business though they had tried to produce some videotape and come up with an early high-density diskette. Both were technical successes, but not marketed effectively due to their relative cost. So, perhaps Polaroid's leaders felt they'd had some bad experiences when trying to enter the digital field of information storage.

As we know in the end, Polaroid decided to build a plant that would house the developing Helios-related products. The plant, known as NB6, was built next to a 20-year-old plant (NB1) in New Bedford. Over time NB1 had reduced its staff by 1/3rd and become a model of production efficiency using the old silver halide technology which has been standard in the photographic film industry. NB6 would start with a staff half the size of that at NB1 after it had been trimmed down. In effect, Polaroid bet the future of the company on leapfrogging the technology in the field of imaging. Still, the plan seemed conservative. A new film process would emerge out of initially black and white

market, focusing on x-rays and other medical images, with color images and the potential for a broader market developing later.

The case for Helios was to be "environmental" friendly as well as economically sound. Though the cost of the new image would be a bit higher per image than that of the existing x-ray systems at the outset, the fact that they were ready immediately requiring no lab, no technician, not toxic chemicals to dispose of and saved space in the hospital was likely to be very appealing. The only waste would be the peel off covering and that was to be re-rolled and sent to Polaroid for recycling. The vision was pretty appealing, one could be environmentally responsible at no extra cost, and more efficient with fewer toxics around to create safety and disposal problems. The question was how likely would the idea catch on, hence how rapidly the demand for the volume of imaging medium NB6 was designed to produce would materialize?

2.6 Background of the Cognitive Comparison

The Polaroid (Helios) studies at WPI were originally undertaken to compare the technology (product) development cycle with the paradigm cycle in science. Wilkes (1976) demonstrated a shift in emphasis from Differentiation to Remote Association ability in the cognitive profile of scientists in 4 different fields (Physics, Chemistry, Economics, and Sociology) and predicted the differences between them in terms of the paradigm theory. Could WPI student teams do the same as the Helios project developed through stages from the 8x10 mechanical design team to the 14x17 mechanical design team? Could the makeup of the team that got the NB6 plant up and running, be predicted

in comparison with the team that ran it in steady state after the bugs were worked out and the procedures were specified? The key to such predictions was to specify the task environment. The two cognitive qualities being measured dealt with having a special talent for conceptualization and diagnostics as opposed to intuitive problem solving ability or ingenuity.

As the Helios project approached high volume production, data was collected in order to try to compare the cognitive style distribution of the current employees at the Polaroid plant NB6 to the earlier start-up team. Heath and Smith studied the NB^ workforce about one year into the plant opening and start-up process, when an implementation team of about 70 people labored to get the plant operating. While the primary comparison will be with the1996 study that dealt with the start-up team at NB6, comparisons with the earlier Helios mechanical design teams are possible. The following description includes excerpts from previous studies and from the essay written by Prof. Wilkes, "Niches and Strata in Science", published as Chapter 10 of Shadish and Fuller's "Social Psychology of Science".

> Today's perspective on cognitive styles took shape in the 1960's after the organizational behavior studies of innovation by industrial scientists. Gordon and Morse (1969) developed the two step model of the creative process, distinguishing problem formulation from problem solving. This model sparked ongoing debates about how many different types of creativity there are. The pre-existing measures of creativity were based on Guilford's notion of divergent thinking. Following that, measures were combined with IQ measures (convergent thinking) to assess people's ability to handle the problems of the later stages of creativity. Gordon challenged the idea that divergent thinking comes first, noting that his "differentiation" measure seemed to reflect an early problem forming and diagnostic stage, after which divergent thinking and especially convergent thinking were relevant. Further, he parted company with other people in his field by selecting Mednick's controversial remote associate measure, rather than a measure of logic or I.Q. to reflect the ability to bring innovative problem solving to closure. In so doing, Gordon adopted Mednick's Remote Associates Test as an indicator for the second step of the creative process. Both remote association and

differentiation were successful in predicting performance in industrial R&D, although neither of them was highly correlated with each other.

Cognitive style measures are used to describe and quantify the creativity of processes and solutions, not the creativity of individuals. The main reason that these tests are given is to see how the person thinks, and not how creative the person is under all circumstances. Using two different indicators helps the researcher reach a conclusion as to what cognitive type a person is studying. The data indicates where each person fits in the cognitive styles typology developed by Gordon. A person can be either a local or remote associator. They can be differentiated or non-differentiated in their cognitive functioning. In combination one can produce 4 cognitive patterns or "styles".

"Remote Association is the ability to make connections between abstract and seemingly unrelated ideas and concepts. This ability allows someone to make the connections leading to a "creative" solution from the known element in a given problem domain." (Wilkes) Word games are used as the best method to arrive a data that can be concluded as to which of the groups they best fit in. From these word games, an estimate can be made as to whether the person is either a remote or local associator. The word game indicator involves grouping three seemingly unrelated words and asking the subject to respond with a word or explanation connecting the words; the groups constructed such that there are right answers, is only one "correct answer". Each subject is given one minute on average to answer for each word triplet, allowing for analysis of response time. The number of correct answers in a given period of time results in the subject being characterized as either a remote or local associator.

Differentiation is defined as the ability to discern the subtle differences between concepts and ideas. The ability to make distinction between subtle, minute, or ambiguous dissimilarities is crucial in the creative process in that it forms the basis for criticism, diagnosis, and distinguishing what is relevant from what is not. The measurement of differentiation ability is done through a slight of hand. The subject is asked to rank ten fellow employees on a scale of one to ten on such vague criteria as creativity, sociability, and commitment. From this indicator, one is able to see how the person answering the question views of 10 fellow employees. Although they rank their fellow emplyees, the idea is to be able to tell whether or not the respondent is high or low in the category of differentiation.

From previous studies some conclusions can be drawn of about people who have taken the differentiation test. Differentiators perceive their environment as broken into distinct parts, attending to unique qualities of things and people, and drawing subtle distinctions based on nebulous or subjective criteria. In contrast, non-differentiators are bound more by preconceptions and see the environment as homogeneous, tending to suppress discrepancies. Sometimes being a non-diff. is considered a negative quality, although it can also be a positive quality because differentiators are more likely to get caught up on details than non-differentiators.

When the results of the Remote Association and Differentiation tests are combined, a judgement can be made on a subject's cognitive style. When a subject achieves high score on both tests, he or she is considered an "integrator", while low scores on both tests indicate that the subject is an "implementor". A mix of high and one low score can indicate a "problem solver" (High RA) or "problem finder" (High Diff)

depending on whether the differentiation or remote association was in the high range of score.

2.7 Previous Projects Completed

Three projects relate directly to my project, and this project will act as a conclusion to an ongoing series of projects. The project that I am doing is acting a closing to all three of these projects. The first project, completed in 1988 by Boynton et al. is titled "Personal Factors in Group Organization". The second project, titled "Product Life Cycle (Parts1+2): The Helios Group" and was completed in 1993-94 by Campbell (part 1) and Convent (Part2). The third project, which relates most closely to my project, is titled "Helios Implementation Team and the Product Development Cycle" and was done in 1996 by Heath and Smith.

The first project focused on the relationship between cognitive types, group organization, and performance of research and development teams. The goal of the project was to examine WPI's Major Qualifying Project (MQP) and see how well it modeled the industrial R and D experience. The project team compared the cognitive styles of an actual industrial project team with those of 50 WPI MQP students organized in groups of 1 to 4 people. Polaroid's 8x10 Helios team provided data on the industrial cognitive style distribution for the project. The results of the first project were then used comparatively in the next two projects in an investigation of how the Helios team had changed overtime, as if grew and got more organizational priority. The Boynton et al project included "remote association" and "differentiation" tests for both MQP students

and industrial team members. The project team was able to categorize all of the people from each of the two samples in four major groups. The test results revealed that the two groups differed in predictable directions, as the student groups included fewer Remote Associators, and more Implementers than the Helios team at this early stage. Finally, the project team concluded that the internal group dynamics of the MQP team fit with the theory. In short, the more open ended WPI projects attracted the problem finders. In that environment the problem finders were most successful, but the problem solvers were the stars in the well defined, highly structured projects. Further cognitive opposites tend to conflict and the optimal group mix is "moderate" diversity, similarity on one dimension and diversity on the other.

Tony Campbell and Steve Convent completed the second project that was used for reference for this project. The project team predicted the cognitive make-up of 14x17 team noting that the situation was no longer ill defined. There was the 8x10 prototype but it had known problem areas, so it was still okay to critique and redesign it, rather than just scale up the prototype. This environment they called transitional, and predicted a 2 to 1 advantage of problem finder to problem solver. It also was possible to put many more than just one Helios image on a printed page. Many times 6,9,12,15...and many other layouts were put on the 14x17 size. The 8x10 prints were not big enough to accommodate the standard chest x-ray images that doctors were used to, but it could be mailed as needed. The 14x17 can not be mailed conveniently. This presented a new problem for the group working on the Helios development.

As it turned out the Helios 14x17 group was formed in two waves, one was the critics who disliked features of the 8x10 design team, and where shifted to the new

project to allow their concerns to be addressed in the second generation project. The rest did there best to get a working model of the 8x10 out the door without changing anything fundamental. A group of new people was also brought in from other projects Polaroid was shutting down in order to focus on the Helios project. Wave 1, the veterans of 8x10 turned out to be nearly balanced between problem finders and problem solvers, with a few more of the former. Wave 2, the incoming engineers and scientists, was heavy with problem solvers who had no stake in the existing design. Together they decided to change virtually everything in the 8x10 prototype except the head that held the lasers (and later they eventually changed those also). Hence, the design experience Polaroid hoped to gain from the 8x10 effort was not retained, and they essentially started over, losing atleast a year in the process, but producing a true second generation system in the 14x17 development effort. The resulting system was impressive, with new film medium gripper concept and higher image quality, a different arrangement of components to fit the tall stand alone space of the existing x-ray equipment, that Polaroid hoped to make non existant in x-ray labs.

Kim Heath and Derek Smith completed their project in 1996, which makes it the closest related project to the desired outcome. Their project ultimately diverged from what was originally planned. The project team first decided to conduct a comparative study: focusing on employee cognitive styles in "mature" and "emergent" (or "transitional") technological facilities. In addition, the team planned to use the NB6 survey and interview data to establish the overall cognitive style distribution and organization in a comparative with NB1. NB1, the Negative Film Manufacturing facility, was built 20 years ago, adjacent to NB6. However the team was unable to survey the

employees of NB1 within the project time frame. The team then focused on Polaroid's distinctive NB6 recruitment procedures, which had never been used in the company before. In addition, the team explored the decentralized organizational structure of NB6, and cognitive style map of the distribution of employees participating in Polaroid's experimental plant. Ultimately, Heath and Smith realized that, due to time constraints, the project would require a longitudinal research design. This meant that another team would have to return and collect information at another point in time in order to tell the story of what happened at Polaroid. Surveying the newly recruited employees who came in after startup, and noting who had left, was their proposed strategy for the next "team", (me).

My project includes a comparison of my methods of data collection with comparison to those of the previous project. The sample size that Heath and Smith had hoped for was 100% coverage, this is not what they were able to achieve. However, they were able to gather 50 employees at one time to administer a three-part survey. At the time, the 50 people in the Heath and Smith project represented close to 65% of the staff in NB6, and were 90% of those present at the plant the day they collected the data. The first part of the indicator was a cognitive style measure (approx. 20 mins.), and the next part was a survey to be completed at each employee's convenience. Both parts in combination measured remote association, differentiation, satisfaction, contribution, work environment preference, and perceived organizational structure. The third part of their proposed data collection was to be the Myers Briggs Type Indicator (MBTI). However, MBTI was being given to the employees by an outside consultant so they were asked to assist. Heath and Smith received some of the MBTI data later in the project, yet in the end never received the rest of the data and had to drop their MBTI based

hypothesis'. The project team concluded that their predictions about cognitive distribution were accurate. This was stretching it. The distribution may not have been surprising in retrospect, but it was not quite what they had predicted. The NB6 startup cognitive distribution is representative of a mix of the cognitive distributions found in the fields of Economics and Chemistry. In predicting "transitional" rather than a "paradigm" distribution, they probably underestimated the degree to which new recruits to NB6 were being told that this would soon be a stable, automated, high tech. manufacturing environment. The incoming employees with these expectations would be severely stressed by the actual pattern of events to follow. The situation at NB6 would be far from stable.

3.0 Hypotheses and Research Strategy

From the beginning of this project there were two issues that would have to be addressed in order to bring it to conclusion. The first issue was how to find out what the prevailing conditions at NB6 were now and in the recent past. An in-depth case study, based on interviews with selected employees covering the full range of perceptions and opinions seemed to be the way to accomplish this first task. The second challenge was how to gather cognitive styles data in an environment that is stressful, turbulent and in which management was not well regarded. If cognitive data was to be obtained, it could be used to compare to the data that was gathered by the previous project teams. It was not clear that a comparative cognitive analysis would help me reach a conclusion about the reason for the outcome of the Helios project at NB6. Still I was determined to complete the study series and suspected that the time line data on cognitive styles would be helpful.

Whether or not the cognitive data was revealing an attempt would be made by using the data from the case study and the survey, along with other information that I gathered by talking with Don Foster, my contact at Polaroid and published sources to figure out what went wrong. All this would be used together in an attempt to arrive at a quantitative description (and possibly a theory) of why the events dealing with the Helios project unfolded in so disappointing a way for Polaroid. Due to the fact that an interpretation of the events from the perspective of higher management was never received, the conclusions of this project are only based on the opinion of people at one Polaroid facility. Not only are these gathered from the lower level employees, they were the people at the plant most directly and negatively impacted by the failure of the project.

In an ideal situation all of the participants surveys from the last NB6 study would have been saved on lists, therefore making the ability to see who had stayed and who had left as things fell apart relatively straight forward. Having this data would have made it possible to complete this final project using the same measures used in the Heath and Smith study. However, to carryout the last study the Heath and Smith entered into a confidentiality agreement that prohibited retaining data with names in the computer files, nor were names required at the time of their data collection since the two surveys they used were completed at the same time and coded with the same number.

Heath and Smith offered the NB6 start-up team anonymity by using a complex data coding scheme. Then they did not mention in their report whether they actually used it to link the data they needed to connect. Their raw data could not be located to assess the problem of linkage in any case, so in effect I was starting from scratch in a suspicious and stressed research environment needing to restudy the whole population, not just the

new arrivals. We would never be able to to tell exactly who was who, but would be working with distributions based on samples of varying quality.

It was not clear whether it would be possible to say anything in the end about the cognitive distribution as that would depend entirely on the quality of the sample. Thus, I put my greatest attention into capturing the moment, telling the story of the last phase of the Helios project at Polaroid quantitatively. I knew I could do an interesting case study, whether or not it was possible to collect cognitive data to help inform it. Personally, I had hoped to understand why Helios had been abandoned by Polaroid, which was a management decision.

The major part of my project was to collect the cognitive style data from a representative group of employees at NB6. This data will be compared to the data from prior studies. There are comparability problems because the prior studies used methods that I will not be able to use for this data collection effort. The status of the Helios has changed since the first three projects were completed. At this time, it is considered impossible to get together with 50 people and have them complete a survey and the cognitive style indicators, as was done with the Heath and Smith project. Therefore, a remote association proxy that was used in Prof. Wilkes' study at an R&D lab at Gillette was adopted, along with a standard differentiation indicator. This methodology was quite different than that of Heath and Smith. Also, their survey on aspirations and perceptions would not be repeated due to the massively changed conditions at NB6. Also, Heath and Smith wanted to use the MBTI as a way of describing the group, but because the MBTI data that was collected was lost from the study, there was no comparison possible.

There has been considerable speculation as to how the cognitive styles distribution of the employees would have changed since the plant was opened. I expect the distribution to have changed, but there is another theory that since plant openings tend to be turbulent times, and things never did stabilize at NB6, the distribution will not have changed since the conditions never changed. The reason I do not expect this outcome is that the cognitive distribution of the start-up team described by Heath and Smith was a surprise. It did not look like a turbulence ready start-up team, but rather like a distribution of people one would have expected to find in a mature, stable, production facility.

Together, all of this new data, and that collected by my predecessor project teams, was combined with the information that was gained from reading about Polaroid's history (Insisting on the Impossible: The story of Edwin Land) and interviewing my contact at Polaroid, Don Foster. Some conclusions can be made as to why the certain things that have occurred has occurred. With looking at the data, it is also important to see what sort of coverage of the general population of the employees at Polaroid is covered by the survey's that are distributed. I wondered whether the time when the person arrived at NB6 would have an effect on the answer that an employee would give me about corporate philosophy and their level of optimism and satisfaction? Would the work group that they are a part of have an impact on their view of conditions at present and likely future? Do the people of the plant really understand what Helios meant for Polaroid? How would you feel about the idea of Polaroid's reverting back into an idea company with more R&D than manufacturing? How much has the level of optimism changed for the employees since the beginning of the project? It seemed that the growing emphasis on outsourcing rather than producing would affect hourly production workers much more

directly that engineers, but this was a whole plant selected by each other and trained to work well together.

The case study will be a look at the very interesting situation at Polaroid during the last days of the Helios project. The case study for this project is a story that focuses on the NB6 plant, but is really about the project.

Over the few years, Don Foster has come to WPI to speak about Helios and NB6 twice over. The very interesting organizational structure that evolved out of and helped justify the hiring process was the focus of the first talk. The second talk was on what happened at NB6 after Polaroid sold the Helios technology. Both of these occasions were video taped as part of this project series. In these discussions at WPI, Don has talked with groups of students as part of the taped sessions. Many interesting points were made in response to student questions during the discussions that were part of the talk.

After some time was spent learning the background of Helios technology, it was time to construct the "filter" survey that was going to be used to ask the first round of questions of the NB6 employees. Based on this "filter" survey a group of 12-15 employees would be chosen to help represent the full range of opinions the employees had at the time. Those chosen would be asked for an hour interview each. This closed-door session would then allow for a far closer look into how the employees see and feel about the situation around them. On these interviews the in-depth case study was to be based. However, due to time constraints and a modest response rate, the initial survey (intended to be simply a filter survey), became the sole basis for the case study. There was no time to do the interviews by the time Don Foster felt the survey was ready to be fielded.

When the initial survey was being constructed, there seemed to be so many questions to ask, yet there was a limited amount of time and space that the employees would be willing to allow for this survey. If it was any longer than a few pages, the cooperation and interest of the employees would be low. So, less was more, and it had to be brief. Therefore in the constructing of the survey, it was important to ask the important questions only, and ask it the right way since the respondents were alienated from management and suspicious of outsiders. The process of making the survey was one which involved back and forth communication with Don Foster many times in order to ensure that the questions did not offend anyone or cause trouble for the employees answering honestly during such a turbulent time. Many times Don would ask me to revise a certain question to ensure that it did not come across as biased or critical in the context in which it would be read. On the other hand I really did want to know what went wrong. He was concerned that I not display too much knowledge about the subject and the actions going on. It was very important not to show how much I knew so that the employees answering the survey would not think that I was working for the company and trying to find out what everyone thought. The employees are not very trusting, and feel that I may be enlightening higher management about who are the more controversial people.

The first five questions of the filter survey where used to establish the employee's position in the company. An employee who recently joined Polaroid may feel that the company has a brighter future, while a veteran Polaroid employee sees the company gone in a few months. Of the two I expected that the newer employees to Polaroid would more optimistic about the future of the company and Helios. Therefore it is essential that the

experience and physical location of each employee be considered when trying to predict their responses. Other questions in the first five, address employee work groups. The information is critical to the cognitive style part of the study. Past groups have carefully distinguished managerial, technical, support and operatives in their samples. The operatives were organized into teams that coat, finish, etc. At a minimum, a separation of the three main groups had to be made so that the engineers involved in different phases of Helios could be compared to one another. In this way, an appropriate comparison can be made as to what has changed since the first cognitive style study at NB6. The importance of knowing the work groups extends to the possibility of a group sharing the same opinion, an opinion different from that of other groups. With this data some possible conclusions could be made about whether or not group membership is a determinant of opinion or perceptions about the situation in a company or project.

Question six asks how employees feel about Polaroid's future. This is designed to reveal whether they are optimistic or pessimistic about the future. Some people reported that Polaroid will be gone sold in 2-4 years, while others say it may take closer to 10 years for Polaroid to disappear completely. Still others may feel that the company will last through this current down time and then thrive in the future. The focus of the company could return back to R&D or it may move to marketing, or it could revert back to manufacturing. It all depends on what direction the company leadership tries and what works. Ideas about what is the best possible direction for them may or may not be a matter of wide agreements. The responses will reveal how some of the employees of Polaroid see themselves and its future.

The next question is designed to uncover trends. The employees are asked to think of where the company was 5-10 years ago, and project where they think things will be in another 5-10. This information will be used to identify what has changed within the company and how those changes have impacted Polaroid's future. Some may feel that over the last five years the focus has changed greatly while others feel that it has not changed much. But the question was designed as it is based on Don's expectation that the employee will report that the company has changed a great deal in the last 5-10 years.

Questions 8,9,10 are all designed to see how each employee feels about the Helios project and the revolutionary organizational structure that was used at the opening of NB6. This will indicate how their perceptions of what has happened and what is going to happen has changed since the startup period of NB6. This question leads into a final open-ended question that allows the employees to voice their opinions. The employee can explain how they feel about the company has taken in recent years in their own words. This final question also presents risks that some employees may feel that this is a too involved question, and will not to answer it. However, it gives those who want to talk a chance to do so.

After the survey was created it needed to be distributed to the employees who would be willing to answer the questions. Don Foster decided to distribute these to the employees he felt would be most likely to answer the questions, but he made sure not to leave anyone out of the sample just because he thought that it was unlikely they would take the time to respond. He made a point to hand out the survey's to whoever he passed during his usual day over a period of a week. This would help to make sure that the data gathered was reasonably random and that he did not skip or prejudge certain people on

purpose. It may be possible that he does not often run into certain people. Some of the people traveling in other circles may better tell the story of the facility in another more revealing was or have more an interesting version of what has happened. There is till a risk of bias in the sample assumed as a part of this initial survey, due to the way it was distributed to about 50 people, out of the 110 or so working on Helios in one of the 3 shifts of production at NB6. Other variables that may have come up with regard to completion of this project are those that have to do with who actually answered the survey's. Don distributed them to many people, buy there is a question of who returned them back to Don. Are these the people that Don knows best and fell better with what he says or is it truly a good sample of the employees at NB6.

With the data gathered from the initial survey it may be possible to analyze where if any the fault may lie. When looking at the results it is important to know that the conclusions made are those made using only the data gathered from the current employees at NB6, and not those of higher management. Also just because the employees who answered the survey responded a certain way about the possible reasons for the outcome at NB6, it does no mean that it is the only cause of the problems. From asking the employees how they feel about the situation around them, it will be possible to see what the general feeling of the causes of the downfall could be. After talking with Don Foster about the possible feeling of the employees, it may be interesting to see what the employees say. Having looked into the current status of the company and hearing about the decisions that have been made recently, some possible predictions can be made about the outcome may be of the initial survey. From learning of the history of Polaroid and how it has grown from a small R&D company to a large manufacturing company, it may

be possible that the higher management is trying to cut back the company in order to return to the roots of the R&D company. This seems to be a possible reason for the actions that the company has made in the recent years. With the selling of most of Polaroid's assets it seems that they are trying to minimize the size of the company and get as much money back for it as possible. Also it seems that Polaroid is trying to outsource as many of the products that they make as possible. This way they will only have to put their name on the product and not have to worry about producing the good.

When looking at the sample that was collected for both the initial survey and follow up cognitive style survey, it is very important to know that the sample size of the survey's were not randomly distributed on nearly complete coverage's of the number of employees at the plant at the time as was the case in Heath and Smith. The plant staff had grown from 70 to 140 over the years, so gathering everyone in one place was no longer practical. A sampling procedure would be needed. of the 140 only about 110 were involved with the production of Helios medium film. Due to the limited amount of people that Don was able to contact because of different shifts, this pool was cut down to about 75 people, approximately the size of the group Heath and Smith tried to represent with their sample of 50.

Our goal is not 100% coverage, but to be considered representative as a whole and make the possible findings be as truthful as possible. Since we cannot claim random selection procedures with any confidence, the goal must be to get 50% of the engineers, 50% of the managers and 50% of the operatives to respond, for a total of at least 36 people. The actual number of respondents to the first survey was 34, received in two waves, with the operatives heavily represented in the second wave, while egnineers

dominated the first. As expected, response rate was affected by social connection and frequency of contact with Foster. Further, the distribution of respondents by occupational group did not reflect their proportion of the work force. The coverage of the engineering and management groups was nearly complete, at least as good as their coverage had been in the Heath and Smith study. The actual numbers of operatives responding was as great as that of the engineers, but as a proportion of their numbers 15/90 (or 1/6) is smaller than 50% response rate. I cannot demonstrate that the operative respondents were randomly selected. Hence, a claim of adequate coverage to be representative can only be made for the technical and engineering portion of the sample. Even the finding that that the engineering and operative samples had similar distributions of responses does not resolve the question of whether it was a self selected group of respondents that dominated the sample returned surveys.

The second survey that went out to the respondent of the first survey, was adjusted to gather cognitive styles data. There was only one wave data collection, due to time constraints. Again the engineering and technical staff closely associated with Don Foster participated rapidly and completely, representing who listed their occupation 12 of 18 respondents to their second survey. Of the rest who indicated what group they came from 3 were operatives and 3 were managers. Thus, nothing can be said about the cognitive distribution of the operatives. The views of the managers were captured by the survey, but even with 3/6 cognitive style return little can be said about them other than that it is not longer the case. that the cognitive profiles of the technical staff and the managers are very similar. There has been considerable management turnover, and the

technical staff has both shrunk from 16 to 12, and experienced considerable turnover. Only 6 still there were present when the plant opened.

The study will therefore focus on the technical staff, particularly a comparison of those who stayed and were effective during the turbulent aftermath of Helios, to those who left, and those who came in to help during the crisis.

In the cognitive style survey, a new (yet to be validated) Remote Association proxy measure was used. The research leading to the new measure was began in a previous IQP completed by Mike Lynch in 1991. In some respects his efforts were motivated by a similar problem, since his study was of DEC at a time of troubles and change and he had to had trouble administrating a "test" like instrument in a time of layoffs. Lynch gave up on his study at DEC.

4.0 Findings

4.1 Cognitive Data Analysis

The data collected from the employees currently at NB6, will permit a comparison to be made with the data that was gathered from the previous NB6 start-up study. Below are four tables showing the data that was collected for the three previous projects, Boynton et al, Campbell and Convent, and Heath and Smith. All of the data will be described with regard to the importance of this, the final project dealing with NB6.

Boynton et al. Data **TABLE #1**

	SPLIT INDIVIDUAL PERFORMANCE							
Cognitive Type	Defined				Undefined			
	n	very	good	fair	n	very	good	fair
HH (Integrator)	5	33%	50%	17%	3	33%	33%	33%
HL (Prob. Ident.)	5	40%	40%	20%	10	60%	30%	10%
LH (Prob. Solv.)	10	70%	20%	10%	3	0%	67%	33%
LL (Implementor)	6	30%	40%	30%	6	17%	33%	50%

The data from the Boynton et al study dealt with WPI student groups that were carrying out their MQP's, a sort of senior thesis. The data from the project dealt with the different cognitive styles and how they reacted in different work situations. Above, the data shows how different cognitive types react in different situations, defined or undefined. This is an easy way to see how the different types react under different terms and conditions. Later in this findings section a more thorough meaning of the table will be explained.

Combination of Data from Previous Three Projects **TABLE #2**

	Cognitive Style			
Which Project?	**HH** Integrator	**HL** Problem Identifier	**LH** Problem Solver	**LL** Implement
Boynton et al. (8x10)	29%	19%	38%	14%
Campbell and Convent (14x17)	22%	31%	16%	31%
Heath and Smith (NB6 Startup)	23%	8%	25%	44%

Heath and Smith Data (Three Main Groups) **TABLE #3**

	Cognitive Style (Groups of Technical/Engineering)			
Job Description	**HH** Integrator	**HL** Problem Identifier	**LH** Problem Solver	**LL** Implement
Engineers	4(25%)	1(6%)	4(25%)	7(44%)
Operators	5(22%)	2(9%)	6(26%)	10(43%)
Admin/Support	2(22%)	1(11%)	2(22%)	4(44%)
Ave Distribution	23%	8%	25%	44%

Data Gathered During this Project **TABLE #4**

	Cognitive Style			
Job Description	**HH** Integrator	**HL** Problem Identifier	**LH** Problem Solver	**LL** Implement
Operations/Production	0	2 (66%)	0	1(33%)
Management	1(50%)	0	1(50%)	0
Technical/Engineering	5(41.6%)	4(33.3%)	0	3(25%)
Totals	6(31.5%)	7(58.3%)	2(10.5%)	4(21.1%)

Technical/Engineering Data Distributed **TABLE #5**

	Cognitive Style (Groups of Technical/Engineering)			
Time Frame taken From survey data	**HH** Integrator	**HL** Problem Identifier	**LH** Problem Solver	**LL** Implement
Part of Helios Since Inception	4(57.14%)	1(14.28%)	0	2(28.57%)
With Helios since NB6 Opening	0	1(50%)	0	1(50%)
Began with Helios and NB6 at Same Time	1(33%)	2(66.6%)	0	0
Totals	5(41.6%)	4(33.3%)	0	3(25%)

In order to fully understand the data that was collected for this project, a careful look at the data collected for each of the three projects completed before me dealing with the Helios and NB6 need to looked. It is very important to see how tables 1,2, and 3 have to do with the data that was collected for this project.

Table one is very important because it helps to set a possible theory about how different cognitive styles react in different situations. Boynton et al. made sure to look at how each of the four cognitive styles were effected by working in a defined and an undefined task situation. What they found was that there were two glaring situations that helped to fulfil many predictions that were made. For them it was interesting to notice how the LH (Problem Solver) were able to do remarkably well in a defined situation (70%), while the HL (Problem Finders) cognitive style group was able to function real well under undefined situations (60%). This was a recognition that these two groups were better than each other in regard to the defined and undefined situations.

The importance of table 2 is to see how the distribution has changed over the time that the three projects were completed. In the Boynton et al. project the larger of the four groups are the HH (Intergrators) and the LH (Problem Solvers), while the next group studied by Campbell and Convent was higher in HL and LL. Finally the group studied by Heath and Smith was much larger in the LL group, while the HH and LH are the same with a small sample of HL. This will be essential to the comparison of where the distribution is now.

Table #3 is the specific data of the cognitive styles that was collected for the Heath and Smith project. It is very important to see that the distribution is rather even

among the three work groups. The reason for this is that the employees of NB6 hired the new employees that would be part of the work force. In the data the LL are highest with the HH and LH behind it, with the HL with a small amount of an avg. of 8%.

Initial Survey Data

The purpose of the initial (filter) survey changed during the project, but its importance can still be seen in the data gathered from the survey. From the data gathered There was nothing very unusual about what was found. It seemed that the general feeling was that the company was going to be out of the Helios market, and soon may be out of business all together. The only differences that occurred was the time frame of the remaining time at Polaroid. Some felt that in 24 months the company would be existent, while others felt that Polaroid would last a while, but would change its focus. Below is the quantitative analysis of one of the most important questions asked in the initial survey.

What do you feel was (will be) the Focus of Polaroid on the Following items.

	Low		Med		High
	1	2	3	4	5
Five Years Ago					
Research	2	2	6	7	15
Manufacturing	0	2	10	7	13
Sales/Marketing	10	6	12	3	1
	Low		Med		High
	1	2	3	4	5
Five Years from Now					
Research	24	6	3	0	0
Manufacturing	14	5	10	0	4
Sales/Marketing	5	3	12	3	10

From the data collected from the initial survey there may be some conclusions made in regard to the reason behind some of Polaroid's recent decisions. This helps to show how management's philosophy has changed from being a manufacturing company with high R&D to a company that is more focused on the marketing side of the product, which is something that Polaroid never focused on before.

Also within the project was a key source of information. Don Foster was able to tell me what I needed to know regarding the intricate parts of the project that would be impossible to know if he did not inform both me and Prof. Wilkes. Don was able to tell of the past history of some of the people who had made some key decisions at Polaroid, along with telling what the general opinion of the plant was. This was key so that proper hypothesis's could be made.

5.0 Discussion of Results

With the data that was collected for this project, along with the data gathered from previous projects, a possible conclusion regarding the reasons behind the events leading to the sale of Helios by Polaroid can be drawn. First of careful look at each of the projects data that was presented in this project needs to be done.

The findings reported by Boynton et al. based on project team at WPI (50 students covered) was able to set a precedent for projects yet to come dealing with this same subject. From the table it was apparent that the group HL is best performing in an undefined situation, while the LH group excels in the defined situation. This shows that these certain groups are best suited for certain situations. From looking at the table with the data from the previous studies, it was apparent that when they opened NB6 they were

preparing to have those with LH and LL be in greater number than those of HH or HL. Upon opening NB6, the hiring process was geared toward hiring those who are LL or LH. This would show that the people that they are hiring are prepared to work in a defined situation, which they are best suited for. This was the start-up group, but only three years later, the data from this project proves that it was not the best process to use for hiring. The data from my project shows that the number of HH and HL in the very representative sample of engineers is larger than that of the LH and LL. This shows that when the situation at NB6 turned uncertain the larger number of LH and LL who were in greater number at start-up left, while the HH and HL stayed the same or increased slightly.

Altogether the data gathered for this study was very helpful in helping to prove the predictions that were set forth by the previous studies. This was amazing to find due to the small sample size, and such a chaotic situation at NB6. By comparing the data gathered from this project the data seems to prove some of the predictions made in the previous projects.

With this data proving a theory, there needs to be an analysis of why this situation happened. From looking at the responses of the initial survey which seem to show that in the past Polaroid was more focused on R and D and manufacturing, while not as much on Marketing and sales. This seems to change completely when the employees are asked to predict what the focus will be in the next five years. From the data of the initial survey, it seems that the focus on R&D and manufacturing will be non existent, while sales and marketing will become the new focus. This seems to be contrary previous predictions of what the focus will be. From the discussions with both Don and Prof. Wilkes, I had the

idea that the company was selling the assets they had, in order to become smaller, and eventually revert back to R&D, which they had become so famous for many years ago. It would seem to make sense that they would do this, but the fact that the employees inside the company feel different makes the question of why these two options are open, and which will Polaroid follow. Due to the lack of conversation with higher management, it is impossible for me to predict which of the two, or even other options, will Polaroid follow.

There can be many possible ideas that can be received from the analysis of this data. One possible idea is that NB6 was built too early and that it was doomed from the start. This seems hard to believe, but it is not totally unreasonable. It would be common sense that the highly educated people who run Polaroid would make sure that before spending billions of dollars on a plant, there would be a market that would help keep the plant above water. As of yet it seems that maybe the idea that they had all of this money from the Kodak court case, they felt that they could take this chance. But smart business practice would have said to slowly build up the market, and then when there is a market of substantial size, build this enormous plant.

Another possible cause could be that the 14x17 team missed the window for the Helios printer. This means that they would have been able to make money in the market at a certain time, but because of development problems, they took longer than planned. This seems possible, but it is unreasonable that the management team set such a short time frame for a product that they knew was completely new to the market. This then could be turned back to management as a managerial problem, but that is only part of the fault that they may have. There prevailing opinion of the employees that completed my

survey was that management bailed out too early with the Helios. They were not making money, so with the new CEO they decided to sell it off to get some money in order to pay for NB6 which was not producing to its peak level. This is one solution that could be looked at, but it seems that they would have known that with such a new product, you would need to wait until the product formed the market that they needed to make money. This again, seems to be amazing management practice, but from the data it seems to be true with this case.

6.0 Conclusions

From the data that was gathered there is a possible reason why the events at Polaroid have occurred. We are able to see how the employees feel know that the management sold off technology too early. Also the cognitive data shows that the people who are able to excel better in a situation that is not defined. Also the general feeling is that the future of Helios at Polaroid is nonexistent, leaving NB6 as an orphan, with a group of people who feel that they were left out to dry. They thought that NB6 would be the newest greatest thing, but only a few years after opening the plant is in danger of being sold totally to another company. This is not the only plant being sold off. In Norton, Ma. a warehouse was built, then sold to another company, and now is being rented back for less than it cost. There are also other assets of Polaroid being sold off. This seems strange, but it is all occurring.

With the data gathered here there seems to show that there is a conclusion on what has happened. This is a conclusion that is made only with the data that was gathered

for this project. The fault, as I see it, lies with the management. First of all the decision to build NB6 so early in the life of Helios was remarkably unfounded. Even though the company had just come across with all of this money, they should have been able to wait till more of the market was established by the Helios. This was they could guard against an occurrence like really has happened. This same thing happened with Edwin Land and Polavision. He knew that he was wrong, then decided to sell off the rest of the stock, but he was not too heavily invested in that product as of that time.

Management clearly acted too early with regard to building NB6, but what followed was an even worse decision. They further decided that with this new plant that they were going to build, they would invoke this new organizational structure that had never been used in a Polaroid plant previously. This was a bad idea with the fact that with the way that the Helios was going, it was not ready to be produced at such high volumes, with minimal number of employees.

The following decision that Polaroid management made was the one that clinched the fate of Polaroid. After the development of the 14x17 printer, the market began to grow, but at minimal amounts each year. The management saw this as not growing fast enough, and decided to sell off the technology to a competing company. But they thing that really made it worse was the contract the Polaroid signed making them the only place that would produce the medium for the Helios printer. First of all the need for patience in a new market with a new product is enormous. There was not even a market for the Helios technology, so how were they expecting that in the short time that it was produced at full strength, it was going to make money. Most new products need time to work there way into markets, never mind the idea that the Helios was entering a market that did not

exist. This industry that they are entering has been the same for many years. The process for the medical imaging has been using the regular x-ray machines that had been used for years before. The idea of a new product that would cost as much as Helios did would need time to build and gain a reputation before serious amounts of money can be made. These seemingly strange actions by the management show how the direction that company wants to go in has changed. During the younger days of the company, Edwin Land was focused on R&D, as time went on and the instant camera became more profitable, the focus changed to manufacturing, with still some focus on R&D. With the actions that have been going on not only at NB6, but in the rest of the company too, it is apparent that they are trying to get rid of the major assets that they have in order to experience a quick influx of cash. This can be seen as a way to save the company from going down, but if the decisions regarding NB6 and Helios had been made more wisely, then this would not have happened. But for the time being, Polaroid needs to save itself, and therefore selling off the assets for cash is the best option they have now.

There is only one action by the management that can be seen as worthwhile is the fact that now that Helios is gone, and there is no need to have NB6 running for Helios, other products should be produced in its place. In this case, recently Polaroid has produced a instant disposable camera, but has yet to prove it be the best product to have. This is another example of management trying to save the company that they wasted away with strange and unusual management practices.

In the end the fault lies with the management, but with further study of what the management has to say, the fault could change, but until then the fault lies where it is.

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Appendix:

A: Initial (Filter) Survey

B: Cognitive Style Survey

C: Technical Information on Helios Provided by Polaroid

D: Picture of NB6 Plant in New Bedford

E: Flow Chart of Product Design Process

Helios, NB6, and Polaroid
(Phase 3 of WPI's Helios Study Series)

This study may be the last of several WPI studies undertaken over the prior 11 years dealing with Polaroid's Helios project. The first was in '88, and dealt with the original 12 to 15 engineers and scientists who developed the initial prototype 8x10 medical printer. Following studies examined the development of the 14x17 printer and the early stages of the media development. In recent years, the studies have focused on the unusual organizational structures developed for the high volume manufacturing facility at NB6.

The purpose of this study is to examine the long and complex process of developing a concept into a product. Originally NB6 was to be the shining example of Polaroid's future, but recent events suggest otherwise.

I plan to interview 25-30 people soon, an even distribution of employees from the start-up team and those who have joined NB-6 since then. I would like to meet with a mix of employees who started the plant and others who have joined recently in order to hear a variety of perspectives on what has happened at the plant.

Thank you for participating in this survey. I look forward to reading your responses.

Respondent Selection Survey:

1. What is your job title?
2. What group do you consider yourself a part of?

   a) Operations/Production. b) Management. c) Technical/Engineering.

   If you feel you are not clearly in any of the three categories, please describe your position.
3. How long have you worked at Polaroid?

4. How long have you been involved with the Helios Project?

5. How long have you worked in NB6?

6. What do you think Polaroid will look like in 5-10 years? (Please write a few sentences.)

7. a) Five years ago, how much focus did Polaroid have on these activities? (Please place an X on the line at the point you consider the best response.)

	Low	Medium	High
Research and eng'g:	---------+	----------+	----------+---------
Manufacturing:	---------+	----------+	----------+---------
Sales and marketing:	---------+	----------+	----------+---------

b) Five years from now, how much focus do you think that Polaroid will have on these activities?

	Low	Medium	High
Research and eng'g:	---------+	----------+	----------+---------
Manufacturing:	---------+	----------+	----------+---------
Sales and marketing:	---------+	----------+	----------+---------

8. How excited were you when you first learned you would be working on the "Helios" Project?

Please respond on the scale below.

Not at all-------- A little ---------Neutral ----------Somewhat --------Very

9. How interested and supportive were you of the original NB6 organizational design concept?

Not at all---------A little ---------Neutral ----------Somewhat --------Very

10. a) When you first joined the Helios Project, how optimistic were you about its chances of success? Rate your response on the following scale.

Very Pessimistic -------- Somewhat Pessimistic -------- Neutral ---------- Somewhat Optimistic ---------- Highly Optimistic

b) How optimistic are you about the future success of Helios?

Very Pessimistic --------- Somewhat Pessimistic --------- Neutral ---------- Somewhat Optimistic ---------- Highly Optimistic

c) How much difference do you think it would make if Polaroid decided to stay involved?

Little or None----------A Great Deal

11. Briefly, why do you think Polaroid has decided to sell, or is interested in selling many of its facilities, including NB6?

Group Perceptions and Cognitive Style Indicator

Worcester Polytechnic Institute

NB6 Study 1999
Product Evolution Study

The following questions are designed to try and gather cognitive style data similar to that gathered in the previous study done at NB6 in 1996. My goal is to compare the distribution of people at NB6 now with those of the employees that opened NB6. The first project done had to do with the 8x10 development team, followed by a study of the 14x17 project team. There were prior Helios projects studied in this way. The first was the 8x10 development, followed by a study of the 14x17 design team. Next was the study of the start-up team with NB6. This will be the last part of the studies dealing the Helios project and NB6, as this is the closest the plant will ever get to a mature technological production system. The Polaroid chapter of two product development role ends soon.

The question below is only for grouping purposes. This enables me to keep the groups the same as was used for the 1996 study. Nothing more will be used other than the groups in which you are a part of.

Classification Item (Repeated from 1996 study)

Which of the three groups listed below would you most closely fit with?

a. Operations/Production b. Management c. Technical/Engineering

Proxy Items for the Cognitive Style R

Very strongly agree – Very strongly disagree	Strongly Agree	Agree	Disagree	Strongly Disagree
1) I'm just not satisfied with anything less than a truly elegant solution. Brute force, "quick fix" or "quick and dirty" solutions that work just don't appeal to me.	1	2	3	4
2) My personal style is decisive and exact.	1	2	3	4
3) I feel that I have the ability to make Something really intricate work.	1	2	3	4
4) Things leap to my mind, very quickly, and I instinctively know when these ideas are right, or on the right track.	1	2	3	4
5) I'm really smart, you know…right off the charts, but that is not always an advantage at my kind of work.	1	2	3	4
6) I really do not like computers. They are too sensitive to errors on small details and far too logic bound.	1	2	3	4
7) I tend to be careless dresser – real casual whenever possible.	1	2	3	4
8) I am basically a philosophical person.	1	2	3	4
9) In my career so far, others have overlooked or underestimated my talents most of the time.	1	2	3	4
10) Sometimes I play little practical jokes. I even enjoy a good one played on me.	1	2	3	4
11) I often wonder if it is good for me to be as completely immersed in the specialized little world of engineering as I am.	1	2	3	4

12) I don't like to stop working on a problem until I've solved it, no matter how difficult it is.	1	2	3	4
13) I try to solve the tough problems first, then the easier ones.	1	2	3	4
14) I'm happiest when I can focus on my piece of a project. What the other team members are doing isn't of great interest to me.	1	2	3	4
15) I think that I can do things that most people would consider nearly impossible, if I don't know in advance how difficult they really are.	1	2	3	4
16) During periods when I am doing nothing but practicing and improving my technical skills, I begin to feel restless, restricted and quite concerned that I am becoming too narrow.	1	2	3	4
17) I am very disappointed in colleagues who can't understand my way of looking at things, don't see what I see, or grasp its implications.	1	2	3	4
18) I trust my hunches and take it as it comes, day by day.	1	2	3	4
19) I like jobs in which I am trusted and left alone to repeatedly do something that is somewhat specialized and not too important – but which I have practiced and know that I do well.	1	2	3	4
20) I generally approach problems indirectly so as not to assume that a problem is what it seems to be on the surface.	1	2	3	4
21) If there wasn't a crisis every once in a while I'd be tempted to create one.	1	2	3	4
22) I would prefer to be the person assigned to put a big project together by myself (cont,)	1	2	3	4

rather than try to do it as a group effort.

23) When I was in college, I thought about majoring in one of the social sciences, like psychology or anthropology	1	2	3	4
24) I'm not a technical genius, but I do have a gift when it comes to figuring out why something won't work.	1	2	3	4

Group Perceptions

The purpose of this final section is to get a feel for your view of the mix of associates with whom you have been working.

After carefully reading the explanation for each question, proceed at your own speed. However, you are encouraged to move along rapidly because first answers that come to mind are fine and this will make it easier for you.

Remember: When in doubt, pick your first impression, and move along.

BEFORE TURNING TO question 1 do the following:

Detach the last page of your booklet, which should contain a blank list labeled A to j, and place it next to your booklet.

From A to J print in the names of the ten people, preferably peers or subordinates, with whom you have worked most often or most closely. In general it is best to pick those with whom you have come in contact with regularly at one time or another, possibly on a project team, whether or not they are the people in the organization that you like best. One need not know these people as friends to answer the following general impression questions about them.

YOU WILL BE ASKED TO DIPSOSE OF THE LIST OF NAMES AS YOU PLEASE AFTER USING IT ON THE FOLLOWING SECTIONS, SO REST ASSURED THAT THE PRIVACY OF YOU COWORKERS WILL BE PROTECTED. WE DO NOT NEED TO KNOW WHO IS WHO TO GET AN IDEA OF THE KINDS OF PEOPLE WITH WHOM YOU WORK. (*Just try to be sure you are referring to the same person, as person A through J, for each of the two impressions that you will be reporting.)*

Please turn to Question 1 and begin.

Question 1 EXPLANATION
Based on your experience and observations, circle for each individual (A-J) a number from 1-10 which represents your opinion of how **focused** they are about their work in the sense of being **able to concentrate their attention** on what really matters, given the overall task at hand.

REMEMBER The higher the number is, the more focused a person is, the lower the number the less focused a person is- in terms of being able to concentrate their attention.

Please do not circle more than one number for each individual.

1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10

Question 2 EXPLANATION
based on your experience and observations, circle for each individual (A-J) a number rom 1-10 which represents your opinion of that person's **creative ability**, meaning their **capacity to be innovative** or bring something new into existence, such as new products, ideas, or processes.

REMEMBER The higher the number is, the more focused a person is, the lower the number the less focused a person is- in terms of being able to concentrate their attention.

Please do not circle more than one number for each individual.

1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10
1	2	3	4	5	6	7	8	9	10

To protect the privacy of your coworkers, please dispose of this page when you have completed questions 1 and 2

A._____

B._____

C._____

D._____

E._____

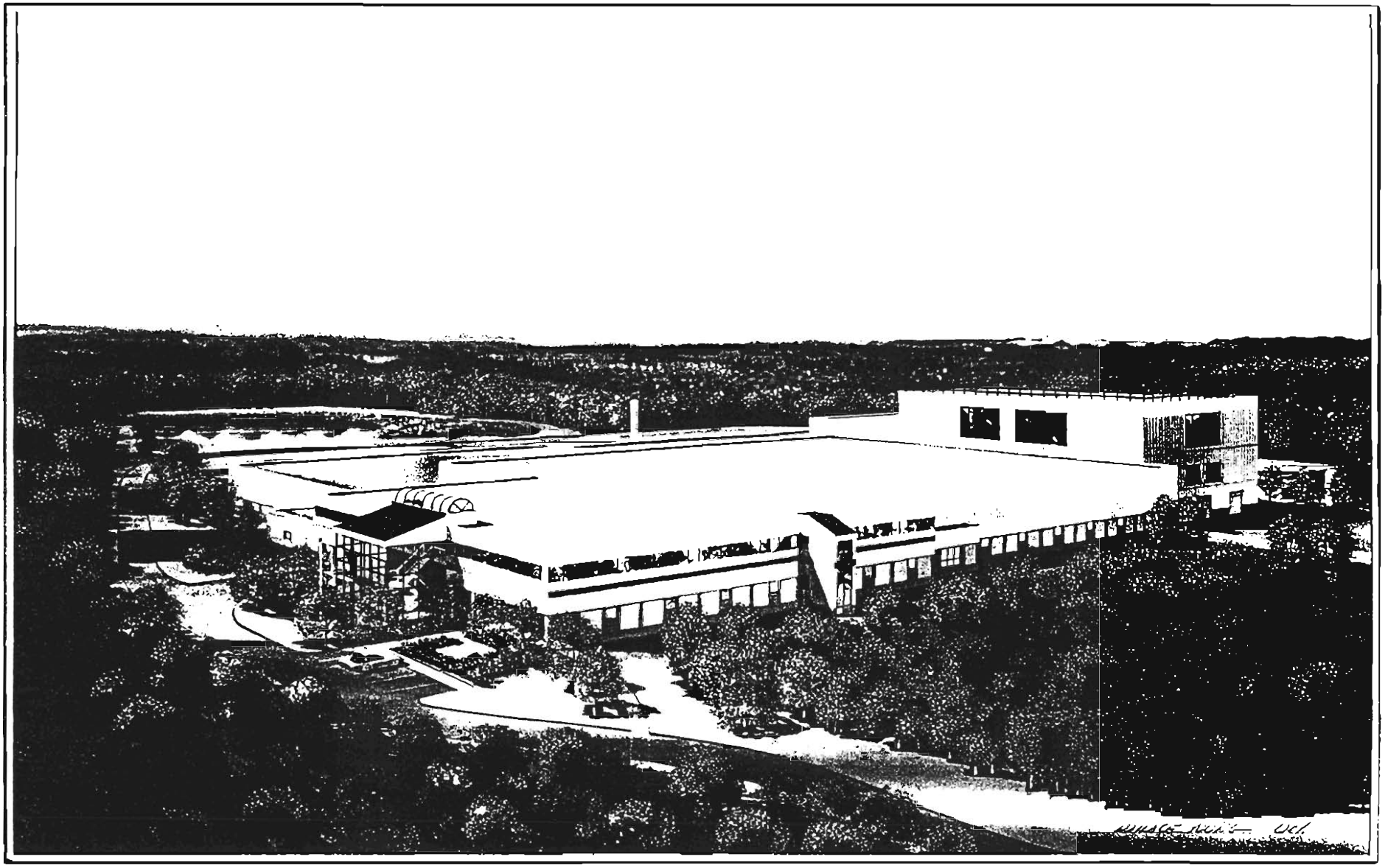
F._____

G._____

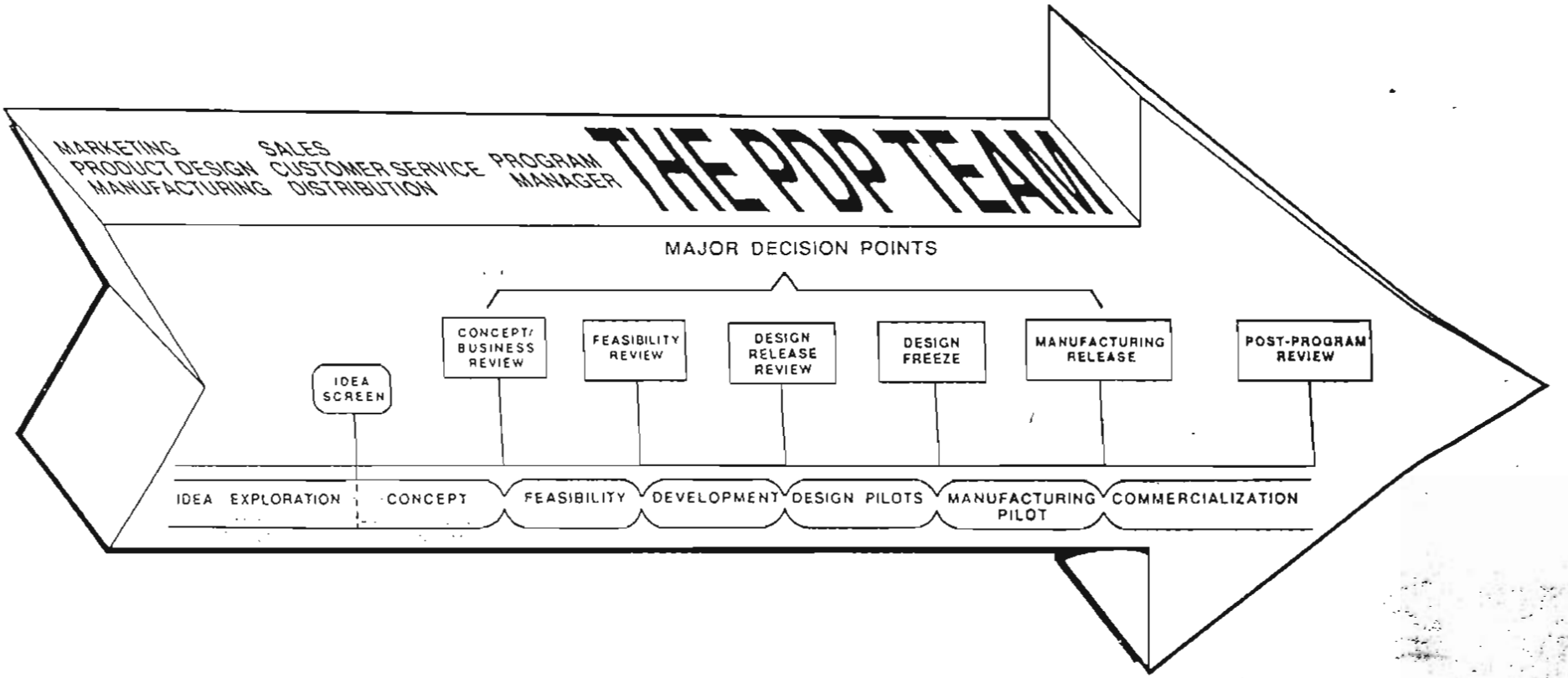
H._____

I._____

J._____



POLAROID 11X FACILITY


MARKETING
PRODUCT DESIGN
MANUFACTURING
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CUSTOMER SERVICE
DISTRIBUTION
PROGRAM MANAGER
THE PDP TEAM
MAJOR DECISION POINTS
IDEA SCREEN
CONCEPT/ BUSINESS REVIEW
FEASIBILITY REVIEW
DESIGN RELEASE REVIEW
DESIGN FREEZE
MANUFACTURING RELEASE
POST-PROGRAM REVIEW
IDEA EXPLORATION
CONCEPT
FEASIBILITY
DEVELOPMENT
DESIGN PILOTS
MANUFACTURING PILOT
COMMERCIALIZATION