MATCHING COMPANY GROWTH TO SKILL ADAPTATION LEVELS

by

Alison Dale McCaffree

B.S. Mechanical Engineering
Stanford University

Submitted to the Sloan School of Management and
the Department of Mechanical Engineering in
partial fulfillment of the requirements for the degrees of

~~**Master of Science in Management**~~ [M.B.A.]
and
Master of Science in Mechanical Engineering

In conjunction with the Leaders For Manufacturing program at the
Massachusetts Institute of Technology
May, 1999

Signature of Author _____
Sloan School of Management
Department of Mechanical Engineering
May 7, 1999

Certified by _____
Professor Nelson Repenning, Thesis Advisor
Sloan School of Management

Certified by _____
Professor Dave Hardt, Thesis Advisor
Department of Mechanical Engineering

Accepted by _____
Ain A. Sonin, Chairman of the Graduate Committee
Department of Mechanical Engineering

Accepted by _____
Lawrence S. Abeln, Director of Sloan Master's Programs
Sloan School of Management

MATCHING COMPANY GROWTH TO SKILL ADAPTATION LEVELS

by
Alison Dale McCaffree

B.S. Mechanical Engineering
Stanford University

Submitted to the Sloan School of Management and
the Department of Mechanical Engineering in
partial fulfillment of the requirements for the degrees of

Master of Science in Management
and
Master of Science in Mechanical Engineering

In conjunction with the Leaders For Manufacturing program at the
Massachusetts Institute of Technology
May, 1999

ABSTRACT

Many companies struggle to develop effective product development processes in fast paced competitive environments. These same companies experience periods of tremendous growth that are unlikely to be sustainable. This research examines the hypothesis that these growth difficulties are caused by a failure to understand the different communication skills that are required as a company's size increases its organizational complexity. As a company gets larger, poor communications skills start to affect its product development process. This puts limits on company growth. A framework is presented for managers in those companies to assess any lack of skills in their organizations in the three main areas of discipline, process improvement and leadership that might prevent them from developing products quicker and with higher quality.

My specific research at Qualcomm Inc. shows that its organizational size has outstripped its employees' communication capabilities. This situation is limiting its ability to do effective product development. Managers in the company know that changes in the product development process need to be made but cannot see the limiting dynamic factors. This paper walks through Qualcomm's organizational dynamics. It is a story that System Dynamics calls "limits to growth". The way people interacted when the company was a small technology start-up worked to create tremendous growth. However, the communication skills used in those interactions do not scale to a larger, multi-functional, multiple divisional company. The absences of some key skills is causing some negative side effects and limiting longer-term growth.

Lacking employees with the higher level skills needed to effectively interact at a team, group and organizational level, Qualcomm is seeing a negative affect on its product development process and potentially on continued growth. I observed different skill capabilities in process improvement, discipline and leadership at Qualcomm. I formulated a framework for the adaptation process that will take them from their current communication capabilities to where they need to be as a large, complex organization. This framework is called the Skills Adaptation Matrix.

After careful examination, I give specific recommendations as to what Qualcomm might consider to improve their situation. First, Qualcomm might complete a thorough assessment of the skills of every individual as outlined in the Skills Adaptation Matrix. It will then be able to determine each individual's training needs. My analysis shows that the most effective training will be in developing disciplined meeting skills. Qualcomm employees can then acquire the skills at the higher levels of interaction that will help sustain long-term growth.

Thesis Advisors:
Nelson Repenning, Professor of Management
David Hardt, Professor of Mechanical Engineering

ACKNOWLEDGEMENTS

I gratefully acknowledge the support and resource made available to me through the

MIT Leaders For Manufacturing Program,

a partnership between MIT and major manufacturing companies.

I would also like to thank the people who supported me during my LFM career.

To my advisors Nelson and Dave: Thank you for your encouragement, advice and valuable time.

The LFM program needs more people like you.

To The Class of 99: You have made these past two years

the most incredible experience of my life: personally and professionally.

I sincerely wish that we maintain the bonds we have formed.

Each of you is destined for great things.

To Mom and Dad: Thank you for teaching me the value of education.

You continue to support me in all my endeavors - never judging

and always willing to lend an ear or a hand.

To Ken: I never thought my internship would change my life, but meeting you, it did.

Thank you for investing so much time and energy in me.

Thank you for the small things: the phone calls and the flowers.

Thank you for the large things:

Changing your life to fit me into it and exploring our new possibilities.

TABLE OF CONTENTS

TABLE OF FIGURES

CHAPTER I: Introduction

This research was done in connection with the Leaders for Manufacturing (LFM) Program at Massachusetts Institute of Technology. As part of the LFM program, I worked for QUALCOMM Incorporated's Consumer Products Division for six months. I was assigned to the handset manufacturing group and asked to improve the method by which Qualcomm introduced new phones. As a relatively young company Qualcomm did not have a well-documented product development process. The original request from Qualcomm's manufacturing group was that I understand how products were developed currently and design a new process. The new process was believed to be of great importance to the division in order to streamline their actions and get quality products to the market faster. It turns out that the problems with the Qualcomm's development were more fundamental. Through my experiences and observations at Qualcomm, I realized that individual and organizational behavior issues where more critical to Qualcomm's ability to produce products than an actual written process. Therefore, I expanded the scope of my research to look at the larger issues surrounding the organization's ability to implement good procedures.

The approach I took towards my research at Qualcomm was threefold. First, I was an Operation Program Manger for a new product that combined a personal data assistant and a cell phone. Second, I was an external consultant asking questions and trying to understand what change was needed and what solutions might be implemented. Third, I participated in a task force that was writing the new Product Development Phase Process documentation.

A. PdQ Smart Phone Product Introduction – Operations Program Manager

As an official means of incorporating me into the main stream of activities at Qualcomm, I was given line management responsibility as the Operation Program Manager (OPM) on a new product being developed from June through December 1998. This product is a combination of the Palm Pilot Personal Data Accessory and Qualcomm's CDMA cellular phone technology. It is commercially named the pdQ Smart Phone. The pdQ was in the midst of design development and was fast approaching a handoff to manufacturing when I arrived at Qualcomm. This made the pdQ an ideal product for studying how product development was currently done. As the pdQ OPM, I confronted the processes and systems in place at Qualcomm first hand. I experienced the same frustrations and successes of

other managers in the company. The OPM role also gave me leadership responsibility that allowed me to experiment with my hypotheses.

B. Consultant Role

Because of my unique position at Qualcomm, I was both an outside observer as well as an inside advocate for change. In my consultant role, I interviewed key members of many departments involved in product development. From these interviews I collected data about the organization and how it operated. Also in this consultant role, I held meetings with many departments to discuss the product development process. The people in the meetings guided me toward innovative ideas, listened to possible solutions, and gauged the difficulty of implementation. These meeting gave me insights into the culture of each department and into the most important issues with the current product development process.

C. Product Development Phase Process Task Force

I attended the Products Development Phase Process task force discussion sessions on a regular basis. This group was assigned to write down a new procedure for doing product development starting with concept generation and ending with product obsolescence. In order to manage the stages of product development, Qualcomm wanted a procedure that spelled out timing for specific task as well as timing for management review meetings. This cross-functional effort contributed to my understanding of many of the nuances of the organization. It provided many useful insights on the interactions and decision-making abilities across the functional organizations. I also saw the heads of each department interact with one another as well as saw how they led their departments. The task force's effectiveness will be discussed in the Data section of this paper.

D. Importance of Insiders View

It is important to emphasize that this research was conducted while I essentially a Qualcomm employee. I had line responsibility and therefore had to deal with the systems, the communication skills and the culture of the company in real time. I believe that this assessment would not have been possible if I had not experienced an insider's view of the company. Unless I engaged in the world of the company, it would be impossible to truly understand the dynamics effecting employees. For this reason, my results will not only be relevant to academics that study organizational behavior but they also will be useful to leaders, managers, and employees within companies. Company insiders can use my framework to analyze their company and can then make intelligent decisions based on that analysis.

These different roles allowed me to work at many different levels in the organization. I could understand the details of implementing a manufacturing line on the production floor, the difficulties in communicating across departments, and the big picture problems facing the division. Overall, I had a very unique experience that has led to some interesting hypotheses and recommendations.

CHAPTER II: Background

No research takes place in a vacuum. In this chapter, I set the stage for my research by first clarifying some terms and explaining Qualcomm's environment. Secondly, this chapter describes the theories that have influenced my thinking and have given me tools to use during my research.

A. Introduction to Terms

Before describing my observations at Qualcomm, I would like to make clear a few terms that will be used throughout the paper. This should clarify some of the confusion that might come up both about telecommunications in general and specifically about Qualcomm.

Qualcomm is a $3.5 billion dollar revenue business that has 5 main divisions: ASICS, Wireless Business Solutions, Consumer Products Division, Infrastructure and Globalstar. This research took place while I was working in the handset manufacturing operations of the Consumer Products Division. The older name for this division was "Subscriber" due to the products being specifically made for individual consumers of a wireless service. When I refer to "Qualcomm" or "Subscriber" in the rest of the paper, I am referring to the Consumer Products Division in which this research and analysis took place. Colleagues in other divisions have made it known that the problems described here exist in other divisions of Qualcomm, however I am simply referring to my direct experience in the Consumer Products Division.

B. Qualcomm's Background

1. Handset Market Growth

Qualcomm's Consumer Products Division has been in the middle of the rapid growth in the cellular industry and its shift from analog to digital technologies. Within telecommunication, wireless cellular telephony is the fastest growing segments. The rise of wireless was led by big names in the electronics and communications fields like Motorola, AT&T (now Lucent), Ericsson and Nokia. Qualcomm entered the wireless scene in the early stages of the transformation from analog (the original technology) to digital (Qualcomm's technology is digital).

Qualcomm developed CDMA (Code Division Multiple Access) technology for commercial applications and spent its first years in business proving its viability and superiority in the wireless market place. CDMA's advantages over analog are its lower system power requirements, its higher capacity due to high utilization of the

spectrum, and its increased security due to unique patterns of frequency encoding on each call. Cellular is an extremely global market that is influenced by government regulations and usually requires companies to invest in large-scale ventures.

The handset environment, in which Qualcomm's Consumer Products Division finds itself shows the following five characteristics.

1) rapid growth
2) huge dependence on technology,
3) need to meet dual standard (digital and analog) because of lack of full digital coverage
4) fast paced towards miniaturization (i.e. 3 ounce phones)
5) rapid product development

These characteristics create dynamics in the organization that have fueled Qualcomm's company growth, forcing them to think only of adding extra workforce and not of their organizational capabilities. For a more detailed description of the birth of the industry read the wireless chapter in Richard Lester's book titled The Productive Edge. (Lester, 1998, pp. 164 - 190)

2. Growth in Number of Employees

Qualcomm has been hiring employees at a tremendous rate in order to match their desired growth. They have hired 30-50 people a week for the past 3-4 years. A common saying around Qualcomm was "half the people have been here for less than a year." It felt like everyone throughout the company was new. Many of the people came from other electronics and high volume manufacturing companies. There were people who had previously worked at Motorola and a large group that had worked at Digital Equipment Corporation. These people tended to stick together because they could talk the same "language." They tended to understand the concepts and the specific procedures that were developed at their previous employer. Being a mix of many of these cultures, there was not one single Qualcomm culture. Later, I will explain some of the other effects of this tremendous growth in number of employees.

3. History of Manufacturing

Based on the success of CDMA in their original OmniTracs wireless truck tracking product, Qualcomm decided to make cellular handsets using similar technology. However, they needed a manufacturing partner that had high volume experience. Sony turned out to be one of the late players in the cellular industry and wanted to get into the digital market. A joint venture between Qualcomm and Sony had a lot to offer. Qualcomm wanted a well-known name to do its bidding with suppliers as well as a partner that understood high volume electronics manufacturing. Sony wanted access to CDMA technology and it intended to startup manufacturing operations anyway. In 1994, the joint venture agreement between these two parents formed Qualcomm Personal Electronics. They have been manufacturing phones for 3 years.

4. Teenage Company

Qualcomm was a technology startup. In 1984, Irwin Jacob and Harvey White created the basic digital wireless technology idea and started the company. Now it has $3.5 billion in revenue, five different product divisions and over 10,000 employees. Qualcomm's Consumer Products Division is stuck between its roots as a technology startup and the need to be a mature consumer product company. The metaphor I like to use is that they are in their "teenage" years. Qualcomm as an entire company has grown to the point that they can no longer act like a startup. The discussion here will focuses on why their current way of doing business was an asset for Qualcomm as a technologically savvy and creative technology startup, but is now a detriment to the company.

C. Supporting Theories

1. Communication

Theories of communications serve as a background for this research. These theories describe how humans communicate and work together towards common goals. Deborah Tannen's theory suggests that individuals have certain learned cultures and these cultures effect the way that people act and interact and communicate. (Tannen, 1990) Although her work centers on the differences between women and men's communications habits, I believe that Tannen's concepts apply across organizations. She shows that if we understand our own styles as well as the styles of others, the success of our communication would increase tremendously. (Tannen, 1990, pp. 47-48)

Theories abound concerning the way people interact and how individuals can improve communication. Fernando Flores and Business Design Associates (BDA) espouse a theory known as Conversation for Action. (The Power of Words, "Fast Company", 1990) This theory suggests that no work is done until people have a conversation and create a picture of a common future. Thus, action is based on language that allows individuals to make commitments, share understanding about those commitments and mutual agree upon future outcomes. ("The Power of Words" p.150) BDA's theory is similar to the one presented in the Total Quality Management literature called The Atom of Work. (Shiba, 1994) It suggests a methodology for working through request and commitments such that breakdowns in the communication do not occur.

My research suggests that these theories are relevant to the way things get done at Qualcomm. Whether it is how meetings are conducted or how different functional groups interact, communication theories explain why these interactions are ineffective and inefficient.

2. Leadership and Change Management

Writings on leadership and change management cover every topic from self-help for managers, to how to become rich, personal leadership, and organizational design. I have reviewed many of these in the effort to understand why a company like Qualcomm has difficulty changing the way it does business. Why is it that a decent project leader with a good idea about running a project cannot lead his group to a predicable and positive outcome? Looking at popular theories, I explored whether it was poor leadership, poor management, or poor organizational structure.

Effective business management theories were popularized by some very well know names such as Ken Blanchard, The One Minute Manager (Blanchard, 1993) and Tom Peters, In Search of Excellence. (Peters, 1988) These works focus on the business aspects necessary for effective management, but tend to marginalize the individual and the forces acting upon them. These were followed with the "Reengineering" effort. Authors like James Campy, Reengineering the Corporation, tackled organizational design problems. (Hammer and Campy, 1993) These addressed the ideas that re-structuring (i.e. 'who reports to whom') can enough make companies more effective. Getting people to change in more general sense is another aspect of leadership that is relevant here. For example, Leading Change by John P. Kotter describes the steps in the process for leading change (Kotter, 1996). These ideas are crucial to implementing change once the vision for the future is determined.

Another useful set of theorists are those who are targeting the personal aspects of good leadership. Books and workshops by Dale Carniege and Warren Bennis's book, On Becoming a Leader, talk of knowing yourself, speaking effectively and with confidence, influencing people and creating your own future (Bennis, 1989) (Carneige, 1981). Stephen Covey also writes in this category. In his work, Seven Habits for Highly Effective People, Covey addresses the core issues for personal change (Covey, 1989). I believe that extending these ideas to organizations begins to explain the reasons companies have difficulty with effective processes. All organizations are made up of individuals that could benefits from the 7 habits Covey espouses. When each individual in an organization acts more effectively, a synergy can be attained. There will be a greater performance by the entire organization. In addition, Covey's concepts of quadrant II (important but not urgent work) versus fire fighting (urgent work) and that of being independent versus interdependent, I believe, can readily be apply to organizations (p. 146 – 180). Covey does not explain, however, how an organization can develop collective values and the collective understanding that is essential for these habits to work.

3. System Dynamics

System Dynamics is the study of complex interactions involving the structures, policies and feedback mechanisms in an organization. Jay Forrester developed System Dynamics at the Massachusetts Institute of Technology's Sloan School of Management. (Forrester, 1958) It is extremely useful because individuals have an inherently difficult time grasping complex systems. A typical product development process is an example of a complex system. In any organization that manufactures a product, there are many disciplines, functions, expertise and activities that must get coordinated. When product development happens in a rapidly changing competitive environment, the complexity increases many times. The study of System Dynamics aids in describing these complex systems and in the policy making surrounding these systems.

Peter Senge's The Fifth Discipline popularized the components of System Dynamic thinking and feedback analysis. (Senge, 1990) His work characterizes the main archetypes that reoccur in business and provides simple ways for managers to recognize their problems. His ideas on collective learning and the learning organization provide managers with simple actions for building solutions. Senge explains that there are two basic types of feedback dynamics. (p. 79) The first is a reinforcing or amplifying dynamic. Situations of growth or accelerating decline typify this dynamic. The second is a balancing dynamic. This effect describes a gap between a current state

and a goal. For example, when a person fills a glass of water, they monitor the gap between the current water level and the top of the glass. The person adjust the input (i.e. the rate of water flow out the tap) until just as the water reaches the top, they turn off the tap. Thus, it is a balancing action that stops when the goal is achieved. (p. 74)

The System Dynamics methodology has four main features. The first feature is extracting mental models from people with respect to how they think a process works and decisions are made. The second part develops causal loop diagrams portraying those thoughts in a simple way that can be understood by everyone. After the causal loops are drawn a simulation model is developed in order to demonstrate the dynamics. This is the third feature. Fourth, the inputs of the developed model are adjusted to known data (model calibration) so that this model can be used to predict the results of a policy change.

I found that mental models and causal loop diagrams helped me the most in my research. Getting the management at Qualcomm to explicitly express their ideas about how decisions were made was tremendously valuable. Expressing these ideas in causal loop diagrams allowed them to understand their own environment better. I was also able to check my understanding of their mental models through the causal loops. The diagrams allowed cross-functional management to stop fighting amongst one another, to gain a common understanding of the situation, and to focus on solving the system wide problem. In the end, I used these tools to create insights into the functioning of the organization and the employees within it.

Some specific System Dynamics research pertains to process improvements for the product development processes. The work of Nelson Repenning at MIT uses System Dynamics modeling to simulate work he conducted at Ford's Electronic Division and in Harley-Davidson's product development group. (Repenning, 1997 and Repenning, 1998 (Draft)) Repenning discusses the dynamics surrounding scarcity of resources, locally rational decision-making, and change initiatives. He points out the undesirable outcomes if these dynamics are not recognized or dealt with effectively. Repenning and Sterman developed a model that combines both the physical structures of process improvement and theories on human cognition and organizational learning in order to explain why some initiatives succeed and others fail despite initial success. (Repenning and Sterman, 1997)

As I thought about Sterman and Repenning's theories in relations to my own research at Qualcomm, I realized that Qualcomm's situation is more fundamental. Although these issues relate to Qualcomm's problems, Qualcomm needs to recognize its problems. The companies in Repenning and Sterman's studies seem to have

already recognized the need for change but were struggling with effective implementation. In contrast, Qualcomm struggles with recognizing change processes and with initiating.

A. Background Summary

My research is set in Qualcomm's technically challenging and dynamically growing environment. Communications, leadership, change management and System Dynamics are the fundamental building blocks for my study. Comparing my observations of Qualcomm's current operations with these theories, I was able to discern some fundamental questions. Why do people not do what they know needs to be done? If we know what is stopping people from changing, can we then choose an effective method for organizational improvement? Can change succeed if we do not eliminate the forces that prevent the organization from doing what is right? How can organizations grow and adapt in order to foster good processes? If an organization does not change, is it limiting its future prospects? These questions will be addressed in the following chapters.

CHAPTER III: Data and Observations

This chapter describes my observations while working at Qualcomm. These observations fall into three critical areas: process improvement, discipline and leadership. They describe all types of interactions from individuals doing their jobs to cross-functional teams working together. These observations are the raw material from which my analysis stems. My goal here is to describe the situations that will be brought into my analysis.

Category	More Design for manufacturing in the Design Process	Better Forcasting would make my job easier	Our resources are spread too thin - less products-right projects	Longer more stable relationship with suppliers	Diversity of Cultures and Philosophies is strong (among people and depts)	Manufacturing Capabilities are not well spelled out	Manufacturing needs more clout, Techology driven company	Need a clear transition plan from QC to QPE	Incremental Improvement methodology is needed	Decsion Making culture - emotion vs facts	Need to instill some planning and discipline to our processes	Product Life Cycle Time needs improving (don't repeat NGP-TGP)
BU	3	1	3		2	1	1	1	1		3	1
BU	3		3	1	1	1	1	1	1		1	
BU	1	3	3	2				3		1	1	3
BU	1		1			2	2					3
BU				1	2			3			2	3
BU	1				2	3	1	2		3	3	
BU	2	3			1	2		2	1		1	
BU	2		2			1	1			2	2	2
BU	1	2	3	3	1	2		1			1	1
BU	1	2	1			2		1	3		2	1
TOTAL	15	11	16	7	9	14	6	14	6	6	16	14
Eng	2					3		3			2	
Eng	2				2				3		3	
Eng				3	2							
Eng	3		2		2		1			1	1	1
Eng	3				1	2						
Eng	2		3		1	1						
Eng			2		2			2			3	
Eng	1		1					1	1		3	3
Eng	2		2		2	1		3	1		2	
Eng	1					3	3	2		1	2	
TOTAL	16	0	10	3	12	10	4	11	5	2	16	4
Manu	1	2		3	1			2			2	
Manu					3		1	1	1	2	3	2
Manu	3				3	2	2				2	
Manu	3					1	2	2	1	2	3	
Manu		2		3				2	1	1	1	
Manu	3	1			2		3	3				1
Manu		3		3	3			2				2
Manu	1				1	2	1				3	
Manu	2		2		1		3	1			1	1
Manu		2		2	1			1		1	1	
Manu	2						2	2			1	
TOTAL	15	10	2	11	15	5	14	16	3	6	17	6

1 Mentioned among other things
2 Mentioned and felt it was important
3 Strong point talked about for a long time

Figure 1: Management Interview Results.

Sorted by functional group, these results show that despite perceptions all groups thought similar things were hurting product development.

When I first got to Qualcomm I was asked to look at the product development process. I interviewed 32 managers in the Consumer Product Division. This allowed me to get to know the division and its players and allowed me to document what the current management thought was wrong. I interviewed all levels of management and in all the functional categories within the Consumer Products Division. I interviewed vice presidents, directors and managers from manufacturing and purchasing (Manu) as well as business (BU) and engineering (Eng). The interviews were informal sessions where I simply asked what they thought were their biggest problems. I documented the topics that came up and their relative importance. I then made a matrix of these topics to determine any correlation between functional groups or management levels and the specific ideas about improving product development. The matrix is shown in Figure 1sorted by function. Each line represents an individual interview. The top three issues in each group are shaded. See the appendix for more analysis of this data.

My Operations Program Manager (OPM) role on the pdQ Smart Phone allowed me to observe first hand how the company worked. I got to interact with people and experience the effects of their actions. I had the experience of being part of the Qualcomm system and even found myself acting in similar ways.

My observations from experiences as OPM and from the discussions in the interviews can be summarized in three critical areas: process improvement, discipline and leadership. Process improvement is the ability to see and implement positive change. Discipline is the ability to consistently follow a set of methodologies for decision making. Leadership is the ability to command respect, integrate ideas at a system level and execute major strategy effectively. These categories cover the topics I looked for in assessing Qualcomm's product development ability.

In each of these categories, I looked at all levels of interactions: the individuals, the teams, the groups and the interaction of the organization as a whole. The following is a full analysis of each area and each level within the organization.

A. Process Improvement

Examining how Qualcomm managed process improvement, I found the first hints at what was hurting product development. I looked at what skills were being employed to improve product development. Process improvement skills include an awareness of what is working and was is not, an ability to communicate these things to others and an ability to put in place actions for making processes better. Taking on different forms at each level of interaction in the company, these three basic improvement skills were apparent in some places and not in others.

1. Individual Contributor Level

At Qualcomm, I met many very knowledgeable people who were able to execute individual process improvement. The pdQ development manager (my counterpart in the business group) described his improvement process. He said that he knew he could not change everything at once so he just concentrated on making his current phone project a little bit better. He picked a few things such as the qualification test planning to improve for this phone project. He concentrated on communicating to others how these few improvements were going to be implemented.

The scheduler for the New Product Introduction manufacturing group was also very good at process improvement. She would implement new scheduling practices and improved reporting documents on a regular basis. She recognized where her tools were lacking and worked to implement new ones in order to improve her communication with others. These examples show effective process improvement at an individual level.

2. Poor Communication – Larry, Curly, and Moe Story

As an example of poor process improvement at the team level, I am going to tell a story. It is a story of three engineers who had responsibility over radio frequency testing and Stacey the operation program manager on their product. Because of the nature of the three engineers, I have nicknamed them Larry, Curly, and Moe.

The over-the-air radio frequency testing unit needed to be brought to the manufacturing line from the engineering labs on October 16th to support a build the following Monday. Larry was in charge of organizing the move. The tester was currently running in Moe's (the design engineer) lab where. Curly was the test engineer who was responsible for calibrating the tester once it was moved. These three guys were responsible for getting the test station running on the manufacturing line. This test station runs a simple test inside a square chamber. It turns on the product remotely and then tests its performance characteristics. Stacey carefully asked when the chamber was going to be moved and who was going to move it. She asked if Larry could organize the move, if Moe would be done with it and if Curly would be ready to calibrate it. All three said yes. She checked again the next week and again the next week to make sure the plans were still on target. They had another meeting the day the test station was to be moved. Stacey walks into the meeting and asked how everything had gone.

"Great!" Larry says, "I got the chamber moved no problem."

Turning to Curly, "Are you calibrating it now?" Stacey asks.

"No." he says, staring her down.

"Well, why not?" Stacey asks raising her eyebrow.

"There is no computer." Curly says simply.

Stacey turns her head towards Larry, "Larry, do you mean to tell me that all you guys did was move the box and not the computer that actually runs the test?"

All three, Larry, Moe and Curly start talking at once.

Larry: "I got the movers to move the chamber over here."

Curly: "I just calibrate the thing, I thought those guys were going to set it up."

Moe: " It's not my tester. I kept my computer. They're the test guys. They should get their own computers."

Stacey shook her head. She had made the assumption that if they all had agreed that the tester was going to be up and running, then one of them would have sorted out the computer issue. Instead she got a useless box on the line and three guys all pointing fingers at one another.

Tools exist at Qualcomm to aid group communication; however, these tools are not used effectively. The abundant use of the internal network and of e-mail at Qualcomm seemed at first to be a big advantage. Theoretically e-mail should allow everyone on the team to receive timely information. However, in reality, too many e-mails are sent. And, people cannot read them all and end up getting information late. Qualcomm's meeting-scheduling program allowed people to schedule meetings without having to talk with the other person. With the ease of the meeting program, meetings being scheduled to fill up the entire day negate the increase in productivity from not wasting time setting up meetings. Many different tools on the internal network have been tried as a coordination point for the development teams: web pages, SEEK (an information database) and Livelink (special web based environment). Despite these tools, people do not get the information they want unless it is sent to them directly. Larry, Curly, and Moe used these tools regularly but still had communications mishaps like the one described.

This is failure at the team level. The leader did not have the skill to see that the process lacked adequate design for effective action between individuals on the project. The individuals did not have team assessment skills to see where their effort should be placed to improve the process.

3. Management Interviews

I talked to a large cross section of the management in Subscriber during my initial interviews. These people interacted at the group level. The results of the data collection from the interviews were somewhat surprising. (See Figure 1) Process development and design for manufacturability were in the top issues mentioned for each of the functional groups. Although there was animosity between functional groups, without knowing it, they all agreed on what needed to be done. These managers knew their counterparts in other functions, but lacked coordination to assess the real issues effecting product development.

4. The Beer Game Impact

The System Dynamics simulation game, called The Beer Game, teaches the importance of thinking system wide (Sterman, 1989). It shows that the structure of human decisions influences people's behavior and that the most valuable policy changes come from thinking in new ways. Nelson Repenning, an MIT System Dynamics professor, came to Qualcomm's Consumer Products Division and ran the Beer Game workshop for 40 people in a variety of levels and functional groups. The lessons of The Beer Game such as the need for better communication and the effect of delays on inventory were very applicable to situations at Qualcomm. Many people enjoyed the workshop and said that they found value in this new kind of thinking. The system thinking ideas in this workshop were talked about a lot in the next couple of days, however there was little long-term effect.

This was a tremendous opportunity for an outside person to bring in new ideas and help the organization improve. Information on the physical and emotional state of the division could have been gathered. By assigning an internal advocate and a developing a plan the lessons from The Beer Game could be integrated into the operation or work styles of the division. The Beer Game experience represents a missed opportunity for process improvement at the organizational level.

B. Discipline

Qualcomm is a relatively new company and the Consumer Products handset manufacturing division is even newer. Discipline, the ability to consistently follow a set of methodologies for decisions making, was a significant concern in building effective product development. Existing processes did not work all the time and were not executed consistently. A well disciplined process usually has well-defined roles and responsibilities, a good use of

the tools available, the correct levels of management decision making, and a consistent use of methodologies that have been proven to work. My observations of discipline at Qualcomm range from very organized individuals to very disorganized group meetings, unclear team roles and responsibilities and limited strategy setting.

1. Individuals Discipline

Good personal discipline is evident in many people at Qualcomm. Individuals are good at keeping their own schedules, documents and methods. A director in charge of factory introduction was meticulous at following the rules that had been set down. A final assembly and test manager loved the discipline he instilled for himself and his direct reports. Another operations program manager was great at open discussion with people trying to solicit necessary information to improve her product. These people knew what their own responsibilities were and used the tools available to accomplish their tasks.

2. Meeting Culture

The meeting culture at Qualcomm shows many insights on the discipline in the company culture. Meeting methodologies and tools used in many other companies are not used effectively.

Meeting methodologies seem counter productive at Qualcomm. Meetings tend to lack a significant productive time. They tend to start 10-15 minutes after the scheduled time and chitchat is common. Meetings tend to be "pow-wows." Everyone gets to say what he or she thinks of the issue. Even if the point was already made, people feel like they need to put in their thoughts. Rarely does anyone take meeting minutes or leave with action items.

Meeting tools are not used effectively at Qualcomm. Meeting agendas are uncommon. Aside from a meeting title there is not much thought put into the meeting's topic or how to really solve the issues. Many times I would come to a meeting and no one would know who called it. Someone's assistant had put it on the meeting schedule and everyone showed up but no one knew who was supposed to lead the discussion. No one is responsible for a meeting's outcome. People feel they are simply gathered to talk, so no one needs to lead the discussion or write anything down. White boards provided in every meeting room are not used. There was a feeling of not wanting to be exposed by putting things down in writing. One manufacturing manager wrote things on the board to

illustrate his point. However, he was so afraid of leaving it up there that he would write with his right hand and erase what he had just written with his left hand.

Lack of discipline in processes in general at Qualcomm is evident in how meetings are run. If managers started helping people with the skills to run meetings effectively and started requiring agendas, and action item lists, perhaps the entire thought process of how business gets conducted could be changed.

3. PdQ Team Roles and Responsibilities

The pdQ team created many opportunities to study the disciplines and practices of the organization. The team consisted of a group of 100 people that had taken the product through the initial design, had built several engineering prototypes and recently had been starting to develop the process for manufacturing.

The roles and responsibilities on the pdQ team presented a challenge for the group. Specific tasks needed sorting out between engineering, program management and operations program management. The group had been in existence for a year but continued to do work without defining these roles. In addition to miscommunications like the story about Larry, Curly, and Moe many meetings were spent discussing solutions but did not lead to any specific conclusions. Five meetings were held on the top of the pdQ repair and return service without making any forward progress. This inability to focus on solution was due primarily to poor definition of responsibilities. Who had responsibility for defining how returned product was brought back to the factory? No one knew.

Teams located in close proximity with each other did little to help these issues. At first look, close proximity ("co-location") seemed like a good way to help people communicate with each other and sort out roles and responsibilities. Experience showed that the boundaries among functional groups were still there. These issues with clarity of roles and responsibility represent a breakdown in the group's ability to coordinate effectively.

4. Communication of Strategy Setting

The pdQ was the first product in which prototypes of a phone were going to be made on a separate pilot line and not on the production line. This was a new strategy for manufacturing. Because of the interruption of production revenue phones by new products, management created a separate line called the Pilot Line on which to build prototype phones. When I first introduced pdQ to the Pilot Line not all of the equipment was ready. The first build limped through the necessary processes. By the second build all of the tests were available. This phone project had trail blazed the new way of developing the manufacturing process. The pdQ team promoted the use of the Pilot Line and an increased interaction between the development team and the Qualcomm Personal Electronics

(full production manufacturing) people. However, it is unknown whether these improvements made by the pdQ team will actually influence other teams. This example shows the inability of Qualcomm to communicate a new strategy throughout the organization.

C. Leadership

Struggling to implement change to Qualcomm's process improvement and discipline practices, I realized there was another core area, leadership, which was hurting their product development. The leadership aspects I looked for at Qualcomm were the ability to empower people, the ability to command respect, the ability to interpret between the cultures of different groups and the ability to foster open communication and timely resolution of issues. I found that individual leadership was strong but that team, group and organizational leadership lacked some of these basic abilities.

1. Individual Empowerment

Many Qualcomm employees show individual leadership. They hire bright self-starting people who follow up on their own ideas. For example, a product engineer had a great idea about combining two manufacturing testing stations into one station. He collected his ideas, wrote the description for the new combined tester, got the two people that knew each of the previous testers to work out the details, proved out the combination and introduced it into the manufacturing line. This example demonstrates how an individual can initiate and follow through with well thought out projects. Subscriber is fortunate to have many empowered people that are able to implement their own good ideas.

2. Team Leadership

Some team leaders at Qualcomm worked well leading their groups, others seemed unprepared for the task. The director in charge of the pdQ module team was a good team leader. He had the respect of his team. He communicated the needs and the timeframe of his direction and was able to get the team to complete tasks in the time that he estimated. In one situation, he needed to discover the correlation between the test results at the module level and those at the phone level. Within a few weeks, this director was able to call his team together, develop a plan to discover the information, assign roles and responsibilities and execute the plan to change the testing limits in final assembly. On the other hand, I saw many teams that did not work well together. Product testing plans were

not developed because no leader took responsibility for their organization or completion. Repair strategy decisions were delayed by months because of a lack of coordination and leadership.

3. Functional Group Cultural Descriptions

In Subscriber, each function (Manufacturing, Engineering and Business Unit) has developed a very distinct culture. These groups interacted freely with those people in their same functional group. Starting with the original management personalities, each group also tended to hire others in their own image. As the groups grew they tended to attract people that liked the same kind of environment. Thus, these cultures have been reinforced over time. In the following section I will describe each culture and include my assessment on how each culture took to my discussion of change. For a company that was an innovative technology startup, there is a surprising amount of functional silos. The term functional silos is used to describe departments that are established along functional lines that do not communicate well outside of that function. It comes from an analogy to silos in farming. Everything inside one compartment stays within that compartment and there is no mixing between compartments. Just as Deborah Tannan would predict, these vastly different cultures did not communicate very well with one another even when they were working on the same products. (Tannen, 1990)

a. Manufacturing

The Manufacturing group included purchasing people, new product introduction people as well as line supervisors for both Qualcomm and Qualcomm Personal Electronics (the manufacturing joint venture). Many of these people come from traditional manufacturing jobs and continue to operate in a very hierarchical mind set. The common dress code for this group, suit and tie contrasts directly with most high tech companies in San Diego. This sets the tone for a very "do the best with what you are given" attitude.

Although they felt the requirements that upper management placed on them were unattainable, they were people with excellent skills and good intentions doing the best they could. Having no sense of history or evolution, the manufacturing group acted as if they had formed recently and were just trying to figure out their processes. They accepted me as a facilitator and although the discussion was very slow to start, once it got going I was no longer needed. When asked what specifically needed to be done to improve the manufacturing process for introducing a new product, the group could come up with many tools that were not currently being used. Some of

the good ideas for tools included design for assembly analysis, simulation analysis, and statistical process control. As though waiting for someone else to proscribe what to do, they talked at a pragmatic level but were hesitant of collective action. They had many suggestions on how to improve the development process but felt powerless to effect the way other groups worked. People said that they want to be more involved in the up front design process but it was difficult to schedule time in their busy schedules.

b. Engineering

The engineering culture in Subscriber is very typical of a fast paced high tech startup culture. They have cultivated a creative and relaxed atmosphere. Resisting conformity, most of the engineers do not like being told that there is only one way to do something. Engineers tend to resist discipline in any process because it might interfere with their individual autonomy. Process rules and paperwork are shunned and seen as getting in the way of getting their design work done. Most people wear very casual clothes: jeans and T-shirts are probably the most common attire but shorts and Teva sandals are not considered out of the ordinary. Engineering seems to act as if they have an unlimited budget. If something was not getting done or not getting done right I would hear people in the engineering group say that they should put together a group to do it.

The engineering community was very willing to sit down and discuss process. They were a very cohesive group. They started first to talk about the history of engineering in the Subscriber division. They had a strong sense that the way they did business today was directly related to how it was done when the division was just starting. They admitted that the biggest breakdown was probably between engineering and manufacturing. Their top concern was how to improve communication without hurting the things about the culture that made engineering great, namely: creativity and flexibility. When asked for solutions, this group talked at a very philosophical level and came up with little that was concrete. This gave participants things to think about but gave them no specific actions. They listened carefully to what I had to say, but once the discussion was started it became a discussion between the engineering managers.

c. Business Unit

The Business Unit was responsible for program management and the marketing on each of the phone projects. In my observations, a few very visible people set the business unit character. They tend to dress up and

have a designer look. Females are typically dressed in suits or flowery dresses. Males might have a shirt and tie with a sweater. They are very intense individuals driving to get things done sooner and better.

The Business Unit did not want to discuss new product process at first. They had a distinct sense that it was someone else job and they should "just go fix it". They were under tremendous pressure to get their jobs done and they did not have time for process discussions. When many of these people were involved in a meeting, the discussion took a life of its own and there was a lot of talk about what was wrong. There was an enormously strong sense that engineering had lots of the problems and they needed to fix them. The business unit people were frustrated with the rate of improvement in the other groups. They think that other groups just do not understand what needs to be done. The business group came up with improvement ideas but did not empower anyone to go do any of them. The business people talked of equalizing the power structure in the organization by sharing knowledge, but were only willing to share one way. They wanted information from other functional groups without giving up any themselves.

The business group history is dominated by stories of individuals. I was told stories of what specific people did 4 years ago when phones were first being manufactured. These individuals set the tone for the organization. They felt like they had "done it all" in the past and they needed to continue to do so in order to get the products out.

d. Cultural Summary

The functional silos in this division were exacerbated by the extremely different cultures. Engineering and the Business Unit argued over scheduling and product features. Manufacturing complained about not be allowed to do their jobs their own way. The overall effect is best explained with an analogy. This division is much like three different colors of play-dough. Each color represents a functional group. You can try to smash all three globs together but it seems that no matter how hard you push they always seem to break apart at the interfaces. The only way to get them to stay together is to knead them enough to get the colors to mix. Similarly, the distinct cultures at Qualcomm have trouble communicating across the functional boundaries. The groups are pushed together on the project team, however they often have communication breakdowns along functional lines.

4. Product Development Phase Process

When I was initially asked to join the task force that was creating Qualcomm Consumer Product's Product development phase process, it seemed like an easy cross-functional endeavor. The team would simply collect the requirements from each of the functional groups and determine where the natural breaks would be for the management phase reviews. It turned out not to be so simple.

Getting buy-in from all of the functional groups was difficult. The processes and the requirements for developing a phone differed from phone to phone and there was not any evidence as to which way was better. Because the vice presidents of the division wanted to make sure that their views were integrated, the process was tremendously slow. It took about four months for the vice presidents to meet and decide on the names and basic definition of each phase. The understanding that they developed was not documented. Without this documentation people may have different concepts of what each phase means. This process, although mandated now, has not been explicitly communicated beyond the initial group that created it. This means that true implementation will be very slow because of the re-learning that has to happen in order for the other levels in the organization to use it effectively. The language of the phases may get propagated through the organization but the learning and sharing about each phase is not likely to happen.

During the management interviews, I realized that there was no consistency in the importance of issues among management levels. The emphasis of the vice presidents was different than the directors and those were different than the managers. (See Appendix) This warns that new policies are not clearly passed down the levels of the organization. The Product Development Phase Process is likely to be ineffective if it is not communicated well. Some fundamental communication skills need to be enhanced by the organization as a whole.

D. Data Summary

All these observations are interesting, but what do they mean? The individuals at Qualcomm are acting effectively, but the teams and groups seem to be struggling. Qualcomm has not embraced some important aspects of process improvement, discipline and leadership and it is hurting the product development process. Although not a complete list of all the activities at Qualcomm, these examples are representative of the successes and failures in the organization. Next, I will discuss the hypothesis that puts these observations in perspective.

CHAPTER IV: System Dynamics Causal Loop Analysis

Using System Dynamics causal loops diagrams; this chapter describes the dynamic story of Qualcomm's growth and the resulting circumstances that are hurting their product development process. The acceptance of CDMA (Code Division Multiple Access) in the market place and the desire of good engineers to work at Qualcomm reinforced the basic business growth dynamic. However, this growth is coupled with undesirable side effects. Through these side effects, the skills in the organization are limiting Qualcomm's ability to develop products and thus hurting its ability to grow further. This model is not only my core hypothesis for Qualcomm's difficulties; it is also a general model that can apply to any company going through rapid growth.

A. Introduction and Basic Dynamics

The evolution of Qualcomm's Subscriber handset business is an example of "limits to growth." (Senge, 1990, p. 380) The basic story for a company goes like this: A favorable market and a basic ability to meet the market needs set in motion a process that produces the desired results. The company produces increasing sales volumes and increasing revenues. Unfortunately, the company's actions, which create the spiral of success, also create inadvertent secondary effects. These balancing factors in the system that slow the company's growth. If policies are not changed, the company risks a rapid decline. Figure 2 shows the basic S-shaped growth and rapid decline phenomenon.

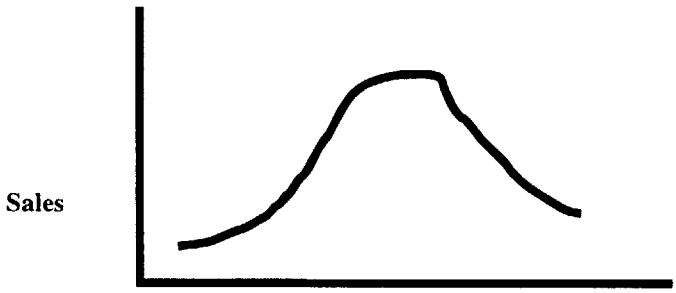

Figure 2: Basic Limits to Growth Pattern

S-shaped sales growth followed by rapid decline demonstrates the basic "limits to growth" pattern. Policies that aid in the beginning growth phase cause side effects that slow and eventual turn around sales.

If policies are put in place that reduce the impact of these secondary effects, then the decline can be pushed out farther or possibly even indefinitely as shown in Figure 3. If growth continues for longer than the original

scenario then sales numbers might look like the second solid line. If the limits to growth are reduced enough, sales growth could continue for some time. The dotted line shows this result.

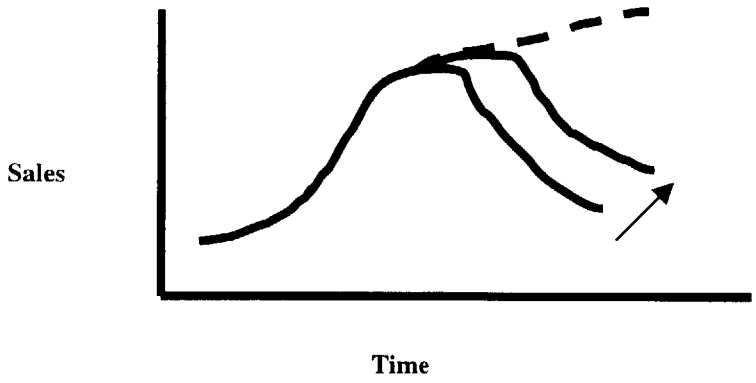

Figure 3: Reducing the Effect of Limits to Growth.

Rapid decline of sales is delayed for a certain amount of time (second solid line) or indefinitely (dashed line).

Qualcomm's story is this "limits to growth" story. The expansion of the wireless handset industry has fueled Qualcomm's growth. They have designed and manufactured more and more products as sales have grown and projections have shown continued growth. They have also continuously hired people for the last 5 years. The ability of people at Qualcomm to communicate with one another is the condition that is slowing their growth.

First, I will give a quick lesson on how to read System Dynamics causal loop diagrams. In causal loops, arrows are drawn between the variables to show a cause and effect relationship. These arrows are labeled with a plus or a minus sign to signify if the variables are positively or negatively related. For example, if one variable increases causing the next variable to increase, a plus sign labels the arrow to show that these two variables are positively correlated. If the first variable goes up but the second goes down, then the variables are negatively correlated and the arrow is labeled with a negative sign. Any variable without an arrow pointing to it is considered exogenous and has a value set outside the bounds of the diagram. The reinforcing and balancing dynamics explained in the System Dynamics background sections are also labeled. For a reinforcing cycle either a snowball or a simple R with an arrow is inserted inside the loop. The balancing cycle is labeled with a scale or a B inside an arrow. These markings help identify the basic building blocks of the causal loop diagram. Figure 4 shows the causal loop diagram of Qualcomm's limits to growth story.

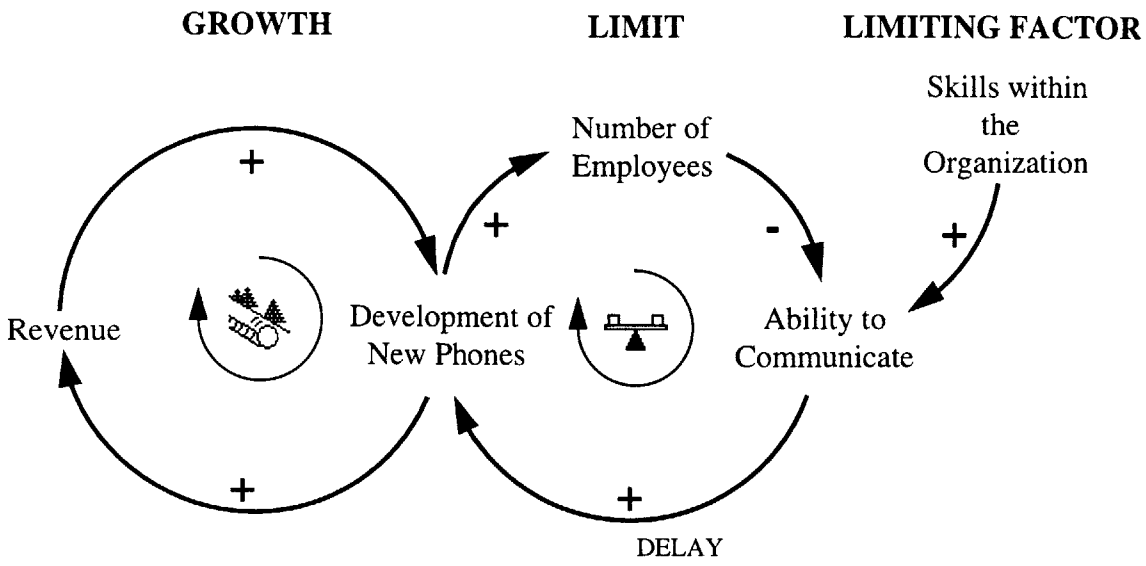

Figure 4: Qualcomm's Limits to Growth Story

Product Development and Revenue form a reinforcing growth cycle. But, the growing number of employees hurts communication given the current set of skills in the organization (balancing cycle).

The left-hand loop shoes how Qualcomm's development of new wireless phones produces rapid growth through generating revenues that can then be placed back into producing more new phones. The right-hand loop describes the basic secondary effect that limits the growth of the left-hand loop. As more phones are developed more people are hired. Given a certain level of skills in the organization, more people make communication more difficult. The communication difficulty means that Qualcomm's ability to produce new phones is hampered. The delay in the diagram represents the fact that poor communication does not immediately effect product development. This delay allows the revenue growth to continue for a period of time. However, the effect of poor communication over time will limit the growth cycle. This diagram represents the main hypothesis of this paper. The skills in the organization are not matched to the growth of the organization, and therefore the growth is inherently limited. Development growth can only be as good as the skills in the organization will allow.

This diagram in Figure 4 produces the same graph shown in the Figure 2 called Basic Limits to Growth Pattern. At first there are few employees so the ability to communicate does not affect growth. The development of phones and the collection of revenue continue to grow exponentially (first half of the S-curve). Then the number of

employees reaches a level where their ability to communicate decreases. This slows the product development growth and products the second half of the S-shaped curve. Eventually, the balancing loop will overpower the reinforcing loop and cause it to work in a detrimental fashion. At this point there is the rapid decline: No new phones are able to be developed so there is no revenue, which means there are not funds to develop anything more.

Of course these loops are over simplified. In the following sections I will expand each of these loops in order to give a better description of the growth dynamics and the limits to growth dynamics present at Qualcomm. I will draw on my experiences at Qualcomm to spell out how the actions I observed demonstrate these dynamics.

B. Growth

1. Basic Business Growth

As I have said, the Qualcomm's basic growth story shows revenue from products feeding back into new product development. I call this dynamic Basic Business Growth. Revenue from other businesses seeded the phone development. Seeing all the work that needs to been done, management hires more engineers to develop products. This in turn lets Qualcomm ship more phones and receive revenue, which starts the cycle again.

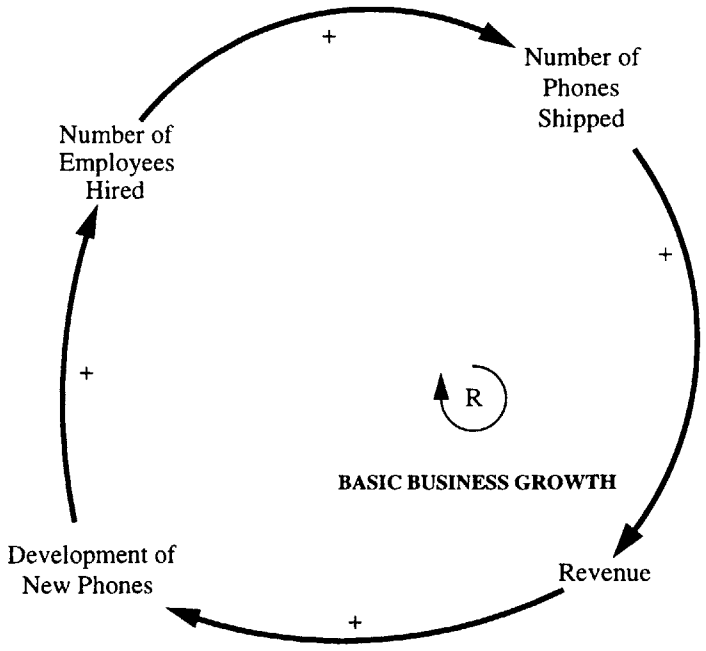

Figure 5: Basic Business Growth Dynamic.

Revenue allows the development of phones and hiring of people which allows increases the number of phones shipped and the revenue gained.

On closer analysis, Qualcomm's growth was also fueled by the acceptance of Code Division Multiple Access (CDMA) as a viable wireless technology and by the creation of an environment where engineers love to work. These two dynamics contribute to Qualcomm's tremendous growth.

2. Acceptance of CDMA

The overwhelming focus of Qualcomm was to get CDMA accepted as a viable technology and grow its market share. Market demand allows Qualcomm to ship phones. As phone shipments increase and more CDMA handsets are in the market there is a greater public awareness of CDMA as a wireless technology. Greater awareness fuels the demand for Qualcomm's CDMA products. This allows Qualcomm to sell more of its phones. This effect is shown in the Figure 6.

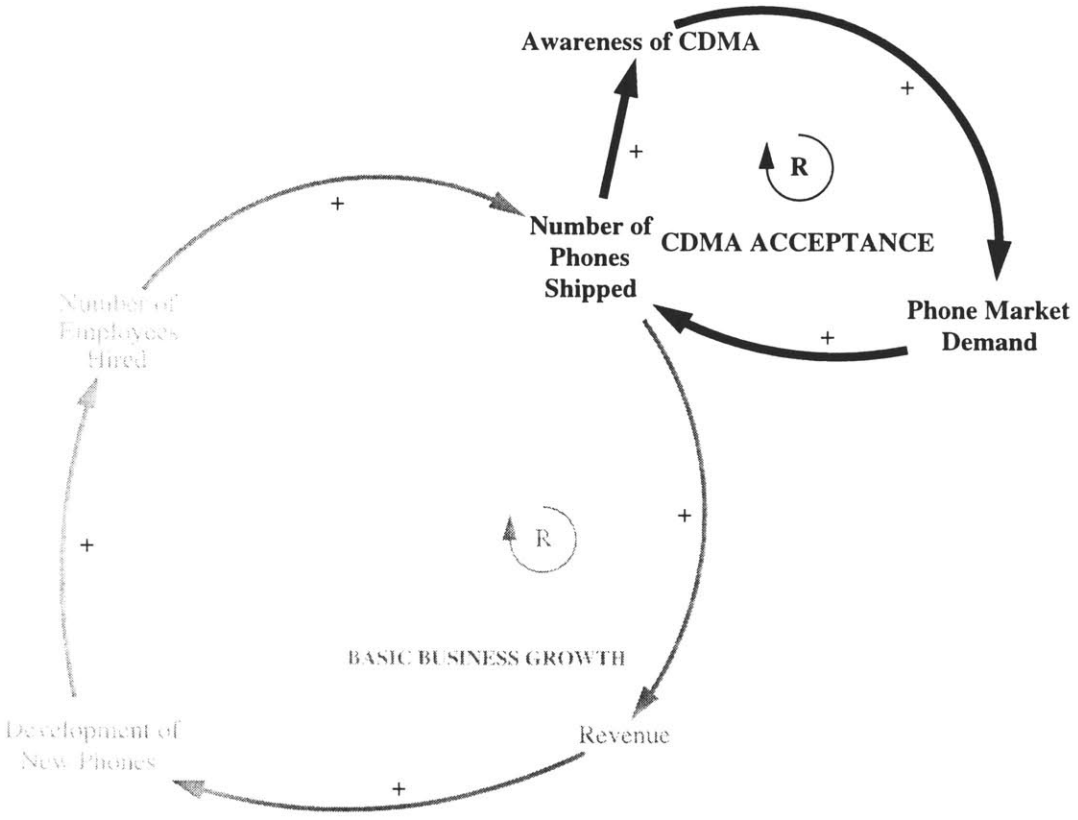

Figure 6: Acceptance of CDMA Growth Dynamic.

As more CDMA phones are shipped into the market, the awareness of CDMA as a viable technology increase and this in turn increase the demand for phones.

3. Engineer's Disneyland

The other growth effect at Qualcomm is the ability of the environment to attract engineers. Qualcomm is famous in the local area for being a great place for engineers to work. Engineers hired originally created a place that was ideally suited to their desires. This increases the desire of other engineers to work there. This was a supply limited market and Qualcomm hired to high standards. Thus, the more attractive the workplace the more good quality engineers applied for employment and are hired.

Qualcomm's attractive environment consists of many amenities in addition to exciting work on highly technical products. It is an engineer's Disneyland. At Qualcomm, flexible work hours are the norm. Casual dress is common and food is free at meetings. The country club atmosphere includes bike lockers, showers, sand volleyball courts and an Olympic size swimming pool. Engineers are given their own offices, cell phones and any amount of lab space and fancy equipment they need. The culture that I described in the engineering department was pervasive at the beginning. Overall, engineers work on the latest technologies with the best equipment available in a place that is fun. Although this effect is most relevant to the engineering functional groups, many people within the other groups also have engineering backgrounds and feel the same desire to work at Qualcomm.

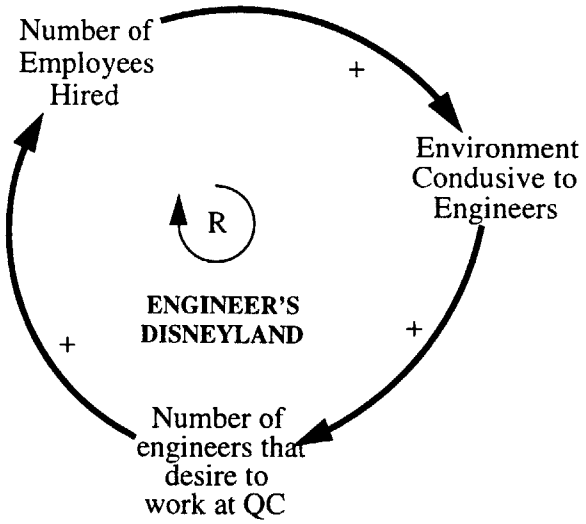

Figure 7: Engineers' Disneyland Growth Dynamic.

The environment established by current engineers makes it extremely attractive for other engineers to work at Qualcomm. Qualcomm can then hire more engineers.

One successful engineering manager's story typifies this dynamic. He came to Qualcomm three years ago from another electronics manufacturing in San Diego. He had heard about Qualcomm from engineer friends who already worked at Qualcomm. Intrigued by the environment both personally and technically, he approached Qualcomm and was hired easily. This attractive environment dynamic is drawn in Figure 7.

The combination of the three growth dynamics are shown in Figure 8. Each spirals upwards with positive results for Qualcomm.

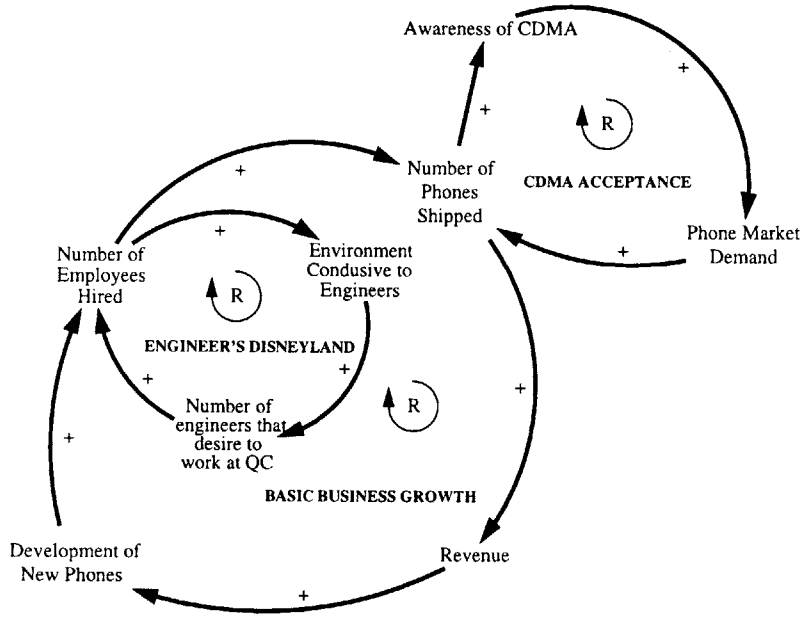

Figure 8: Qualcomm's Growth Dynamics.

Three growth patterns make up Qualcomm's tremendous growth. (Basic Business Growth, CDMA Acceptance and Engineer's Disneyland)

C. Limits to Growth

Seeing these three powerful reinforcing growth dynamics, our first inclination would be to think that Qualcomm would continue to grow as long as they could sell more phones, get CDMA accepted in the market and continue to be an attractive to the work place. However, there are four unintended side effects of this rapid growth. Because of a long delay, these dynamics do not show up at first, but gradually become more powerful. Eventually, the Water Cooler Effect, Too Many Project Teams effect, the Shipping Phones Early effect and the Rework Competence effect will limit Qualcomm's growth.

1. Water Cooler Effect

So what is the effect of all this hiring? One of the more apparent dynamics is the functional silos. For such a young company and a young division it was remarkable how much separation there was among the business, engineering, and manufacturing groups. The disparity in cultures along with poor meeting and program management skills facilitated this separation.

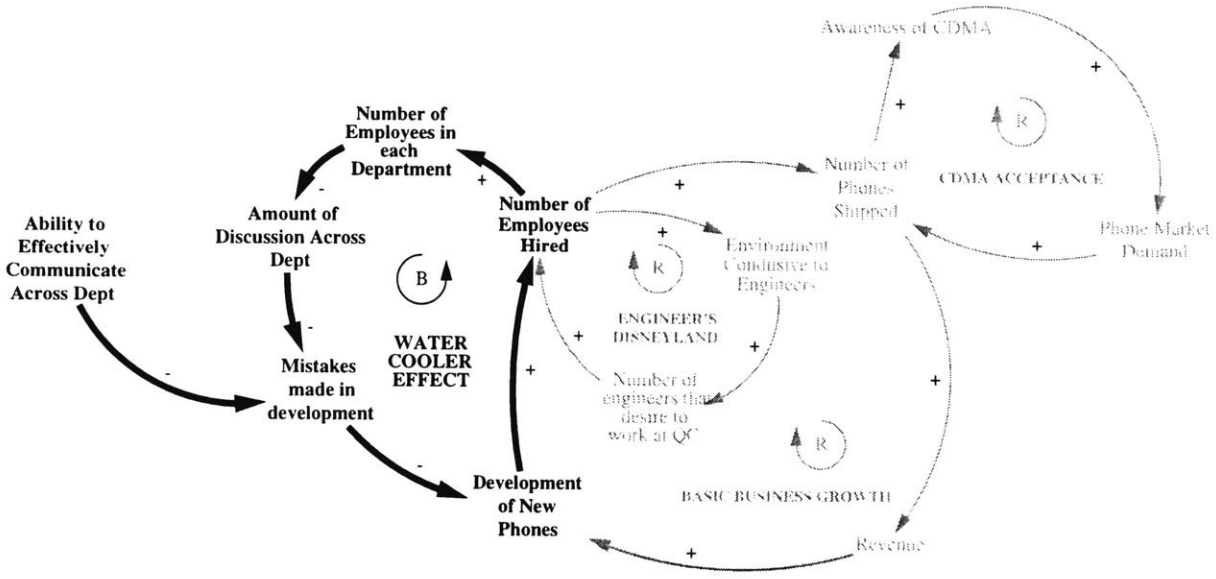

Figure 9: Water Cooler Effect.

An increasing number of employees in each department make it harder for people to talk outside of their functional groups. Poor communication across departments leads to mistakes in development.

As people got busier on phone projects or factory startup and as the number of people grew, it became harder to interact with people outside their discipline. It is only natural that electrical engineers talk with other electrical engineers or that marketing people tended to talk to marketing people. The pace of the work left little free time to communicate across the functional areas. This resulted in poor communication on specifications, manufacturing capabilities, market needs, etc. and the projects ended up in confusion. Larry, Curly, and Moe could have easily prevented their miscommunication. In the end, mistakes are made in the development process. For example, engineers designed a connector between circuit boards early in the design process, but did not communicate with manufacturing who knew it could possibly be a problem. The design was already in the factory

when it was confirmed to be a problem. Many phones had already been made and now had to be reworked. This failure to communicate across the functions is what I call the Water Cooler Effect. It symbolizes that people only talk to those in their functional groups that they are likely to see at the water cooler. As shown in the causal loop in Figure 9, this is an effect that is limiting Qualcomm's basic business growth.

2. Too Many Phone Projects

Another unanticipated effect of growth for Subscriber was the affect of having too many phone projects and phone teams. There were 8-10 different phone project teams developing many different derivatives of each phone type. There were three different 'brick' phones being developed, one 'brick' phone in the factory and two flip phones being developed; not to mention the pdQ Smart Phone and its second generation. The teams were working so hard they did not have time to have any discussions across project teams. Each project team tended to do things

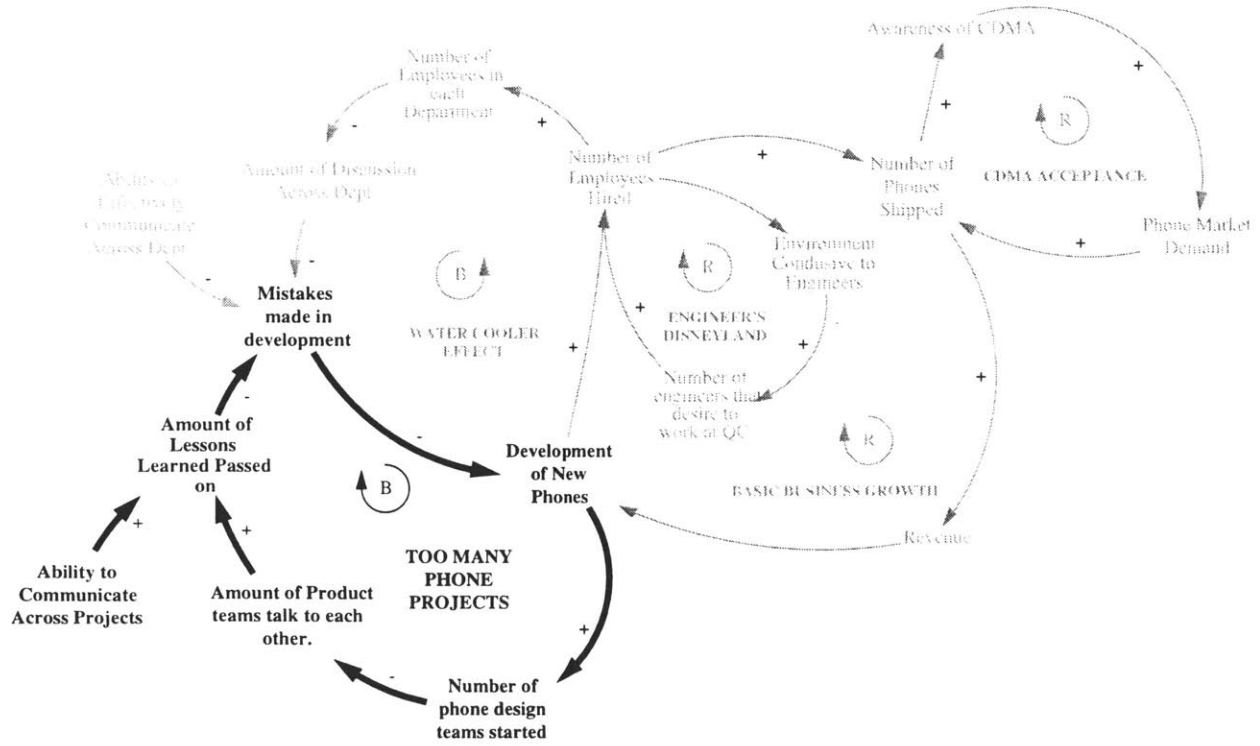

Figure 10: Too Many Phone Projects Dynamic

The desire to develop more phones means the number of teams increases too much to allow effective communication between teams. Lessons learned are not passed on and mistakes are made in development.

in their own way and repeat mistakes similar to other teams. The failure in their information exchange shows up in this dynamic. Teams do not follow specific steps making sharing across project very time consuming if not impossible. There were few lessons learned that were passed from one phone team to the next causing unnecessary mistakes. These mistakes slowed down the development process. See Figure 10 for a picture of this dynamic. The increase in product development time further limits Qualcomm's growth in the handset market.

3. Shipping Phones Early

Another effect that is limiting Qualcomm's growth, is the drive to make the quarter's revenue numbers. The Business Unit is closely tied to revenue and they tend to get judged more specifically on whether other not they are making their numbers. They sense the gap between actual and potential revenue and push to ship the phones as

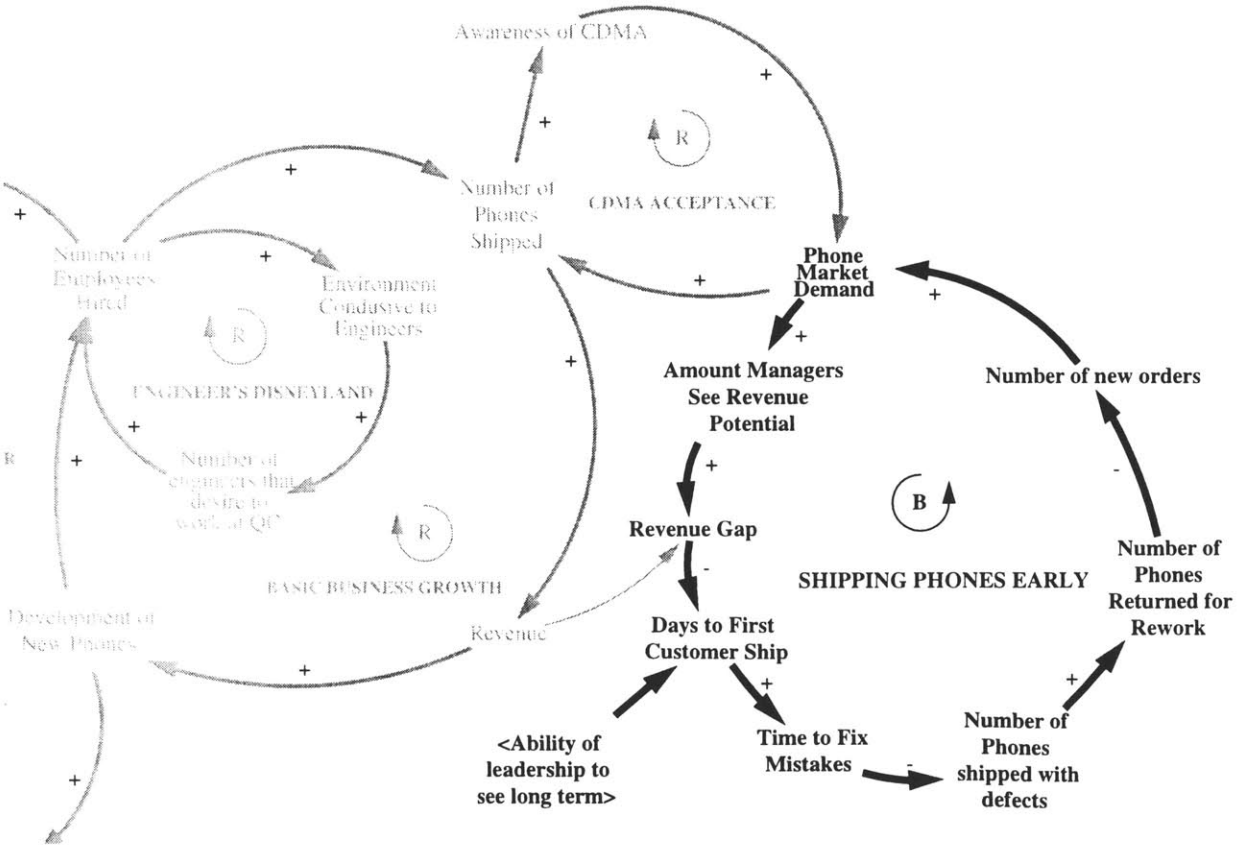

Figure 11: Shipping Phones Early

The pressure to make revenue pushes the shipment of revenue phones. This level less time for mistakes to be fixed. The phones shipped with defect cause demand to decrease.

soon as possible in order to meet the quarter's revenue numbers. This drive decreases the time between introducing the phones into the factory and shipping the first phone to a customer. Because of this, the development teams have less time to fix the problems that have been found with the phone. If the problems are not fixed, phones go out the door with quality issues, and eventually get returned by the customer. Dissatisfied customers will not order new phones and Qualcomm's phone demand will go down. The failures in organizational leadership that I described above hinder these decision-makers from seeing the negative effects of their actions. Believing that getting phones to the customers earlier would increase revenue growth, these decision-makers let poor quality phones reach the market and actually reduced long term revenue growth. This effect is shown in the causal loops in Figure 11 and again it is obvious that "Shipping Phone Early" adds to issues that are limiting growth.

4. Ship More Defective Phones: Rework as a Core Competence.

We can look at another dynamic imbedded in the loops of the other limiting effects. A common joke in many meetings was "rework is our core competence." While I was working at Qualcomm many production lines

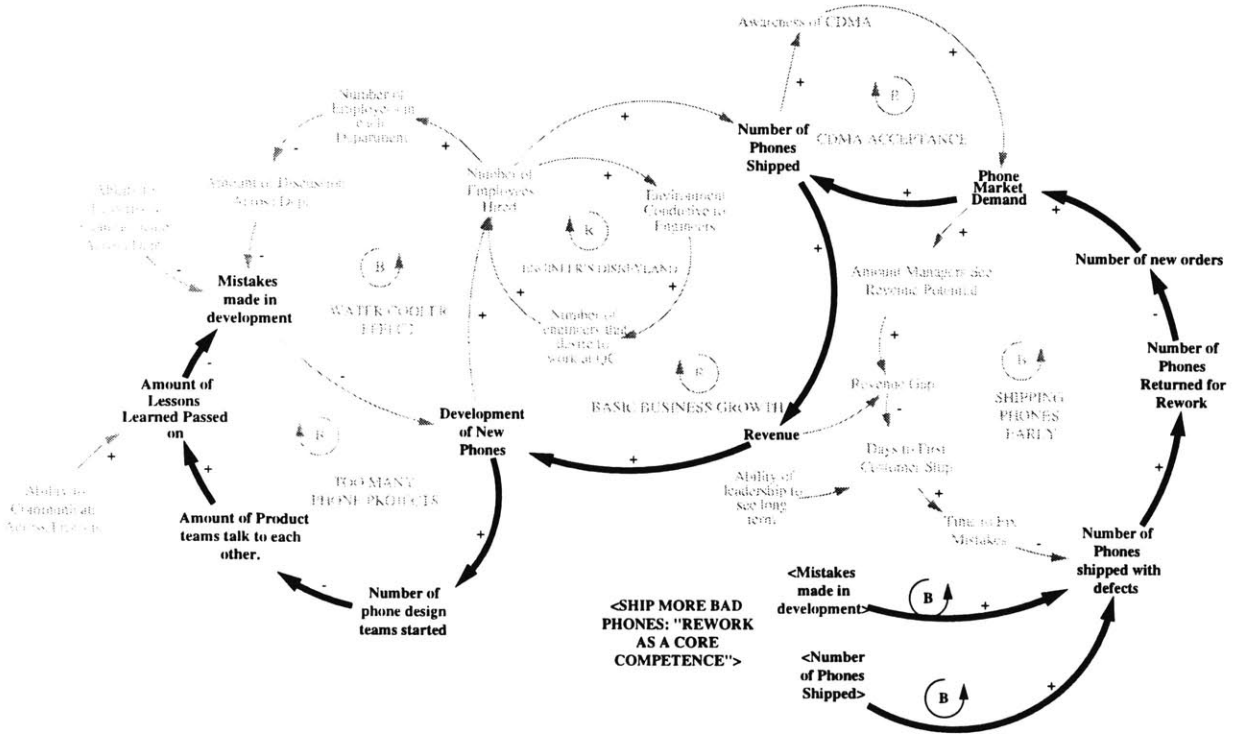

Figure 12: Ship More Bad Phones: "Rework as a Core Competence"

The combination of all of Qualcomm's dynamics creates this over reaching dynamic. Qualcomm is experiencing more and more rework.

were converted over to do rework on phones that either got returned from customers or were known to have defects. Qualcomm planned to rework 60,000 phones over the winter shutdown in order to meet schedule. No one seemed to know what was causing so much rework. From the complex set of loops shown in Figure 12 we can see that these growth and limits to growth dynamics paint a clear picture of this rework effect. If we trace a path from 'Mistakes Made In Development' and 'Number of Phones Shipped' around to 'Number of Phones Shipped with Defects' we see the effects that are causing the rework. The tremendous amount of rework is limiting the production growth of the handset business.

D. Causal Loops Summary

These dynamics are not specific to the Qualcomm case. They can generally be applied to any growth situations. If decision-makers experiencing the growth dynamics make rational decisions, it seems as if the organization as whole should behave rationally. Only we can see that it does not. When reacting to growth dynamics, decision-makers inadvertently cause growth to slow. The interaction of other dynamics are not appreciated or accounted for by the decision-makers. Without the ability to understand the entire system of cause and effect, managers tend to point fingers at other departments and they continue to push the same policies. Instead of seeing these other dynamics, these managers reinforce them and perpetuated the cycle.

Because these causal loops describe dynamics at the organizational level, individuals in the company might not see the entire picture. It is natural that seeing the desired growth, managers would want to continue to do what you had been doing. Many of the Qualcomm managers that I interviewed did not understand the policies that were successful in the past no longer worked. The truth was that they saw only the growth dynamics and not the other factors that were actually limiting them. Unfortunately the more they emphasize the old way of doing things, the more strongly the limiting factors resist. It is not that individuals in the organization sought to create the problems that exist, it is just that these secondary effects have not been addressed. These effects in turn limit Qualcomm's future growth potential.

Maintaining continued growth will require Qualcomm to look at the skills surrounding of the balancing factors and give up the old policies that led to their original growth. In the following section I will describe the management tool I have created to help diagnose the skills in an organization that might be limiting the organization's growth potential.

CHAPTER V: Conclusion

A. Introduction

We have seen that Qualcomm's growth produced inadvertent side effects. In this conclusion, I will describe how managers can understand the exact skills that are limiting growth. Senge recommends in The Fifth Discipline that management, which finds itself in a limits to growth situation, not try to push growth. (Senge, 1990, p. 101-102) This is also true for Qualcomm. Management cannot keep hiring new people and forming more project teams without addressing the negative effects also introduced. I believe management must work to eliminate the effects of the secondary dynamics, namely the organization's ability to communicate among large numbers of people. They must manage processes in a disciplined way. Qualcomm must improve the skills that are limiting its ability to communicate across products and departments. They must also understand the leadership skills necessary to see the larger perspectives and to optimize activities at many different levels.

The various levels of interaction among people at Qualcomm fall into four categories: individuals interacting, teams of people trying to work together, groups or departments trying to function effectively and the

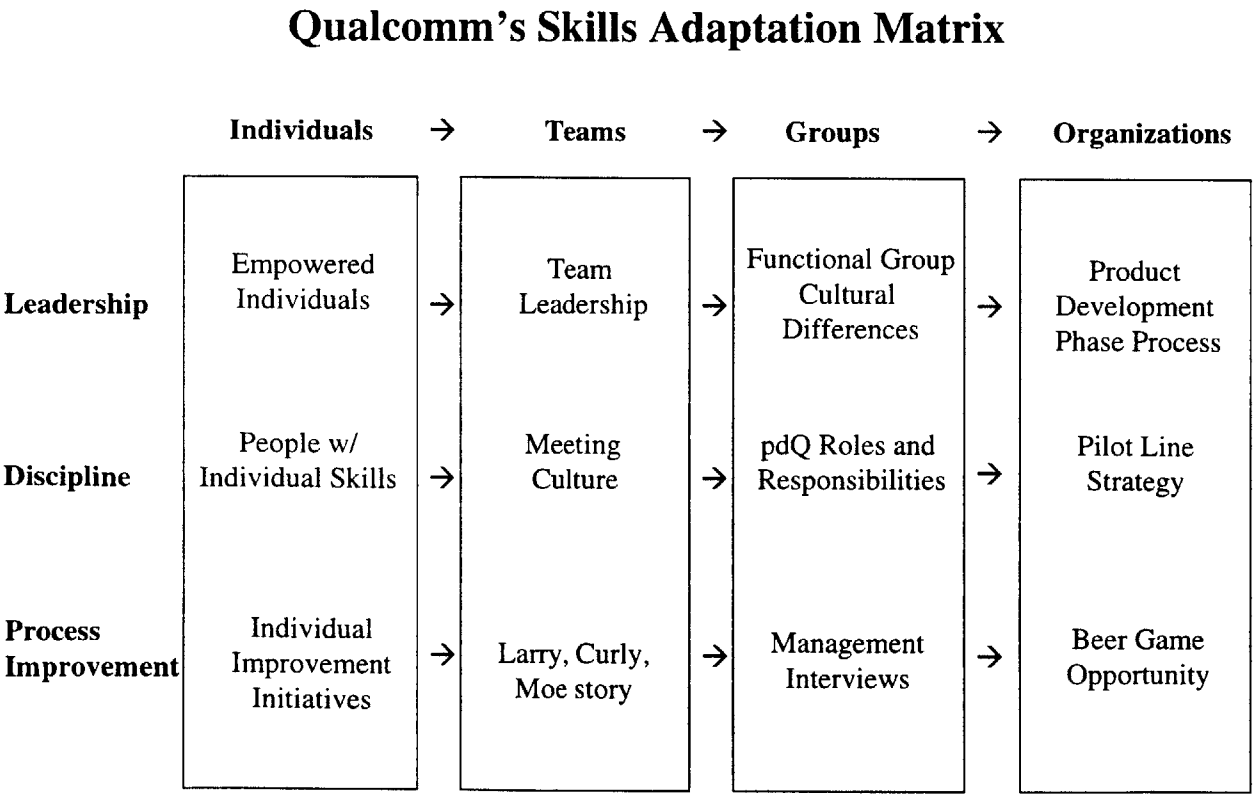

Figure 13: Observations at Qualcomm fit into a matrix of skills and disciplines.

entire organization working smoothly. For example, Larry, Curly, and Moe are functioning at the team level. The director of the pdQ modules team is a good example of individual interaction. Each of these levels of interaction has unique skills in the categories of leadership, discipline and process improvement. I have named the three by four matrix formed by this set of skills the Skills Adaptation Matrix. Each one of the examples from Chapter III can be mapped into the Skills Adaptation Matrix as shown in Figure 13.

I have used the term "adaptation" to impart the idea that companies need to develop their skills as their size grows. A technology startup can be very successful with individuals with good skills. However as the company grows, levels of interaction grow and people must have different skills. The company must adapt its skills to the number of people in the organization and the levels of interactions that exist. This Skills Adaptation Matrix is complex enough to cover the situations in a variety of different organizations but it is simple enough to aid managers in targeting their efforts for improvement.

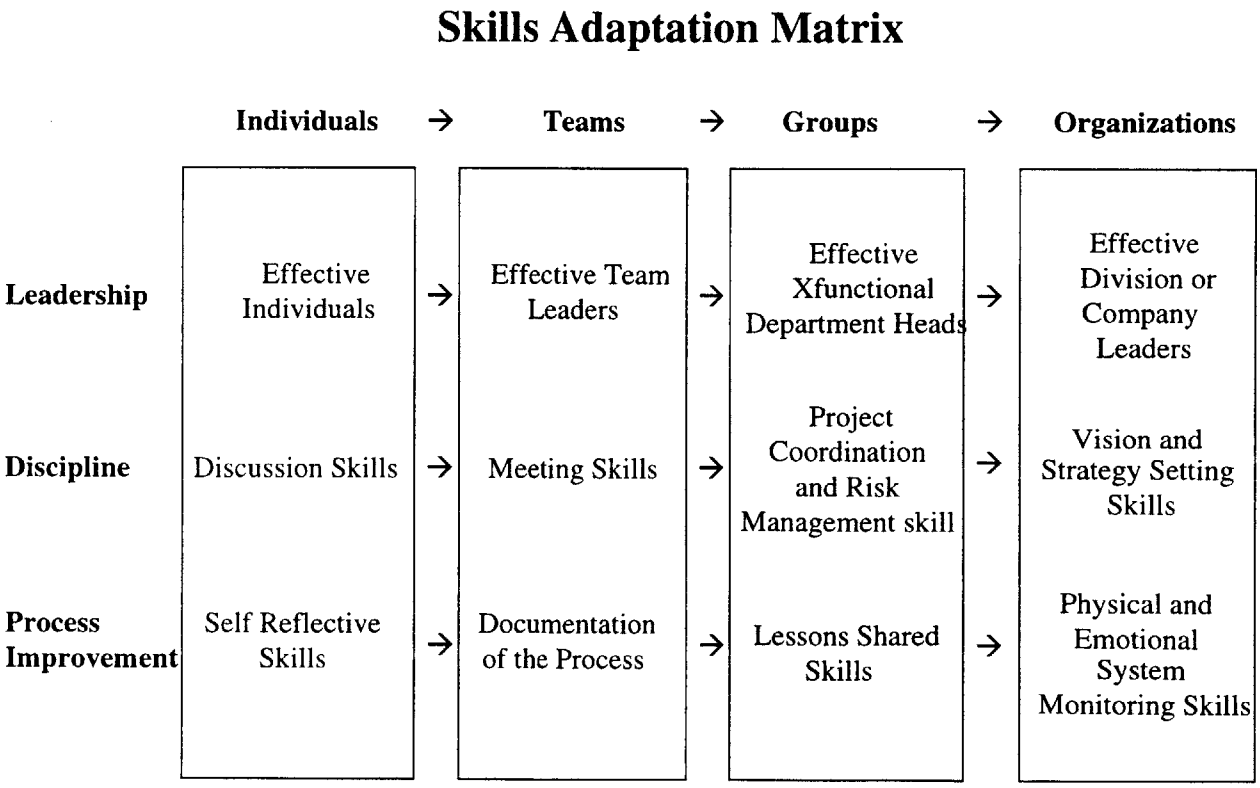

Figure 14: Generic Skills Adaptation Matrix.

This matrix shows the basic skills that are needed at each level of interaction and within each discipline.

B. The Skills Adaptation Matrix Explained

1. The Levels of Interaction

If we start with a one on one interaction, individuals share their experiences in order to work together and move forward. As we start adding more people to this interaction, the communication gets more complicated but not impossible. The team can still have a common experience and can act on that common experience. As we move to larger groups and organizations, people must adapt and utilize different skills. If the leadership, discipline and process improvement mechanisms are not in place, you end up like Qualcomm with many bright, empowered people going many directions. Figure 14 shows the Generic Skills Adaptation Matrix. And, the next sections describe each part of the matrix in more detail.

a. Individual

I will start with an interaction that is one person with a single other person. If these two people want to work together to accomplish something they agree on how to accomplish that task. I will assume that it is a complex enough task to require both of them. By working together, these two people learn how each other communicates and learn how each respond to certain situations. They come together and express not only their own experiences but also emotional responses to situations. They develop a common understanding that allows them to work effectively together. One of the outcomes of this shared mind set is an ability to act in a rational way and optimized resources. In this case, optimizing resources might simply be deciding who is better to handle what set of tasks to reach the end goal. These individuals can accomplish a great deal because of their skills. Different skills are required when we move to a larger group of people.

b. Team

With more people on this team trying to accomplish a little bigger task or the same task in a shorter amount of time, the interactions are still manageable. They still can develop a common understanding of how the project will get accomplished. And now the resources are greatly increased. They will spend more time explaining than they had to with just two people. However, with good meeting skills and good documentation it is still possible to come out of a discussion with everyone on the team understanding the status and direction at a specific point in time.

The effectiveness of this team requires strong leadership on the part of the team leader and needs to be built on the foundation of individuals who interact well.

c. Group

Imagine that this small team adds more people and transitions into a large group. Now this large group of people, trying to accomplish a very large task, has to struggle to maintain the same level of shared understanding as the smaller group. The delays for reporting and updating people are longer. No longer is there one point in time where everyone has the same intuition, emotions, or even understanding about the project. Despite good intentions the group, left unmanaged, will tend to go in different directions causing inefficiencies in achieving the desired goal. To combat this, good cross-functional department leaders need to use their skills of project coordination and risk management to understand the issues from past projects and implement the optimum route to achieving the new goal.

d. Organization

When we combine the groups, it becomes even more difficult to make the entire organization communicate effectively and execute things efficiently. The Skills Adaptation Matrix points to skills that need to be present. Company leaders need to set vision and strategy and monitor the physical and emotional health of the organization in order to create a shared experience. Developing a shared experience with a large organization is more than just putting lessons learned and project management mechanisms in place. It is more than just the learning organization of The Fifth Discipline. (Senge, 1990 p. 14) It is about having the organization take a life of its own and an intuition of its own that the people in that organization share. There is no impedance to action in a certain direction, so it is simple for people to act. Their results, however, show that they acted towards the collective goal. A shared experience is one where an organization can run many experiments on product development in parallel and gain the knowledge that comes with the results of each one. These organizational level skills must build on the group skills and the team skills.

2. Skills Categories

Now, look at the Skills Adaptation Matrix from the horizontal rows or skills categories. The skills categories by which I have broken down my experiences at Qualcomm represent the three strategic sets of skills needed all organizations. The categories of leadership, discipline, and process improvement are applicable to Qualcomm and many other companies. As it grows, a company must insure that the skill levels present in the organization match with the types of interactions present. The organization must adapt its leadership, discipline and process improvement skills as it grows. The arrows in the matrix represent the fact that the skills on the right need those on the left to exist in order to successful. It is important to emphasize that these skills build on one another. If there is a person with good skills at the group level who is surrounded by people that do not have good individual or team skills, that person will be frustrated in her attempt to coordinate the project. As we look at each category, we see how these skills build on each other.

a. Leadership

In the leadership realm, a company needs good leaders in each specific function. At the individual level, people with good personal leadership can interact with one another in a very professional and focused manner. Team leaders are able to take a handful of people and move them toward a common goal. At the group level, a company needs people who can lead across functional departments. At the top of an organization there must people with the breadth of understanding and strength of personality to lead the entire organization towards a common goal.

Good company leadership helps employees have a shared experience. Leaders show people how to communicate. They keep track of the group's understanding of vision, direction and current actions. They also think ahead to anticipate what needs to be done to keep everyone on track. They manage the "knowledge transfer" and "lessons learned" processes instead of micromanaging the urgent tasks that come up every day. A knowledge transfer process is the process by which organizations take specific work done in one area and share it across all areas of the organization. A lessons learned process takes the experiences of each project team and uses them in the creation and execution of the next project in order to eliminate problems, reduce development time or improve product quality. Good organizational leaders are able to unite people and create a common experience. They can get a large number of people to move in the same direction. Under effective leadership, each individual shares a similar understanding of what went right and what went wrong. Individuals know how they contributed to the final

product and they feel they were part of the same experience as their colleagues. People can either learn these leadership skills as they advance in an organization or companies can hire outside people who already demonstrate the leadership ability that matches their place in the organization.

b. Discipline

Discipline is the ability to consistently follow a set of methodologies for decisions making. Processes for conversations, meetings, projects and strategy setting must work every time and must be executed consistently. Individuals with good discussion skills such as listening and succinctly articulating views will communicate effectively with their colleagues. At the team level, meetings are necessary way to organize discussion among many people. Running meetings effectively and efficiently is crucial for sharing information among team members. Moving up a level, companies need to develop employees with good project coordination skills such project direction risks assessments and resource allocation decisions. However, these will not be useful if the skills at the individual and team level are not yet ingrained into the culture. Division presidents and company leaders must have the skills to set vision and strategy. Because they are formalized processes that are followed logically, vision and strategy setting fall under the topic of discipline. Although many leadership books talk about setting mission and visions, they do not explain that without the other organizational skills in place to reinforce them, mission and vision cannot be executed effectively.

c. Process Improvement

Process improvement starts at the individual level with self-reflective skills. An introspective individual has the ability to see his or her role in an organization, to analyze past mistakes and to form new methods for improvement. At the team level, documentation of processes is essential for process improvement. The team must understand the different roles and responsibilities of each team member and document the actions that each took to accomplish the goals. The group level process improvement skill is sharing lessons learned. Group leaders must understand the applicability of their experiences to other projects. At the organizational level, leaders must monitor both the resources available to projects and the emotional state of the employees. They must be able to improve morale and resources constraints in order to keep the organization moving the desired direction.

Qualcomm's Skills Adaptation Matrix

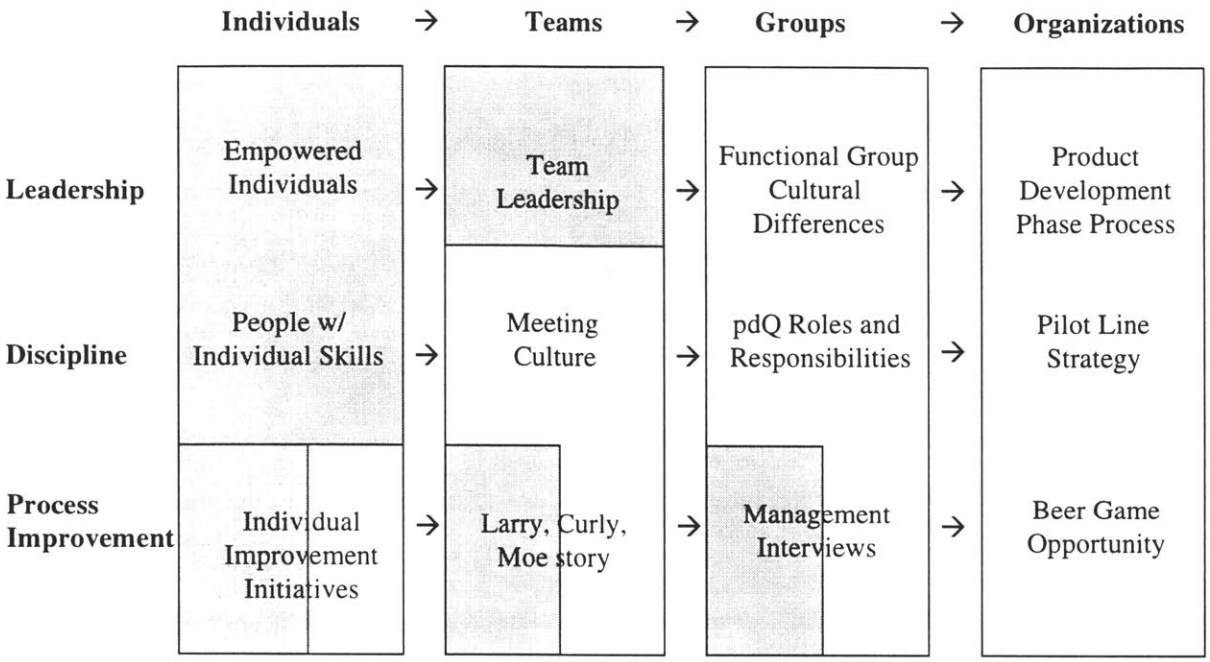

Figure 15: Qualcomm's Skills Adaptation Matrix

This adaptation matrix shows the areas that Qualcomm is good (shaded) and the areas that need work(clear).

C. Qualcomm's Skill Proficiency

Looking at where Qualcomm is proficient at the skills in the Skill Adaptation Matrix, we see a pattern emerge. The shaded regions in Figure 15 show Qualcomm's strengths. A half-shaded region means that Qualcomm does show some development in the area although not full development. The distinct difference from left to right shows that they are good at the individual level skills, decent at the team level skills with the exception of discipline in meetings and have shown little skill at the group and the organizational levels. The Larry, Curly, and Moe story is an example of a breakdown at the team level. Although they have good intentions, these people lacked the necessary process improvement skills to execute the project smoothly. Management's inability to disseminate effectively the product development phase process describes poor leadership at the organizational level. This Qualcomm specific matrix pinpoints where Qualcomm's communication and organizational skills are limiting their ability to do effective product development and continue to grow.

The arrows in Figure 15 show how the skills to the left build off of the skills to the right. Companies need to start with good individuals then build good teams then build good group and finally implement an entire effective organization. A company cannot try to jump ahead and build an effective organization without working on the other skills first.

Qualcomm's ability to develop new products is limited because some skills have not been developed. Many skills have not been developed in the logical order. Upper management, currently concentrating on running good teams, needs to develop their skills as good cross-functional facilitators and good divisional leaders. Project leads are trying to coordinate without adequate discipline. Good discussion skills and meeting skills in the people reporting to them are essential. Good divisional vision and strategy cannot be implemented if projects are not coordinated well. Process improvement at Qualcomm shows skills missing. Some individuals have self-reflective skills. Others do not. Documenting their processes is just beginning to happen. Some attempts at transferring experiences by collecting lessons from past projects also exist. Organizational level skills are not apparent. Qualcomm needs to develop these skills to work effectively. Raising the level of skills within the organization will eliminate communication problems and allow them to continue to grow and develop products.

D. Conclusion Summary

When Qualcomm was small, the people with good individual skills were able to achieve great success. Growth was inevitable. However, Qualcomm has grown faster than its skills in communication. As it grew Qualcomm concentrated on getting into the market without taking a comprehensive look at its management and communication capabilities. As a consequence, Qualcomm is seeing the limitation this mismatch puts on its ability to effectively launch products and do so continuously.

CHAPTER VI: Recommendations

Understanding the growth and organizational limitation at Qualcomm and considering the framework I have established, I recommend that Qualcomm do an in-depth analysis of their skills. They should start improving these skills by working on improving meeting effectiveness, and then work on continuously improving other skills in their organization. My recommendations to any company would follow a similar pattern. Any company that is experiencing growth should analyze what types of interaction it needs and analyze what skills it can do well. It should then match its skills to those outlined in the Skills Adaptation Matrix. It should systematically build the necessary skills starting from the level in which it is proficient and move to the higher levels. This will insure that there are no mismatches and consequently growth limitations.

A. In-depth Analysis of Skills

My first recommendation to Qualcomm is to do an in-depth analysis based on the Skills Adaptation Matrix. Identifying an individual's skills in each area will motivate managers to help him or her acquire and practice the skills they need.

Team leaders should head up the drive to have good meetings. They should tutor people that still need help with individual leadership skills, discussion skills and self-analysis skills. Steven Covey's idea of being independent so one can be interdependent can be applied in the team setting. (Covey, 1989) Team leaders should concentrate on running meetings well and on documenting the development process.

Cross-functional management should assess project coordination skills as well collate and distribute the ideas learned from their projects. They can use ideas from traditional business theory. The most powerful skills will be those that break down the functional silos, that make sure experiences get shared with other groups, and that insure logical risks are taken.

Divisional leadership should concentrate on strategy and vision building skill and execution. Strong division leadership should have control over all functions (Business, Engineering and Manufacturing). This person should have responsibility for profit and loss and should communicate it to everyone in the division. Divisional leadership should stay away from getting involved in day to day operational tactics and trust it to those people in the cross-functional roles. There are a lot of good books on leadership (for example Bennis, 1989) that point to skills that can be learned by the people in these leadership positions. The company or division leader should lead by

empowering people to implement a clear and specific vision. An in-depth analysis of the skills in each individual, department and group will help Qualcomm understand the skills that are limiting its product development growth.

B. Discipline of Meeting Culture

From the analysis I have done, it is obvious that Qualcomm needs to address its weakness at the team interaction level before moving to the group and organizational level. In short, they need to attack their weakness at the team level by developing discipline skills in meetings. This will be the start of many changes. Improving meeting skills is an easily understood action that represents a significant cultural change.

In the beginning of the company everyone knew each other very well professionally and socially. By talking in a meeting, leaders could pass on the direction and lessons to everyone in the company. Now the company is too big and groups are not aware of other groups' activities. Managers can no longer empower people and know that everyone will be headed in the same direction. Instituting a meeting discipline in the culture will counteract these effects of a large organization. Meetings should give everyone a forum to talk. Writing on the white board and recording action item lists make commitments clearer and spread understanding of the larger. Discipline in writing good meetings agendas will help people target topics that most need discussing.

Meetings should be limited to those issues that cannot be solved elsewhere. Meetings should not be a long report on project status. Status of projects can be communicated on the web where there is access for anyone at anytime. Many people get easily caught up in urgent business and forget about the important but non-urgent things. They forget about things like developing a plan for the next project phase, learning from other projects or congratulating people on a job well done.

Overall, meetings should cultivate the shared experience by having people express their problems, solutions, ideas and emotions. Good team leaders can use the ideas of Deborah Tannen to frame better discussions. (Tannen, 1990 and Tannen, 1994) Personality typing, such as Meyers Briggs testing, can help in understanding how other people receive and use information. (Cummerow, 1997). Roles and responsibilities need to be ironed out in meetings and not left undetermined. Implementing the idea of solid commitments from the Business Design Associates, (Rubin, 1999) I believe Qualcomm needs a culture that accepts responsibilities in meetings and follows through with those commitments. The essence of good communication is making a request for action and knowing that the person will do exactly what was intended in the agreed upon time.

In the company's transformation from a startup to a mature company this development of good meeting procedures is crucial. Changes in meeting culture do not need to hinder the good parts of Qualcomm's culture. The atmosphere can still be casual and friendly. Food and drinks can help facilitate good morale. People will simply be more disciplined in their communication with others.

Figure 16 shows once more the full dynamic picture of Qualcomm's product development growth. These recommendations will break the limiting effects. Good meeting discipline will increase the communication link among product groups and across functional boundaries. Thus, it will eliminate the 'Water Cooler Effect' and the 'Too Many Phone Projects' effect. It will decrease the number of mistakes made in product development, which in turn will speed up the process and raise profitability.

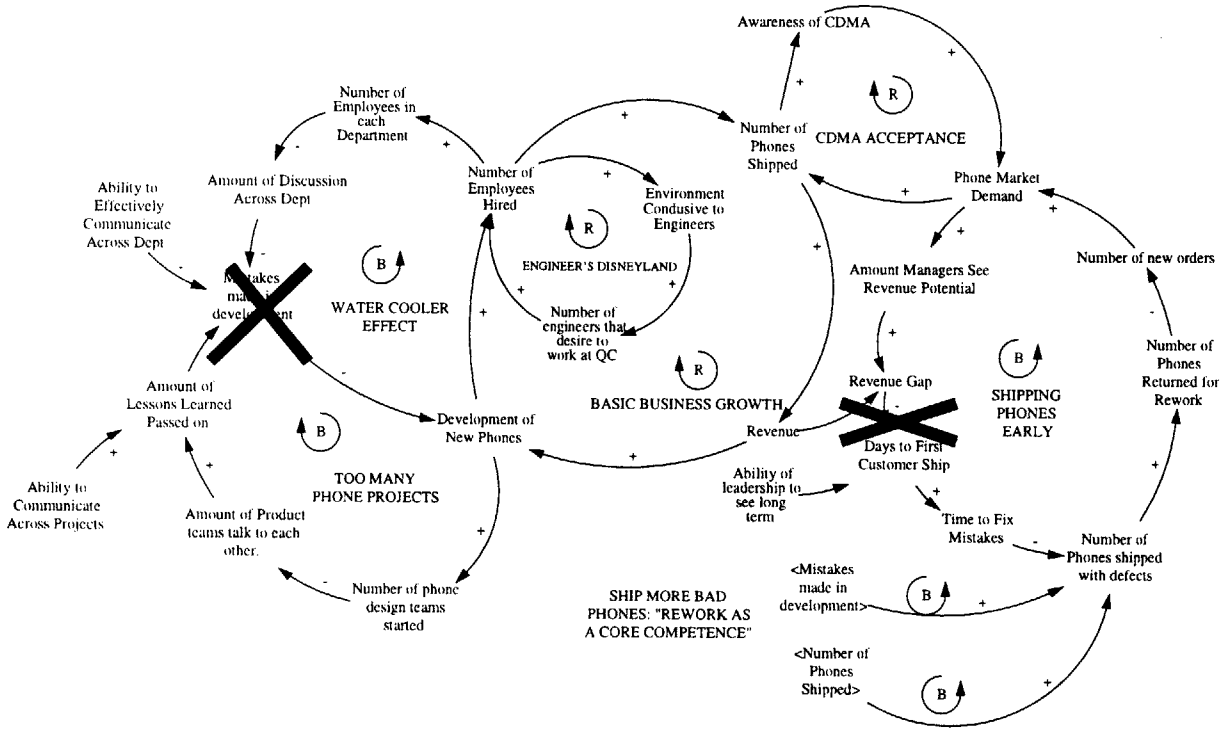

Figure 16: Reforming Qualcomm's Dynamics

Enhancing communication skills will break Qualcomm's limiting (balancing) dynamics. The large X's show the places were these reforms will break the cycles.

C. Continuous improvement

Gaining discipline in meetings is only the place for Qualcomm to start. Following the Skills Adaptation Matrix, Qualcomm should sequential attack each of the skills outlined. It should learn how to use the tools

effectively that are ubiquitous in the culture, (namely e-mail, web based activity, teams in close proximity and a creative fun culture) to support and emphasize the development of each of these skills at each of the levels. Qualcomm needs to realize that it is not a startup any more and that the communication skills that worked when the company was small will no longer work. It needs to realize that these skills are limiting their ability to develop products effectively.

When cross-functional teams work better together, the antagonism between business and engineering will disappear. The company can then look at eliminating the problems that are causing all the rework in the factory. Thus the link between the 'Revenue gap' and the 'Days to first customer ship' will not be as strongly linked. This will break the Shipping Phones Early dynamic (See Figure 16).

If steps are taken to bolster leadership skills, discipline skills and process improvement skills in the logical order presented, Qualcomm will raise the limits currently placed on it and be able to continue to grow its handset business.

D. Timeliness of Reforms

I cannot emphasize enough that NOW is the time for Qualcomm to change and create the needed skills. The market is still shining favorably on Qualcomm, so sales growth has not slowed. However from the insider's view, past mistakes demonstrate that the skills of employees are not as developed as they need to be. Seeing that sales are not slowing, people will be inclined to wait to make changes. This could be a fatal error. The time to adapt

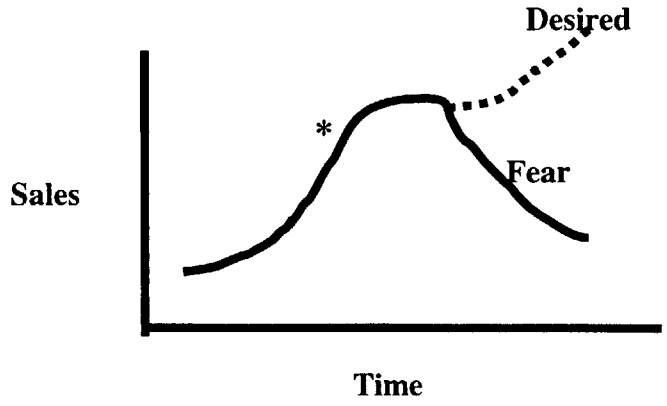

Figure 17: The Timing for Action.

The timing for policy change is NOW (asterisk) while the company is still experiencing growth. The reforms will cause the desired results instead of the feared results.

employees' skills is while there is still growth. Figure 17 shows the generic curves for limits to growth theory. Because of the inherent delays in establishing solid improvement, changes need to be made at the asterisk in order to see the effects in the future. Removing the limitations to growth, the company can follow the dotted line of continued growth and not the solid line of rapid decline.

I recommend that now is the right time to implement these actions. If Qualcomm waits until growth stops, then the window of opportunity will have passed. The company will not have time or resources to actually implement changes when they are most needed.

E. Generalizing the Matrix to All Companies

This is not a unique problem to Qualcomm. Every company goes through growth phases and every company faces the limits to that growth. The limits to growth curves shown again below are generic and demonstrable. Data from many companies can be examined to show the basic limits to growth curves. One dramatic example is the story of People Express Airlines. (Senge, 1990, p 128- 135) Their revenues followed the pattern of rapid S-shaped growth and then declined as they struggled frantically to beat the competitors. In reality, it was not the competitors but certain internal forces that where limiting their growth and eventually caused their demise.

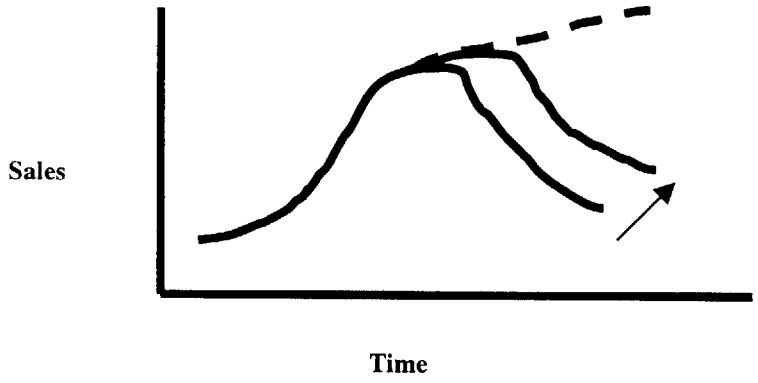

Figure 18: Limits to Growth Curves.

These curves show that when a company understands its dynamic environment and implements corrective policies, growth can be extended.

My first recommendation to Qualcomm can be generalized to any company. Analyzing a company's skills at each level of the Skills Adaptation Matrix gives a guide to where to concentrate its improvement efforts first. A

company can analyze which skills have been successfully implemented in the organization and which skills need to be worked on next. Where Qualcomm needs to implement effective discipline in their meeting structure, another company might need to concentrate on the skill level in its individuals. Still another company might have all the skills needed for the individual, team and group levels and it must concentrate on building organizational skills. Basically, companies can assess their existing skill levels and direct improvement efforts toward the skills in the next adaptation level. Each company can use its unique combination of circumstances, culture, and current operations in order to apply their new skills effectively.

The timing for skill development is critical. This array of skills in the Skill Adaptation matrix needs to be developed as the need for each type of interaction arises. Urgent problems should not be the trigger for skill development. A company needs to recognize its weaknesses during the times when it is growing. Growth can be expanded (dotted line) if companies recognize their limitations before they become problems.

The fast clockspeed (Fine, 1998) of Qualcomm and its environment allowed me to study the effects of the mismatch of skills and company growth more effectively. Clockspeed is defined as the rate at which an industry develops new products and new technologies. In other industries that have slower rates of product development and slower technological development and have less competition, it is harder to see these effects. However, they are there. The breakdowns in companies like Qualcomm are greater because of their faster clockspeed. More mature industries must have gone through similar mismatches in growth and skill. The automobile industry, for example, probably struggled with these issues in the 1920's.

Many companies face the problem of trying to make improvements to their product development processes and seeming to be limited by something. That something is the skills in the organization. These skills can be systematically improved to reduce the negative side effects on growth. A company must recognize that its problems with product development are a result of having communication needs that are mismatched with the skills in the organization. It can then the Skills Adaptation Matrix to map out their plan for skill development and give the company the means to do effective product development.

APPENDIX

This appendix contains the data from the management interviews done in conjunction with this research. The matrix in the body of this paper shows the data sorted by functional group of the interviewees. These in the Appendix show the data sorted by other relevant classifications. Each has some interesting results worth documenting here.

title ranking	More Design for manufacturing in the Design Process	Better Forcasting would make my job easier	Our resources are spread too thin - less products- right projects	Longer more stable relationship with suppliers	Diversity of Cultures and Philosophies is strong (among people and depts)	Manufacturing Capabilities are not well spelled out	We need to improve yield in the factory	Design Varification testing is not done early enough	Manufacturing needs more clout. Techology driven company	Need a clear transition plan from QC to QPE	Incremental Improvement methodology is needed	Decision Making culture - emotion vs facts	Need to instill some planning and discipline to our processes	Product Life Cycle Time needs improving (don't repeat NGP-TGP)	Mechanical Issues need more work - were's EE focused	Need to get more decision making people in PM roles
Vice President	3		3	1	1	1			1	1	1		1		1	1
Vice President	3				3	2	2		2				2		3	3
Vice President				3	2										3	3
Vice President	1		1			2			2					3		2
Vice President	3				1	2		1							3	
Vice President	2		3		1	1		1							1	
Vice President	1				1	2	3	1	1				3			2
Vice President	1		1				1	2		1	1		3	3		
Vice President	2	3			1	2	2			2	1		1			
TOTAL																
Director	1	2		3	1					2			2			
Director					3				1	1	1	2	3	2		
Director	2		2		1		2		3	1			1	1		
Director	2					3	1	1		3			2			1
Director	3	1	3		2	1			1	1	1		3	1		1
Director	1	3	3	2						3		1	1	3		1
Director	3	1			2		2		3	3				1		
Director		3		3	3					2				2		
Director	3		2		2				1			1	1	1	2	1
Director			2		2					2			3			
Director	1				2	3			1	2		3	3			
Director	2		2		2	1		2		3	1		2			
Director	2						2		2	2			1		2	1
Director	1					3	3		3	2		1	2			
TOTAL																
Manager	2				2			3			3		3			1
Manager				1	2					3			2	3		
Manager		2		3						2	1	1	1			1
Manager	2		2			1			1			2	2	2		2
Manager		2		2	1			2		1		1	1			
Manager	1	2	3	3	1	2	1			1			1	1		2
Manager	1	2	1			2		2		1	3		2	1	1	1
Manager	3					1	3		2	2	1	2	3		1	1
TOTAL																

Figure 19: Management interviews sorted by title ranking

Although all three management categories picked some of the same top three subjects, the order of importance of those subjects is different. Managers were most concerned about process discipline. Directors were most concerned about the product transition from Qualcomm to Qualcomm Personal Electronics. And lastly, Vice Presidents were most concerned with the lack of design for manufacturing in the product designs.

Personality Strength Ranking	More Design for manufacturing in the Design Process	Better Forcasting would make my job easier	Our resources are spread too thin - less products- right projects	Longer more stable relationship with suppliers	Diversity of Cultures and Philosophies is strong (among people and depts)	Manufacturing Capabilities are not well spelled out	We need to improve yield in the factory	Design Varification testing is not done early enough	Manufacturing needs more clout, Techology driven company	Need a clear transition plan from QC to QPE	Incremental Improvement methodology is needed	Decsion Making culture - emotion vs facts	Need to instill some planning and discipline to our processes	Product Life Cycle Time needs improving (don't repeat NGP-TGP)	Mechanical Issues need more work - were's EE focused	Need to get more decision making people in PM roles	Need to tye in service and field repairs to our product development
2	1	2		3	1					2			2				
2					3				1	1	1	2	3	2			
2	2				2			3			3		3			1	1
2	3					1	3		2	2	1	2	3		1	1	3
2				1	2					3			2	3			
2		2		3						2	1	1	1			1	
2		3		3	3					2				2			
2			2		2					2			3				
2		2		2	1			2		1		1	1				
2	1	2	3	3	1	2	1			1			1	1		2	
TOTAL																	
3	3	1	3		2	1			1	1	1		3	1		1	
3	1	3	3	2						3		1	1	3		1	1
3	3	1			2		2		3	3				1			
3	3				1	2		1							3		
3	2		3		1	1		1							1		
3	1				1	2	3	1	1				3			2	
3	1				2	3			1	2		3	3				
3	2		2		1		2		3	1			1	1			
3	2		2			1			1			2	2	2		2	
3	1	2	1			2		2		1	3		2	1	1	1	1
TOTAL																	
4	3		3	1	1	1			1	1	1		1		1	1	3
4				3	2										3	3	
4	3		2		2				1			1	1	1	2	1	
4	1		1				1	2		1	1		3	3			
4	2	3			1	2	2			2	1		1				3
4	2						2		2	2			1		2	1	1
4	1					3	3		3	2		1	2				
TOTAL																	
5	2					3	1	1		3			2			1	
5	3				3	2	2		2				2		3	3	
5	1		1			2			2					3		2	
5	2		2		2	1		2		3	1		2				
TOTAL																	

Personality Strength was determined by the author based on the interaction in the interview as well as the amount this person seemed to be talked about in the organization.

Figure 20: Management interviews sorted by strength of personality

Strength of personality shows a slight correlation to the topics discussed. It appears that those I have judged to have less forceful personalities had somewhat different topics on their minds than others.

	More Design for manufacturing in the Design Process	Better Forcasting would make my job easier	Our resources are spread too thin - less products- right projects	Longer more stable relationship with suppliers	Diversity of Cultures and Philosophies is strong (among people and depts)	Manufacturing Capabilities are not well spelled out	We need to improve yield in the factory	Design Varification testing is not done early enough	Manufacturing needs more clout, Techology driven company	Need a clear transition plan from QC to QPE	Incremental Improvement methodology is needed	Decsion Making culture - emotion vs facts	Need to instill some planning and discipline to our processes	Product Life Cycle Time needs improving (don't repeat NGP-TGP)	Mechanical Issues need more work - were's EE focused	Need to get more decision making people in PM roles	Need to tye in service and field repairs to our product development
< 100				3	2										3	3	
< 100	3		3	1	1	1			1	1	1		1		1	1	3
< 100	1		1			2			2					3		2	
TOTAL																	
100 - 1500	1		1				1	2		1	1		3	3			
100 - 1500	3				1	2		1							3		
100 - 1500	2		2		2	1		2		3	1		2				
100 - 1500	2		2		1		2		3	1			1	1			
100 - 1500	2					3	1	1		3			2			1	
100 - 1500	3				3	2	2		2				2		3	3	
100 - 1500			2		2					2			3				
100 - 1500	1				1	2	3	1	1				3			2	
100 - 1500	1					3	3		3	2		1	2				
100 - 1500		2		3						2	1	1	1			1	
TOTAL																	
< 1800	2		3		1	1		1							1		
< 1800				1	2					3			2	3			
< 1800	1	2	3	3	1	2	1			1			1	1		2	
< 1800	1	2		3	1					2			2				
< 1800	3	1	3		2	1			1	1	1		3	1		1	
< 1800	1				2	3			1	2		3	3				
< 1800	2						2		2	2			1		2	1	1
< 1800	3		2		2				1			1	1	1	2	1	
< 1800	2		2			1			1			2	2	2		2	
< 1800					3				1	1	1	2	3	2			
< 1800	1	2	1			2		2		1	3		2	1	1	1	1
< 1800	1	3	3	2						3		1	1	3		1	1
< 1800	3					1	3		2	2	1	2	3		1	1	3
< 1800		2		2	1			2		1		1	1				
< 1800	2	3			1	2	2			2	1		1				3
< 1800	2				2			3			3		3			1	1
TOTAL																	

Figure 21: Management interviews sorted by employee number

The data sorted by employee number show interesting results. Employee number also corresponds to the number of year the individual has been working at Qualcomm. Those with employee numbers that are less than 100 have been at Qualcomm more than seven years. These people have basically been at Qualcomm since it was a startup. Those in the 100 – 1500 ranges have been at Qualcomm four to seven years. They were hired during the time of the most rapid growth. Those people with employee numbers over 1800 have been hired in the last four years. The most important topics are strikingly different among these groups.

BIBLIOGRAHY

Bennis, Warren. On Becoming a Leader. Reading, MA: Addison Wesley Publishing Company, 1989.

Blanchard, Ken. The One Minute Managers. Berkley, CA: Berkley Publishing Group, 1993.

Carnegie, Dale. How to Win Friends and Influence People. New York, NY: Simon & Schuster, 1981.

Covey, Stephen R. The 7 Habits of Highly Effective People; Restoring the Character Ethic. New York, NY: Simon & Schuster, 1989.

Cummerow, Jean M. Work Types: Understand Your Work Personality. New York, NY: Warner Books, 1997.

Fine, Charles H. Clockspeed: Winning Industry Control in the Age of Temporary Advantage. Reading MA: Perseus Books, 1998.

Forrester, Jay W., "Industrial Dynamics: A Major Breakthrough for Decision Makers", Harvard Business Review, 36(4) (July-August) 1958: 37-66.

Forrester, J. W., Industrial Dynamics. Cambridge, MA: MIT Press, 1961.

Hammer, Michael and Champy, James. ReEngineering the Corporation. New York, NY: Harper Collins Publishers, Inc., 1993.

Kotter, John P. Leading Change. Boston, MA: Harvard Business School Press, 1996.

Lester, Richard K. The Productive Edge: How U.S. Industries Are Pointing the Way to a New Era of Economic Growth. New York, NY: W.W. Norton & Company, 1998.

Peters, Tom. In Search of Excellence: Lessons from America's Best-Run Companies. New York, NY: Warner Books, 1988.

Repenning, Nelson P., The Transition Problem in Product Development. MIT Sloan School of Management, 1998. (Draft)

Repenning, Nelson P. Successful Change Sometimes Ends with Results: Resolving the Improvement Paradox through Computer Simulation. MIT Sloan School of Management, 1997.

Repenning, Nelson P., and Sterman, John D. Getting Quality the Old-Fashioned Way: Self Confirming Attributions in the Dynamics of Process Improvement. MIT Sloan School of Management, 1997.

Rubin, Harriet. "The Power of Words", Fast Company January 1999: 142 – 151.

Senge, Peter M. The Fifth Discipline: The Art & Practice of The Learning Organization. New York, NY: Currency and Doubleday, 1990.

Shiba, Shoji, A New American TQM : Four Practical Revolutions in Management. Boston, MA: Productivity Printing, 1994.

Sterman, J. "Modeling Managerial Behavior: Misperceptions of Feedback in a Dynamic Decision Making Experiment" Management Science. 35(3), 1989, 321-339.

Tannen, Dehorah, You Just Don't Understand: Women and Men in Conversation. New York, NY: Ballantine Books, 1990.

Tannen, Dehorah, Talking From 9 to 5: Women and Men in the Workplace: Language, Sex and Power. New York, NY: Avon Books, 1994.

Weick, Karl E. " Organizational Redesign As Improvisation" in Huber, G.P. and W. H. Glick (eds) Organizational Chanfe and Redesign. New York, NY: Oxford University Press, 1993.