TOTAL QUALITY MANAGEMENT AT AT&T

by

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Submitted to the Alfred P. Sloan School of Management
in Partial Fulfillment of the Requirements for the Degree of
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Abstract

Total Quality Management (TQM) has entered a difficult period. The excitement that characterized early efforts in the 1980’s has been replaced with disappointment in many cases. Over two-thirds of all TQM efforts end without achieving significant improvement. However, AT&T’s Merrimack Valley Works succeeded not only in winning the Malcolm Baldrige National Quality Award, but in sustaining the improvements over time. By examining the case of AT&T in the form of a learning history and contrasting it with earlier work on TQM false starts, I show how a successful improvement program can be achieved, and what circumstances may be necessary for this to happen. In addition, I show how certain events in AT&T’s corporate history contributed to the success of TQM at the Merrimack Valley Works. This suggests how the history, culture, and environment of an organization, as well as the actions of its members, may affect the success of change programs.

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Introduction

Total Quality Management (TQM) has entered a difficult period. The excitement that characterized early efforts in the 1980's has been replaced with disappointment in many cases. A 1989 Gallup survey of Fortune 500 executives found that only 26% felt that they had achieved significant results from TQM, and only 28% were pleased with the results. A 1991 Arthur D. Little study reported that 93% of the companies surveyed had quality programs, but only 36% had realized significant results (62% thought the results would be significant in the future). Many companies, such as IBM, GM, and Westinghouse, have had divisions that won the Malcolm Baldrige National Quality Award, but have still run into severe difficulties. Either implementing TQM successfully is trickier than it looks, or TQM by itself is no guarantee of improved financial performance.

Nevertheless, there are notable successes. In this thesis, we examine an example of a factory that appears to have successfully implemented TQM - AT&T's Merrimack Valley Works in North Andover, Massachusetts. A manufacturer of voice and data transmission products, the Merrimack Valley Works won the Baldrige Award in 1992 and achieved dramatic improvements in quality. These improvements appear to have been sustained, although as we shall see, the rate of improvement has slowed.

Why do some companies achieve successes while others do not? Some writers on quality such as Main (1994) argue that quality takes time, more time than the typical short-term-focused manager is willing to give it. Others, such as Brown and Tse (1992), Ehrler and Jansen (1993), and Balz and Garberding (1993), point to inherent limitations that are built into TQM; as improvements take effect, there are balancing forces within the organization that limit the progress that can be made. Sterman, et. al. (1994) point to the unintended side effects that occur when different parts of an organization change independently of each other, or at different rates. These side effects can adversely affect financial performance, leading to the misperception that TQM “failed.”

In this thesis, we shall examine the case of the Merrimack Valley Works in detail, in the form of a “learning history.” We shall see that AT&T experienced a number of initial failures on its journey to the Baldrige award, and that it did take AT&T more than ten years to develop its quality system to the point where it could win that award. Quantitative and interview data will show that limits to progress have been encountered, and have been overcome with varying degrees of success. We shall contrast the case of the Merrimack Valley Works with another case, that of Analog Devices,
Inc., a company which was extremely successful in its implementation of TQM, but nevertheless encountered serious difficulties, in order to find out why the two companies' results were so different. I will use two frameworks in the analysis: the six stages model of change processes developed by George Roth (1994) at the Organizational Learning Center; and system dynamics, developed by Jay Forrester (1961) and many others (Richardson and Pugh 1981, Morecroft and Sterman 1994).

I shall show that the success of a TQM effort depends on how it is measured. Defining success with measures such as financial performance or employment can lead to disappointment, since TQM can cause unintended side effects that hurt the company in both areas in the short run.

First, we will take a look at the factory I studied, its industry and organization, and the particular improvement program that was implemented there.

The Merrimack Valley Works

An organization chart for AT&T is given below, showing the Merrimack Valley Works' position:

![Organization Chart](image)

Figure 1. Organization Chart. Source: Internal Company Documents.

The Merrimack Valley Works is located in North Andover, Massachusetts, and employs about four thousand people, including Bell Labs and AT&T Microelectronics. In 1994 gross sales of its products were around $1.2 billion. The factory manufactures transmission equipment, long distance digital switching systems, and lightwave systems, as well as wire and coaxial cable systems. The equipment is used to multiplex telephone calls, or combine and separate the calls as needed to route them through the network. Effective multiplexing increases the capacity of a network, and is therefore a critical technology for the growing telecommunications industry. The
Merrimack Valley Works' principal customers are the local exchange carriers and the long
distance carriers, as well as communications companies abroad. Quality is a critical attribute for
the factory's products, since they are used for mission-critical communications. Competitors
include the French company Alcatel, the Canadian company Northern Telecom, and others.

Methodology

NSF Project
This thesis is being produced with the aid of a grant from the National Science Foundation and
AT&T, as part of a project to study the unintended side effects of TQM initiatives. AT&T is one
of four companies (the others are National Semiconductor, Harley-Davidson and Ford) being
studied by the system dynamics group at MIT. Our group is working to create a management
simulation program that will allow managers to experiment with various ways of implementing
TQM. Users will be able to see the results of their actions without actually risking their own
companies. Through repeated experiments, managers can improve their understanding of how to
implement TQM and avoid many of the pitfalls that have befallen others.

The first prototype of the simulator has been constructed based on work done with Analog Devices,
Inc. (Sterman, et al. 1994). We are now working with other companies to generalize our model
and ensure that the simulation applies to a wide variety of firms and structures.

I have written this thesis in part to provide data for the construction of the simulator. By pointing
out additional structure and phenomena that were not evident in the Analog Devices case, I hope to
aid in the generalization of the underlying system dynamics model.

Structured Thesis
This thesis is also part of a "structured thesis" being carried out by the Organizational Learning
Center, an organization at MIT dedicated to understanding and improving the ways organizations
learn and change. In the fall of 1994, a group of Sloan Masters students and Management of
Technology students were assembled to study a number of companies that had initiated change
projects. By using a standard format and analytic technique, we hope to elicit comparisons across
companies, and come up with some general principles that may help future change efforts be more
successful.
Six Stages of Change Processes
The structured theses are being organized around the idea that change processes go through six common stages (Roth 1994), which include Historical Context, Strategy Formulation, Selection, Preparation, Implementation, and Outcomes. The stages proceed chronologically, from the forces that impel the change (i.e., the historical context), to the selection of what change process to follow, to the implementation of that process, and finally to the eventual outcome, be it success or failure.

Four Levels of Organization
To ensure a balanced picture of the change process, it is important to capture perspectives from a variety of levels and functions within the organization. To this end, I and my colleagues have interviewed executives, managers, specialists and employees, from a wide range of functions including operations, human resources, customer service and product development. We have obtained data on financial performance, defect rates, customer satisfaction, and employment. I believe that this range of viewpoints helps mitigate the bias that can arise in field studies. Where I believe this bias is present, I will point it out.

Interviews
I made extensive use of interviews in the composition of this learning history, since they can provide information not only about what happened, but why. Of course, interviews suffer from several shortcomings, which were evident during my work at AT&T.

First, participants tend to remember events in the light of conclusions and judgments which they may have made quite some time later. They may remember, and believe, a history that omits crucial information or includes fictional events. At AT&T, I heard a remarkably uniform story from almost everyone I talked to, with few exceptions. Since the employees have already had to tell their quality story many hundreds of times to outsiders as a requirement of winning the Baldrige, I am concerned that the stories may have converged over time into an “accepted” account which has come to be believed by all the participants. AT&T's implementation of Total Quality Management has encouraged this sort of convergence by constructing a “golden thread,” where everyone in the organization is expected to share the same goals, as expressed through particular actions that they can implement. Quantitative data can offset this tendency by offering contrary evidence, but so little of what happens appears in the numbers that one should still be cautious about believing that the story is as simple as it is presented here.
Second, all interviews were arranged through the quality control personnel at the Merrimack Valley Works. These people appeared at times to be concerned about maintaining control over the story being told; I believe that after having put so much effort into the quality program, they may be concerned about an outsider coming in and finding something that would weaken support for quality. It is possible, therefore, that dissenting points of view exist and were not heard by me. To guard against this possibility, I assured all interview subjects of confidentiality, and the quality officials did encourage them to be open and honest about their views. As a result, no names are provided herein, and some of the quantitative data has been disguised.

Third, tape recording was not possible when the interviews were taken. Therefore, the text is reconstructed from notes and memory.

Where possible, people were interviewed individually. In some cases, this was not possible, and so there may have been some bias introduced as a result of people thinking about how their colleagues would interpret their answers.

I always began the interviews by introducing myself, explaining why I had come and what I was doing, and assuring the subject of the confidentiality of their responses and the importance of their participation. I took pains to emphasize that I was not looking for any particular answer, but that I wanted their individual perspective. A sample question list is provided as Appendix A.

I was accompanied on several of these interviews by Rogelio Oliva, who also assisted in the analysis of some of the quantitative data.

**System Dynamics**

One of the analytic frameworks used in this thesis is system dynamics, which was developed by Jay Forrester of MIT (Forrester, 1961). System dynamics provides a methodology for modeling and simulating systems that change over time. A particular focus of system dynamics is systems that feed back upon themselves: in other words, the behavior of the system at a later time is determined by the behavior of the system at an earlier time.

A simple example of such a system is chickens and eggs: the number of chickens is determined by the number of eggs, and the number of eggs is itself determined by the number of chickens. A common way to look at such systems is through the use of causal loop diagrams, which show the relationships between different parts of the system graphically:
Figure 2. Chickens and Eggs.

The arrows indicate that the number of chickens affects the number of eggs, and that the number of eggs also affects the number of chickens. The "+" signs indicate that this effect is positive.\textsuperscript{1} In other words, an increase in the number of eggs will lead to an increase in the number of chickens beyond what there would have been otherwise. Likewise, a decrease in the number of eggs leads to a decrease in the number of chickens beyond what there would have been otherwise. Note that a decrease in the number of eggs does not mean that the total number of chickens goes down; simply that the rate of increase is less. The "R1" in the center of the diagram indicates that the loop is a reinforcing loop, which means that the system tends to accelerate in one direction, rather than reaching a stable equilibrium. In this case, the number of chickens and eggs will increase exponentially as time goes on, without ever reaching a maximum.

However, we know that the number of chickens does not actually increase forever; their numbers are reduced by deaths. We can show this with the addition of another loop:

Figure 3. Chickens Reduced by Road Crossings.

Here, we see that an increase in the number of chickens results in an increase in the number of road crossings, and that an increase in the number of road crossings results in a decrease in the number of chickens, as chickens are hit by cars. This is known as a balancing loop, and it is indicated by a

\textsuperscript{1} Some causal loop diagrams use an "s" in place of the "+"; the "s" means that the effect is in the same direction, so that an increase in chickens also results in an increase in eggs.
"B" in the center. The "-" next to the arrow leading from Road Crossings to Chickens indicates that an increase in Road Crossings leads to a decrease in Chickens.  

Causal loop diagrams are an important conceptual tool in designing system simulations, which use a computer to simulate what the behavior of a system would be under specified conditions. Research has shown that, as the number of loops and interconnections increase, our ability to mentally simulate what will happen if a certain variable changes goes down rapidly. Most people are unable to predict how even a simple system will operate. Since real organizations are very complex, with many loops and interconnections, our intuition as to how they will behave is often faulty. As I wrote earlier, the ultimate goal of our work is the development of a management simulation program that simulates an actual Total Quality Management implementation, so that managers can practice without the risk that would exist in a real situation. By accurately simulating the effects of various policies, the game teaches managers where their intuition is faulty and helps them avoid costly mistakes. In this thesis, we will use causal loop diagrams to illustrate certain points about the effect of Total Quality Management on the Merrimack Valley Works. These loops will be used later to build model structure for the TQM simulation.

**Total Quality Management: Theory and Practice**

Total Quality Management, or TQM, is a theory of management which promises that by building superior characteristics into a production process from the outset instead of at the end, it is possible to achieve dramatically superior performance.

The style of American management prevalent in the modern industrial era up to the 1980's was to correct flaws either at the end of the production process or in the field. Quality Control departments were set up to sample the products being turned out by the production line and reject those that failed to meet minimum specifications. Failed products would either be scrapped or returned to the factory to be reworked. Products that escaped the Quality Control screen would fail in the field, whereupon the (angry) customer would be return them to the factory for replacement.

This method had two unnecessary costs associated with it: first, it not only cost money to fix the faulty products, but to make them in the first place; in essence, the company was spending money

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2 Some causal loop diagrams use an "o" in place of the "+"; the "o" means that the effect is in the opposite direction.
to turn out unsalable items. Second, it cost the company business, in that a customer who received
a faulty product was less likely to buy from that company again. TQM adherents argued that,
although it might cost money up front to design a process that reduced the number of faulty
products, in the end one would save money by eliminating the unnecessary costs. TQM also has
psychological benefits, in that the morale of employees improves if they believe they are producing
the finest products that can be made. Happy employees are more productive and less likely to
leave, thus saving the company money in training costs and headcount.

Although the basic concepts of TQM were developed by W. Edwards Deming and Walter
Shewhart in the United States in the 1920’s, they were first adopted in practice by the Japanese.
who were looking for a way to improve the quality of their products so that they could enter the
U.S. market. U.S. manufacturers, already dominant in the world economy, had less incentive to
improve. Japanese quality became so good that, by the late 1970’s, Japanese products were
capturing an increasing amount of market share from their U.S. competitors. The automobile and
consumer electronics markets were particularly affected, and many U.S. companies were either
driven out of the market or suffered dramatic downturns in profitability. After the initial shock
wore off, many American companies discovered TQM to be one of the key elements in the
Japanese success, and decided that they had to adopt TQM as well to regain their competitive
position.

The Four Fitneses
What TQM is has continued to evolve: Shiba, et. al. (1994) have portrayed it in terms of “four
fitneses:”

1. Fitness to Standard
2. Fitness to Use
3. Fitness of Cost
4. Fitness to Latent Requirement

At the “fitness to standard” stage, quality is measured in terms of conformance to specifications.
Variability in the production process is the enemy of quality: customers will accept lower
performance more readily than inconsistent performance. If the output of a production process is
graphed, it forms a bell-shaped curve like the following:
The vertical bars on either side represent the specifications of the product: the minimum and maximum values it can assume to fit the standard. Most of the products produced are within boundaries, but a few fall outside and must be rejected. In order to reduce variability in the outgoing product, one must narrow the bars (thereby throwing away more finished products) or redesign the process so that more products fall within the bars.

A weakness of "fitness to standard" is that the standard may still be inadequate for how the product will actually be used. For example, a laptop battery may have a specified lifetime of two hours; but if most of its users are on airplanes for six hours, the standard is inadequate. A standard of six hours better reflects the way the product is used. Attention to the way a product is used is called "fitness to use."

The problem with "fitness to use" is that the "use" is constantly changing. Initially, six-hour laptop batteries were considered perfectly adequate; however, eight-hour batteries are now replacing them. Makers of six-hour batteries must lower their prices to compete, reducing profits. A more durable source of competitive advantage is low cost combined with high quality: this requires competitors to excel on two fronts instead of one. Low cost combined with high quality is called "fitness to cost," and the idea here is to eliminate non-value-added steps in the production process. "Non-value-added" means that the step does not contribute directly to the value of the product to the customer. The largest of these non-value-added steps is inspection and rework. These steps do not add value for the customer; they are simply making up for deficiencies in the production process. They are only of value to the producer, because they allow the producer to make faulty products without losing business. TQM concentrates on reducing the number of faulty products by reducing the variability of the process. Lower variability reduces the amount of
rework required, saving money, and also reduces the need for inspections. Theoretically, it is possible to design a process that produces perfect products, allowing one to eliminate inspections entirely. Something similar happened in the Component Verification Center at the AT&T Merrimack Valley Works, where incoming integrated circuits were inspected for defects; the number of defects became so small that it was no longer cost-effective to inspect. In fact, the quality staff determined that the inspectors were probably adding more defects than they were catching. There are usually many other non-value-added steps in the production process that can be eliminated; TQM provides tools for identifying and removing them.

Even “fitness to cost” is not the end of the story, however, because customers will pay extra for a product that meets a previously unknown need. Meeting unknown needs is called “fitness to latent requirement.” One popular example is the Sony Walkman, a portable stereo that attaches to the belt and allows the user to listen to music through small headphones. Until the Walkman was introduced, none of the customer surveys that had been done had identified the need for a personal stereo; customers did not know it was possible, so they did not ask for it. It was a latent requirement. Achieving fitness to latent requirement requires close attention to customers.

Customer Focus
The purpose of a production process is not simply to produce a product; instead, it is to produce a product that is of value to customers, so that they will buy it and the company can make money. TQM teaches a “market-in” approach, as opposed to the old “product-out” approach. Customer surveys are used to identify the product characteristics that are of value to customers. These may be features, price, reliability, ease of use, and others that are specific to each product. The purpose of the production process is to reliably produce a product that has all of these characteristics at the lowest cost possible.

Management by Process
Knowing the goal is not enough; one must also have a method for getting there. TQM teaches a process based on the notion of continuous improvement, which breaks down the task into achievable steps. Guesswork and intuition are rejected in favor of rigorous analysis, acknowledging that human intuition is often faulty. The process is also known as the Plan-Do-Check-Act (PDCA) cycle, after the following four steps:
Figure 5. The Plan-Do-Check-Act Cycle. Source: Shiba, et al (1994).

- **Plan**: determine the problem and the method for solving it;
- **Do**: implement the plan;
- **Check**: see whether the plan had the desired effect;
- **Act**: identify shortcomings and return to the Plan stage; or, if the problem is solved, document the revised process and use it.

There are two important concepts in the PDCA cycle; first, it is based on facts and data. Once the facts of the case are agreed on, they form a firm foundation for deciding what to do next. Reliance on facts helps to eliminate misperceptions of reality. Second, the PDCA cycle recognizes that we do not always know at the outset how to fix a problem; if we did, we might have already fixed it. Instead, it encourages experimentation and learning, which increases the value of the solutions identified.

**Quality Improvement Stories: Seven Steps**

TQM divides the PDCA cycle into seven steps:

1. Select theme
2. Collect and analyze data
3. Analyze causes
4. Plan and implement solution
5. Evaluate results
6. Standardize solution
7. Reflect on process (and next problem)
The results are presented in the form of a Quality Improvement Story, which allows them to be communicated in a uniform way to upper management. The story describes each of the seven steps in turn.

Tools
TQM has introduced a number of tools into management practice, of which the most prominent are control charts, Pareto diagrams, and cause-and-effect (or Ishikawa) diagrams.

Control Charts
A control chart graphs the output of a process against upper and lower control limits. Since controlling the variability of process output is a principal goal of TQM, this is a frequently used chart. At AT&T the production associates are required to keep updated control charts next to their machines, to help them adjust the machines and keep them within the control limits, although examples were found where the charts had not been updated regularly. Figure 6 shows a sample control chart.

![Sample Control Chart](image)

Figure 6. Sample Control Chart

The vertical axis represents defects, the horizontal axis time. The goal is to keep the measure within the horizontal lines.

Pareto Diagrams
These are bar graphs showing the respective contribution of different parts of a process to either time or defects. For example, you might measure the defects resulting from each stage of the production process and graph them in order, from most to least defects. This helps focus the team’s efforts on the most serious problems first. Figure 7 shows a sample Pareto diagram.
Figure 7. Sample Pareto Diagram.

**Cause and Effect (Ishikawa) Diagram**

Sometimes known as "fishbone" diagrams, these trace a problem to its origins. Figure 8 shows a sample cause and effect diagram.

![Cause and Effect Diagram](image)

Figure 8. Sample Cause and Effect Diagram.

The cause and effect diagram breaks down the causes of defects into a few main areas (at AT&T, these are Human, Machine, Material, and Method). Within each area, there may be many causes. These in turn are caused by other problems deeper within the structure, which are reflected by branches off of the main trunk. The number of branches gives an indication of how deeply the team needed to analyze the problem. This diagram helps the team ensure it has considered all the possible causes of the defects, and also helps communicate the results to management.

All of these diagrams are used by AT&T teams in their Quality Improvement Stories, along with many other graphs and tools.
Teamwork
It is impossible for one person to know everything there is to know about a process, or to come up with all the possible good ideas; therefore, TQM teaches the value of teamwork. Many people participate in the production process; by involving as many of them as possible, you can increase the rate of improvement. TQM teams are known by various names; at AT&T’s Merrimack Valley Works they are known as Quality Improvement Teams (QIT). It is important that the team be cross-functional, so that all of the various functional groups (marketing, sales, finance, design, operations, purchasing, etc.) are involved in the provision of products to customers. Cross-functional teams are often difficult to achieve, since the management of the various functions may be focused on different outcomes; however, companies that have ignored this requirement often suffer from unanticipated side effects as the changes in one area affect operations in another.

The involvement of managers in teams can cause problems if team participants begin to feel that their contributions are not welcome. People can be less willing to advance original ideas in the presence of their boss. However, if the manager is excluded, he or she may come to feel that their needs are not being addressed, and they may feel threatened by the loss of control. This can weaken support for TQM within the organization. Furthermore, the team will need the manager to implement its recommendations.

The AT&T Approach to TQM
Although the implementation of TQM at the Merrimack Valley Works will be discussed in greater detail below, it may be helpful to present the whole system in one place, so that the reader can obtain a coherent picture.

The AT&T approach to TQM is depicted in the following diagram, which shows four complementary tools (Policy Deployment, Strategic Intent, Quality in Daily Work, and Quality Teams) resting on a foundation of the Common Bond Values and measurement techniques such as the Chairman’s Quality Award (CQA) and the Malcolm Baldrige National Quality Award.
Strategic Intent

The Strategic Intent\(^1\) is formed out of two pieces: the AT&T Mission statement, which is, “We are dedicated to being the world’s best at bringing people together – giving them easy access to each other and to the information & services they want and need - anytime, anywhere,” and the Global Public Networks Strategic Intent, which is: “To be the global leader in furnishing information providers and network service providers with the end-to-end capabilities they need to competitively meet their customers’ needs.”

Policy Deployment

Policy Deployment is a means of achieving the Strategic Intent by cascading key business and customer priorities down through the organization, breaking them down into increasingly detailed tasks, so that the worker on the shop floor knows how his or her job fits into the overall corporate mission. Policy Deployment activities are organized into four main categories (with associated metrics), as follows:

1. Exceeding Customer Expectations (Customer Value Added);
2. Enhancing Our Quality (Chairman’s Quality Award);
3. Engaging Our People (People Value Added); and
4. Increasing Shareowner Value (Economic Value Added).

\(^1\) Until recently, Strategic Intent was called “Purpose, Vision, and Values.”
For an illustration of the Policy Deployment Process, refer to Table 2, p.42, where a sample Quality Planning Matrix is shown. The various “Value Added’s” in the above list, which were added after the Merrimack Valley Works won the Baldrige, refer to the TQM method of evaluating each step in a process to make sure it provides value to the customer. Policy Deployment, while explicitly putting the customer first, acknowledges that there are other stakeholders in the production process, among them the employees and the shareowners. Certain activities, such as leadership training, may indirectly affect quality but directly affect the ability of the employees to accomplish their objectives.

**Quality in Daily Work**
Quality is not the responsibility of a “quality department,” but the responsibility of every member of the company. Nor is quality only to be considered by a Quality Improvement Team; instead, every employee is expected to follow TQM principles in their daily work. AT&T hopes to avoid the problems encountered by some organizations that find the quality organization a tempting “frill” to be cut when financial conditions are difficult. TQM at AT&T is part of the organizational structure.

**Quality Teams**
AT&T emphasizes teamwork as the best way to improve quality. The teams follow the seven-step method, and are organized around a specific goal. They are disbanded once the goal is accomplished.

**Common Bond Values**
These are:

1. Respect for Individuals
2. Dedication to Helping Customers
3. Highest Standards of Integrity
4. Innovation
5. Teamwork

Most of the people I spoke to appeared to be very committed to quality and to the values described above. Although there were some complaints that the values are not always realized in practice,
there was widespread commitment to the ideal. No one described TQM as a “flavor of the month” or as a waste of time. How did AT&T arrive at this enviable situation? In the next section, I will present a learning history of quality at AT&T Merrimack Valley Works, as told to me by the people who were involved.

Learning History

Origins

The Importance of Technology
AT&T had its beginnings on the now-famous day in March 1876 when Alexander Graham Bell perfected a transmitter/receiver based upon the principle of variable resistance and was able to summon his assistant, Thomas Watson, from another room with it. Bell beat out a rival inventor, Elisha Gray (later the founder of Western Electric, which was eventually bought by AT&T) by just a few hours in filing his patent for the device. Despite determined attempts to break the patent, it formed the foundation of the Bell System telecommunications monopoly.

The American Telephone & Telegraph Company (AT&T) was formed in Boston on July 9, 1877, as the Bell Telephone Company. For two years the company had to compete with the Western Union Telegraph Company, which had hired Thomas Alva Edison to develop a different form of telephone transmitter so that it would not have to use Bell's invention. The competition ended in 1879 when Bell Telephone brought a successful suit against Western Union for infringement of its patents. The company moved to New York City for financial reasons in 1885 and was reorganized as AT&T, with the Bell System as one of its subsidiaries.

As AT&T grew, it continued to rely on technology for competitive advantage. Thomas Watson became the father of Bell Telephone Laboratories in 1876 when he agreed to focus on research in exchange for a 10% interest in any and all patents. Bell Labs developed many of the innovations which led to long distance telephone service, one of the ways in which AT&T established control over most of the local telephone companies in the United States.

Such an early focus on technology, plus the fact that many of its early leaders came out of operations, gave AT&T an engineer’s perspective to business. Later, AT&T employees developed many of the scientific methods for maintaining quality.
The Science of Quality
In the 1920’s, Walter A. Shewhart of Bell Labs developed statistical quality control, which would become a centerpiece of Total Quality Management. W. Edwards Deming, the man who taught quality to the Japanese, himself worked at AT&T’s Hawthorne factory in Chicago while he was a university student. The 328-page Statistical Quality Control Handbook, first published by Western Electric in 1956, is still widely used today. Yet, although these techniques were useful in enhancing manufacturing productivity, they were never fully adopted. One senior quality manager told me that Shewhart was never more than a marginal figure at the company. Instead, the company used the traditional method of the time, which was to inspect products before they left the factories. One of the technical staff told me that AT&T’s excellent reputation for quality was based mainly on the strength of its Quality Assurance (QA) department, which represented the customer’s interests within AT&T. While this technique did result in relatively high quality, it was based on AT&T’s notion of quality, not the customer’s. AT&T’s products may have worked as advertised, but they did not always meet customer needs. Of course, the “customers” for AT&T’s telecommunications equipment were captive, being the wholly-owned regional Bell telephone companies. They had little recourse in getting the types of products they wanted. Furthermore, the process was very wasteful. A system was set up where manufacturing felt less and less pressure to maintain quality, because they knew that QA would catch it:

Figure 10. Shifting the Burden from Manufacturing to Quality Assurance.
The causal loop diagram is a simple “shifting the burden” archetype (Senge, 1990). As quality problems increase, resources to fix the problems increase, both in terms of Quality Assurance (a “quick fix”, loop B1) and in terms of tracking down the root causes of the defects (a “fundamental” fix, loop B2). However, it takes longer for the factory to track down the root causes of the defects than it does to simply rework the faulty products. The delay is indicated by the double bars intersecting the arrow from “Resources for Tracking Down Causes of Defects” to “Quality Problems.” As a result, when there is time pressure (as there usually is in a factory), the tendency is to rely on Quality Assurance (QA). This has the unintended side effect of reducing the pressure on Manufacturing, which is then able to cut resources devoted to tracking down root causes (loop R1). Reliance on QA increases, and the system gradually comes to rely entirely on final inspections. Final inspection, as we have seen, is more expensive than correcting bad processes, because one is essentially paying the factory to produce errors, as well as to rework the products. Total Quality Management reverses the cycle by focusing attention on the “fundamental” solution, that of tracking down the root causes of defects.

Unfortunately, despite having been the originator of much of TQM, AT&T had to “discover” it in the 1980’s along with all the other American companies. A senior corporate quality official gave me an example of a case where the customers were very unhappy, and exerted considerable pressure on AT&T. He described a failed switching system that came out in 1972, saying that in Texas, “they were shooting holes in it with rifles.” The company addressed the problem by sending Bell Labs technicians out to install the equipment themselves, and the technicians agreed that the products were unacceptable. AT&T developed a new cabinet patterned after the Heath Kit do-it-yourself electronics kits popular at the time, with picture instructions developed with the assistance of the installers. This product was very successful, and is still being sold overseas. However, it was yet another case of fixing problems after the fact, and once the regional operating companies were no longer owned by AT&T, they would have greater flexibility to go after the best combination of price and quality. Furthermore, there was no way to spread innovative ways of working around the company. The group that developed the easy-to-assemble cabinet was almost unknown around AT&T.

A Special Relationship
The second major difference between AT&T and most companies of its era was its relationship to the federal government. Although AT&T was one of the enemies of the anti-trust forces of the
early twentieth century, it was seen by some as deserving special status due to its nature as a public utility. AT&T argued effectively that a monopoly was the most efficient and beneficial means of providing communications services to the entire country. Under its first great president, Theodore Vail, AT&T developed an enlightened policy of "customer first," which held that customer service was the top corporate priority, not profits. In order to avoid being broken up under the Sherman anti-trust act, AT&T agreed to regulation by the Interstate Commerce Commission, which allowed AT&T a reasonable profit for its shareholders, but limited its attempts to buy up local telephone companies. In what became known as the "Kingsbury Commitment," Vail agreed to allow the connection of all of the local networks across the country into one nationwide service, forming the modern Bell System.

The federal government did experiment with nationalizing telephone service during World War I, along the lines of the Postal Service, but the experience was widely regarded as a failure. The government raised rates 20%, instituted a connection charge, and still managed to run a $13 million deficit. Control of the Bell System returned to private hands following the war. In addition, anti-trust fervor had subsided; in 1921, AT&T was exempted from the Sherman Anti-Trust Act, and began buying local telephone companies again. Before long, it had near-complete control over the nation's telecommunications. In October, 1927, then-president Walter S. Gifford proclaimed AT&T's mission to be "the best possible telephone service at the lowest cost consistent with financial safety." That balance between public and private interest became the model for public utilities in the United States after World War I. In 1934, Congress passed the Communications Act, which formed the Federal Communications Commission and laid out the twin goals of universal service and nondiscriminatory rates. It also explicitly endorsed the Bell System monopoly. This cooperation between AT&T and the federal government flourished during World War II, when a private Bell System aggressively supported the war effort, sending its employees to the front lines to set up communications systems for the Allied forces.

After the war, AT&T became the most widely held stock in the United States, which cemented the company's status as an institution apart from all other private companies. It also spread ownership so widely that management was effectively in control of the company, insulating them from the usual pressures that managers face to cut costs and reduce staff. AT&T was able to absorb inefficiencies and roll out new technology at its own pace, free from competitive pressures.
The special relationship had one main effect on AT&T's corporate culture: it reduced the priority of profits in the managers' minds, and reinforced the priority of customer service (here, I am referring to the telephone user as the customer, not the regional telephone companies). It is possible that this set of priorities made AT&T's management more receptive to Total Quality Management, with its focus on the customer, than would otherwise have been the case.

The Monopoly Crumbles

The special relationship between AT&T and the federal government was both boon and hindrance, although AT&T was free of competitive pressures, it was unable to capitalize on many of the innovations that Bell Labs developed, and had to forego leading positions in radio broadcasting, motion pictures, television, and satellite communications. In 1949, the Department of Justice sued AT&T, seeking to break its Western Electric manufacturing subsidiary away from the main company. The rationale was that Western Electric was able to charge artificially high prices for its products, since it was the only legal supplier of telephone equipment, and that these excessive charges were being passed along to the consumer in the form of higher lease charges and telephone rates. The suit was resolved in 1956 with a consent decree that limited the Bell System to common carrier communications services and constrained Western Electric to the manufacture of equipment used in telephony. Although AT&T's monopoly had survived, its ability to enter new industries was curtailed, and this restriction caused the company to become more inward-looking.

By 1966, the political pressure began to intensify again. In that year, the FCC ruled in favor of Carter Electronics, who wanted to market an acoustical device for relaying mobile radio/telephone messages. One senior corporate manager recalled this event as the beginning of the deteriorating political support for AT&T. Soon after, the FCC moved to lift the tariffs preventing outsiders from connecting to the Bell System, and AT&T was forced to provide devices to make such connections possible.

Another crack in the dam came in the form of private lines, which provided lower cost service by connecting high-volume telephone users outside the regular Bell System. Microwave Communications, Inc. (MCI) got its start in 1963 petitioning the FCC for permission to set up a private microwave line from St. Louis to Chicago. Although AT&T argued that this was cream skimming, focusing on the profitable high-volume segment while forcing AT&T to handle unprofitable outlying areas, the FCC approved MCI's request.
The Breakup
AT&T tried several times to respond to its new low-cost private line competitors, but was thwarted by the FCC, which wanted to preserve competition even at the cost of higher rates. Frustrated by the Commission’s stance, the Chairman and CEO of AT&T, John DeButts, gave a speech in 1972 in which he called for a re-evaluation of national policy toward the telephone system, asserting that the quasi-competitive state in which AT&T was held was not realistic. He intended to establish a case for the Bell System monopoly, but instead his speech was seen as a challenge to the federal government. The Justice Department, which had never been entirely satisfied with the 1956 consent decree, began a new investigation. On November 20, 1974, it filed a lawsuit seeking to have Western Electric and the regional Bell telephone companies divested from AT&T.

AT&T responded by attempting to have its monopoly ratified by Congress, which only intensified the battle, as Congress proved unwilling to do so. The inflexibility of AT&T, bred by years of special treatment, hurt its cause in the end. The lawsuit led a tortuous life until 1982, when the Justice Department and AT&T reached the now-familiar settlement to divest the local operating companies (hereafter known as RBOCs, or Regional Bell Operating Companies) from AT&T, although Western Electric and Bell Labs would remain as part of AT&T. President Reagan’s Assistant Attorney General for Anti-Trust, William Baxter, did not see vertical integration as a competitive threat, and so the Western Electric provisions were dropped.4

After the Breakup
The breakup was disastrous for Western Electric, because it had long been used to selling only to internal customers, and these internal customers were eager to get away. In one case, AT&T had refused to make digital switches despite requests from the regional operating companies. Senior managers reasoned that to do so would waste the investment made in analog switches, without a commensurate increase in quality. According to one corporate manager, as soon as the regional operating companies were freed from AT&T, they immediately began buying digital switches from Northern Telecom. The relationship between Ma Bell and her children became almost adversarial.5
As a result, Western Electric lost both market share and profits. Large force reductions ensued,

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4 For more details on the process leading to the breakup, see Temin, Peter. The Fall of the Bell System.

5 One quality manager disagreed with this assessment, saying that the regional operating companies were interested in “testing the waters,” but that AT&T’s quality was so good that there was little chance of them not buying from AT&T.
consisting of early retirements, attrition, and layoffs. At the Merrimack Valley Works, employment went from a peak of about 12,000 prior to the breakup to about 7,400 in 1987. It now rests at about 6,000.

The Survival Imperative
Many of the people I spoke with described the period from 1984-1989 as a period of great stress and worry. The region of Merrimack Valley, near Lawrence, Massachusetts, had been an old manufacturing center, but most of the companies had moved away, in search of cheaper labor. The nearby city of Lowell, once a thriving textile center, had lost almost all of its manufacturers, and now struggled to attract new business. AT&T had closed several factories, and the employees at Merrimack Valley Works knew that they would have few attractive options if a similar happened to them. Robert Cowley, the general manager in 1986, said, “We have a profound impact on the economy of this Merrimack Valley area.... It would be a big bang, I’ll tell you, if it were to be that we would go under.”

Something had to be done, but what? Here the evidence is confusing; although many of the people we spoke with smiled when we asked about the early days and said that there was a lot of resistance to change, anecdotes were scarce. It is clear, however, that change came slowly and incoherently at first. One manager saw a failure of leadership among the senior managers in the corporation; they used buzzwords such as “world class” or “customer satisfaction” without explaining what the terms were intended to mean, or how they translated into concrete actions that the employees could take.

One of the employees said that she did not hear anything about quality until 1989 or 1990. It would seem that the reach of the quality program was inconsistent before that point, although as we shall see, there was considerable activity in the factory during the mid-1980’s.

The Early 1980’s: The Drive for Quality Begins
In the early 1980’s, the Merrimack Valley Works had two quality organizations in place: a Quality Control (QC) department, which was often held accountable for the quality of the factory’s output, and the Quality Assurance department mentioned earlier, whose function was to act as an independent advocate for the customer. At that point, according to one of the technical staff in the

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quality function, QC's role was one of enforcement, "to be policemen and shut the line down."
The manufacturing personnel were measured on output and financials, but not on quality. Quality
was the responsibility of QC, which would be held accountable if quality did not meet the goals set
by senior management.

This put QC in the untenable position of being held responsible for a result that they had no direct
power to implement. The power to shut the line down was very limited, because the factory had to
ship product in order to make money. As a result, there was occasionally management of the
measurements: for example, if it looked like defect levels for the period would be too high, QC
would sometimes arrange for the shop to delay shipment of any more units until the period had
ended, so that the defects would appear on the next period's charts. Although the products were
still fixed before shipment, this obviously reduced the usefulness of the measurements.

When QC was able to induce manufacturing to change its processes, manufacturing tended to
focus on a quick fix, rather than addressing the root causes. This is as we would expect from the
"Shifting the Burden" loop we saw on p.24. One employee said, "we were working on quantity,
not quality. You got your bonus by making your numbers." The incentives dictated a "quick-fix"
approach, in order to get the line moving again as soon as possible.

About a year before the breakup, the factory's senior management became interested in the
Japanese method called Total Quality Management, and began to see that the quality model at that
time was in need of change. One influence cited by senior management was the automobile
industry, which was losing market share to the Japanese at a rapid rate. They foresaw a similar
fate for AT&T, which was beginning to face competition in the manufacturing area from
companies such as Northern Telecom and Alcatel. In addition, the liberalization of world markets
opened new opportunities in areas where AT&T had no monopoly advantage. In Japan, for
example, it was impossible even to sell products without high quality standards. Furthermore, the
monopoly AT&T enjoyed in the U.S. was coming to an end, and the company would need new
markets to offset the inevitable loss of market share that would come with competition.

Deming Seminars
The initial effort to implement TQM took the form of a series of Deming Seminars, which took
place between March, 1983 and October, 1985. The general manager, Robert Cowley, was
curious about quality from his experiences with sales and customer service at Western Electric's
Northeast region, and his own personal experiences with American cars. He was encouraged by
his engineers to attend a Deming seminar, and he agreed, subject to the condition that a hundred AT&T volunteers be found to accompany him. He believed that if only a few people in a factory understood the concepts, they would be unable to have much of an effect. About two thousand employees participated in all. Unfortunately, there was no immediate change in the organization. One of the employees said, “a lot of people went to the Deming Seminars, but nothing happened. There was no structure to support any of it, no strategic plan.” One of the union officials said, “only a few [union] people got the training, and it just died.”

However, Director of Quality Leonard Winn cited the Deming Seminars as the catalyst for his own pursuit of TQM at AT&T. He said of Deming, “he provided the seeds for growth of the quality system, and was a major inspiration for me personally.” On the subject of the perception by various people within the factory that the seminars had no lasting effect, he said, “nothing immediate happened. It took a long time for the seeds to sprout. Deming said it would take ten years to see results, and it took ten years from the seminar to when we won the Baldrige award.” It appears that unrealistic expectations were generated, which led to disappointment when they were not realized.

The situation where a company makes an effort to train personnel in TQM, but the tools never take hold, has been seen in other studies (Brown and Tse 1992, Ehrler and Jansen 1993). The dynamics behind this phenomenon are shown in the following causal loop diagram, which is based upon a similar diagram in Brown and Tse (1992, p.25).
Figure 11. Use of TQM Rises, Then Falls.

The diagram should be read beginning with "Quality Goal Gap." Either Business Quality Goals rise, or Quality Performance falls, and a gap develops which must be closed. The increase in the gap causes an increase in Senior Management Desire to Improve Performance. Senior Management in turn puts pressure on the organization to improve performance. Ordinarily, the organization would respond by implementing a Quick Fix, which would improve quality performance and close the gap (balancing loop B1). However, in this case there has been some TQM Training, which results in a certain amount of Utilization of TQM. We shall assume for the moment that the training has been conducted for some reason which is outside the system. The TQM activities result in fundamental improvement after a delay which may be many months. This improvement increases quality performance, thereby closing the gap (B2). The success of each technique reinforces the use of that technique; in other words, if a quick fix is successful in improving quality performance, the organization will be encouraged to use the quick fix more in the future (reinforcing loop R1). The same logic applies to TQM (R2).

Unfortunately, TQM operates with a delay. Even though the magnitude of the improvement in quality performance from TQM may be much larger, the quick fixes have a more immediate effect.
They may solve the problem before TQM has a chance to work. Pressure is relieved, and utilization of TQM subsides. Also, the quick fixes reinforce themselves faster than TQM, and end up stealing resources from the TQM program. If all of the manufacturing managers are busy running around putting out fires, they cannot devote energy to supporting their quality teams. This link is not shown in the diagram, for simplicity. Another loop which is not shown is the possibility that quick fixes may have a long-term harmful effect on quality performance, because TQM has other benefits that are not directly related to product quality. Improved quality increases customer satisfaction, which increases sales. It also reduces returns, which reduces warranty costs. By sapping resources for fundamental improvements, quick fixes hurt quality performance in the long run. However, this effect is unlikely to be seen by the managers. Many studies have shown that people react most strongly to influences that are close to them in time and space, and tend to ignore cause and effect relationships that are more distant (Sterman 1994, Senge 1990). Ignoring the long-term harmful effects can reinforce the quality goal gap, leading to ever greater reliance on quick fixes, until the whole system breaks down because there are no longer enough resources to fix all the problems.

Another weakness of the system is that TQM training takes place on its own, without being linked to performance measurements. As a result, there is no continuing pressure to train people. Without the reinforcing effects of success, utilization of TQM eventually dies out. One solution to this problem is to link TQM training to the quality goal gap. As long as quality performance is not adequate, training continues. By measuring and rewarding employees based on defect rate improvement, the incentive to use TQM can be sustained; defect rates can respond to TQM efforts in a few months, which provides the needed reinforcement to the process. A similar measure for product design is time to manufacturing, which measures the time required to complete a design to the point where it can be manufactured. Attempting to tie TQM to financial results can lead to disappointment because of the delays involved.

After the initial effort to use TQM failed, management was very frustrated, according to one technical staff member in the quality department. They realized that training alone was not enough. Their reaction was to try a more forceful approach.

**Quality Architecture Teams**

From 1986 to 1988, the Merrimack Valley Works instituted what were known as Quality Architecture Teams. The structure was imposed by Transmission Systems headquarters. Workers
were organized into teams, with each team reporting to a team higher up, forming a hierarchy of teams. Everyone had to be on a team. However, since the teams were formed before any problems were identified, the result was that teams tended to work on problems that were not critical to the business. There was even an attempt to impose such metrics as the number of meetings attended and the number of people at the meetings, among others. One quality manager termed it, “teams for teams’ sake.” One employee described them as “bitch sessions” and said that the focus was on quick fixes. According to one manufacturing manager, they were a “dismal failure.” As he described it, the production associates (the people who operated the machines) continued to see the engineers as the ones who were responsible for fixing the problems, and so the engineers would emerge from the meetings with huge lists of action items. Without any way to prioritize or select problems to focus on, the teams became overwhelmed and disillusioned. Also, the supervisors ran the meetings, which had a chilling effect on the discussion. The workers had little sense of responsibility for the outcome of the meetings, since they did not run them or volunteer to participate. Instead, they saw their function as pointing out problems rather than solving them. Gradually, the teams disbanded. As one employee put it, “they died out before they had a chance to live.”

Policy Deployment

Out of the Quality Architecture Team experience came the understanding that continuing management pressure was not enough to sustain a quality program. There needed to be a structure to support the employees, so that their efforts were directed towards solving problems that were central to the success of the business. As one senior corporate manager put it, “TQM is not about quality- it is about creating a great business.... For this reason, I don’t look for a commitment to quality. People can get sidetracked that way. The important thing is the commitment to a successful business.”

Customer Surveys

In 1989, AT&T’s top management began to press for greater customer focus. The Merrimack Valley Works managers looked for ways to increase their understanding of their customers’ perception of quality, and adopted the “report card” structure that Pacific Bell was using. Pacific

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7 In fact, there was some disagreement about this; one employee said that participation in the team was optional, but that one had to participate in the training.
Bell had been rating all of its suppliers, including AT&T, on a "report card" that showed the supplier how well it was satisfying Pacific Bell's requirements on a five point scale. Two consecutive quarters of unacceptable ratings meant a supplier would be dropped from the standard vendor list, and Pacific Bell departments would not be allowed to buy from it. The Merrimack Valley Works managers decided to urge all of their customers to use the "report cards," and conducted a survey to find out what was most important to them.

The results were somewhat surprising, in that quality was ranked above price. The rank order of customer priorities are given in the table below, based on a 1 to 5 scale:

<table>
<thead>
<tr>
<th>Priority</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality/Reliability</td>
<td>4.78</td>
</tr>
<tr>
<td>Features/Functions</td>
<td>4.5</td>
</tr>
<tr>
<td>Understand &amp; Support</td>
<td>4.49</td>
</tr>
<tr>
<td>Price/Value</td>
<td>4.45</td>
</tr>
<tr>
<td>Compatibility</td>
<td>4.36</td>
</tr>
<tr>
<td>Delivery</td>
<td>4.32</td>
</tr>
<tr>
<td>Technical Assistance</td>
<td>4.29</td>
</tr>
<tr>
<td>Technology</td>
<td>4.27</td>
</tr>
<tr>
<td>Documentation</td>
<td>4.02</td>
</tr>
<tr>
<td>Training</td>
<td>3.94</td>
</tr>
<tr>
<td>Repair Service</td>
<td>3.91</td>
</tr>
<tr>
<td>Installation Service</td>
<td>3.85</td>
</tr>
<tr>
<td>Contract Obligations</td>
<td>3.84</td>
</tr>
<tr>
<td>Engineering/Service</td>
<td>3.71</td>
</tr>
<tr>
<td>Billing</td>
<td>3.61</td>
</tr>
<tr>
<td>Order Management</td>
<td>3.51</td>
</tr>
</tbody>
</table>

Table 1. 1990 Customer Survey Results. Source: Internal Company Documents.

Fortunately, the customer priorities fit well with AT&T's existing image among customers, which was one of high quality but premium pricing. It also served to reinforce the arguments of the quality managers at the Merrimack Valley Works who were urging a more thorough approach to quality.

The report cards could actually anger customers, if they were not responded to quickly; the Transmission Systems Business Unit devised a system for making sure that they were. An AT&T Regional Steward was assigned for each part of the report cards (e.g., AT&T Installation, Product Expectations, etc.). He or she did pre-analysis and broke out the results for Transmission Systems. The results were given to Customer Report Card Managers, who were responsible for assigning people to work on each problem. Product and process issues were dealt with separately. The Customer Report Card Managers had to respond within 30 days. The answers went back to the Regional Coordinator and were shared with the rest of the organization, so that solutions could be
spread. The Merrimack Valley Works maintained the report card records and tracked performance.

Reorganization Needs a Focus
At the highest levels of AT&T, the importance of customer focus was being realized. In 1988, the President of the Network Systems Group, Wayne Weeks, instructed Pete Fenner to develop a new business model. In April, 1989, Chairman and CEO Robert Allen announced a restructuring of AT&T into 20 business units focused on specific customers, markets, and competitors. One of these was the Transmission Systems Business Unit (TSBU), under the leadership of Pete Fenner as President. Fenner knew he had to improve customer focus and quality, but did not know how he was going to do it. As he and his management team thought about the problem, their attention was caught by a new award that was featured in the business press at the time.

The Malcolm Baldrige National Quality Award
In the mid-1980's, President Reagan's secretary of commerce, Malcolm Baldrige, died after a fall from a horse. Baldrige had been an advocate of a national quality award, and in his honor the Bureau of Standards created, and Congress enacted, the Malcolm Baldrige National Quality Award. The first award was made in December 1988. By providing a consistent, comprehensive standard for what Total Quality Management really means, the Baldrige award helped companies like AT&T focus their efforts and rally their workforces.

The Baldrige Award used customer-oriented judging criteria\(^8\) that make it clear that simply conforming to product specifications is not sufficient; products must also deliver superior customer satisfaction for the price. This is referred to by Shiba, et al. [1993] as "fitness to use." Out of 1,000 possible points on the Baldrige score sheet, 300 were devoted to Customer Focus and Satisfaction, more than any other category. The other categories are listed below:

1. Senior Executive Leadership (95 points)
2. Information and Analysis (75 points)
3. Strategic Quality Planning (60 points)
4. Human Resource Development and Management (150 points)
5. Management of Process Quality (140 points)

\(^8\) The criteria discussed here are those in effect when AT&T Merrimack Valley Works won the award; they have since changed.
6. Quality and Operational Results (180 points)
7. Customer Focus and Satisfaction (300 points)

The Baldrige concept of quality was built around the following framework:

![Figure 12. The Baldrige Quality Framework. Source: AT&T Merrimack Valley Works presentation.]

Progress in the areas of process quality, human resources, quality planning, and analysis is driven by senior executive leadership toward the goals of customer satisfaction and operational results. The cycle shown within the "System" box graphically illustrates the exchange of focus between action and analysis found in the PDCA cycle (see above, "Management by Process").

Fenner was attracted to the Baldrige because it offered a clear and coherent set of measurement criteria for quality and for running the business. He believed that by evaluating his business units on the Baldrige criteria, everyone could quickly obtain a sense of where they stood and how far they had to go. He assembled a group of managers to rate the transmission systems business on the Baldrige criteria. The quality team at Merrimack Valley Works provided the first analysis, and the result was a score of 324 points. Although this was a very disappointing result, several of the managers involved remembered that Fenner reacted positively to the information, portraying it as having given them a clear sense of what they had to do. One of the quality staff members
emphasized what a dramatic change this was in AT&T's culture. Many times, the reaction to such news had been to "shoot the messenger." As a result, at times it had been difficult for some managers to get an accurate picture of what was going on in the business. Fenner's positive reaction to the low score encouraged the managers to continue working on quality improvement, and to deal with the problems more directly and openly.

**Florida Power & Light**

In 1989, Florida Power & Light (FPL), an electric utility, became the first company outside Japan to win the Deming Prize, Japan's top quality award. As a result, it became known within the quality movement as an example of what could be achieved (Main 1994, p.203). Also, it was a service company that was publicly regulated, so there were similarities to AT&T's situation. In January 1990, a group of managers from the TSBU, including Pete Fenner, Jack McKinnon (the new Vice President in charge of the Merrimack Valley Works), and the other members of the senior management team, visited FPL to see their quality system. They were all struck by what they found. Quality Improvement Teams, composed of workers who were knowledgeable, committed and enthusiastic, presented their seven-step stories detailing their accomplishments. The managers sat down at the customer service phone bank and listened in on headsets while the employees dealt with customer concerns. McKinnon said later in an interview, "I sat there and tried to figure out how the hell did they get this quality of service to work down at that level?"¹

Excited by what they had seen, the managers next hired FPL's internal consulting division, Qualtec, for a three-day seminar on quality techniques. One of the main ideas that they got from Qualtec was Policy Deployment. This, as we have seen, was a method by which high-level strategic goals could be cascaded down through the organization in successively finer levels of detail, so that every floor worker would know his or her role in the organization, and how his or her work contributed to the success of the company. In the language of the causal loop diagram in Figure 11, what this does is increase the amount of customer satisfaction improvement attributed to TQM, thereby strengthening the reinforcing loop that generates support for TQM. If a worker's internal mental model links TQM directly to customer satisfaction, he or she will be more willing to devote time to quality activities. Management usually does attempt to make this link, but Policy Deployment, by showing the logic behind the connection, is a more effective way of doing this.

Employees can see for themselves how the link is formed, instead of having to trust their manager.

¹ Porter, 1993. p.3.
Qualtec also introduced the TSBU managers to the seven-step story and PDCA cycle of TQM, which gave them the methodology and the improvement tools they had lacked with the Quality Architecture Teams. One of the quality department staff members felt that this first-hand experience was critical to the managers’ acceptance of TQM. Once they had seen the results at FPL, they could no longer say for sure that TQM would not work at the Merrimack Valley Works.

Ironically, Florida Power & Light disbanded much of its quality program in mid-1990, just a few months after the AT&T group’s visit. The CEO, James L. Broadhead, who had taken office just before FPL won the Deming, cited complaints from the employees about preoccupation with process. He chopped the headquarters quality staff from 25 to four people, made the seven-step quality improvement process voluntary rather than mandatory, and reduced the use of charts and indicators of quality. Main (1994) cites some troubling statistics that suggest that FPL’s quality did not improve after 1989, and that in some areas, such as customer complaints, FPL was worse than its competitors. In Broadhead’s defense, his predecessor John Hudiberg had made some ill-conceived investments in insurance, real estate, and cable television, for which Broadhead had to write off $752 million in 1990. The new CEO saw quality as a distraction from the main task of getting FPL back on track. In addition, the quest to win the Deming Prize had distracted the utility from some of its business issues, and it was probably time to consolidate. TQM is still practiced at FPL, but in muted form. It would appear that FPL was not as successful as AT&T Merrimack Valley Works at integrating its quality program with its strategic priorities.

**Top Down Training**

One of the other innovations that was introduced at this time was the notion of training the senior managers first, then their subordinates. It was not clear whether this came from Florida Power & Light, or from the managers’ personal experience. One of the senior quality managers said that they looked at past initiatives on things like safety, and found that often the senior manager would get excited about something and instruct everyone to watch a film about it. The employees, on the other hand, would have many other responsibilities, and would put off watching the film in favor of their more immediate responsibilities. Without any pressure from their immediate superiors, the initiative would gradually die out. This is essentially what happened in Figure 11: without continuing management pressure for TQM, the initial momentum from the training was not enough to overcome the inertia of solving problems the old way.
Changing Mental Models
There is another basic causal loop structure that may be worth looking at here, which is the employees' perceptions of the system they are in. If we accept that Figure 11 is correct, and that the best financial performance in the long term is gained through TQM, then the challenge is to get the employees and managers to accept it as a valid mental model, so that they will act according to its logic.

The reason that mental models (that is, our mental picture of how things work) are important is that they condition how we see the world. We tend to give greater credence to information that fits with our worldview than that which contradicts it. This is a psychological necessity; if we were constantly evaluating each piece of information we receive on its own merits, we could not function. For example, if our mental model says that we are affected by gravity, we are not likely to jump off of a cliff just because we are told we can fly. Workers are unlikely to come forward with honest criticism of their managers or processes, even if the manager says there will be no repercussions. It does not fit with their mental model of power relationships in the workplace.

Isaacs and Senge (1994) view the learning process as a continuous cycle

![Managerial Learning Loop](image)

Figure 13. Managerial Learning Loop. Source: Adapted from Isaacs and Senge (1994).
At the top of the loop are our mental models; they inform our strategy and decision making. These decisions have real world effects, which are fed back to us in the form of information and experiences. If the results are in accord with our mental models, the models are strengthened; if not, we modify them in light of the new information.

Unfortunately, this ideal learning process is subject to numerous obstacles. To begin with, everyone’s mental models are different; they must be reconciled for everyone to believe that a decision is correct. Usually, this cannot be done within the time available, so some mental models go untested. We never find out what would have happened if they had been followed, and so they never get altered. The learning loop breaks. Even if a unanimous decision is reached, it is usually some time, often a long time, before the results occur. The managers who made the decisions may have moved on to other responsibilities, and are not around to see the results of their actions. If they are around, they may attribute the results to something else they did, or to something else in the environment. Indeed, there are many confounding factors, such as recessions and material shortages, that can produce unwanted results and obscure the effects of our decisions.

Even if the results can be attributed to the decisions, they may be inaccurately reported. Information systems do not capture all the relevant information, and other people within the organization may have reasons of their own to hide or distort our view of what has occurred. Information is delayed, so that by the time we get a result, it may be too late to do any good. The delay is also another chance for confounding factors to obscure our conclusions.

Finally, even if we can draw valid conclusions from the results, we may ignore them if they do not fit our pre-existing mental models. We may discount them as a fluke, or “beginner’s luck.” We may perceive bias or hidden agendas on the part of the presenter. There may be many other results which appear to contradict the conclusions drawn in this case.

Policy Deployment provided AT&T with a measurement and reporting methodology that helped address the obstacles of ambiguous and imperfect information. By making the connection between strategy and implementation explicit, it allowed the employees and managers to look beyond the day-to-day deluge of information and see long-term cause-and-effect relationships.

**Quality Planning Matrix**
The principal planning and reporting tool for Policy Deployment is called the Quality Planning Matrix, and a small portion of one is shown below.
<table>
<thead>
<tr>
<th>NSG Directions</th>
<th>TSBU Detailed Objectives</th>
<th>TSBU Individual Projects</th>
<th>Indicators</th>
<th>Goals</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 Exceeding Customer Expectations</td>
<td>1.1 Measure and Improve Customer Satisfaction Coordinating Exec. Morgan</td>
<td>1.1.1 Increase Customer Satisfaction</td>
<td>Customer delight</td>
<td>50% exceeds</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.2 Improve Response to Feedback</td>
<td>% initial responses to customer issues within 31 days</td>
<td>100%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.1.3 Institute Feedback Process</td>
<td>% revenue in feedback process</td>
<td>90% of sales</td>
</tr>
</tbody>
</table>


In the first column are the Network Systems Group Directions, the four main goals of Policy Deployment. The second column contains TSBU Detailed Objectives, which are assigned to senior managers in the division and organized according to the four main objectives. These in turn are divided into individual projects, which are assigned to lower-level managers. Each individual project has an indicator, and short and long-term goals for that indicator. The matrix, which was invented by the TSBU independently of FPL, follows the top-down philosophy. The chain of responsibility begins at the top, with the four Network Systems Group objectives, and then cascades down.

The structure provided by the Quality Planning Matrix gives employees additional reason to perform TQM activities, because it makes them part of their regular responsibilities. An article in The Economist (1992) features Richard Palermo, Vice-President of quality at Xerox, stressing that he is not a quality professional: "A Baldrige winner in 1989, Xerox has no quality department. Mr. Palermo thinks most programmes fail because firms construct isolated quality departments. At Xerox, cross-functional teams attack quality problems, most of which, says Mr. Palermo, result from "functional foxholes" -- misunderstandings between departments. Every employee is responsible for quality."

Another comparison can be drawn with the subject of strategic planning, which, as Mintzberg (1994) has pointed out, should not be left to dedicated strategic planners. Instead, the planners should assist line managers in developing their own strategic plans that support their business objectives, and should assist the corporation in achieving a unified vision of corporate mission. In the past, according to one of the corporate quality managers, the plans made by planners were often nine inch thick documents that few would read. It often seemed that the object for the planners was to get the plans done, rather than to have them implemented.
At the Merrimack Valley Works, the Director of Quality, Len Winn, was pushing the viewpoint that quality is everyone’s responsibility. In our initial meeting, he said that in his view, the biggest change that had occurred at the factory was that everyone now saw quality as a part of their jobs. If we refer back to the quality situation at AT&T prior to the breakup, we will see that quality was originally considered the responsibility of Quality Control and Quality Assurance, and that management of the metrics and “quick fixes” took place as a result. Policy Deployment helped the managers and employees redraw their mental models so that they could see the long-term benefit of TQM. Once the managers changed their expectations, the employees began to change their behavior. Of course, the critical test was yet to come: what would the results of Policy Deployment be?

The Drive for the Baldrige

Following the visit to Florida Power & Light, Pete Fenner and the rest of the senior management team decided to implement Policy Deployment and Quality Improvement Teams in the Transmission Systems Business Unit. At the same time, they decided to apply for the Baldrige Award in 1991. Although they did not expect to win, they wanted to do well enough to merit a site visit (this is an indication of superior quality in itself).

In the meantime, the training organization at AT&T began training the first and second level managers within the TSBU in Policy Deployment and the tools of TQM, working down from the top. Leonard Winn, the Quality Director at the Merrimack Valley Works, took a leading role, becoming the champion of TQM at the factory. Many of the people I spoke with cited Winn’s tenacity and commitment as one of the main reasons why TQM was implemented so thoroughly at the Merrimack Valley Works. As we have seen, Winn believed strongly in the idea that quality should be the responsibility of every person in the plant, and not just the quality department. One of the staff members in the quality department told an anecdote about a talk that Winn gave one time to a group of employees. He asked everyone to raise their hands as high as they possibly could. Everyone did so. He then asked everyone to raise them a little higher, and they found that they could, illustrating Winn’s point that it was always possible to make an additional effort to improve, even without additional resources.

The production workers, called production associates, were encouraged to volunteer to form teams. Making the teams voluntary ensured that only those most comfortable with change and eager to improve would be on the first teams. Supervisors were allowed into team meetings by invitation
only. Engineers and other support staff could be included in the team meetings, but the AT&T trainers made it clear that the team itself was responsible for analyzing the problems, selecting one to work on, and developing a recommended solution. The training organization trained employees in TQM techniques as they formed teams, but not before. Training at the time of team formation helped keep the total training load manageable, avoided wasting training resources on employees who were not interested in TQM, and ensured that the training would be relevant to the actual tasks that the employees were doing. Qualtec consultants helped to develop the curriculum and trained the AT&T training staff. Some production associates were given special training to act as facilitators to teams outside of their own department. Several of the people I spoke to had served in this capacity.

According to the employees I interviewed, support for TQM varied among the first-line managers. The first line managers I spoke with appeared to view the teams positively, but the employees told me that some of the team suggestions were rejected because some supervisors believed them to be too expensive, without allowing for an actual cost-benefit analysis. Some employees felt that this approach was arbitrary. One employee said, “What [top management] says and what the first line [supervisors] do are worlds apart.” Another said that the suggestion of a high-level executive was more likely to be implemented than the same suggestion coming from a team. Often the suggestion required cross-functional cooperation, which the first line manager may have felt unable to implement. In some cases, this led to teams suppressing ideas that they believed would not be approved.

Again, I did not have the opportunity to speak with a first line manager who had been opposed to the quality teams at the time, although the supervisors I did speak to acknowledged that some of their colleagues had been opposed to them. One supervisor said that some of the supervisors had to be forced by their managers to accept the teams. He also said that the engineers were one of the groups that was particularly resistant. Participation was not voluntary for engineers, as it was for the production associates; if a team needed their support, they had to be involved. Time did not permit any interviews with engineers, so I was not able to verify this independently.

One of the senior quality managers at the factory told me that the white-collar portion of the business was another area that was particularly resistant to TQM. In general, it appears that the Merrimack Valley Works was similar to other cases that have been studied (Sterman, et. al. 1994,
Main 1994), in that resistance to TQM often comes from groups that either feel threatened by the formation of teams or are not used to measuring their work processes quantitatively.

**Product Development**
One common trouble area among companies who implement TQM is product development, because the usual measure of progress, defect reduction, does not translate well. Although it is possible to talk about defects in a design, the criteria are so vague and subjective that they are difficult to measure. Furthermore, the engineers who work in design often value their autonomy, and resist what they see as attempts to interfere with their creativity by defining what their process should be.

AT&T's solution to this problem was to focus on time-to-market and design cycle time, rather than defects. One of the product development managers said that his focus was on optimizing the design process to take the least amount of time. The TSBU 1992 Baldrige Award Application identified improving features and functionality as another priority. Other focuses included design for manufacturability and design for testability. Product developers formed APEX Teams (short for Achieving Process Excellence), which broke down the product cycle into segments, each with an APEX team to work on it using the Quality Improvement Story methodology, as follows:

- Front end process
- Requirements and architecture
- Circuit Pack
- Integrated circuits
- Equipment
- Software
- System verification
- Product Delivery
- Project Management

Teams focused on identifying "roadblocks" that lengthen design intervals, typically because of a lack of coordination between different functional areas. One of the senior quality managers said that in the telecommunications equipment business, because it is so technical, the first manufacturer out with a product owns the industry standard, so reducing cycle time is critical. Starting in 1991, the teams were supported by business unit-wide "Business Management Teams" composed of senior managers, who were responsible for resolving functional conflicts. The results of the APEX program are shown below.
Figure 14. Product Development Cycle Time Index. 1989 = 100. Source: Internal Company Documents.

One of the product development managers, reflecting on the process, said that the key management decision was the trade-off between up-front planning and productivity. He said that the typical time required for analyzing and optimizing a process was eight months, so it was impractical to try to look at all the processes. Instead, the APEX teams had to rank the processes in order of priority, just as the manufacturing Quality Improvement Teams had to do with defects. He also said that it was not always clear when the team had done enough planning. After benchmarking and analysis, it was still possible to design a process with serious problems. The temptation to move ahead always competed with the fear that the new process would still contain flaws, and discredit the people who developed it.

**Supplier Quality**

Another main focus at this time was supplier quality. A substantial amount of the variation in output for the Merrimack Valley Works was attributable to variation in the quality of supplied material. One quality manager said, "when you really think about it, all any manufacturer really does is assemble and sort out the defectives." As a result, AT&T aggressively managed its supplier relationships. Prior to the breakup, one supplier quality manager told me, AT&T had what he called an "open door" policy, where anyone could become a supplier. AT&T saw the "open door" policy as a part of its public service obligation, since it was the only customer for many small companies. While there was no explicit policy to reduce the number of suppliers, greater emphasis on quality has reduced their number by about two-thirds.
Figure 15. Supplier Quality. Source: Internal Company Documents.

To encourage its suppliers to improve quality, once a year the Merrimack Valley Works recognizes its outstanding suppliers with "a real first-class day," according to one of the supplier quality managers. Supplier representatives are treated to a day-long program including a factory tour, a dinner, a plaque, a banner to hang up at their factory, and an overview of AT&T's business and where it is going. Their names are published in the local newspaper. Top executives, including Chairman Robert Allen, have attended. Recognition shows them that AT&T is willing to stand behind them and give public recognition for their contributions. The award is open to all suppliers; not just component suppliers, but service companies too, such as pharmaceutical labs.

Once suppliers achieve outstanding results, the Merrimack Valley Works' level of controls and inspections decreases substantially. AT&T's quality staff no longer visit the supplier and recommend changes; instead, they give the supplier their goals and let the supplier come up with the solution. For example, the senior quality manager told me that the incoming integrated circuit defect rate has gone so low that it is no longer feasible for them to measure defects. They cannot get a statistically valid sample. As a result, they have eliminated Incoming Inspection for this type of component, and use component removal rates during factory testing as their quality measure. He believed that roughly half of the defects could have been caused by the inspection itself.

The Merrimack Valley Works used to ship back defective parts, which caused a problem because there was very little inventory on the floor, and according to one of the senior quality managers, "Manufacturing would go berserk" when they saw parts going back to the suppliers, because they had made plans based on the original level of inventory. Now the AT&T supplier quality
personnel go out to the suppliers' facilities and inspect the parts there. They call it a "demand-pull" system, because they can inspect a supplier's whole inventory and thereby allow the supplier to ship only what they need as they need it.

Not all suppliers can maintain quality levels. There has been backsliding on occasion. Figure 15 shows that after 1992, supplier quality levels ceased to improve, and even deteriorated in 1994, although this could be due to normal variation. Several times during my visits, senior quality managers described supplier quality as a continuing problem. Relationships with existing suppliers may become disrupted because they change locations, and even though they try to maintain their quality, the confusion caused by moving causes quality to deteriorate. Or else the ownership may change, as happened with an internal supplier based in Reading, Pennsylvania, which was sold to an outside company.

One of the senior quality managers suggested that the defect rate may be rising because the number of new suppliers is increasing as new products come out. New products require new parts that are not available from the existing suppliers, requiring the addition of new suppliers. In addition, existing suppliers are required to supply new parts, for which their production processes have not yet come down the learning curve. The manager believed the quality level would improve again in the future, as parts become standardized and poor suppliers are improved or replaced.

**Practice Run: 1991**

The Merrimack Valley Works succeeded in winning a Baldrige Award site visit, and hired a senior Baldrige examiner named Clifford Moore to conduct a mock site visit so that they could get feedback in advance of the actual visit. As Moore entered the Merrimack Valley Works, he was met by a union picket. I encountered a number of opinions as to the meaning of this event. Jack McKinnon explained that the visit had unfortunately coincided with a round of downsizing. One of the quality staff members said that the picket had caught management completely by surprise, and believed that the union saw TQM as a prelude to layoffs. The union would not even meet with the examiner. In response to the picket, Moore told the plant managers that if they thought they could move the process forward without the union, they were out of their minds, according to one of the human resources managers.

Both of these comments appear to suggest that the picket was a protest against the non-involvement of the union in the Baldrige process; however, when questioned about this, the senior union officials at the factory said that the union did not even know that the examiner was coming
that day. Instead, they described the picket as “informational,” designed to inform the workers that the union disagreed with management on a particular issue, and thought it might have been related to some outsourcing that was going on at the time. In any case, they stated that it was not related to TQM.

When told of the union officials’ perspective, one of the Merrimack Valley Works managers replied that “there was no question that the picket was aimed at the ‘mock’ Baldrige site visit. There was even one sign that said: ‘Mock Picket.’”

Whether or not the picket was intended to be a protest against TQM, it was clearly seen that way by the management, and was described by several managers as an influence on their decision to involve the union more in organizational reforms. McKinnon said, “if we don’t have cooperation between union and management, we may not have a factory.” He began to sit with the union representatives monthly. Although the union did not meet with the Baldrige examiners during their actual site visit in 1991, by 1992, the union was included in the Baldrige effort, even writing a letter to the examiners endorsing the Baldrige application. Union officials received the same TQM training that the executives had. This greater involvement of the union led to an improved level of rapport that one employee told me that the union officials sometimes seek to avoid friction with management. 10

Employee Involvement
In addition to courting the union, McKinnon took steps to increase employee involvement. He had a strong belief in empowerment, and regularly walked the floor and talked with employees about the situation in the industry and why he believed quality was an important thing for them to be focusing on. He often used the example of the American automobile and consumer electronics industries to prove his point. He would point to the parking lot, with its many Japanese cars, and warn that the same thing could happen in the Merrimack Valley Works’ markets if quality was not improved. His direct manner of speaking appealed to the employees; the ones we spoke to had high regard for McKinnon, and said he had been very effective at explaining the need for quality.

One manufacturing manager emulated McKinnon’s example by situating his office on the opposite side of the floor from his staff, so that he has to walk through the production line to go to meetings.

10 It should be noted that, two days before my interviews with the union officials, they entered a new round of contract negotiations with AT&T. This may have influenced their responses to my questions.
He encouraged his first-line managers to do the same, and went to occasional team meetings. He said that this enabled him to know who was doing what, so that no one could take unfair credit.\(^{11}\) He was careful to reassure his supervisors that he was not bypassing them by going to team meetings; successful teams resulted in merit awards for supervisors.

Besides giving employees a sense of participation in the decision making, McKinnon’s approach to team building increased accountability. One of the human resource managers said that one of the best values that developed was personal responsibility. Instead of passing the buck, employees made an effort to solve the problem themselves. The Common Bond values were taken seriously, to the point where employees evaluated their managers on their adherence to the values, and personnel used the values to critique each others’ performance.\(^{12}\)

People were rewarded for stopping the line, in contrast to the early 1980’s, when one did not stop for any reason. One of the human resources managers said that the attitude at that time was, “On Friday, the boxes go out with bays or bodies.” Now managers are measured more on their quality performance than on their shipping performance, according to one of the senior quality staff people.

Another major step that McKinnon took was to flatten the management structure. He removed two layers of middle managers, and gave the remaining ones more authority. Within a certain set of parameters, they were given full responsibility to run their operations. With 20 people now reporting to him, he said, it was impossible for him to check in with them every day, so he had to delegate responsibility. He tried to foster an atmosphere where suggestions were welcome and people took initiative. A casual dress policy further broke down barriers between management and the factory workers.

**Rewards and Incentives**

To increase participation in teams, the Merrimack Valley Works rewarded employees’ contributions with public recognition. Twice a year, about six teams were recognized as

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\(^{11}\) While this may be a valid rationale for attending team meetings, it might tend to reduce the cohesiveness of the team if members knew they were being judged on their individual contributions. This illustrates the difficulty that managers face in knowing how to relate to their teams.

\(^{12}\) Although the identification of the employees with the Common Bond is desirable, this example raises the disturbing possibility that employees may simply be using the values as another weapon with which to attack their colleagues. It was not clear whether the critiques referred to were part of a formal anonymous feedback process, or direct person-to-person communications.
outstanding. Teams presented stories to management and shared a dinner. The best were sent to New Jersey for a corporate-wide event. The bus trips were described as “a huge party.” Generally it was the production associates who went, although engineers who participated in a team’s work were invited as well.

The incentives for engineers were somewhat different. Generally, they had focused on a 3-5 year view of where AT&T needed to be in the factory to support advanced manufacturing. Their role was to conduct R&D and develop new products and processes. They were not so reliant on celebrations and honors; for them, the reward was the chance to work on new technology. Another reward was the opportunity to go on trips (sometimes overseas) to benchmark and learn from other factories. Other rewards were “dinner for two” certificates, promotions, technical challenges, and a special title, “Distinguished Member of Technical Staff.”

One of the manufacturing managers I spoke with said that non-monetary rewards were often more effective than compensation, because raises were almost seen as an entitlement, more of a cost of living increase than a reward for superior work. If a raise was not received, it was perceived as punishment. Also, cash rewards to union employees were prohibited by the collective bargaining agreements, which specified how much employees were to be paid, and under what circumstances. Therefore, the managers had to be more creative in finding ways to motivate union members.

One successful program was “Walk in My Shoes,” which brought senior managers down to the shop floor to work on the assembly line alongside the employees. This broke down some of the barriers to communication by giving employees a chance to have their frustrations and suggestions heard by the senior managers, and by giving the senior managers an opportunity to communicate their vision to the employees. In addition, the senior managers learned that the employees’ jobs were more difficult than they appeared. According to one of the human resources managers, when AT&T CEO Bob Allen came to visit, he came in after some of his direct reports, and was worried that he would not perform as well as they did.

One of the human resources managers said that Policy Deployment gave everyone a common language. That was a powerful asset for the Production Associates, because they could now go into a Vice President’s office with a story and come out with a commitment. They had never had that privilege before.
However, some employees said that AT&T is still too stratified. They said that, although upper management works very hard at improving employee participation, this is not always embraced by first line management. Some first-line managers are uncomfortable with their roles in the new system, and persist in treating the employee as a “puppy in the back of the car.”

In 1989, the factory conducted an employee opinion survey, which revealed some managers with communications scores as low as 43%. The employees I spoke with told me that the quality of management communications varied widely; this was demonstrated by the level of knowledge that the employees had of the quality program and its history, which also varied widely.

When I asked about resistance, nearly everyone I talked to agreed that resistance had been heavy at first, and that it had taken a long time to overcome. This appeared to have been overcome chiefly by persistence and consistency on the part of top management, as well as communications. There were also many “pockets of excellence,” early adopters of the Quality Improvement Stories, who served as role models and encouraged other people to join in. The voluntary nature of the program seems to have been key.

One of the managers who had promoted TQM inside the factory cited four initial objections from management, expressed during training at Florida Power & Light:

1. Another project? My in-basket is full.
2. Communication is a waterfall - it only goes downhill
3. Don’t shoot the messenger - what if the problem is outside his responsibility or control?
4. Presentations are applause overviews - people only feature the good news.

Managers were concerned about getting support from upper management for problems that spanned departments. In particular, middle managers were the ones most threatened by employee teams. In retrospect, one quality advisor said that his biggest regret was not getting middle management involved sooner.

As we discussed before, the first-line managers I spoke with did not appear to fit this mold. They appeared disappointed that more of their employees did not join teams.
I encountered a wide range of opinions regarding employee involvement in teams, which suggests that adoption varied substantially between work groups. Some supervisors were more supportive than others, and this may have affected the degree to which their employees joined teams. One of the employees I spoke with said that participation peaked at 30% in 1992 and has declined to about 15%. This was confirmed by one of the supervisors, who estimated participation at 25%. Another supervisor said that participation had remained relatively constant at 40%. A third supervisor said that peak participation had been 60%, and had declined to 20%. One of the human resources managers had results from the annual employee survey showing that 66% of all the respondents had "participated in a team focused on improving quality."

Dealing With Layoffs

One of the common reasons that TQM programs lose momentum is opposition from the workers, who often lose their jobs to the increased productivity that TQM makes possible (see, for example, Sterman, et. al., 1994). In our first meeting, one of the senior quality managers at the factory said that an unanticipated side effect of TQM was the layoff or encouraged retirement of the very people who had made it possible. The amount of the position reductions is shown in the graph below.¹³

¹³ These employment figures include AT&T Microelectronics, which is not under Jack McKinnon's control; however, it shares the collective bargaining contract with the rest of the factory, and its employees were eligible to "bump," or displace, Transmission Systems employees with less seniority. Accordingly, I have included Microelectronics in the chart.
Remarkably, commitment among the Merrimack Valley Works employees for TQM did not deteriorate, despite staff reductions of almost 50% during the mid-80's to early 90's. In other studies (Sterman, et al. 1994), TQM has been linked with layoffs in the minds of the employees. When asked how this was avoided, one senior manager said that he believed honesty was critical, and that the employees should be told what was happening. It was important to establish a track record of telling the truth, in order to build credibility.

One analogy used was that of a lifeboat. As one senior manager described it to me, the lifeboat only holds 50 people. If 70 try to get aboard, all 70 will die. If there is space for 20 people in another lifeboat, you do everything you can to move people over. He went on to say that one of the worst things you can do is to try to cure personnel problems as part of the downsizing. Managers who are laid off because they are surplus may come to believe that they are considered poor performers and were never told. This destroys senior management credibility. All the managers could come to fear for their jobs, because there are no explicit criteria for choosing people.

Management's communications ability was put to the test in July, 1993, when the AT&T Communications Services Group, the long distance division and one of the TSBU's largest customers, cut its orders in response to internal financial difficulties. This represented 50% of the TSBU's total sales, and led to the elimination of eight hundred production positions. Coming just nine months after the Baldrige Award (we are jumping ahead here: the Award was won in October 1992), this event could easily have been linked with TQM in the employees' minds. However, one of the senior quality staff members told me that management had been keeping the workers informed as to their sales forecasts and actual orders, and were able to show them that the layoffs were necessary because of a reduction in business, not an improvement in productivity. In addition, since the Communications Services Group was an internal division, they were able to show that the lost business was not going to a competitor.

I asked everyone I talked to whether TQM was seen as being responsible for the downsizings, and their responses were consistently no. A human resources manager said that they had feared a backlash, but it did not happen. Management said that people would not lose their jobs due to

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14 The quality staff were careful to point out that there were extensive early retirement programs, hiring freezes, and job training programs used to mitigate the effect of downsizing. Thus, although employment levels did decline precipitously, not all of the reduction was due to layoffs.
quality improvements, instead redeploying personnel if necessary. Since other areas of the company continued to grow, it may have been easier to move people at AT&T than at other companies in the same situation. Early retirement incentives have taken up some of the slack; AT&T also provides extensive outplacement services. Several people said that layoffs have been due to technology improvements that mean less people are required to make the products. There have also been layoffs due to changes in corporate strategy. The most recent wave of layoffs, which took place at the end of 1994, was at AT&T Microelectronics, which shares the Merrimack Valley Works building with the Transmission Systems Business Unit. AT&T had decided to get out of some non-strategic component businesses. Unfortunately, since the two business units at Merrimack Valley Works are covered by the same collective bargaining agreement, Microelectronics employees were able to “bump,” or displace, TSBU employees from their jobs.

The employees I spoke to showed a high level of commitment to TQM, and a good understanding of why it was important. One employee said to me, “personally, I think quality is the most important thing you do. Poor quality means you’re just wasting time doing the same thing over and over. It costs more, and reworked parts are never as good as if you simply did it right the first time.” Another said that she supported TQM because it gave her a chance to find out what was going on with the business and to contribute to the decision-making.

**Quality Standards**

Much of the focus of the TQM program was on quality standards. We will look at two such measures here: the Manufacturing Test Composite Failure Rate, which shows the percentage of products coming off of the assembly line that fail the internal tests, and the Quality Index, which is produced by Quality Assurance and shows the relative quality of the products against customer standards.

**Manufacturing Test Composite Failure Rate**

For each product line, a “Vision Goal” was set and the monthly average defects were measured against it. Figure 17 displays the manufacturing test composite failure rates from 1989-1994 for the Merrimack Valley Works.
Figure 17. Manufacturing Test Composite Failure Rate, 1989-1994. Source: Internal Company Documents.

A look at the chart shows that there has only been one period of lasting improvement, with plateaus on either side.\footnote{The reader will notice a large spike in the third quarter of 1993; the entire increase was in one of the factory's largest areas. One of the senior quality staff members speculated that this could be attributed to an incident where a production worker accidentally left a batch of components in an oven for a whole weekend, ruining the entire batch. However, the increase went on for three months, so this is unlikely to be the whole explanation. In any case, it appears to be an aberration. Quality officials informed me that this indicator does not include all operations, and so may exaggerate the changes in quality.} This was not the impression of the managers I spoke with, who seemed to believe that there had been continuous improvement. Instead, it looks like TQM took off at around 1991-1992, resulting in a dramatic improvement across the board, and since that time there has been little sustained progress in defect rates.

**Defect Index**

Another measure, called the "defect index," is shown below. The defect index is based on a ratio of Actual Defects to Expected Defects, where Expected Defects are set by customer standards.

The defect index is AT&T's standard way of showing product quality improvements.
Figure 18. Defect Index. (Indexed: 1985 = 1) Source: Internal Company Documents.

As with the composite defect rate, this chart shows a plateau after 1991, although the improvement starts earlier.

Quality managers explained the apparent lack of progress by referring to the increasing complexity of the products, which grows the number of potential sources of defects, and the problem of finding enough defects at low levels to devise a process improvement. With fewer defects, a longer time is needed to collect the data required by the TQM tools. Another suggested possibility is that the factory workers are getting better at finding defects before they reach the customer.

One indicator that has shown consistent improvement since 1991 is warranty costs, which are shown in Figure 19.

Figure 19. Warranty Costs. Source: Internal Company Documents.
The warranty costs are indexed, so that 1991 equals 1. Since 1991, warranty costs have dropped by 53%, an indication that product reliability continues to rise even though the initial quality of products leaving the factory has remained relatively constant.

Victory!
On October 14, 1992, Commerce Secretary Barbara H. Franklin announced that AT&T had won not one, but two Malcolm Baldrige National Quality Awards: one for the Transmission Systems Business Unit, and one for the three-year-old Universal Card credit card unit. Hackman said that the results of AT&T's TQM efforts “are clearly proof that there's a renewed devotion to excellence, detail and good old-fashioned hard work in this country. I have never been prouder or more optimistic about the future that lies ahead for American industry.” The Merrimack Valley Works released statistics showing a ten-fold improvement in product quality, a 50% reduction in the time it took to get products to market, a 40% reduction in inventory, a 50% reduction in product returns, and more than $375 million in cost savings.\(^{16}\) In the same year, the Merrimack Valley Works also received ISO 9001 certification, which indicates that the manufacturing facility meets international recognized quality standards, and the first Feigenbaum Massachusetts Quality Award.

Employees and managers at the Merrimack Valley Works were rewarded with a gala celebration on the giant front lawn of the factory. Governor William Weld of Massachusetts came to offer his congratulations, the local high school marching band put on a parade, and everyone was given “We Won!!!” flags and T-shirts.

Unanticipated Side Effects
Along with the victory came some surprises. Although all of the people I spoke to were extremely proud of what they had accomplished, and believed that they had derived permanent benefit from TQM, there was a sense that the Baldrige Award was a high point, and that the pace of improvement since then was not what it had been from 1991 to 1992. New problems now presented themselves, and the answers did not come as quickly.

Competitors Have Quality, Too

Although AT&T's quality improved, so did that of its competitors, to such an extent that the most recent customer surveys tend to put price ahead of quality in importance. Quality officials at AT&T told me that quality is a requirement for admission to the game, not a source of competitive advantage.

Furthermore, the advantage that any company enjoys in quality is harder to maintain as overall industry quality goes up. Len Winn gave the following example: Let's say you have 500 defects per million parts, and your competitor has 1000. That means you have a 500 part advantage. If both of you improve quality by the same percentage (let's say 90%), then you have 50 defects per million and your competitor has 100. Even though both of you have improved your processes by the same percentage, the absolute gap has narrowed.

Expectations Have Been Built Up

One of the weaknesses of Total Quality Management is that it has continuous improvement as a goal. Yet all improvement must have an inherent limit, which is zero defects. At some point, no further improvement can be made. The quality officials at AT&T said several times that, with some processes, they are at the point where there are so few defects that it takes too long to build up a statistically significant sample with which to plan improvements. Teams are allowed to disband, and the people are allowed to form new teams as necessary.

As long as there are other processes or products needing improvement, this approach works. But, ultimately one runs out of obvious improvement candidates. One employee said, "I can tell you: for a fact that the fat rabbits have gotten skinny." When this happens, interest in TQM begins to wane. She saw a definite backsliding in involvement, and even a feeling that, now that the Baldrige was won, there was no further dramatic improvement to be had.

One employee said, "we've heard that Xerox, after they won the Baldrige, they went (makes descending noise)," and added that, in general, companies do not do as well after they win the Baldrige, losing business. That employee said that there is a feeling around the plant that it may be AT&T's turn now. However, the same employees admitted that there was no hard evidence to back up their fears; the performance of the plant is as good as it has ever been.

One of the senior quality advisors at Global Public Networks headquarters told me that, now that the Baldrige has been won, some people are seeing a return to business as usual, and are relieved
that they do not have to worry about quality for another five years (the minimum interval between successful Baldrige applications). Although quality has not deteriorated, there has been a loss of momentum.

That quality advisor’s perception was not shared by all of the managers, one of whom said that he “continued to be amazed” at the improvements still being generated after six years of Policy Deployment.

Nevertheless, attention is now focused on the Workplace of the Future program, or Workplace 2000. The Merrimack Valley Works is taking a further step toward self-managed teams, and is currently piloting the idea with the ATM group (Asynchronous Transfer Mode, a leading-edge communications technology). One concern I have is that the success of TQM has raised expectations for Workplace 2000 that may not be realizable. TQM represented a radical change for the Merrimack Valley Works, introducing self-managed quality improvement teams and customer focus, whereas Workplace 2000, using self-managed teams for operations, is only an incremental increase in team empowerment. I consider it unlikely that this new program will produce the same improvements as TQM. The goals are not as clearly defined; TQM had defect rates as its principal metric, but even so was essentially an act of faith. When I asked to see financial results tied to the implementation of TQM, the factory staff were unable to provide me with them. They explained that since the factory was considered a cost center, their only financial benchmarks were standard costs, and even these change every two years, to reduce manufacturing variation. In short, the Merrimack Valley Works management implemented TQM without establishing any specific sales improvement and profitability goals. TQM was seen as a competitive necessity as well as a competitive advantage. The defect reduction was taken as evidence that TQM was having its desired effect, rather than any increase in profits or market share. Some contracts have been won as a result of TQM (such as one large contract with Pacific Bell), but most cannot be tied directly to quality improvements. Workplace 2000 is an incremental improvement to TQM and Policy Deployment, and so will not result in such a dramatic improvement.

Labor is Now a Small Part of Costs
With the labor reductions and the elimination of redundant processes, labor and overhead are now only about a third of the total costs of the factory. As a result, the quality control staff are now having to focus more on supplier quality. However, improving supplier quality does not
necessarily give AT&T any substantive competitive advantage. One of the supplier quality managers pointed out that improvements in supplier quality benefit all competitors equally, to the extent that they share the same supplier. Although AT&T's quality may go up, it does not leave the company with any longtime advantage.

**System Dynamics Analysis**

As we have noted, AT&T's success with TQM has been somewhat unusual. In 1992, the same year the Merrimack Valley Works won its Baldrige Award, The Economist ran an article entitled "The Cracks in Quality," in which it cited a new Arthur D. Little study claiming that, of 500 American manufacturing and service companies, "only a third felt their total-quality programmes were having a "significant impact" on their competitiveness."17 The article cited a lack of customer focus, inexperience, and the existence of a separate, marginalized, quality organization as some of the most common problems.

In 1994, the System Dynamics Group at MIT sponsored a study by John Sterman, Nelson Repenning and Fred Kofman that examined the case of Analog Devices, an integrated circuit manufacturing company that, despite achieving dramatic success with its TQM program in terms of product quality, nevertheless suffered severe financial distress. They used the technique of system dynamics to model Analog Devices and determine the causes of the paradox.

**The Case of Analog Devices**

Here I shall just cover the main points in the Analog Devices study (Sterman, et. al., 1994).

As a result of its TQM program, Analog Devices achieved impressive improvements. Defective products went from 500 PPM (parts per million) to 50 PPM, while the yield (fraction of parts usable) went from 26% to 51%. Manufacturing Cycle Time decreased from 15 weeks to eight. Cost of Goods Sold per unit sold decreased by 15.8%. At the same time, however, Operating Income per unit shipped decreased by 44.7%, causing a drop in share price from $24 to $6 and a drop in return on equity from 7% to -4%. In 1990, Analog laid off 12% of its staff, and transferred approximately 150 manufacturing jobs to overseas subsidiaries. Analog Devices came perilously close to being a takeover candidate, and although its financial results rebounded, the

short-term result was a weakening of the commitment to TQM. Management turned its focus to improving financial performance, and the resulting reorganization and cutbacks disrupted the quality teams. Many of the employees who had worked to improve quality were let go, linking TQM with layoffs in the minds of the remaining workers. As Analog's TQM program stalled, competitors continued to improve, hurting the company's competitive position.

Eventually Analog Devices rebounded, as the emergency measures had their effect. Financial results improved, boosting morale, and a second wave of TQM activity began. However, the question remained as to whether the downturn could have been avoided. Sterman, et al. concluded that the recession from 1989-1990 did not by itself cause the problems; instead, there were three factors internal to the system that produced the financial deterioration.

First, product development improved more slowly than manufacturing productivity. Since sales growth for Analog was dependent upon the marketing of new products, sales did not grow fast enough to take up the slack caused by increased manufacturing yield. Second, Indirect Costs did not fall as swiftly as Cost of Goods Sold, yet Analog maintained roughly a 200% markup (Average Selling Price divided by Cost of Goods Sold). Operating Income fell, because the proportion of Gross Profit to Indirect Cost was smaller. In effect, Analog underpriced its products, because they did not understand how TQM changed the balance of direct and indirect costs. Third, Analog's competitors also improved their quality, leaving Analog with less of a competitive advantage than it had planned.

Once layoffs were deemed necessary, commitment to TQM deteriorated because many workers believed that it was TQM that caused their dismissal. Somehow this trap was avoided at AT&T; as we have seen, there is remarkable agreement at all levels of the business unit that the 50% reduction in workforce suffered over the last ten years was not due to TQM. In the following sections, I shall examine the case of AT&T's Merrimack Valley Works for each of the identified factors, and see what, if anything, AT&T did differently.

Differences Between Analog and AT&T

AT&T and Analog Devices, Inc. are very different companies. It will help us to assess the validity of the Analog Devices model if we can see how it responds to the situation faced by the Merrimack Valley Works.
AT&T Succeeded in Shrinking Product Development Time
As was noted in the section on Product Development (p.45), AT&T succeeded in reducing product
development cycle time by 64% by forming cross-functional APEX teams. This was not the case at
Analog Devices, which was unable to achieve an equivalent level of improvement.

Analog’s managers reported tough resistance from the engineers in Product Development to TQM
tools. Several interviewees at AT&T also reported resistance from the engineers. However, AT&T
was apparently able to overcome much of the engineers’ resistance. Part of the reason may have
been that engineers were included in the Quality Improvement Teams, and so had an opportunity to
see the effectiveness of TQM in manufacturing for themselves. Also, the managers were
successful in recasting the TQM tools so that they were applicable to product development, using
measures such as design interval instead of defects.

AT&T Successfully Adjusted Prices
Sterman, et al. (1994) provide a simulation run showing that, had Analog Devices, Inc. managed to
adjust its markup so as to maintain its usual coverage of indirect costs, profits would have
remained stable and much of the pressure on the organization could have been avoided. Although I
was not able to obtain pricing and cost data for the Global Public Networks (the new name for the
business that absorbed the Transmission Systems business unit), one of the senior corporate
managers told me that they have been profitable for seven years. It appears that AT&T
successfully managed the cost reductions from TQM. One possible explanation is that in the
Global Public Network division, sales are made through a competitive bidding process, typically
for very large amounts. As a result, the company must evaluate its costs each time it bids a
project, in order to determine the amount of its bid. Analog, on the other hand, sells standardized
products in great quantities, and so does not have this built-in opportunity to re-evaluate its cost
structure every so often.

AT&T Maintained Quality Lead Over Competitors
Since AT&T did not experience the financial downturn that Analog did, it also did not experience
the same pressures to turn away from TQM. Nevertheless, its quality advantage over its
competitors has narrowed over time. As quality improves, the pace of improvement slows,
allowing competitors to catch up. AT&T is now increasing its focus on non-quality-related cost
factors as a means of maintaining its competitive edge. I believe that the focus on quality may
have diminished at some levels in the organization as a result. It continues to use the same tools, so its commitment to TQM remains strong.

**Employees Believed That Layoffs Would Have Happened Anyway**
I found remarkable uniformity among my interviewees on the subject of layoffs. All agreed that layoffs were inevitable due to the advent of new technology and automation in the factory, and said that if AT&T had not done TQM, the layoffs would have been greater (probably ending in the shutdown of the factory). This was supported by the Analog Devices model, which showed worse results for the case where Analog did not implement TQM. However, AT&T management was more successful than Analog Devices management at convincing the employees and union representatives that layoffs were inevitable. I find it curious that few of my subjects considered the automation to be linked to TQM in any way. Certainly it is possible for a quality improvement team to recommend automation as a way to reduce process variation, but the people I spoke to said that none of the teams they were familiar with had ever done so. Automation was seen as something that came from the engineers that were designing the manufacturing lines, not from the quality improvement teams.

Since AT&T had been in existence for much longer than Analog Devices (Analog was founded in the mid 1960’s), it had an older workforce. As a result, it may have been easier for AT&T to implement an early retirement program than it would have been for Analog. Early retirements are more benevolent than layoffs, since they are voluntary and leave the displaced worker with a means of support. As a result, employee reaction would not be as negative.

I did not have an opportunity to interview the employees who had been let go or chose to retire, which might have provided another perspective. One manufacturing manager said that the managers who could not adapt to the changes are gone, suggesting that the survivors are disproportionately willing to see TQM as a beneficial force in their lives. A set of interviews conducted earlier in the implementation process might have uncovered a different perspective. It is easy in the wake of a successful improvement program and continued good financial performance to see the past in a positive light.
AT&T Breakup Enhanced Employees' Acceptance of Change

Ed Schein writes, in "Planning and Managing Change," that successful change projects rely on three stages - a stage of unfreezing, a stage of changing, and a stage of refreezing. The unfreezing stage is important because it establishes willingness to change. It is often driven by a disruption in the normal state of affairs that produces great anxiety about the future at all levels of the organization.

When AT&T was forced to divest itself of its local telephone subsidiaries, as we have seen, it produced tremendous change in the operating environment. Suddenly, AT&T faced competition where none had been before. Furthermore, AT&T’s special status as a regulated monopoly was gone, and was replaced with active hostility on the part of the U.S. Government. Almost immediately, market share began to decline, and with it profits. Huge force reductions followed.

All of these events contributed to an environment where AT&T’s employees, particularly those in Western Electric, were not only willing to change, but believed it necessary to their survival. No such situation was experienced at Analog Devices. At Analog Devices, the rationale for change was a missed five-year plan (Sterman, et. al., 1994, p.3), and growth that had dropped from the high level of 27% per year. The survival of Analog Devices was not in doubt at the time.

Furthermore, the employees at Analog Devices were accustomed to success. They may not have truly believed that TQM was necessary to their very survival, as the AT&T employees did. Thus, when layoffs came, they believed that TQM had caused layoffs that would not have happened otherwise.

Management Ability

The top management seem to have done an exceptional job of communicating the necessity and meaning of TQM to the employees and managers of the Merrimack Valley Works. Several people we spoke to cited Len Winn’s persistence and leadership as the principal driving force behind implementation at the factory. Jack McKinnon received praise for reaching out to the employees and the union, and for treating his workers as partners. Upper management seems to have been remarkably consistent in its support for TQM, in spite of many top-level managerial transitions. Contrast this to the situation at Florida Power & Light, the role model for AT&T, where a new CEO discarded many of the quality procedures. One senior quality advisor at AT&T said,

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"Actually, we’re still worried about leaders coming in from Z-space. What amazes me is that the leaders have come in with no method for running the business. They see the tools we have, and decide they look useful. We’ve had turnover of 75%, but all are supremely committed to quality, despite having never been trained."

The key idea in that statement may be that the tools are so robust that they attract the support of new managers. I was told that the Chief Financial Officer reports the quality metrics at the same time as the financial results. The business has now been structured so that the definition of high performance includes quality. In our first interviews, the quality managers emphasized that quality could not be seen as the responsibility of a “quality department,” but instead must be the responsibility of everyone in the organization. In an article on the failure of TQM projects, the Economist stated that “those firms whose quality programmes had succeeded were twice as likely to have pushed responsibility for quality down to the shop floor, flattened their organisational structures and broken down functional barriers....Wresting control of the quality programme from the quality department may be the only way to do that.”

By pushing responsibility for quality down to the shop floor, AT&T has avoided creating an easy target for cost-cutting efforts. One top manager said, “We don’t have any quality fluff around here that we could shut down in case of a crisis.” In fact, the total staffing level of the quality organization has been reduced by two-thirds over the last ten years. This in itself would tend to insulate the quality program from changes in management. Added to this has been consistent support from top management for the concept.

**AT&T Faced Expanding Global Market**

In recent years, with the fall of the Iron Curtain and the growth of free trade, many international markets have opened up in telecommunications. AT&T Network Systems therefore faced an expanding external market, which may have allowed AT&T to avoid the productivity trap, where TQM results in excess productivity that the market cannot support.

**AT&T Had Other Businesses to Cover Losses**

In the mid-80’s, when the manufacturing arm of AT&T was unprofitable, the company had its other businesses, such as long distance, to rely on. Analog Devices, with a strong position in only one industry, was highly susceptible to demand fluctuation in that industry. AT&T’s diversity may

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<sup>19</sup> *The Economist, op cit.*
have reduced the pressures on the company to discard programs like Policy Deployment that were not having an immediate effect. One piece of evidence that supports this view is the statements of several managers that financial results were not the primary measure of success for TQM. One manager, when asked if it was “an article of faith” that high quality would lead to superior financial results, agreed, suggesting that financial results, while important, were not as critical a concern for the Merrimack Valley Works as they would have been for another company.

Suggested Model Enhancements

Market Expansions
The Analog Devices model assumes that growth of the potential market is influenced by the introduction of new products, the average age of the product portfolio, and the current state of the macro-economy. The macro-economic index of the demand for electronic components is modeled exogenously, which means that the model is highly specific to the electronic components industry. The telecommunications industry would have different characteristics, in particular the growth of international markets. In order to make the model more general, an international market growth parameter could be explicitly modeled that would allow the modeler to set assumptions regarding the growth of international markets. Different scenarios could then be tested to see how the model responds, and see whether the growth of international markets does in fact reduce financial pressures on a company.

Receptiveness to Change
The Analog Devices model assumes that commitment to TQM is driven by a diffusion process, where word of mouth from those who have tried TQM affects the attitudes of those who have not tried it. Word of mouth can be positive or negative; positive results (i.e., increased manufacturing productivity) result in positive word of mouth and higher commitment, whereas layoffs result in lower perceived job security and lower commitment. A causal loop diagram is given below:
Figure 20. Effect of Layoffs on Commitment to TQM.

Here, we see a set of opposing loops: as commitment to TQM increases, so does productivity (R1). However, increased productivity reduces the need for labor, which increases layoffs (B2 eliminates the gap between required and actual labor force), which lowers perceived job security due to TQM, reducing commitment to TQM (B1). Increased productivity eventually results in higher sales and more required labor, but this takes time. The balancing loop tends to be dominant, because the people who may be laid off are the ones who are responsible for the success or failure of TQM. The people who may be hired later have no say in company policy.

Clearly, this loop worked differently in the case of AT&T, because commitment to TQM remained strong, despite the loss of almost 50% of the workforce over ten years. The problematic link appears to be the one between Employee Beliefs That TQM Improves Job Security and Commitment to TQM, because employees do not link layoffs with TQM. I suggest that the link be weakened through the addition of an "other causes" effect, as follows:
In this figure, Job Security is placed in context. The fact is that all around the workers, there are other companies doing layoffs. Their friends and family members have been downsized. In addition, management tells them that, without TQM, the company will be uncompetitive, and may have to close the factory. All of these influences contribute to a separate sense that job security without TQM might be worse. As workers in the factory are laid off, this contributes to the feeling that no jobs are safe. The key here is context; in other words, the situation at other companies. At Analog Devices, the company was competing in a growing industry, where layoffs were a comparative rarity. Therefore, when layoffs came, there could be no explanation other than TQM. At AT&T, there had been repeated layoffs due to the introduction of competition and the increasing pace of technological improvement. In addition, the factory is located in a declining manufacturing area, where much of the local economy has been devastated by the departure of major employers. The employees we spoke to considered themselves lucky to have a job at all, and saw TQM as their major hope for keeping the Merrimack Valley Works open. The union representatives agreed.

Conclusion
Up to two-thirds of all TQM efforts fall short. Given this fact, why did AT&T’s Merrimack Valley Works (M VW) succeed? There were five factors in AT&T’s environment that positively affected the company’s ability to implement TQM. First, the willingness to change was established by the breakup of AT&T into separate long distance and local companies. MVW’s products were
losing market share and profitability, and change was perceived as necessary for survival. Second, MVW had successful examples to draw from. One was the case of the Japanese automakers, whose defeat of U.S. car companies was seen by AT&T management as a threatening precedent. They sought to emulate the TQM method that had carried the Japanese to prominence. Another was Florida Power & Light, a regulated utility like AT&T, that had been extremely successful with TQM, and had a training organization available for AT&T to use. Third, the Merrimack Valley Works was blessed with extraordinary management continuity. Although there were four general managers from 1984 to the present, all of them totally supported the TQM program. Furthermore, the “champion” of TQM, Len Winn, stayed at his post throughout this period and was tenacious in getting TQM implemented throughout the factory. Fourth, MVW was fortunate to have an expanding market for its products, so that the productivity gains resulting from TQM did not directly result in layoffs of employees. Instead, TQM became the key to entry into foreign markets. Fifth, the factory was fortunate to have cooperative union officials who believed that TQM was a way to preserve jobs in Merrimack Valley.

In addition, AT&T chose to implement TQM in ways that proved to be successful. First, TQM was voluntary: employees were invited to form teams, and the teams only lasted until the problem they formed around was solved. Thus, there were no “teams for teams’ sake,” and employee commitment remained high. Second, AT&T was careful to reward employees for good work, even if corporate goals were not met, so that employees associated TQM with the means to get ahead. Third, the company took care to integrate its corporate strategy with the improvement efforts through the use of a “Quality Planning Matrix” that cascaded the goals down to the level of the individual on the shop floor, thereby giving the employees a share of responsibility for the success of the business.

There is remarkable unanimity of purpose at AT&T. Employees at each level of the company, from top managers to supervisors to specialists to floor workers, spoke in the same language, told the same story, and often used the same examples. Everyone described TQM as a way to save their jobs. Everyone talked about the great ceremony on the front lawn when they won the Baldrige. All levels appeared to be equally invested in the TQM program and its success. To a certain extent, the unanimity may have come about as a result of telling the story to so many people; for a year after winning the Baldrige, AT&T was required to open its doors to anyone who wanted to learn how they did it. I believe it is possible that a kind of “groupthink” has settled in where everyone has learned the same story simply through telling it so many times. Nevertheless,
to the extent that this has given everyone a sense of shared purpose, it extends and supports the effectiveness of TQM. It remains to be seen how a large shock would affect the TQM system.

One manager cited an article he had read on emotional memories (LeDoux, 1994), which held that very stressful situations cause a person to revert to earlier modes of behavior. For example, a supervisor who has learned to empower her employees may revert to micromanagement when her job is in danger due to poor results. Recently the focus among customers has shifted from quality to price; most of the top competitors have roughly equivalent quality, and so cost is the new driver of competitiveness. Several managers expressed doubt and concern about whether TQM would be able to provide the same dividends in the area of cost that it had in quality. Also, the cost-cutting drive may result in layoffs that would weaken the support for TQM among the employees. However, senior managers seemed to be more optimistic about the future than specialists and supervisors, perhaps because their jobs are more secure.

One thing that works in AT&T's favor is that the quality system is firmly ingrained; the same employees who said that interest in TQM was declining said that, nonetheless, belief in and adherence to the current standards is very strong. The Chairman's Quality Award, an annual company-wide award patterned after the Baldrige, serves as a "post-Baldrige" goal. A permanent Business Improvement Team has been set up to receive feedback and plan corrective actions. Management focus on quality continues to be strong, although cost reduction and the Workplace of the Future are taking some of their attention now. In addition, people who participated in quality are sought after both within and outside the company, so it is possible that other people may see quality as a way to advance their careers. Perhaps most importantly, the factory continues to undergo regular ISO 9001 audits to maintain their certification, which provides a regular incentive to measure and maintain quality.

One senior corporate quality official pointed out that the measurements are now so highly developed that they are as structured and precise as the financial measures. The CFO actually reports the quality metrics in the same report as the financial numbers. By making quality as easily measured as financial results, AT&T has managed to institutionalize it. This makes it less likely that quality will be dropped. Instead, the current standards will probably be retained, with less improvement than in the past. One of the factory quality staff told me that defect rate improvement has indeed slowed, but that the Quality Improvement Team concept is applicable to more than just defect reduction. They are using teams now to reduce costs not connected with quality, as well as
to address other issues, such as order processing, customer service, robust design, and administration.

One area of concern is employee satisfaction. In 1994, after several years of improvement, employee assessments in all areas except job security and competitive position declined, often to 1991 levels. Whereas in 1993 61% of employees responded favorably to questions on management leadership, only 45% did so in 1994. The assessment of teamwork actually dropped below its 1991 level of 64%, with only 55% of employees rating it favorably in 1994. Only 42% rated the level of respect in the factory favorably, and only 43% liked the level of recognition they received. These results appear to corroborate the somewhat negative impressions I received of management from the employees about the supervisors. While commitment to TQM appeared strong, the employees sent a clear signal that they felt the ideals of TQM were not being satisfied in all cases. Having tasted empowerment through the quality improvement teams, it is possible that the workers have higher expectations than before. Also, as the rate of improvement deteriorates, there are fewer award ceremonies, and those that do occur are less noteworthy than when they were new. There appears to be a restlessness in the factory, an impatience to get on with the next great crusade. If the Merrimack Valley Works and AT&T can harness the energy and ambition of its employees, further progress may yet be forthcoming. If not, the result may be disappointment.

Future Research Directions
This study has raised more questions than it has answered. It is difficult to see the future of TQM at the Merrimack Valley Works; will it continue to be sustained as it has been for the past three years, or will a change in management or rising employee dissatisfaction lead to its decline? Has TQM led to increased profitability, or is its only benefit improved product quality? Can the lessons learned at the Merrimack Valley Works be transferred to other divisions within AT&T, or are they too dependent on the individual managers and employees who discovered them?

In the time available, I was not able to interview engineers, sales and marketing staff, financial analysts, and corporate managers. No doubt these people would have added different perspectives to the story. Customers themselves were also not included; nor were past managers and laid off employees. Opponents of the TQM program must exist, but I did not meet them during my interviews. As a result, what is included here is only part of the story. Future research should examine the information and participants who were left out.
In addition, a complete comparison with Analog Devices, Inc. would have to include equivalent financial data, including sales revenue, cost of goods sold, and indirect costs. Without this information, it is impossible to know for sure whether the factory increased profitability as a result of TQM, stayed where it was, or even lost money. As we have noted, the factory's financial performance has been obscured through its inclusion in higher-level financial results. Future research should clarify financial outcomes.

Once the management simulation game is complete, it will be interesting to see how well it matches reality. I have suggested here some of the external factors that can influence the success of TQM efforts, but it was not possible to determine whether they were necessary for the success of TQM. A comprehensive system dynamics model should allow for such tests.

In the end, it appears that the greatest motivation is belief in the goal. Whether through example, evidence, or simple persuasion, the leaders of the Merrimack Valley Works were able to instill that belief in their people.
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Appendices
Appendix A: Standard Interview Questions

PRELIMINARY DATA:

Name of Interviewer, Name of Narrator, Location of Interview, and Date.

INTRODUCTION: One of the things we are trying to understand is how TQM got started at AT&T. Who originated the ideas? How did people get involved? What were their roles? For this reason, we would like to start by asking a few questions about your background and role in the company.

How did you come to work at AT&T?
What were your initial responsibilities?
How did you become involved with the TQM program?
What were your prior experiences with TQM?
What is your current role at the Merrimack Valley Works?

Please tell us, as you saw it, the story of how TQM was instituted at the Merrimack Valley Works.

How did TQM get started at AT&T?
At which level of the organization did it originate?
When was this?

Why did you decide to initiate TQM?

Were there any doubts about whether a TQM effort should be started? What were they?

Who was most responsible for championing TQM within AT&T?
Within the Merrimack Valley Works?

Was anyone or any group particularly opposed to TQM?
Why do you think that was?

Were outsiders involved?
Who were they?

Were suppliers involved?
Which ones?
How were they involved?

What effect, if any, did the government or politics have on your efforts?

How did the economy affect your efforts in TQM?

What internal groups were involved?
(Possibly: Product Development, Engineering, Manufacturing, Sales, Administration, Finance, Quality Assurance, Quality Control, Headquarters)
Were there any books or people that were particularly influential?

How did you define the goals of TQM?

What process did you use to gain people's support?

What kinds of training materials did you use?

What was the first application of TQM at the Merrimack Valley Works?
Who was involved?
What was your involvement?
How did it go?
Can you describe how the process changed as a result of TQM?
Were there any unintended consequences?
How did you measure success?
Did this project turn out to be typical?
How was it different?

Please describe any other projects that you believe were particularly significant.
(Use the same questions as above)

At what point did you decide to go for the Baldrige Award?
What was the application process like?
How were you involved?

Can you tell us the greatest success you experienced in TQM?
How about the greatest disappointment?

As you gained experience with TQM, how did your perspective change?
Did you gain any new insights as a result of this experience?

What is your current view of TQM and its usefulness?

What advice would you give another company considering TQM?