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TOTAL QUALITY MANAGEMENT
AND APPLICATIONS TO THE CONSTRUCTION
INDUSTRY

BY

JEFFREY M. SALTER

A REPORT PRESENTED TO THE GRADUATE COMMITTEE
OF THE DEPARTMENT OF CIVIL ENGINEERING IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR THE DEGREE OF MASTER OF ENGINEERING

UNIVERSITY OF FLORIDA

SUMMER 1993

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TABLE OF CONTENTS

Chapter One	Introduction	1
Chapter Two	History	5
Chapter Three	What is Total Quality Management?	10
Chapter Four	Important Points of Quality Management	14
4.1	Create Constancy of Purpose for Improvement of Product and Service	14
4.2	Adopt the New Philosophy	16
4.3	Cease Dependence on Mass Inspection ...	18
4.4	End the Practice of Awarding Business on Price Tag Alone	20
4.5	Improve Constantly and Forever the System of Production and Service	23
4.6	Institute Training, Retraining and Education	25
4.7	Institute Leadership	28
4.8	Drive out Fear	29
4.9	Break Down Barriers Between Staff Areas	31
4.10	Eliminate Slogans, Exhortations, Targets for the Workforce, and Numerical Quotas	33
4.11	Remove Barriers to Pride of Workmanship	35
4.12	Take Action to Accomplish the Transformation	37
Chapter Five	Deadly Diseases and Other Obstacles to Total Quality Management ...	39
5.1	Lack of Constancy of Purpose	39
5.2	Emphasis on Short Term Profits	40
5.3	Evaluation of Performance, Merit Rating, or Annual Review	41
5.4	Mobility to Top Management	43
5.5	Running a Company on Visible Figures Alone - Counting the Money	44

5.6	Excessive Medical Costs and Excessive Costs of Warranty, Fueled by Lawyers That Work on a Contingency	45
5.7	Other Obstacles to Total Quality Management	46
Chapter Six	Safety Management is Vital to Total Quality Management Success	47
Chapter Seven	The Role of Data	60
Chapter Eight	Total Quality Management Today and Tomorrow	62
Chapter Nine	Conclusion - Total Quality Management Implementation Recommendations	69
Bibliography		71
Appendix A	Eternally Successful Organization Grid	74
Appendix B	How Ritz-Carlton Won the Baldrige Award	75
Appendix C	Shewhart Cycle	78
Appendix D	Selected Charts and Diagrams Demonstrating How Data Transformed By Statistics Can be Used	79

CHAPTER ONE

INTRODUCTION

The theory of total quality management is not a new phenomenon. Total quality management was first officially introduced in the 1940's and has continued to change and improve through the years. Even though this concept has not yet been fully accepted by businesses in the United States, the acceptance and implementation of total quality management programs is increasing. The single greatest obstacle for total acceptance seems to be based on the fact that business managers in the United States are more interested in short term results and profits than in steady, long term growth and improvement. This mindset requires that chief executive officers and top management improve the bottom line rapidly. Usually these results are only temporary and after the initial results begin to taper off, top management personnel move on to a new company. This trend produces negative side effects such as loss of company loyalty and decrease in company knowledge.

As the development and evolution of total quality management is examined, perhaps the realization that only the occurrence of an economic disaster will cause America's corporate giants to open their eyes and apply the basic rules of total quality management. In May 1993, the trade deficit was 10.5 billion dollars, with approximately one-

half attributable to the Japanese. Obviously, the principles taught to the Japanese people forty years ago by Dr. W. Edwards Deming are still awaiting endorsement by American businesses today.

For some unknown reason, American companies became locked into a specific format and this tendency keeps them from looking toward the future. Managers believe their company's future will always be in one particular area, producing one specific product. After all, if it is a good product, people will always want it. Not so. Just ask the steel giants of the 1970's. Steel executives believed that foreign countries could never import steel to the United States because it would be too costly. As a result, the steel magnates used capital to pay stockholder dividends rather than reinvest in their companies by improving their processes or by purchasing additional plant equipment. Japan, taking advantage of poor planning on the part of American steel magnates, was able to gain a stronghold in the United States steel industry. People are mortal and will eventually wear out. However, businesses with proper management can always adapt, change and remain successful. Philip Crosby sets up some basic guidelines:

A company that is going to be eternally successful will have these easily identifiable characteristics:

- People do things right routinely.
- Growth is profitable and steady.
- Customer needs are anticipated.

- Change is planned and managed.
- People are proud to work there.¹

For a company to succeed it must always apply the principles of Total Quality Management. Companies begin to realize that the true test of quality is whether or not it has met the customer's needs. Even the American Society for Testing and Materials (ASTM) has recognized this fact. The Society publishes a manual that is used as a guide for consumer sensory evaluation:

The Manual on Consumer Sensory Evaluation concerns itself with testing certain products using those untrained people who will become the ultimate users. These products can be evaluated on the basis² of taste, smell, touch, hearing or visual differences.

Crosby suggests using a grid to determine a company's progress toward becoming eternally successful. The "Eternally Successful Organization Grid" (see Appendix A) is an overview that allows any company to measure itself at any point in time on items such as quality, growth, customers, change and employees.

Total quality management seems to have its roots based on Dr. W. Edward Deming's fourteen points of management. These points, along with other principles of Dr. Deming's, will be examined. Specifically, their application to the construction industry will be explored. The seven deadly

¹Philip B. Crosby, The Eternally Successful Organization (New York: McGraw-Hill, 1988) 16.

²E. E. Schaefer, ed., ASTM Manual on Consumer Sensory Evaluation (Philadelphia: American Society for Testing and Materials, 1979) 1.

diseases and other obstacles which describe reasons why total quality management could fail will be discussed in some detail. Safety management is vital to an organization's success and will also be examined in detail, as will the role of data and statistical methods. Deming's fourteen points of management seem to be the most widely used and accepted when dealing with total quality management. However, for the sake of comparison and reference, Crosby's fourteen steps of quality are as follows: management commitment; quality improvement team; measurement; cost of quality; quality awareness; corrective action; ZD (zero defects) planning; employee education; ZD Day; goal setting; error-cause removal; recognition; quality councils; and, do-it-over-again. Finally, where total quality management is today and where it will be tomorrow will be discussed. Further, one possible plan for implementing total quality management in construction will be presented.

CHAPTER TWO

HISTORY

The concept of total quality management was originated by Dr. W. Edward Deming in the 1940's. Dr. Deming was a graduate of physics from Yale University, but became a statistician by trade. After graduating from Yale, Dr. Deming worked at the Department of Agriculture and for the Department of Commerce. His first application of statistical techniques was in developing a plan for the 1940 census. Prior to 1940, the census process involved an attempt to poll everyone in the United States. It was only through Dr. Deming's random sampling technique that the old, laborious, time-consuming method was changed. It was after this that Dr. Deming received some short-lived notoriety for his use of statistical methods which he had learned from Walter A. Shewhart, a statistician for Bell Telephone Laboratories. Dr. Deming was requested by W. Allen Wallis, a professor at Stanford University (later to become Undersecretary of State), to teach his methods to companies and individuals involved in manufacturing for the war effort.

In July 1941, Dr. Deming taught the first ten day course in statistical methods with the aid of Ralph Wareham of General Electric and Charles Mummery of Hoover Corporation. Wareham had studied statistical

theory at the University of Iowa; Mummery was self-taught in the Shewhart methods."³

This initial effort resulted in 31,000 students across the country being taught these statistical methods. The American Society For Quality Control was initiated in 1946, with Dr. Deming serving as one of its initial members.

Dr. Deming left the census bureau in 1946 and started his own business as a statistical consultant. From 1946 to 1975, he was also a professor in graduate business school at New York University. His first contact with the Japanese was in 1951 after World War II had subsided. His initial purpose for visiting Japan was to help with the planning of a national census. It should be noted that after the war, American industry was unscathed, unlike European countries and Japan, which had their industries obliterated. Because American industry had geared up for the war, they were more than ready to be major suppliers of manufactured goods. With production running at an all time high and with little competition on the global market, corporate managers could literally do no wrong. There was a high demand to produce high quantities because of the attitude that the consumer would buy anything produced. This situation resulted in Dr. Deming's statistical quality control methods being shelved. Another reason Dr. Deming's methods were not put to use was because all of his previous efforts had been directed toward

³Mary Walton, The Deming Management Method (New York: Putnam, 1986) 8.

teaching the technical people formulas and methods and not toward management personnel who set policies and procedures and provided for their implementation. Whatever the reason for the shelving of Dr. Deming's methods, the United States began a joy ride which would last for almost forty years.

After helping with the Japanese census of 1951, Dr. Deming lived and worked with the Japanese people off and on for thirty years. He was successful in Japan for several reasons. First, he lived in Japan long enough to learn about its language, people and culture. This later afforded him opportunities unavailable to any other American at that time. It was only by learning the culture that Dr. Deming was able to devise the best way to have his methods integrated into Japanese businesses. Second, Dr. Deming was able to seize the window of opportunity. After World War II, the Japanese industrial base was nonexistent. In other words, they were starting from scratch, which made them more open to ideas which would help put them on the road to recovery. The Japanese were a hard-working, patient people and were willing to try new ideas that fit perfectly into Dr. Deming's theory of total quality management. Japan was on its way to becoming the most respected quality manufacturer in the world. Third, Dr. Deming was able to reach the Japanese' top management with his principles. On several occasions, he met with top executives from Japan's

twenty-one leading businesses. By doing this he was able to have his methods accepted and implemented from the top down and not from the bottom up as he had once tried in the United States. Additionally, the Japanese were more interested in long term growth than the annual report to stockholders which emphasized the bottom line. Dr. Deming also learned that the Japanese were very loyal people. This became very obvious to the American military that witnessed the destruction of pearl harbor and the Kamikaze pilots that were willing to give up their life because of their loyalty to Japan. This same loyalty was used in all facets of their lives. Unlike corporate takeovers and leveraged buy-outs in the United States, Japanese firms mutually agreed to mergers before they took place, with either company being able to say no.

How and why was Dr. Deming finally discovered in America? It was in 1980, at which time Dr. Deming was 80 years old. The Carter administration had left America with double digit inflation running rampant and economic disaster appearing imminent. People began to ask questions as to why the Japanese were doing so much better in the world markets than the United States. With the yen so strong against the dollar, people wondered how a country like Japan, whose name was once synonymous with junk ("Made in Japan"), could now be setting the global standard for quality. A television documentary was produced on June 24, 1980 entitled "If Japan

Can...Why can't we?" This documentary attempted to discover how "good old American ingenuity" had become lost. The Nashua Company of America was examined because of its Japanese origin. It was found that it applied Dr. W. Edward Deming's principles of total quality management. As to why Nashua was doing so well in the United States, Dr. deming replied "If you get gains in productivity only because people work smarter not harder, that is total profit, and it multiplies several times".⁴ In the documentary, Dr. Deming was able to briefly describe his methods (15 minutes actual interview time). He further used the interview as an opportunity to chastise American industry for its ineptness. After the documentary aired, Dr. Deming's popularity and requests for his services blossomed overnight.

⁴Walton 17.

CHAPTER THREE

WHAT IS TOTAL QUALITY MANAGEMENT?

Total quality management, an effective business technique predominately used in Japan, is rapidly evolving in American business and industry. This concept consists of:

... an integrated process involving both management and employees with the ultimate goal of managing the design, development, production, transfer and use of the various types of products and services, in both the environment and marketplace.⁵

This approach to business strategy involves employees at every level, from the Chief Executive Officer to the blue collar worker who performs custodial duties. To have successful total quality management, the products and services must consist of both quality assurance and quality control. Quality assurance must be differentiated from quality control or inspection, for "although a quality assurance program will include quality control and inspection, both these activities form only a part of a company's total commitment to quality."⁶

⁵Johnson Aimie Edosomwan, Integrating Productivity and Quality Management (New York: Marcel Dekker, Inc., 1987) 9.

⁶Lionel Stebbing, Quality Assurance: The Route to Efficiency and Competitiveness, 2nd ed. (Chichester: Ellis Horwood Limited, 1989) 3.

Quality assurance sets the standard that products and services must meet. The quality assurance function should be based on the customer's needs, not on the desires of suppliers or designers. These standards need to go further than just the basic contract specifications and documents. In doing so, "it is important to understand all of the customer's standards, both those in the contract documents and those more difficult to determine."⁷ After determining the customer's needs and assuring that the products and services can meet those needs, a quality control program can be established which will complete the total quality management strategy. Quality assurance is not stagnant, but must be a continual process that improves, changes, and seeks to satisfy an ever-changing, volatile and competitive market.

A good quality control program guarantees that the products and services will conform to the specifications set forth in product definition. Some of the different parameters controlled in this process are size, type of material used, manufacturing tolerances and reliability. Quality of conformance is defined as "a measure of how well the product conforms to the specifications and tolerances required by the design."⁸ Every member of the quality

⁷Robert D. Martin, "Follow a Simple Strategy: Exceed Customer Expectations," Florida Constructor Jul./Aug. 1992: 1.

⁸Edosomwan 9.

control program must act as supplier, producer and customer. Each employee must supply and produce a product that meets the next employee's need. The employee must also act as a customer upon receipt of the product and determine if the product meets his or her own specific requirements. A good quality control program will seek to deliver goods and services that are correct the first time.

The total quality management process must consist of both quality assurance and quality control to insure a marketable, competitive product for today's demanding customer. This management strategy must involve innovation, continual adaptation and risk taking. In order to minimize risks involved, training of quality management must be provided at every level of the organization. Programs often fail "due to lack of understanding or commitment."⁹ Quality management is moving to the forefront of American business and should make industries more competitive, both in the United States and in the international market. More and more companies are realizing that with proper implementation of the total quality management process, production will increase and costs will decrease. Even with an average three to five year implementation period, companies are realizing that quality assurance plus quality control equals total quality management and this equation is well worth the overall investment. The object of Total

⁹Martin 1-2.

Quality Management is best described by John J. Hudiburg, CEO of Florida Power and Light CO.:

The object of total quality management is simple: to establish a management system and corporate culture that will assure higher customer satisfaction than your competitors".¹⁰

The best way to examine total quality management is to understand and examine the application of Dr. Deming's fourteen points of management. These fourteen points were especially written for American Industry, although with small variations can be applied world wide. Several of the points were never used in Japan, because they were not necessary and did not apply to their specific way of doing business.

¹⁰John J. Hudiburg, "The CEO's Role in Implementing Total Quality Management." Alster, Judith and Holly Gallo, eds. Leadership and Empowerment for Total Quality. Symposium sponsored by KPMG Peat Marwick (New York: The Conference Board, 1992) 21.

CHAPTER FOUR
IMPORTANT POINTS OF QUALITY MANAGEMENT

4.1 Create Constancy of Purpose for Improvement of Product and Service

Most businesses are set up with their primary purpose being that of making money or, at least, to achieve a reasonable profit. Constancy of purpose is the notion that everyone is on board for the purpose of staying in business, being innovative, and investing in research and development. Most businesses are so preoccupied with today that they are unable to envision tomorrow. The most obvious example of this is the recent demise of the computer giant IBM. At one time, IBM stock was worth \$175.00 per share. It has now dropped to about \$46.00 per share. One of the reasons given for this downfall was a lack of constancy of purpose. IBM did everything it perceived necessary in order to maintain its bottom line and, thus, achieved "good management". Unfortunately, when the computer giant awoke the next day, IBM found itself laying off thousands of people and closing facilities worldwide. "It is easy to stay bound up in the tangled knots of the problems of today, becoming ever more efficient in them."¹¹

¹¹Walton 55.

Companies must continually improve and seek innovations. I worked for a manufacturing firm that saw its doors closed in the early 1980's. The first department to suffer large budget cuts and personnel layoffs was research and development. It was obvious that from that point on it was only a matter of time before the company would close its doors entirely. The company had literally cut its own throat by eliminating its ability to be innovative. Innovation does not require the design of a completely new product, idea or service. Innovation does require the manufacturer to be able to step back and examine its current offerings, compare those capabilities to the current or future demands of the customer, and make adjustments to meet those demands. After all, the true test of quality is by the end-user or consumer. Dr. Deming states that the company must have a plan to be innovative and every plan should answer the following questions:

- What materials will be required, at what cost?
- What will be the method of production?
- What new people will have to be hired?
- What changes in equipment will be required?
- What new skills will be required, and for how many people?
- How will current employees be trained in these new areas?
- How will supervisors be trained?
- What will be the cost of production?
- What will be the cost of marketing? What will be the cost and methods of service?

- How will the product or service be used by the customer?
- How will the company know if the customer is satisfied?¹²

For a contractor all of these questions should be answered and independently addressed in the context of every new contract. If these questions are not answered in the pre-planning stages for a job, then constancy of purpose will not be maintained. Each area covered by these questions involves different individuals throughout a contractors' organization. For example, it is impossible for an estimator to know the cost of production without first talking with the crews and determining their actual method of construction. All too often an estimator will assume a certain method when preparing a bid, which forces the field personnel to tackle the problem of how to construct the job and still achieve the same profit based on the estimator's calculations. In order for companies to achieve constancy of purpose they must be willing to expend resources in research and education. Companies should seek continuous improvement of products and services and invest in new aids to production, both in the field and in the office.

4.2 Adopt the New Philosophy

This new philosophy must begin with management. Moreover, it may have to start with major stockholders. In order for large companies to implement a new philosophy,

¹²Walton 56.

stockholders (owners) must be willing to allow the time for a transformation to take place. Only then will managers become loyal and adopt "quality" as the new buzzword instead of "profit". Obviously profit is necessary for success, but quality must be considered first if companies expect to keep their doors open and to compete effectively. American companies have focused on bottom line results for too long and have neglected the total quality management process.

This new approach to management must be applied to the construction industry as well.

Total quality management is becoming a contract requirement within the construction industry. The nation's awareness of quality will be reinforced by the annual presentation of the Malcolm Baldrige Award for Quality. Most of Fortune 500 firms are pursuing this award. As a result, they are requiring their suppliers, which include contractors, to implement their own total quality management process.¹³

The Ritz-Carlton Hotel Company, a 1992 Malcolm Baldrige Award winner, already categorizes its suppliers based on their implementation of total quality management. They currently award services and contracts based on quality and not merely price. Service and contract companies must be able to continually improve right along with Ritz-Carlton or they will be seen as a barrier to the continued success of Ritz-Carlton.

¹³Lou Bainbridge and Bill Abberger, "Partnering - A Progress Report," The FMI Management Letter August 1992: 2.

4.3 Cease Dependence on Mass Inspection

The inspection system currently in place for American industries is set up in such a way that the costs of implementation far outweigh the system's worth. As products are inspected at different points along the production line and at the end of the line, a defective part or product may be discovered. At this point in time the defective item must either be scrapped, reworked or turned into something else. Each of these alternatives are costly. Typically the final cost for the end product is two to three times the original price for that product. This process inevitably slows down productivity.

Inspection with the aim of finding the bad ones and throwing them out is too late, ineffective, costly, says Dr. Deming. In the first place, you can't find the bad ones, not all of them. Second, it cost too much.¹⁴

Inspection will always be necessary, but not to ensure quality. Inspection should be used to gather information. If quality is already built into the process, then inspection is only one tool that is part of the process. As inspectors gather information, the data acquired is used to define, analyze and redefine upper and lower control limits. Statistics derived from this data can also be used to assist in setting quality goals. Inspection is also necessary for gathering information when a new process has been implemented or a new piece of equipment or technology has

¹⁴Walton 60.

been introduced. Further, inspection for quality should be used when attempting to ascertain a suppliers' initial quality or for comparing potential product suppliers.

Using specifications to determine or measure quality is not the answer either.

This practice implies that anything inside the specifications may be all right, while something just outside is all wrong. It was, he says, Dr. G. Taguchi who won the Deming prize in 1960 who saw the absurdity of such suppositions and proposed an important improvement of principle.¹⁵

The principle simply stated is that as variance is decreased, cost decreases.

Is this applicable and true for the construction process? In government and private contracting, quality by inspection will probably always be necessary. Because of the nature of construction, no two projects are the same, jobs have different quality requirements, different crews and customers, and hardly anything ever remains exactly the same from one project to another. However, recently more private companies and some government agencies have started to replace some of their testing specifications. The approach now being attempted is to use statistical acceptance procedures in lieu of the old pass/fail type of specification. This approach could be the wave of the future. Old methods are not only unfair and costly, but involved human judgement and opinions. However, this new

¹⁵Walton 61.

technique will take years to implement. The government bureaucracy still inhibits progress more so than private industry:

Red tape includes delay, buck-passing, pigeon holing, indecision and other phenomena which contribute to an end result of inaction. Red tape is of course a popular phrase for a series of diseases which arise from identifiable and curable specimens of management germs. As we analyze these diseases we see that they are present in industry as well. But the antibodies of industry today keep the degree of infection down to a more reasonable level.¹⁶

Companies need to concern themselves with all aspects of quality: performance; ease of use; delivery time; dependability; consistency; serviceability; life expectancy; aesthetics; and, perception.

4.4 End the Practice of Awarding Business on Price Tag Alone

Every company that produces a product supplies it to someone else. If the supplier of the raw material produces inferior quality, then the end product (having gone through other phases of production) will only be as good as the original raw material would allow. Companies should seek to establish suppliers that can be counted on for quality. After the suppliers have attained the level of quality that meets a company's needs, then a certain loyalty should be established to do business with those suppliers. In the past, companies have mainly used the supply source that

¹⁶J. M. Juran, Bureaucracy: A Challenge to Better Management (New York: Harper, 1944) 38.

could meet the minimum specification at the lowest price. The suppliers with the lowest price more often than not produce inferior products that are unreliable. Often these suppliers go out of business before the warranty on their products expires.

In construction, this point applies to the way the United States Government awards most contracts. Current federal laws and regulations dictate that government agencies must award construction contracts to the lowest, responsive, responsible bidder. This translates into approximately 90% of government contracts being awarded to the contractor with the lowest price. In most cases these are the companies that must cut corners to ensure a profit, resulting in reduction in quantity and/or quality. Typically this could involve means, methods, materials or workmanship. Another problem inherent with this type of government contracting is the "small business set-aside". The current laws and regulations force agencies to award a large percentage of contracts to small businesses. In my experience, the firms that are most able to provide good quality construction are the big business construction firms. They have the resources, continuity and experience to deliver a quality product. In order for the United States Government to receive better construction these problems must be resolved. Obviously, resolution could be achieved through the policy-making and legislative process,

but the "red tape" of the government seems to be unaffected by total quality management at this point.

Currently there are more construction firms and resources than there are jobs available for award. Because of this, the industry will see a consolidation of firms in the 1990's with fewer, but larger firms remaining. This consolidation should be good for the industry.

This will cause the overall competition to improve. Those companies that are marginal in their ability to process work and manage their firms will become casualties. We see this consolidation as being positive for the companies that survive. One of the problems facing the industry today, as it has for the last 10 or 15 years, is an over-abundance of contractors relative to the availability of work. This consolidation will result in enhanced profits for its survivors.¹⁷

The government must seek ways to enhance and improve quality with the low bidders it currently does business with. Several new methods such as "partnering" and "statistical acceptance theory" are currently being tested, but the jury is still out as to their success and acceptance. Other ideas, such as contracting by negotiation and selecting of pre-qualified bidder's list, have had some success in specific contracting fields. Construction contracting should be done in a similar fashion to the way the United States Government awards design contracts. Firms must first pre-qualify based on certain criteria, with price being only one such element. Technical expertise, company

¹⁷"Trends in Construction for 1992 and Beyond," The Contractors Management Journal (August 1992) 2.

and personnel qualifications, and experience are also considered for contract award. Regardless of the eventual outcome, it takes years, even decades, to fully implement new ways of doing business with the United States Government.

4.5 Improve Constantly and Forever the System of Production and Service

This appears to be different from the age-old adage "if it ain't broke don't fix it". Just think where society would be today if it were still satisfied with the first model "T" that rolled off the production floor, the first refrigerator that was cooled with a block of ice, or communications without the use of satellite technology. This improvement to products or services must start at the design stage and continue through the entire process. The process must include all the essential players. The suppliers, producers, designers, quality personnel, owners, management, and the consumer or ultimate user. Sometimes these people are called stakeholders and need to be empowered to contribute to the organization's survival and prosperity. Michael E. Gerber breaks the participants into four groups: customers; suppliers; employees; and lenders. "To succeed, every business must learn to satisfy the essential needs, unconscious expectations, and perceived preferences of these groups in its universe."¹⁸ To survive

¹⁸M. E. Gerber, The Power Point (New York: Harper, 1991) 47.

and excel in the future, organizations need to concentrate on two interrelated issues: meeting the stakeholders' needs, and building a learning organization. Every step in the business process must be continually improving. This strive for continuous improvement must be initiated by management. Improving the process does not mean temporarily putting out a fire. "Finding a point of control, finding the special cause and removing it, is only putting the process back to where it was in the first place."¹⁹

On a construction job, a slump test is taken and the slump is too low. Someone grabs the hose and begins to add water to solve the problem. The problem may be temporarily solved, but neither the concrete nor the process is improved. This is not an improvement in quality, it is putting out a fire. It is very important that all individuals are empowered to make decisions and suggestions to continually improve the process and products. Management must be willing to take this risk. No one knows more about their job than the individual performing that job. If a concrete finisher thinks of an idea that will improve concrete finishing and provides a better quality product, then this idea should be considered and reviewed. Without empowerment, idea wills never surface.

¹⁹Walton 67.

4.6 Institute Training, Retraining and Education

Everyone in a company should participate in continuing education and training. From the Chief Executive Officer to the janitorial workers, each individual should be offered the opportunity and be encouraged to further their education. The more knowledge people have, the more knowledge the company has. For construction, the point of training and retraining is well taken. All too often in construction, workers have learned from other workers. On any job site, it is difficult to find anyone who did not learn their trade from someone else, who in turn learned it from someone else. There are apprenticeship programs used by both union and non-union contractors. The problem that arises is when a worker incorrectly learns his trade. Once a person has been incorrectly trained, it is very difficult to retrain that worker. All too often the situation arises where "you can't teach an old dog new tricks". Statistical control charts can be used to monitor and analyze performance of workers. As long as a worker's performance is not in statistical control, then training should continue. There will always be good workers and bad workers. However, knowing their upper and lower control limits will allow managers to better know if something has gone wrong with the system. Further, every time a new piece of equipment, method, or technology is introduced, training and retraining should take place. Individuals should also

be trained in total quality management concepts as well as the basics in statistical methods. How do we see that workers get the proper training that they need? First, the company must commit resources for that purpose and realize that not only is it going to cost money, but it will require employees to spend time away from work. The Ritz-Carlton Hotel Company, a 1992 Baldrige Award winner (see Appendix B), requires its employees to receive 126 hours of training annually. In the construction industry; contractors, engineering societies, designers, universities, federal, state and local governments all must be willing to take an active role and expend resources of both time and money to promote and upgrade vocational-technical schools. Trade training for the non-college worker must be revitalized. In a recent study it was found that the average unemployment in four major college cities was 4%²⁰. This was mostly attributed to high school graduates not planning on attending college. Not once in the entire article did it mention vocational training as a possible solution. Studies have also shown that a high percentage of crimes are attributed to unemployed high school graduates. With the military scaling back, options are very limited for a high school graduate with no training. Currently, the Association of General Contractors and others are providing

²⁰Lillian Guevara-Castro, "Tale of Four Cities," The Gainesville Sun 20 June 1993: A1.

some help in training, but will need a great deal of help to thwart the inner-city unemployment that plagues America's cities. One major benefit to training is that studies have shown it reduces employee turnover. The Ritz-Carlton boasts a turnover rate of 48% compared to the industry wide standard of 100%. "Training expenditures will be viewed as an ongoing investment of safety, quality and productivity."²¹ Supervisory management training reduced employee turnover in construction industry by 35% (see Figure 1).

Figure 1

By what percentage does supervisory management training reduce employee turnover?

						Total
General	32.80	Under \$30M	39.33	Union	41.84	34.90
Heavy	36.43	\$30-\$74.9M	32.11	Non-Union	24.67	34.90
Sub/Spec.	39.23	\$75-\$199.9M	37.75	Both	30.00	35.15
		\$200M or More	33.00			

Source: Survey of Supervisory Training in the U.S. Construction Industry

Figure 1 - Percentage by which supervisory management training reduces employee turnover.

²¹The Contractors Management Journal 7.

4.7 Institute Leadership

Install the new way of management by utilizing continual quality improvement, principle centered leadership, and use of statistical process control. Management must learn how to motivate workers. Management must also learn how to instill pride amongst the workers, and when a product has been completed or service provided each worker should be proud of his or her accomplishments. It is the job of the manager to do everything possible to help a worker do his job correctly. The problem with most managers today is they do not know or do not understand what the workers' job is. Managers that come straight out of college are book smart, but are not street smart. Programs could be set up to get management out on the floor or on the job and learn about what workers actually do. At the Ritz-Carlton Hotels managers are required to spend 25% of their time on quality management. They actually dedicate time to spend in the hotels interviewing and talking to customers and employees. Programs must be set up to allow workers to progress into management, which can be accomplished through company education and training programs. This could mean that a company sponsor and pay for a workers' college education.

In construction, management does a good job at promoting crew workers to field supervision jobs. Most superintendents, general foremen and foremen were promoted

from the field. Because of this, many field level supervisors know the jobs of the workers quite well, but often lack management and motivational skills. Likewise, many small, independent contractors are owned by tradesmen that have no formal schooling. Companies need to expend more resources to promote and educate from within, which will result in more long term employees. The Department of Defense has a very good program for this. The enlisted commissioning program affords the college opportunity for its best enlisted personnel. These future officers have the advantage of formal schooling and on-hands experience. Generally, these officers are given more immediate respect from their subordinates because of their experience and not merely because of rank.

4.8 Drive out Fear

"Driving out fear" was invented by Dr. Deming especially for American companies. Because of their approach to business, the Japanese did not need to learn this management principle. The Japanese encourage people to ask questions, solve problems and take risks. The American mentality encompasses the fear that one might ask a stupid question and be embarrassed, cause a problem, or even start an argument. If a worker attempts something risky, the worker will not be rewarded, but punished. This fear has been entrenched in American industry for decades and will be difficult to overcome. Workers fear retribution by way of

job loss, reassignment, discrimination, and sometimes harassment.

It is necessary, Dr. Deming says, for better quality and productivity, that people feel secure. He notes that *se* comes from Latin meaning 'without,' *cure* means 'fear' or 'care.' *Secure* means 'without fear,'--'not afraid to express ideas, not afraid to ask questions'.²²

For construction, perhaps driving out fear is not a major problem. Because of its nature, most projects or jobs are temporary and workers are also temporary. However, it is still important that workers know that if they identify a material or process that is lowering quality, then, without fear, they can bring it forward. Workers should not have to worry about the project getting behind schedule or how the bottom line will be affected. Sadly enough, in construction it is too easy for a worker to just overlook poor quality because he knows that job will be over soon and he will be moving on. This happens in the United States Naval Construction Forces (Seabees), typically a detachment will deploy to a job site for six to nine months and receive "turnover" information about all of the ongoing construction. This turnover period usually lasts one to two weeks. Some workers in a battalion know that if they made a mistake it probably will not be found until they are long gone. Schedules, rather than quality, are stressed. Thus, if a worker discovers a mistake or identifies an item that

²²Walton 72.

is lowering quality, that worker may look the other way if the established priority is to stay on schedule. Another problem in construction is the fact that sometimes the subcontractors are not included in quality planning, and subsequently do not adhere to any plan promulgated. To avoid liens and other problems, subcontractors will not ask important questions and instead go with the status quo. They usually believe in minding their own business, even if they see a way to improve quality outside their portion of work. If risks are taken, they fear possible loss of their contract, legal recourse and future loss of business. Companies must do away with the old style of management by results: quotas; personnel evaluations; quality by inspection; evaluate results; and, motivation by fear and intimidation. The most important and perhaps most difficult disease to overcome will be the psychological fear that has been inbred in American workers for too long.

4.9 Break Down Barriers Between Staff Areas

Management must create a system that tears down the inter-rivalries between departments. Teamwork, not just in a department, but throughout the entire company must be promoted and instituted. When it comes down to making a decision between what is best for the company or the individual, the person must choose for the company every time. This means all departments should be aware that what they purchase, produce or sell affects someone else in the

organization. This is why it is very important that all departments are represented from the onset of the initial design of a product or service. It does no good to produce a perfect quality product for which there is no market. Likewise, it is no better to market a product that a company cannot produce.

When determining whether breaking down these barriers is important and relevant in construction, it is helpful to examine the following possible scenario: A job is released for bid that requires a certain type of gravel to be used to produce architecturally pleasing concrete walkways. The estimating department bids the job as specified. The purchasing department orders a material that will conform to all the necessary specifications, except color (scheduling is tight and color of walkways cannot be that important). The purchasing department informs project management that they need to request a deviation in the specification for the color. Management submits the request and, knowing these approvals normally take a long time, instructs the concrete foreman to use the product upon arrival. The wrong color stone has now been ordered, delivered and is being installed. The change has been sent from contract management (owner's rep) to the owner for his approval. The original owner who participated in the initial design has changed companies. No one else remembers why he wanted that particular color, but he was a smart man and if he had a

reason it must have been a good one. Specification deviation request is disapproved.

From this scenario one could surmise that teamwork in construction is important. All departments should be in on the original design. After a problem arose, the company, along with the owner should have met and tried to work out a team solution. At the very least they could have seen how their product was going to effect the next department. Instead, the problem was just passed on to the next department, with no regard to quality or the needs of the owner.

4.10 Eliminate Slogans, Exhortations, Targets for the Workforce, and Numerical Quotas

When management decides to set targets for its employees, it has virtually ensured poor quality. A person whose performance is measured by numbers will do whatever is necessary to meet his quota. This means the number of inferior products will increase because there is only motivation for the individual to speed up and not slow down. Slogans and exhortations that put additional pressure on workers to complete impossible tasks should be eliminated.

'Zero defects.' 'Do it right the first time.' These have a lofty ring, Dr. Deming says. 'But how could a man make it right the first time when the incoming material is off-gauge, off-color, or otherwise defective, or if his machine is in not good order?',²³

²³Walton 76.

Management must provide the worker with everything he needs to work smarter, thus affording him the opportunity to produce his best if so motivated.

Sometimes slogans are managements' way of actually setting goals for employees and putting them on public display, which creates even more pressure. Usually how that worker will accomplish that particular goal is not even discussed with him. Management should encourage employees to create their own slogans and mottos. This allows the employee to show pride in his work. To improve quality, the worker must improve the process and management must improve the process.

In construction, goals are often set by the home office and handed down to the field offices. The project manager or superintendent communicates these goals to construction crews through bulletin boards, newsletters, or weekly toolbox meetings, if at all. However, these goals are top driven and the work force is not told how to accomplish them. They are told to stay on schedule by working harder and longer. More times than not, if a contractor falls behind schedule, the solution is either to hire more workers or work more hours or both. Typically, the causal delay of the schedule is in the construction process and not in the people. The correct solution should be to analyze the cause and improve the process.

Slogans are found in construction just as in any other industry. Slogans such as "Think Safety" or "Safety First" are meaningless to workers if they have not received proper training, equipment and motivation. With management trying to achieve a goal of no lost time accidents on the job, slogans such as these are fruitless without proper planning. If management has not provided the methods to achieve the goal, then it will most assuredly fail.

4.11 Remove Barriers to Pride of Workmanship

Management needs to first identify all items involved in the process of manufacturing their particular product or providing their particular service. The biggest barrier to pride of workmanship is lack of communication between management and the worker. Management tends to be very good at dealing with numbers and dollars, but when it comes to communicating with workers, they have received very little to no training in this area. This makes them feel very uncomfortable if forced to deal routinely with the work force. Therefore, the easiest answer is avoidance. Once this communication barrier has broken down, the other barriers crumble much more rapidly. The other barriers could be anything in the process; from incoming defective material to improperly maintained equipment. If a worker uses a piece of equipment that is faulty, then it causes him to produce defective products. The worker can have no pride of workmanship while producing defective components and the

end result is that his productivity actually decreases. Further, whatever that worker produces is being supplied to someone else, who now has to work with a defective product and this problem continues to get exponentially worse through the entire process.

In construction, communication is very important because most jobs are built vertically. Also, in vertically constructed facilities, all the components end up comprising one final product. Therefore, it is paramount that quality begin with incoming material that is involved in the initial phase. For example, if quality for soil compaction is not ensured for a large building, then the propagation could be catastrophic. Once, while I was a project manager for two \$13 million warehouses, concrete testing identified defective material in the buildings footers. The 28 day breaks revealed that the concrete was falling well below the required compressive strength specification. Obviously, this was an embarrassing situation for the contractor, concrete crews and concrete supplier. Pride of workmanship was being prevented by some barrier in the process. It was discovered that the problem was in the process at the batch plant. There was a defective piece of equipment at the plant that was causing the problem. This piece of equipment was a barrier to people being able to have pride in their job. The equipment was replaced, the process improved and quality was enhanced.

4.12 Take Action to Accomplish the Transformation

This final point emphasizes that it takes a special effort by everyone to implement all of these points. Training in statistics will have to take place and, perhaps, even the hiring of a temporary statistical consultant. The top management must buy in and completely endorse the program or it will fall flat on its face. All members of the company will have to receive training on the program itself. The best way to implement the program is to utilize the Plan-Do-Check-Act (PDCA) Cycle. In the PDCA Cycle, first a company should plan, which involves identifying the opportunity for improvement, documenting the present process, creating a vision of the improvement effort and defining the scope of the improvement effort. Second, it should "do" or carry out the plan which entails piloting the proposed changes on small scales with customers. Next, with time, study the results by observing what you learned about the improvement of the process. Finally, "act" or adjust the process based on your new knowledge by efficiently utilizing the new mixture of resources and repeating the PDCA steps on the very next opportunity. Originally, this was the Shewhart Cycle (see Appendix C). This plan will continually improve as the cycle is used. The implementation must not only have constancy, but also consistency. If there is not consistency among the employees, "they will tend to go off in different

directions, well-meaning but misguided, diluting their efforts and sometimes working at cross-purposes."²⁴

Mistakes will be made because management will actually be trying something new and different. But because fear has been driven out, this should not cause a problem. Further, everyone works as a team and teamwork should be stressed. Each team should find ways in their part of the process to continually improve all points.

²⁴Walton 88.

CHAPTER FIVE

SEVEN DEADLY DISEASES AND OTHER OBSTACLES TO TOTAL QUALITY MANAGEMENT

Application of total quality management in some businesses has succeeded where in others it has failed. Dr. Deming cites some deadly diseases that can and have caused the program to fail. If companies wish to succeed in implementing total quality management, then continual improvement would include avoidance of the diseases. If a company is not willing to completely shake itself up to establish total quality management, then it probably is not serious about improving quality and productivity. However, if ready to become completely immersed, the long term success is in the company's future. Examination of these deadly diseases warrants a more detailed look. It should be noted that these are not the only reasons for failure, but are the major and most common reasons.

5.1 Lack of Constancy of Purpose

If a company goes out of business after having tried to implement a total quality management program, it probably failed to create a constancy of purpose amongst its employees for quality of products and services. The dedication to the new philosophy must be sincere, obvious and widespread. Employees have seen many faddish programs attempted before. To set this program apart from the

others, something dramatic may have to be used. Employees need something to convince them that this is different and is also long term. To show how serious the management is, Deming suggests "such concrete activities as spending money on training and equipment, or shutting down operations when something is wrong can help convince employees."²⁵

5.2 Emphasis on Short Term Profits

Companies may actually have to take a short term loss to make the strategy work. This may require the involvement and cooperation between top management and the major stockholders. With the probability of long term growth and profit, the risk will be well worth it.

There are estimates that 20-40% of an organization's efforts are spent in rework and unnecessary work. By making reductions in these areas, a company can clearly recover its up-front costs to implement total quality management, but it must recognize that there are up-front costs and provide for them.²⁶

The problem occurs when attempting to convince the impatient, profit-driven owners. The return on investment in three to five years should please most owners, especially when given the alternative of decreased profit, short term growth or bankruptcy. Further, their company will become known for producing quality products.

²⁵Walton 90.

²⁶Transportation Research Board 72nd Annual Meeting January 10-14, 1993, Total Quality Management "Putting Theory into Practice" Session 168, Sponsored by Committee A2F03 Management of Quality Assurance, 1.

5.3 Evaluation of Performance, Merit Rating, or Annual Review

Evaluation of personnel encourages competition amongst employees and usually results in less teamwork. Evaluations and merit ratings force people to put themselves number one and the company two. Also, performance ratings mean people must be evaluated against someone or something. If it is against someone, say the top performer in their particular area, then this inspires competition and rivalry. If the evaluation is tied to something, then typically this means quotas or numbers. This will result in production of poor quality and service. A persons' evaluation should be tied to quality. Perhaps, like at the Ritz-Carlton,

In all levels of the organization, annual raises and reviews are tied to evaluations of an individuals' quality of performance. Members of work teams can also share in bonus pools when solutions they recommend to quality related problems are successfully implemented.²⁷

In construction, or any industry, this problem is not easily resolved. Annual raises tied to cost-of-living adjustments should be given out equally to all employees based as a percentage of their income. Companies should consider longevity raises at certain points in workers' careers. This type of raise also keeps people with the

²⁷Edward Watkins, ed., "How the Ritz-Carlton Won the Baldrige Award," Lodging Hospitality Nov. 1992: 22.

company longer. Profit-sharing should be considered as a viable alternative for all employees.

We introduced company-wide profit sharing, which again was driven by our values. Our salaries are set on the 50th percentile of our major competition. In addition, we have a variable component ranging from 1-7% of salary based on how we perform against the year's profit goal. The impact on our employees has been significant. One question in our 1988 survey asked employees to agree or disagree with, 'I will share in the business success of Hoechst Celanese.' In 1988, only 39% agreed with that statement, in 1991, 87% agreed. The responsibility for the quality process lies with line management; 25% of their performance appraisal is tied to our quality objectives.²⁸

Bonuses, and other incentives or raises could be given based on quality improvement ideas or suggestions that continually improved the company. A working suggestion program is also a good way to measure a company's progress in the new culture of total quality management. Florida Power and Light Company initiated just such a program.

The number of suggestions went from 600 in 1986 to 25,000 in 1989. Quite an improvement. If I had only one indicator to judge a corporate culture by,²⁹ I would choose to look at the suggestion program.

Another idea would be to base raises or incentives on an individual's personal strive to continually improve. If the company sponsors education and training, it should reward individuals who take advantage of it. Attention should be given to those employees who go beyond what is expected.

²⁸Ernest H. Drew, "Winning with 'Quality Values'," Judith Alster and Holly Gallo, eds., Leadership and Empowerment for Total Quality, Symposium sponsored by KPMG Peat Marwick (New York: The Conference Board, 1992) 18.

²⁹Hudiburg 25.

Employees should be recognized for their continuous improvement and dedication to quality.

... the recognition process needs to be thought out and it needs to be done on several levels. I have become even more convinced that money is a bad form of recognition. It is just not personal enough.³⁰

5.4 Mobility of Top Management

Retaining the chief executive officer and other top managers is a growing problem in the United States. With corporate mergers and leveraged buyouts, top executives find themselves moving around quite often, usually before they have made any real, long-term impact. For example, the average engineer moves around every two to three years in an effort to either find a better paying job, one with more responsibilities, or perhaps one that is just more satisfying. This constant requirement to improve one's position by being mobile is probably the number one reason I joined the United States Navy. After graduating Auburn University in 1980, I had already started looking to move up with another company in 1986 (this would have been my third company in six years). I figured moving every two years, on average, could be no worse than the moves required in the Navy. Although I change jobs with the Navy every two to three years, I still maintain my seniority and benefits and I do not have to start over from scratch, as would probably

³⁰ Philip B. Crosby, Quality Without Tears; The Art of Hassle-Free Management (New York: McGraw-Hill, 1984) 119.

be required in the civilian world. A definite allegiance to my employer has developed and I have acquired a great deal of corporate knowledge which carries over from one job to the next. With top management moving every couple of years, the opportunity to learn about the company, much less its employees and their concerns, is greatly limited.

Unfortunately, this is presently the American way of life and may never change, especially for the large corporations. There is a great chasm between what the owners perceive as good for the company and what is taught in total quality management. Small and medium size companies, especially family owned, can probably best overcome this disease.

5.5 Running a Company on Visible Figures Alone - Counting the Money

This disease is difficult to avoid because most owners are concerned with hard figures and the bottom line. However, if total quality management is given a viable chance to succeed, then the invisible figures will eventually affect the visible ones. For example, as the number of a company's satisfied customers increases, the effect will be an increase in revenues, a visible figure. As quality (an invisible figure) improves, cost, a visible figure, will decrease. Because the correlations are sometimes difficult to prove and because they take time to occur, owners and stockholders become impatient and abandon the process too early.

5.6 Excessive Medical Costs and Excessive Costs of Warranty, Fueled by Lawyers That Work on a Contingency

For the construction industry, these may be the two biggest deterrents to not only implementing total quality management, but for survival as well. Concerning medical costs, "for some companies this is their largest single expenditure."³¹ Currently, the country is in turmoil concerning the health care debate. The current administration has promised a national health care plan, but the revenue to pay for the plan has not yet been found. Crosby sums up the current national health care problems quite appropriately:

Physicians wouldn't let anyone run the health care industry, so costs went out of sight, and now the insurance and health maintenance organizations (HMOs) are taking over. Thus, practicing medicine is no fun anymore; it's like being in Britain. Soon patients will be assigned, except for the very rich. Hospitals are being bought up and run 'efficiently' through mass purchasing and fewer laboratory tests.³²

Medical costs can be controlled in a large part by using a good safety program as part of total quality management. Lawsuits are either generated by internal employees or external entities. Most lawsuits that come from within involve safety and health issues. These, too, can be controlled for the most part by a new and improved quality safety program being introduced as part of the total quality management process. Because these issues are vital to a

³¹Walton 93.

³²Crosby, The Eternally Successful Organization 20.

construction firm's existence, safety will be discussed later in detail. External lawsuits usually involve product liability. A total quality management program will correct some of this problem, but not all of it. As quality increases and defects decrease, accidents caused from faulty products will decrease. Other ways of reducing external lawsuits are partnering and design-build contracts.

5.7 Other Obstacles to Total Quality Management

Dr. Deming points out several other obstacles to total quality management:

- Neglect of long-range planning and transformation.
- The supposition that solving problems, automation, gadgets, and new machinery will transform industry.
- Search for examples.
- Our problems are different.
- Obsolescence in schools.
- Reliance on quality control departments.
- Blaming the workforce for problems.
- Quality by inspection.
- False starts.
- The unmanned computer.
- Meeting specifications.
- Inadequate testing of prototypes.
- Anyone that comes to try to help us must understand all about our business.

CHAPTER SIX

SAFETY MANAGEMENT IS VITAL TO
TOTAL QUALITY MANAGEMENT SUCCESS

In today's litigious society safety is a major consideration for construction managers. To ignore construction safety could mean the difference between staying in business and filing for bankruptcy. Apart from the economic impact, some sort of moral consideration for the importance of safeguarding human life must also occur:

The struggle to provide safeguards to eliminate or reduce the number of accidents that occur, and the injuries and damage that result are predicated chiefly on these two aspects;³³ (1) costs and (2) regard to human life and well-being.

For many years the construction industry served as its own watchdog. However, safety today is determined through a combination of requirements set forth in laws, regulations, and extravagant costs resultant from rising insurance premiums and numerous claims. Penalties and other deterrents imposed by organizations such as Occupational Safety and Health Administration (OSHA) have raised the safety awareness of construction managers. Some of the safety components that affect and control costs are management participation, education of personnel, hazard identification and control, promotion of safe practices on

³³Willie Hammer, Occupational Safety Management and Engineering (New Jersey: Prentice-Hall, Inc., 1976) 2.

the job, accident investigation and a comprehensive safety program.

To reduce work injury risk there are five basic areas of influence: safety laws and inspection, employee safety training, availability of accident statistics, and management sponsored safety programs.³⁴

The two economic considerations that need to be evaluated concerning safety are direct and indirect costs. Sometimes where safety is concerned, these terms are analogous to insured and uninsured costs. Direct costs are those which can be clearly identified and directly correlated to job safety. Insurance costs depend upon the number of claims for accidents and injuries and the past safety record of the company. Most of these insurance costs are encompassed under workers' compensation. Although the specific requirements for workers' compensation vary from state to state, the employer pays 100% of the cost. Workers' compensation insurance can be obtained either through an insurance company, a self-insurers' fund or by being self insured. Workers' compensation is based on occupational rates published for each particular craft and on the experience of the employer. The insurance premium will vary according to the current safety record of the employer. If an accidental death were to occur on a job site, this could be equated financially to as much as 5,000

³⁴Dalha A. Muazu, "A Safety Program for a Building Construction Firm." Diss. University of Florida, 1976: 3.

lost-time man hours on the job. Consequently, the direct result would be a rise in the insurance premiums.

Liability insurance is also carried by employers in order to minimize loss when equipment or property is damaged through an accident. Liability requirements are usually set forth in the contract. Many studies have been undertaken to establish a basis for which losses could be related to a measurable cost and "in almost every instance it has been found that the total losses exceeded by far the amounts reimbursable by insurance companies."³⁵ This non-reimbursed cost has caused many companies to increase coverage limits, which results in increased premiums, while others have decided to reduce risks instead. Risk reduction can be directly related to a specific job and is the cost attributable to safety prevention. However, the cost savings derived from these elements are negligible when compared to the positive results of increased productivity and increased profits.

There seem to be many indirect or uninsured costs and pinpointing exact amounts is difficult. For example, from the following list some items will have actual costs more readily identifiable than others: cost of wages paid for working time lost by workers who were not injured; payments for settlement of injury or death claims; legal fees for defense against claims; cost of wages for working time lost

³⁵Hammer 4.

by injured workers (other than workers' compensation payments); assessed punitive damages; recovery and salvage costs for equipment and vehicles; extra cost due to overtime work; loss from function and of operation income; wage cost due to decreased output of worker upon return; slowdown in operations; cost of time spent by supervisory personnel and clerical workers investigating or processing claims and workers' compensation forms; OSHA penalties; fines and temporary shutdowns; cost for corrective action; degradation of efficiency of operations because of loss of experienced and trained personnel; training costs for replacements; increased insurance costs; loss of public confidence and, therefore, revenue; loss of prestige; and degradation of morale. However, the actual costs attached to each of these should not be the number one motivational factor:

At the present time attempting to predict how much could be lost in an accident to evaluate risk involved may be an exercise in futility. Not only will any loss probably be far higher than expected, but recent legislation has virtually eliminated cost considerations."³⁶

Passage of the Occupational Safety and Health Act in 1970 forced many companies to reevaluate their safety practices and programs. In addition to fines or penalties, companies can now be forced to cease operations. In some cases jail sentences are invoked. Until recently many companies practiced safety only to avoid hassles with government

³⁶Hammer 7.

agencies such as OSHA and the Environmental Protection Agency (EPA). Even though the construction industry created consensus safety standards to operate under, it became necessary to enact the Occupational Safety and Health Act because on-the-job injuries and deaths remained at unacceptable levels. The fox in the henhouse was not working and perhaps Admiral Hyman G. Rickover said it best:

To forestall intrusion of Government, the industry concerned will usually propose voluntary safety requirements. These requirements represent the minimum all are willing to accept. This is not enough. There are more accidents. Only after the lapse of much time are laws finally enacted. Much harm will have been done in the interval--harm which could have been prevented."³⁷

Unfortunately, regulations and laws applied by agencies vary. This unending problem results from the diversity of the construction industry. The construction industry encompasses many and varied types of work and this tends to increase the complexity and uniform application of the laws as they apply to specific safety plans and practices. According to common law, the employer has historically been responsible for "a safe place to work, safe tools to perform their work, knowledge of hazards, competent fellow employees and supervisors and rules by which all could perform safely and a means to ensure that the rules were observed."³⁸ Simply put, this means the employer must provide rules for a

³⁷Hammer 62.

³⁸Hammer 15.

safe work place and must have a plan or program that monitors safety. Legislation and regulation will not work if workers and management do not take positive action to put these rules into practice in everyday activities and begin to care about safety in the work environment.

From experience we know that as a federal agency OSHA makes rules concerning safety, supervises industry safety, investigates safety violations and holds hearings and makes rulings on those violations. Many companies have problems in dealing with the bureaucracy of OSHA. Once the rules are learned, it seems the rules change or new ones are added. Further, companies cannot use OSHA as a single source for information on safety rules. OSHA alone references more than twenty sources which, piled on top of one another, would be several feet high. Many costs can result from an OSHA inspection such as changing out faulty equipment, fines, penalties, jail terms, operational slowdown, work stoppage and record keeping. Underlying many of the problems in dealing with OSHA and other government agencies is the fact that standards vary from state to state and from agency to agency. This variance causes great difficulties when trying to deal with legal and technical requirements for safety as outlined by government agencies whether federal, state, city or municipality. A "standard" is that "which requires conditions or the adoption or use of one or more practices, means, methods or operations or processes,

reasonably necessary or appropriate to provide safe or healthful employment and places of employment."³⁹ Perhaps in an effort to get away from consensus standards the government went too far. The construction industry and government need to strive toward a medium whereby all can understand the laws efficiently and with relative ease.

Management of safety has been tried many different ways in construction. All styles seem to have their own positive and negative aspects. However, most management safety plans have seven principal factors which significantly reduce accident costs: (1) know safety records of all field managers and consider their record in evaluations for promotion or salary increases, (2) communicate safety on job visits the same way you communicate about costs and schedules, (3) use cost accounting system to encourage safety by allocating safety costs to a company account or allocate accident costs to each specific project, (4) require detailed work planning to ensure equipment or materials needed to safely perform work are at hand, (5) insist that newly hired employees receive training in safe work methods, (6) use safety awards,⁴⁰ and (7) use the expertise of safety departments where they exist.

³⁹Hammer 62.

⁴⁰Safety awards for workers, if used, should be incentives (nominal monetary value) based on first aid injuries rather than on lost-time injuries. Safety awards for field managers should be bonuses (substantial monetary value and made in private) based on lost-time injuries or reduction in insurance claim costs.

An important aspect of construction safety is that all personnel, from the general laborer to the chief executive officer, must have and understand their role in safety. More importantly, each person must know their responsibility and should be held accountable for their respective safety tasks. Just as in their regular job, personnel should be promotable to a higher safety position. If not, they will become stagnant in their safety role and accidents will ensue. Continuing education should be afforded to all personnel. Key personnel should receive first-hand training and be briefed on any new rules or prevention methods and they should subsequently educate their fellow employees regarding same. At a minimum, all individuals should know basic safety responsibilities such as proactive accident prevention, awareness of hazardous situations, knowledge of the safety rules, knowledge of emergency procedures and their responsibility to report mishaps. As personnel function in safety roles, production should increase and risk-taking decrease.

Any accident, as the word implies, can be avoided. Almost all are avoidable through the prevention of human error. This error is not necessarily always by the injured party. Human error could occur in design, operation of equipment, manufacture of equipment, maintenance, or even through the inaction of a witness to a potentially dangerous

situation. All people in the construction industry should strive to provide:

(1) equipment and procedures that will minimize the possibilities of errors by operators, (2) designs that eliminate or minimize the possibilities of accidents if an operator does make an error, (3) designs and safeguards that will prevent injury if an accident occurs.⁴¹

Anyone involved should use their best judgement, apply the known rules, and have a moral consideration for life. Also, we must learn from our mistakes and seek to correct problems. Besides the obvious reduction in insurance costs, accident reporting and accompanying statistics are vital to prevention of similar accidents. If a common problem exists within a community, such as a virus or disease, it must be reported and corrected in order to keep others from being detrimentally affected.

As with most construction jobs, hazards are going to exist. It is the nature of the beast. It is very important that these hazards are clearly identified and controlled. Sometimes this requires bringing in an expert from outside the organization. If the job entails a hazard with which no one in the organization is experienced, an outside expert is advisable. The scope of the hazard must be identified and also controlled. Once identified, all employees should be made aware of the hazard and its potential effects.

⁴¹Hammer 96.

Companies should never attempt to control a hazard for which they have no experience.

A good safety program is probably the best tool for accident prevention on the construction site. Safety programs can be very sophisticated, as often is the case when dealing with large companies, or they can be relatively simple, as is typical of smaller organizations. Due to their inexperience, smaller companies often ask insurance companies for assistance when formulating a program. Regardless of size, most plans seem to have two main parts: planning and controlling. Once the program has been established (planned), then it should be implemented with controls in place. Controls are numerous and vary greatly, but two important elements are regular site inspections and continual, detailed hazard analysis. The National Safety Foundation found that "85% of all accidents are unsafe acts rather than unsafe conditions."⁴² If through a safety program employees are made aware of potential safety hazards, then some accidents could be predictable and therefore avoidable. It is estimated that 50% of all construction accidents could have been avoided by common sense and attention to basic safety practices.⁴³ An employee's responsibilities include such items as: (1)

⁴²Muazu vii.

⁴³The Associated General Contractors of America, Manual of Accident Prevention in Construction, 6th ed. (Washington, D.C.: AGCA, 1971) 8.

compliance with all safety standards, (2) compliance with approved safety plans, and (3) wearing the prescribed safety equipment. Even items that seem trivial can return savings. For example, it has been shown that "a clean, safe job site may increase productivity by 5% and has been responsible in one case for a 12% increase in productivity."⁴⁴

One area still under close scrutiny is the application of behavioral science to construction safety. There are verifiable statistics that show most workers who are needlessly injured on the job through their own carelessness were injured due to lack of attention. This lack of attention is mainly due to a worker's concentration being diverted to other problems present in the worker's life such as marital or family problems, financial troubles, a recent move, new job, new position or others. Values can be assigned to each factor and employees can complete questionnaires related to these specific areas. After compilation of the values, a risk assessment can be made on employees. This could provide a possible warning for an employer that certain employees are at a higher risk than others. This would afford the employer the opportunity to minimize both his liability and the employee's risk for injury. This could be done by employer-sponsored counseling, reduced overtime, work assignment in less

⁴⁴David Goldsmith, Safety Management in Construction and Industry (New York: McGraw-Hill, 1987) 39.

dangerous areas, closer supervision, monitoring and communication. Sometimes emotional or mental problems are considered occupational illnesses if they are found to be work related and may be covered by workers' compensation. "An eager, well-motivated individual who is undistracted by personal problems or stresses can out perform a distracted or poorly motivated person, all other things being equal."⁴⁵

There are many reasons to practice good construction safety. With the threat of government agencies imposing fines, work stoppage or possible jail sentences, companies can no longer ignore the impending cost of not managing safety properly. Even though exact cost savings are difficult to quantify, many managers are realizing significant cost savings through safety management. With the current wave of litigation in the air, everyone must stand up, take notice and assume responsibility. If not, they will be heading down a long, one-way road to extinction. Companies are beginning to realize that proper safety management increases profit and productivity, while at the same time enhancing the company's reputation within its community. More importantly, however, is the significance now being placed on preventing injury and loss of life. Although it is difficult to quantify such

⁴⁵Hammer 108.

achievements, it is clear that total job safety is rapidly becoming paramount in today's construction industry.

CHAPTER SEVEN

THE ROLE OF DATA

Data is an important and useful tool when establishing, maintaining and improving a quality process. Data should always be based on facts and not include opinions, impressions or any human manipulation or intervention whatsoever. If the data is collected cleanly and used correctly, it is a viable tool in the overall scheme of total quality management. Any company that currently does not use statistics will find that statistical procedures can transform their business. "Only with the proper use of statistical methods can people minimize confusion in the presence of variation."⁴⁶ Only after data has been collected and a statistical procedure applied can a company actually begin to understand their own production process. It is only after understanding the production process that they can attempt production. Finally, after learning how to actually control or change the process can a company start the process of continuous improvement. Improvement is possible because a quality process with control limits (upper and lower) has been established. If part of the process exceeds one of those limits, then the fact that a variation has occurred will be readily identifiable. Other

⁴⁶Walton 96.

methods can be used to determine the actual root cause of the variation. In almost every case, the cause will be part of the process, not controlled by the worker. The cause is usually not the worker nor anything within his controllable domain. This is because the control limits were set based on data that included the workers production. Humans do not tend to vary greatly in their day to day job performance, so if a variation occurs outside a control limit, it is likely due to the process and not human error.

Statistics and how they are utilized needs to be understood by all employees. This can be done as part of the training and education process. Statistical methods are fairly straightforward and can be handled mathematically by most people. There are many helpful charts which demonstrate how data transformed by statistics can be used. Some of these are cause and effect diagrams (fishbone), flow charts, Pareto analysis, run (trend) charts, histograms, control charts and scatter diagrams. The actual use and sample applications for each of these is included in Appendix D. Gathering and using data to transform a company into a quality leader in business is important, but only one part of the total program.

CHAPTER EIGHT

TOTAL QUALITY MANAGEMENT TODAY AND TOMORROW

Most companies that have introduced and implemented total quality management concentrate in the following areas: directly exposing employees to customers; self-inspection; simplifying work; cost-of-quality monitoring; and working with vendors and suppliers on efforts of quality (Figure 2).

Figure 2
Percentage of Employees Covered by Total Quality Practices.

	None 0%	Almost None 1-20%	Some 21-40%	About Half 41-60%	Most 61-80%	Almost All 81-99%	All 100%
Direct employee exposure to customers	4	32	31	16	4	4	0
Self-inspection	10	25	31	14	7	7	0
Work simplification	13	26	33	12	7	7	0
Cost-of-quality monitoring	18	35	24	11	4	4	3
Collaboration with suppliers in quality efforts	13	37	27	11	3	3	2
Just-in-time deliveries	24	31	22	11	4	4	2
Work cells or manufacturing cells	41	27	19	9	2	2	0

Figure 2 - Percentage of Employees Covered by Total Quality Practices.

Studies have shown the major problem for the Fortune 1000 companies was failing to expose all employees to total quality management. Less than 40% of all employees were actually exposed to the total quality management program.⁴⁷ For the companies that are involved in manufacturing, emphasis on total quality management is taught to management, then exposure is made on the production floor. The total quality management process sometimes never leaves the manufacturing floor. Similarly, in the service business, because the main business is dealing directly with the customer, the emphasis on total quality management is placed on customer interface first and rarely becomes a company wide program. The good news is that total quality management has been introduced to some degree to most major companies in the United States.

The results show that total quality programs are in use in the vast majority of U.S. organizations and suggest that a fairly standard pattern of practices is typical of total quality programs.⁴⁸

Today companies that are in declining markets tend to adopt total quality management programs more quickly. Further, more manufacturing firms have adopted the program than other major industries, although the service industry is not far

⁴⁷Edward E. Lawler, Susan Albers Mohrman and Gerald E. Ledford, Jr., Employee Involvement and Total Quality Management (San Francisco: Jossey-Bass Publishers, 1992) 96.

⁴⁸Lawler 96.

behind. It should be noted that all industries have, to some point, adopted total quality management (Figure 3).⁴⁹

Figure 3
Total Quality Management Index Scores by Industry.

	Total Quality Index Mean
All Companies	2.8

Chemicals	3.2
Electronics	3.3
Food	2.5
Forest Products	2.4
Motor Vehicles and Parts	3.1
Diversified Services	2.8
Commercial Banks	2.2
Diversified Financial Services	2.2
Savings Institutions	2.3
Life Insurance Companies	2.2
Transportation	2.5
Utilities	2.5

Figure 3 - Total Quality Management Index Scores by Industry.

The chart is based on scoring indices correlated to seven total quality management practices. These are: direct exposure to customers; self-inspection; work-simplification; cost-of-quality monitoring; collaboration with suppliers in quality efforts; just-in-time deliveries; and work cells or manufacturing cells. To interpret the total quality

⁴⁹Lawler 100.

management index, the scores are averaged over these seven principles as applied by each industry.

In examining the construction industry, it is important to know how it currently stands in connection to total quality management and the direction to which it is heading. Due to the nature of the construction industry, only some companies have implemented total quality management programs. However, the companies that have used total quality management report improved customer and employee satisfaction, improved relationships with suppliers, subcontractors, owners and engineers, and that the return on investment is increasing. The companies praise total quality management and report that it has helped business. "The principles practiced in manufacturing firms are just as applicable to construction companies and can produce the same dramatic improvements in the quality of roads and bridges."⁵⁰ The concepts, as discussed, are difficult to incorporate because they change the culture of companies. The culture of the construction industry would have to change and this would be no easy task. Changing the culture of your business is not something that will be accomplished quickly. The change must also happen in such a way as to

⁵⁰Martin 19.

effect a permanent change and not just a temporary phase the business is going through.

A few managers - the explorers - are readily open to testing the new ways. Most managers - the conservatives - want to see results demonstrated before departing from their existing order.⁵¹

As one examines Deming's or Crosby's fourteen points it is obvious the construction industry would have to alter the way it conducts business significantly. Construction companies must begin to look more toward customer satisfaction, quality assurance, and continuous improvement. "Current estimates on improving rework and repair has a potential to exceed fifteen billion dollars per year and are probably closer to fifty billion dollars."⁵² Contractors will have two choices, investing in good quality or paying for bad quality. In the near future the construction industry will see a decrease in the sealed, low bid type of contracts.⁵³ Therefore, companies will need to establish themselves as quality contractors first, and low cost companies second. Numerous studies have shown that more than 20% off the bottom line of most construction projects can be achieved by the use of a good, sound quality management program implemented at the beginning of a job. Quality calls for doing better with your customers, better

⁵¹J. M. Juran, Juran on Planning for Quality (New York: Harper, 1944) 312-13.

⁵²Manual of Accident Prevention in Construction 20.

⁵³Lou Bainbridge and Bill Abberger 2.

than you have ever done before, and better than your competitor. Total quality management will allow the production of better quality products at a lower price.

Productivity improvements represent the single largest opportunity for cost reduction and enhanced competitiveness and profitability. Statistics show that some thirty percent of labor dollars expended annually in construction projects are wasted.⁵⁴

The issue of quality is becoming a competitive force. When times are tough, consumer purchases are based increasingly on the durability and quality of the product and the price-quality relationship becomes much more important. Total quality management has become a trend in United States industries and will continue to grow in the construction industry as well. Those companies that do not use these principles will fall behind the industry standard. Further, many companies in other industries which contract out services and construction will increasingly require their contractors to have implemented total quality management programs. Suppliers for construction companies must also become more active. Typical, adversarial relationships will begin to disappear as ideas like partnering and selective bidding type contracts increase. Even more formal partnering will begin to increase in popularity, such as design-build contracting. This type of contracting will go to the larger firms with more resources and experience. Just as the Japanese are on the verge of using virtual

⁵⁴The Contractors Management Journal 2.

reality to let customers design their own cars, larger design/construction firms will use this technology to sell their services. As companies consolidate, they will invest in employees and the work force will get older, more permanent, experienced and more productive.

CHAPTER NINE

CONCLUSION

TOTAL QUALITY MANAGEMENT IMPLEMENTATION RECOMMENDATIONS

Institution of an integrated approach to total quality management and quality assurance/quality control is vital to the success of today's companies. The development of a total corporate quality management program should be accomplished after thoroughly investigating the different approaches offered by various consultants/theorists and the aspects of each one as applied to the specific needs of the company. Education of management personnel should be accomplished first, as managers must fully understand and support the total quality management process and actively participate in its implementation. Both the technical and humanistic aspects of total quality management must be addressed in the training effort and training should be tailored to the job functions of each employee. Use of pilot projects during the early stages of implementation is necessary to obtain an indication of management and employee acceptance of total quality management. In order to create a team attitude toward improving quality, companies should strive to develop closer, more productive relationships among owners, contractors, subcontractors and vendors.

The company needs to have an overall philosophy that encompasses plans for improvements and makes company decisions based on facts. The company needs to pursue continuous improvement while maintaining a long-term perspective. Improvement will have to be made both in the processes and the organizational system within the company in order for the total quality management program to be successful.

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APPENDIX A

THE ETERNALLY SUCCESSFUL ORGANIZATION GRID

	COMATOSE	INTENSIVE CARE	PROGRESSIVE CARE	HEALING	WELLNESS
QUALITY	Nobody does anything right around here. <i>Price of Nonconformance = 33%</i>	We finally have a list of customer complaints. <i>Price of Nonconformance = 28%</i>	We are beginning a formal Quality Improvement Process. <i>Price of Nonconformance = 20%</i>	Customer complaints are practically gone. <i>Price of Nonconformance = 13%</i>	People do things right the first time routinely. <i>Price of Nonconformance = 3%</i>
GROWTH	Nothing ever changes. <i>Return after tax = nil</i>	We bought a turkey. <i>Return after tax = nil</i>	The new product isn't too bad. <i>Return after tax = 3%</i>	The new group is growing well. <i>Return after tax = 7%</i>	Growth is profitable and steady. <i>Return after tax = 12%</i>
CUSTOMERS	Nobody ever orders twice. <i>Customer complaints on orders = 63%</i>	Customers don't know what they want. <i>Customer complaints on orders = 54%</i>	We are working with customers. <i>Customer complaints on orders = 26%</i>	We are making many defect-free deliveries. <i>Customer complaints on orders = 9%</i>	Customer needs are anticipated. <i>Customer complaints on orders = 0%</i>
CHANGE	Nothing ever changes. <i>Changes controlled by Systems Integrity = 0%</i>	Nobody tells anyone anything. <i>Changes controlled by Systems Integrity = 2%</i>	We need to know what is happening. <i>Changes controlled by Systems Integrity = 55%</i>	There is no reason for anyone to be surprised. <i>Changes controlled by Systems Integrity = 85%</i>	Change is planned and managed. <i>Changes controlled by Systems Integrity = 100%</i>
EMPLOYEES	This place is a little better than not working. <i>Employee turnover = 65%</i>	Human Resources has been told to help employees. <i>Employee turnover = 45%</i>	Error Cause Removal programs have been started. <i>Employee turnover = 40%</i>	Career path evaluations are implemented now. <i>Employee turnover = 7%</i>	People are proud to work here. <i>Employee turnover = 2%</i>



How Ritz-Carlton Won THE BALDRIGE AWARD

An unswerving focus on continuous improvement helped this luxury hotel chain land the biggest prize in quality management.

BY EDWARD WATKINS
EDITOR

The Ritz-Carlton Hotel Co. has done what many people thought no hotel chain could do. Last month, the Atlanta chain became the first hotel company to win the coveted Malcolm Baldrige National Quality Award.

Congress created the award in 1987 to honor and recognize quality achievement in U.S. businesses. Named after the Secretary of Commerce Malcolm Baldrige, an early proponent of Total Quality Management (TQM) in the United States, it is regarded as the ultimate honor among those U.S. companies that excel themselves on the quality of their products and services.

Winning the Baldrige Award establishes that Ritz-Carlton Hotels is not just a luxury lodging, but about providing a very reliable product that gives our guests an exceptional value for their dollars. Says a proud President and Chief Operating Officer Horst Schulze, "And when you think about it, that describes the meaning of quality."

Ritz-Carlton was a finalist in last year's competition. This year, 90 companies competed for the award in one of three categories: manufacturing, service and

with the founding of the firm in 1983, when parent company W.B. Johnson Properties bought the U.S. rights to the Ritz-Carlton name. The company currently operates 23 properties in the U.S. and two in Australia.



President and COO Horst Schulze.

"At the company's founding, it was clear that there was no single supplier of quality hotels in multiple locations that met consistently high standards for transient guests and provided uniformly superior products and services for meeting

a commitment to fill that role with quality products and services that do what we say they will do."

By 1987, Ritz-Carlton was recognized as one of the best luxury hotel chains in the industry, but Schulze wanted more.

"We asked ourselves how we could become even better than we were," says Schulze. "The hardest thing for me to do was overcome my ego and admit that I really didn't know how to take the company beyond where it was. Once we did that, the job became easier."

The company closely examined several early Baldrige winners such as Milliken & Co. to learn how they instituted quality improvement programs in their operations. From there, Ritz-Carlton plunged head-first into TQM with astonishing results. In 1991, it received 121 quality-related awards and earned industry-best ranking from all three major hotel-rating organizations. Independent research commissioned by the chain shows that 97 percent of its customers—both transient guests and meeting planners—aren't just satisfied but say they have a "memorable experience" when they stay at a Ritz-Carlton.

Even though running a hotel is one of





Ritz-Carlton Palm Beach is one of the chain's grand luxury resorts.

are able to apply many of the quality control principles that manufacturing companies use to monitor and improve products. Of course, the challenge for a service company is to create excellence with people rather than with machinery or raw materials. Many people think you can't transfer quality improvement techniques from manufacturing to the service industry," says Mene. "In all business—whether it's a factory or a hotel—work gets done by transforming products, materials and people into a product or service. In both environments, work is processed through a system and management must decide what it's going to concentrate its efforts on. A manufacturing plant probably spends more time on machinery and materials, whereas we're more concerned with the flow of people coming through the organization."

Ritz-Carlton approach to quality is based on a number of basic but common principles, many of them drawn from traditional TQM theory.

To achieve its goals, the company re-evaluates several key quality initiatives: the chain selects and trains all of

correct them immediately and then report them to management.

"When things go wrong in a pattern, some aspect of the process is probably out of control," says Mene. "It's up to all employees to spot those problems and help develop ways to prevent them in the future."

The company trains, coaches and encourages employees to prevent breakdowns in service before they happen. All Ritz-Carlton employees receive at least 126 hours of training on quality topics. Much of the schooling centers on the company's Gold Standards, which include a motto ("ladies and gentlemen serving ladies and gentlemen"), three steps of service and 20 "basics."

Mene views the company's quality improvement effort as an investment rather than an expense. What drives up costs in hotels, Mene argues, is the cost of repeating service that should have been done right the first time. Most properties maintain a safety margin of employees on duty at all times just to correct problems, because management knows that service isn't always provided correctly the first time.

■ The company's top executives

70
tive. The officers are much more than cheerleaders when it comes to quality; they each spend at least one-fourth of their time on quality issues.

"They spend a lot of time working on ways to improve our product by talking to as many guests and employees as possible," says Mene. The chain's 14 top executives also meet weekly as a senior management quality team to review quality standards and performance, indicators of guest satisfaction, market growth and development and profit and competitive status.

The executive team's involvement in quality issues is most evident at the opening of a new property. Rather than soft or phased openings with shake-down periods to iron out operational bugs, Ritz-Carlton hotels open all at once, and management expects everything to be right when the doors open for the first guest.

To see that it is done, a specially selected start-up team picked from the staffs of other hotels makes sure that all facilities, services and systems are in line with Ritz-Carlton standards.

A "seven-day countdown control plan" synchronizes all steps leading to the opening. During that week, Schulze and the other senior leaders work at the hotel, coaching and testing the new employees on the chain's Gold Standards.

■ The company meticulously gathers data on every aspect of the guest's stay to determine if the hotels are meeting customer expectations.

Key to the research are the daily quality production reports that identify all problems, defects and waste reported in each of the 720 work areas in the chain's system. The data compiled ranges from the time it takes for housekeepers to clean a room to the number of guests who must wait in line to check-in.

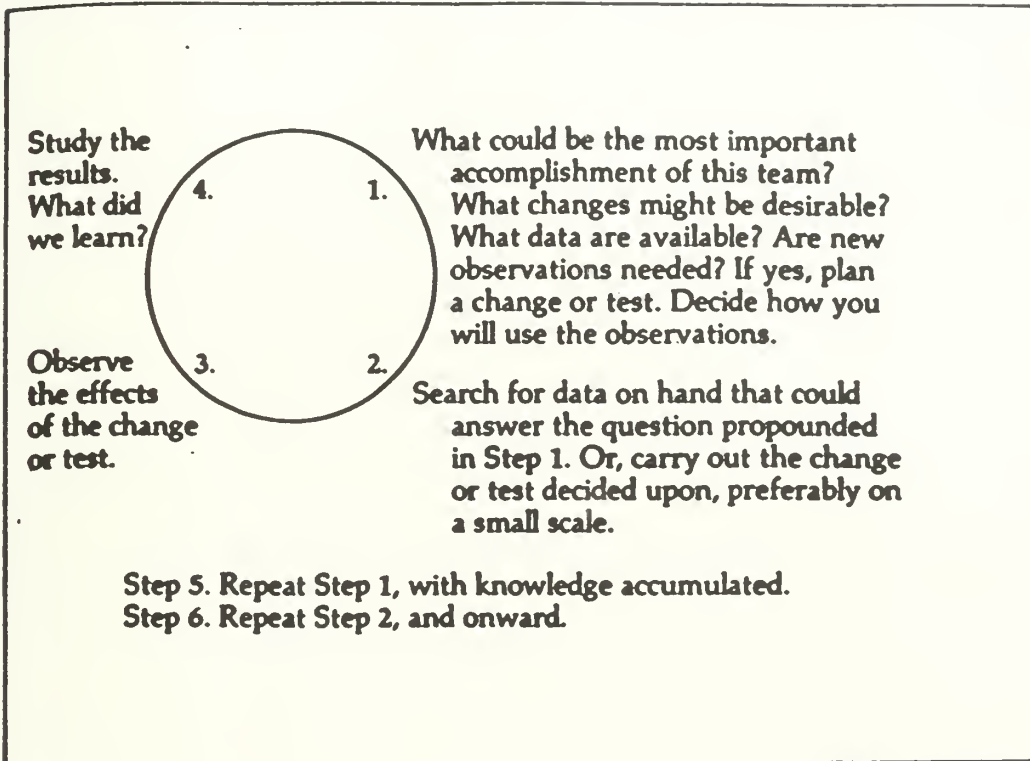
The reports are the chain's early-warning system to detect recurring problems for which it must develop prevention plans. "We make about 100,000 customer contacts every day, and if every one of those encounters is done correctly, the customers are always happy and we have no waste," says Mene.

The chain relies on technology to keep comprehensive computerized guest history profiles on the likes and dislikes of more than 240,000 repeat guests. Researchers survey more than 25,000 guests each year to find ways the chain can improve its delivery of service.

■ The company recognizes and rewards employees for contributions to continuous improvement.

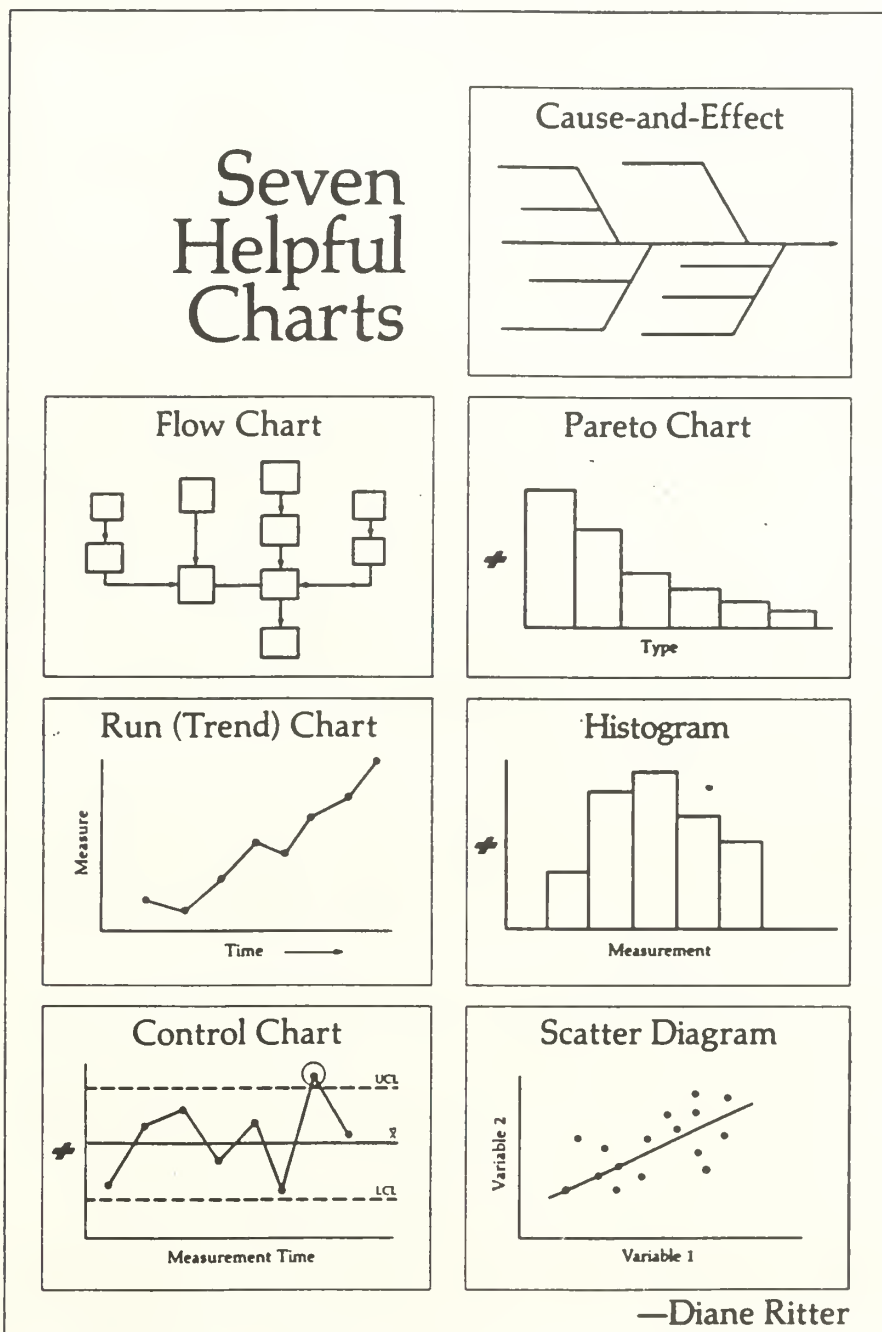
In all levels of the organization, annual

APPENDIX C

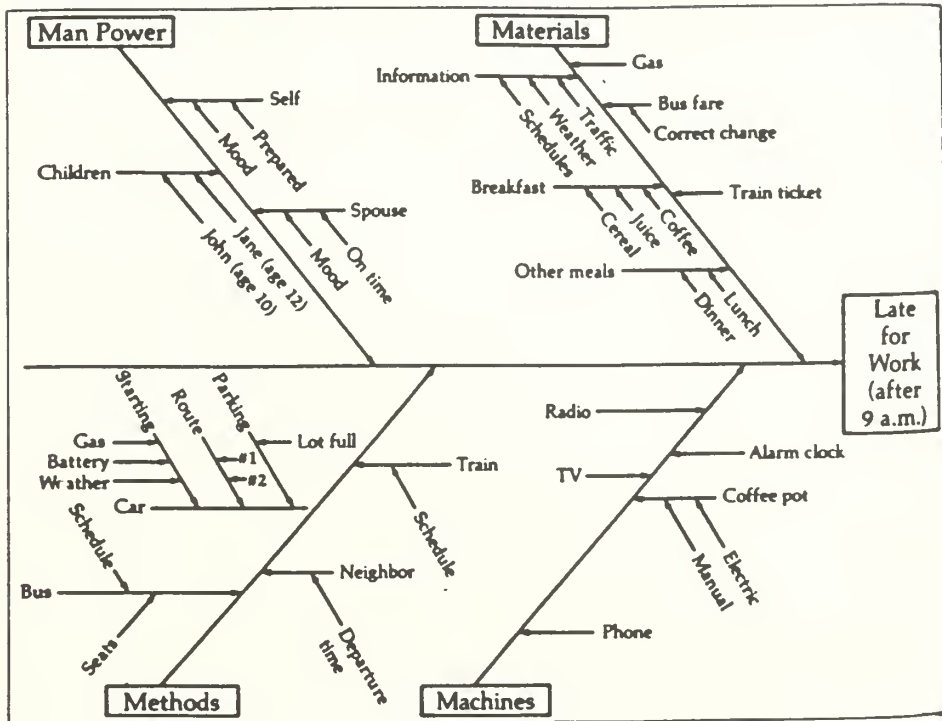
THE SHEWHART CYCLE²—Deming, *Out of the Crisis*

APPENDIX D

Selected Charts and Diagrams Demonstrating
How Data Transformed by Statistics Can be Used



Cause-and-Effect: "Late for Work"

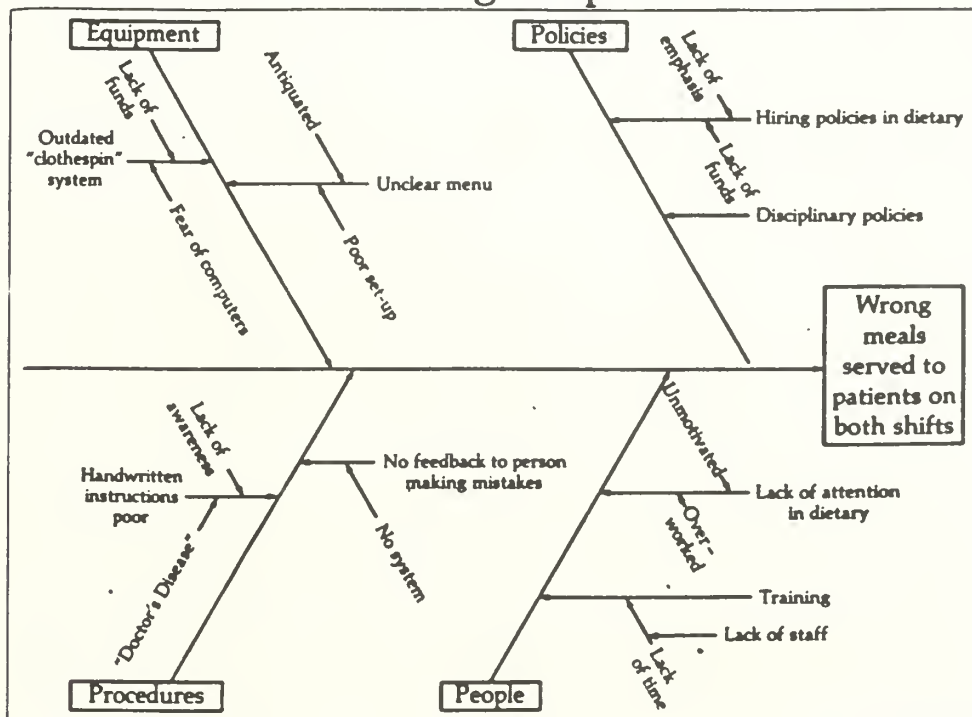


Ishikawa, whose *Guide to Quality Control* was written for Japanese workers and is now the most widely read book on basic statistics for quality in the United States, outlines these benefits from cause-and-effect diagrams:

1. The creation process itself is educational. It gets a discussion going, and people learn from each other.
2. It helps a group focus on the issue at hand, reducing complaints and irrelevant discussion.
3. It results in an active search for the cause.
4. Data often must be collected.
5. It demonstrates the level of understanding. The more complex the diagram, the more sophisticated the workers are about the process.
6. It can be used for any problem.³

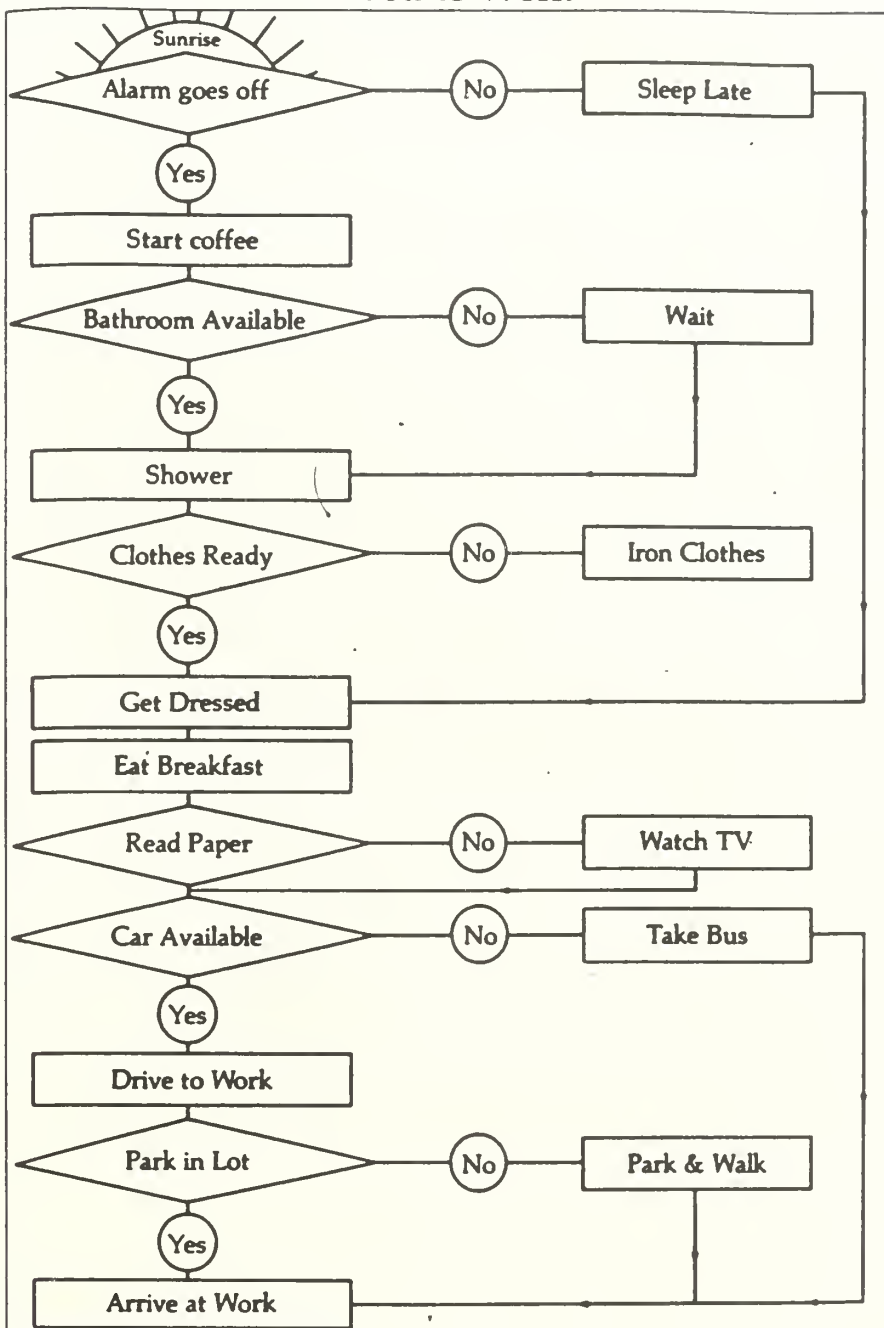
In an actual case, a hospital used a cause-and-effect diagram to examine the reasons why patients were receiving meals that were different from the orders they had placed. Afterward, the hospital staff targeted some of the causes for data collection.

Cause and Effect: "Wrong Hospital Meals"



—GOAL, Memory Jigger

Flow Chart: "From Bed to Work"



Pareto Charts

Pronounced *pah-ray-toe*, these are among the most commonly used graphic techniques. People will speak of "doing a pareto" or say, "Let's pareto it." This chart is used to determine priorities. The pareto is sometimes described as a way to sort out the "vital few" from the "trivial many."

Suppose, in our continuing example of a morning routine, you would like to leave the house at 8:15, arriving at work by 8:45, so as to have a fifteen-minute period in which to relax—or a cushion against being late—before work begins at 9 A.M. More often, you leave by 8:30 A.M. and barely make it. You decided to keep track of the things that interfere with your departure for sixty days. You are sure that waiting for the bathroom is a major cause. And you know that getting caught up in reading the paper is a delay. So is the pesky garage door, which occasionally sticks. Sometimes you can't resist hitting the snooze alarm.

In your research, you might use a checklist, a good way of collecting data.

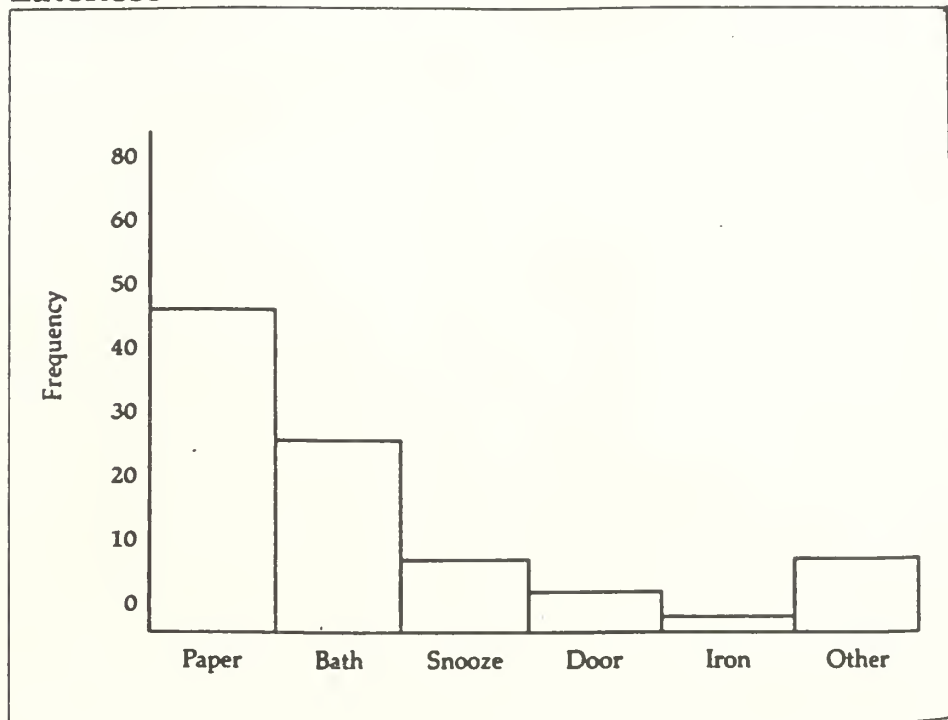
Here are some possible results:

Conditions That Might Cause Lateness (Some days have more than one occurrence)

CAUSE	NUMBER OF TIMES
Reading paper (more than ten minutes)	45
Bathroom delay	20
Snooze alarm	8
Garage door	3
Having to iron	1
Other reasons	9

These incidents could be displayed on a pareto chart.

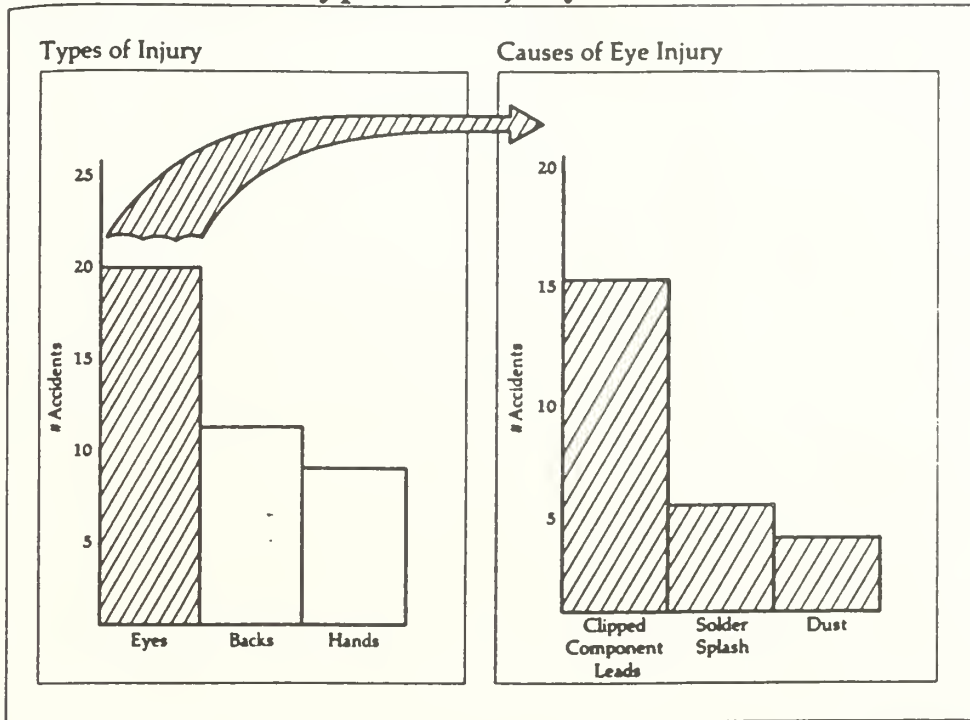
Pareto Chart: "Conditions That Might Cause Lateness"



As a result, you might make some changes. Switch to an afternoon paper. Get up earlier. Buy a clock without a snooze alarm.

At the printed circuit board plant, management organized a safety campaign at the employees' request. A team gathered data on accidents, then used a pareto to diagram the findings. Eye injuries were more common than any other. The team then researched causes and again made another pareto chart. The largest number of eye accidents occurred during the process of clipping the wire leads of components after they were soldered to the printed circuit board. In this fashion, pareto charts can be used to narrow down problems.

Pareto Chart: "Types of Injury"



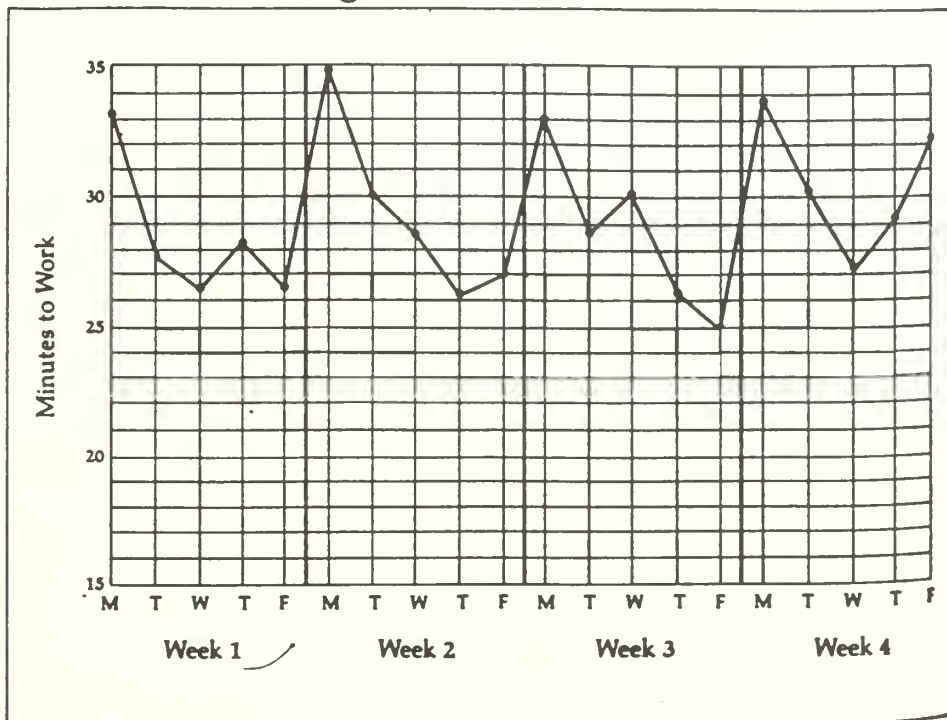
—GOAL, Memory Jogger

Run Charts

A run chart is perhaps the simplest of the statistical tools. Data are charted over a period of time to look for trends. Sales per month over a period of a year is a typical use.

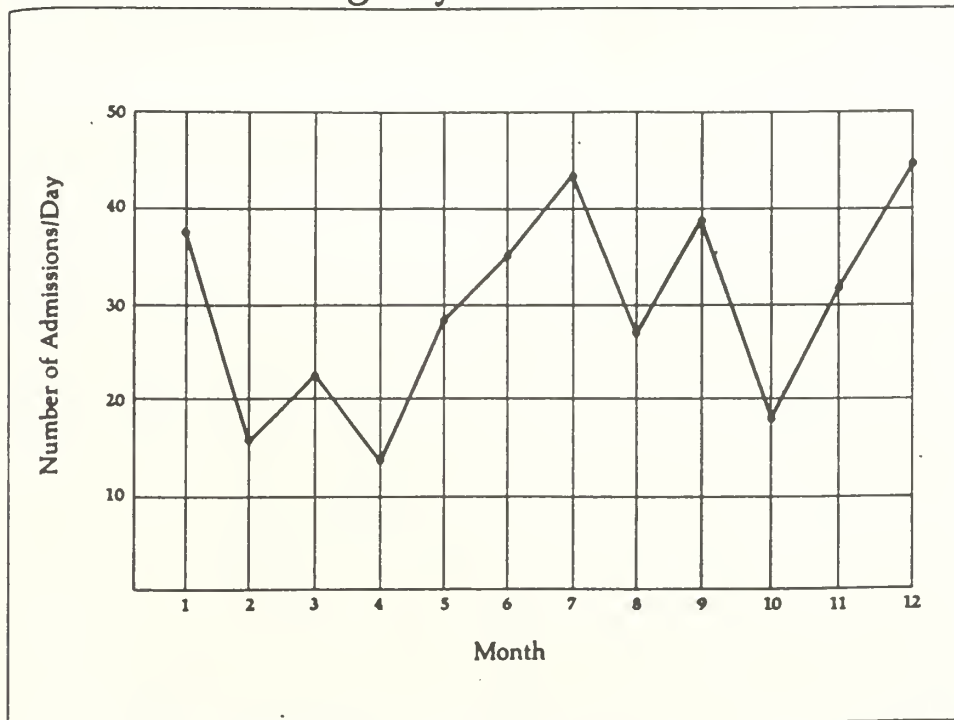
A run chart could be used to track the number of minutes it takes to get to work. You discover that it always takes longer on Monday, and accordingly you allow more time.

Run Chart: "Getting to Work on Time"



A hospital found that its emergency room was often either overstaffed or understaffed. It took the data it already had on emergency room cases and made a run chart. Admissions had been highest during January, July, September, and December. One might speculate that holidays and weather were a factor. The hospital decided it needed more information, investigating past years to see if the same pattern existed. It also used the run chart as a guide for conversations with the admissions staff.

Run Chart: "Emergency Room Admissions"



—GOAL, Memory Jogger

Histograms

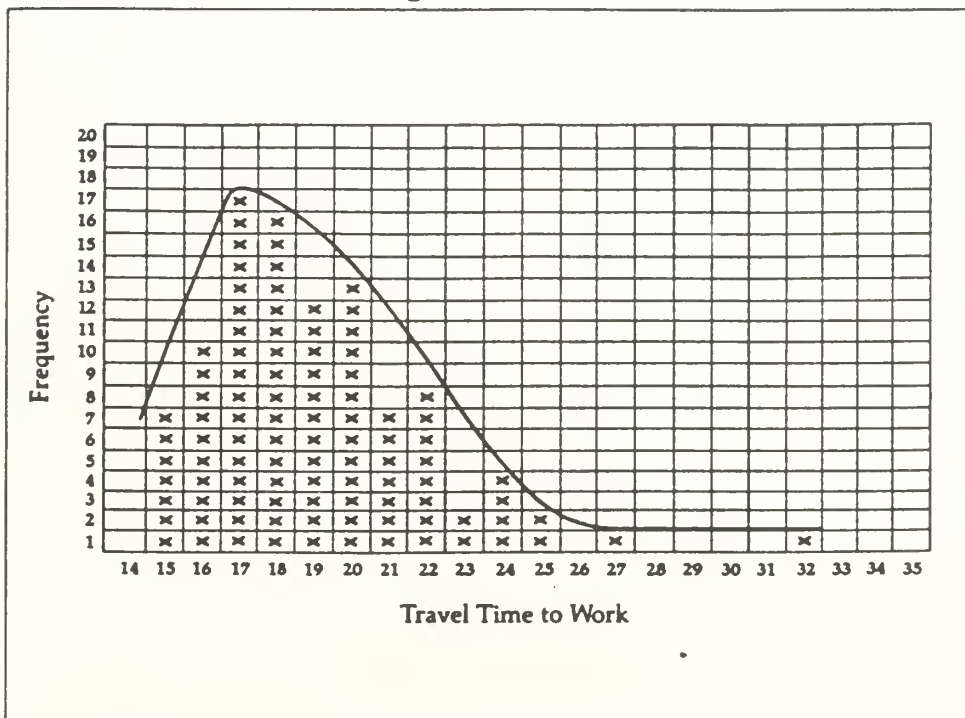
A histogram is used to measure how frequently something occurs. Suppose, for example, you are wondering just how much time you should allow for the drive to work. On good days you can make it in fifteen minutes. Every so often, you hit a traffic jam, and it takes forty-five minutes. What is "normal"? Clearly, not the average of the two. To find out, you might—if you're really committed to this project—collect data for, say, a hundred working days.

Hypothetical Commuting Times

15 16 20 15 18 17 20 18 17 19 23 20 21 21 16 15 17 21 17 17
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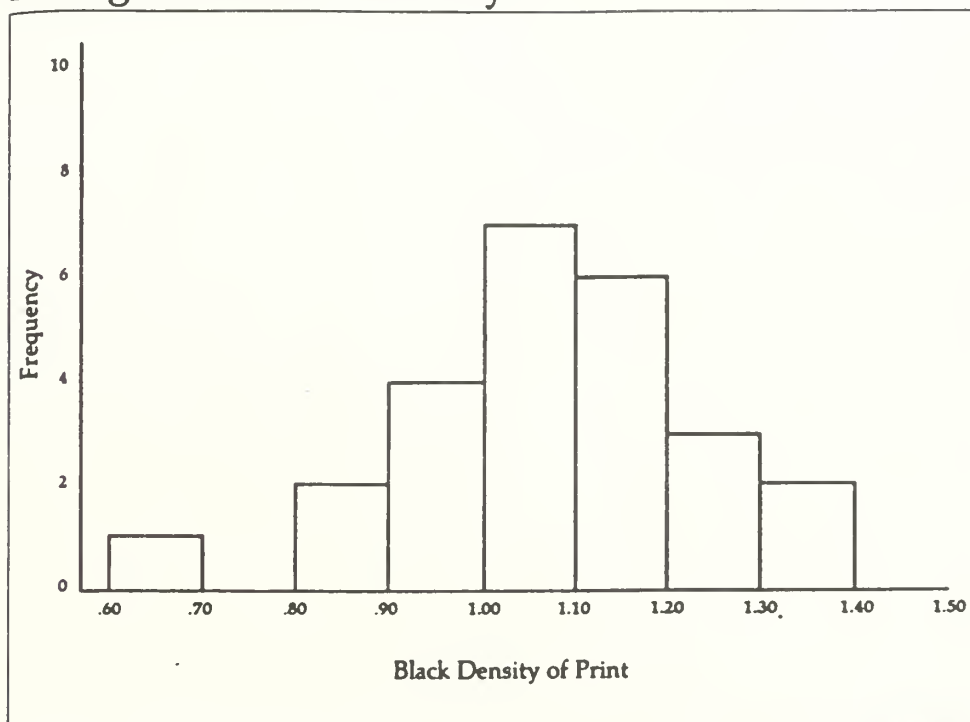
The data show that the longest trip was thirty-two minutes; the shortest, fifteen. All but two of the trips fell between fifteen and twenty-five minutes. On a histogram, there is a distinct curve.

Histogram: "How Long to Get to Work"



A print shop was receiving complaints about the quality of its finished product. Some customers thought the print wasn't dense enough. The shop measured the density over a period of time, then organized the results by frequency on a histogram to see where the bulk of the measurements fell.

Histogram: "Print Density"⁸



—GOAL, Memory Jogger

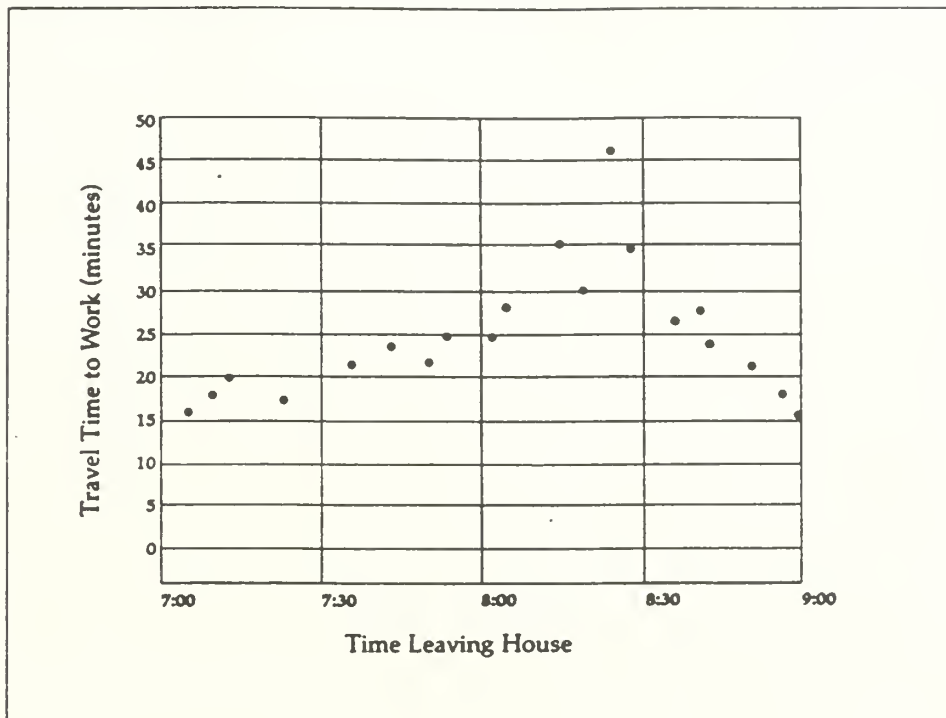
Scatter Diagrams

A scatter diagram is a method of charting the relationship between two variables.

Continuing our example, suppose your office has just instituted flextime. You may come to work anytime between 7:30 and 9:30 A.M. and leave eight and a half hours later. You would like to choose your hours to minimize drive time.

Over the next month, you leave the house at various times between 7 and 9 A.M. and record how long it takes you to get to work. On a scatter diagram, the two variables show a distinct relationship.

Scatter Diagram: "Drive Time"

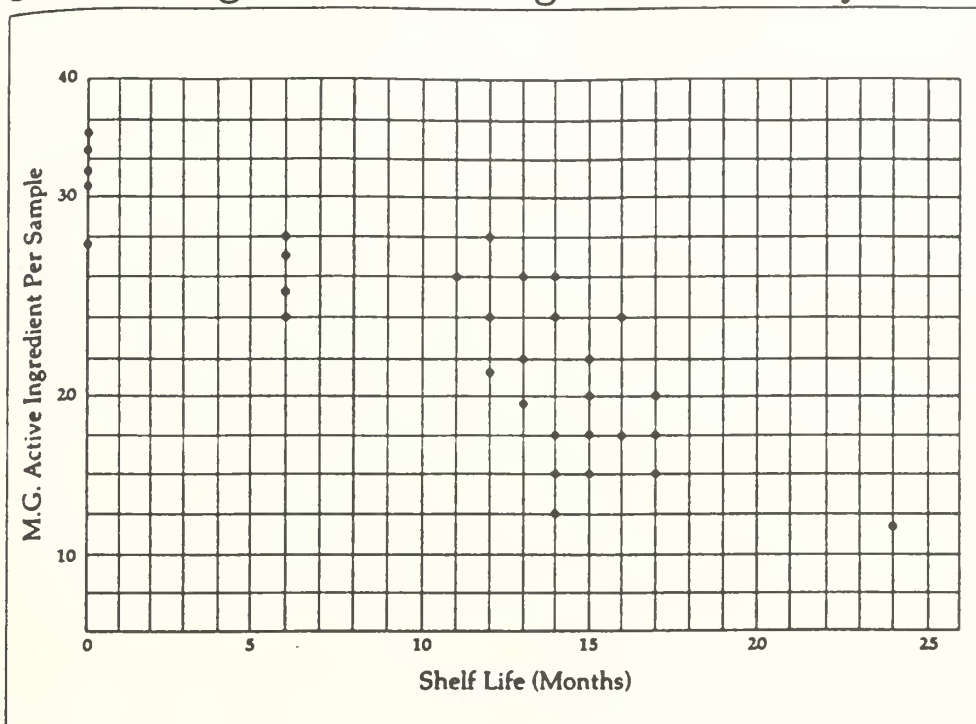


Leaving before 7:30 or after 8:30 greatly shortens the trip. You much prefer leaving later, and it eases competition for the bathroom. You tell your boss you will work from 9:30 A.M. to 6 P.M.

A manufacturer wanted to know whether there was a correlation between shelf life and the stability of his product. A scatter diagram showed that indeed there was.

In business, a scatter diagram might be used to chart the relationship between a worker's training and the number of defects, between moisture content and durability, between light levels and computer errors.

Scatter Diagram: "Active Ingredient Stability"



—GOAL, Memory Jigger

Control Charts

Dr. Deming often talks about the need to use control charts to analyze processes. The purpose, he emphasizes, is "to stop people from chasing down causes." Properly understood, a control chart is a continuing guide to constant improvement. Control charts are easy to use and certainly not beyond the capabilities of most workers. But even experts, notes Dr. Deming, on occasion "find them extremely difficult to interpret."

Writes Dr. Deming on this subject, "The production worker requires only a knowledge of simple arithmetic to plot a chart. But he cannot by himself decide that he will use a chart on the job, and still less can he start a movement for use of charts.

"It is the responsibility of management to teach the use of control charts on the job [ongoing] where they can be effective."

He sounds this cautionary note: "Proliferation of charts without purpose is to be avoided."¹⁰



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