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"William Edwards Deming, T.Q.M.'s Prophet"

by

John E. Fulenwider, PhD

Holland, MI 49423

Introduction:

Encroachment into our sacred industrial goods market a decade after the end of WWII

Starting in the early 1960's many U.S. Industries were beginning to feel the encroachment in their market areas of high quality foreign products, particularly from companies with strange sounding names, like Toyota, Ricoh, Matushita and the like. Japanese Companies were shipping to our shores quality products in the automotive, copier, and printer areas. Remember too, this was fifteen years or so after we had beaten the Japanese war machine in World War II with our fighting forces that were supported by our technology and overwhelming manufacturing capabilities.

U.S. was the only source of manufactured products that the rest of the world needed; and almost any system of management will do in a seller's market. I witnessed this in the telephone industry.

Soon we would see Japanese telephone switching equipment being sold in those sacred domains of USITA, the United States Independent Telephone Association, comprised of some 1400 independents. Automatic Electric Company, AE, the telephone system manufacturing arm of GTE, was losing sales because of the importation of Nippon Electric Company NEC switches to many USITA companies. They couldn't wait for the AE product, the famed step-by-step automatic telephone office, built around its equally famous Strowger Switch. AE would see sales dwindle, as electronic automatic exchanges, from NEC and others led the charge to modernize telephony.

AE's business mentality

AE was struggling in the 1960s to get into manufacture of its EAX product, a wired logic electronic exchange. The business process mentality at the time in AE was to receive orders for 5, 10, or 20 thousand lines of switching equipment from a customer, write up the order and put it in the factory queue; manufacture the switching equipment according to the standard recipe; ship the product; and wait for the next order. The telephone operating companies were on a fast track to expand their systems to meet the growing demand for telephone service. What AE sold was plain ordinary telephone systems or POTS. It was sort of like Henry Ford's philosophy: " sell them any color as long as it's black " In the same vein AE took scant interest in the feedback from the customer as to what features they wanted.

Most USITA companies were asking more and more for touch tone telephones, and switches that would work with them. They wanted central office Centrex. AE company could supply the phones but their Stowger switching offices just could not handle the touch calling; Stowger step-by-step switches could only follow dial pulses, not tones, and Centrex was a ways off in the future.

Meanwhile the research department struggled on.

Automatic Electric company, was run by accountants who were very concious of the bottom line. For example, I had to plead and beg in order to procure a $10,000 analog computer (at that time a digital computer to do the same work would have been $10 million) for my group to perform simulation studies for a new microphone design. Top management felt that research and engineerng was needed, after all other companies had these groups, and A.E. should budget about 3 to 5 % of revenues for this activity. My department knew that in 1960 transistors, circuit logic, and memories could be assembled into electronic central offices,"of the future". It was hard to keep our focus, what with the inter-departmental in-fighting and "fires" that had to be put out.

After hearing a lecture by Professor George S. Odiorne from the Business School at the University of Michigan I hired him to give our managers a short couse on "Management by Objectives." We thought MBO was the best thing since sliced bread at the time.

But AE's upper management couldn't be uncoupled from their pre-WWII business approach of "order filling, manufacturing to old designs, build, and sell, sell, sell." However, we in the research department practiced Management by Objectives. Despite the inter-departmental in-fighting we managed to design and build GTE's first working prototype stored program controlled electronic central office. That was in 1966.

First read about Dr. W. Edwards Deming in book: Japanese Manufacturing Techniques, by Richard J. Schonberger--Free Press 1982--sent to me from editor after he saw my remarks in WSJ, Jan 13,1983 about Japanese targeting communications market.

About 20 years passed before I became aware of the approach to business management taught by Dr.W. Edwards Deming. In a nut shell he preached what engineers would call **closed loop feed-back control** of the business process. The prevailing methods in U.S. industry with few exceptions could be called **open-loop control** of the business process. AE's approach had been just that: "**order filling, manufacturing to old designs, build, and sell, sell, sell**." Dr. Deming didn't believe in MBO either, as it too often erected goals that bore no connection to how those objectives could be reached. By definition he said, MBO focusses on the goal and not on the process. Without that there can be no real improvement in quality he said.

Dr. Deming's teachings had propelled Japanese industry into a level of quality superior to ours. Consumers loved it.

Deming's teachings had helped in the **astounding recovery in Japan after WW II,** and only in the last ten years or so have his ideas helped those American enterprises that would listen. His ideas influenced the International Standards Organization to formulate the ISO-9000 approach to product standards, an absolute must for companies that would compete in the international marketplace. His philosophy laid the groundwork for total quality management or TQM.

Today many of our industrial giants, starting with Ford, Xerox, Nashua, Florida Power and Light, and now reluctantly GM, hired Dr.Deming to teach them how to improve the quality of their products. These and many others, including AT&T embrace the Deming approach. Unfortunately Dr. Deming died in 1993 just as his philosophy on management had started to become widespread. His many "students" and followers carry on the good work.

Never having met the man, his successes left a strong impression on me: he called a spade a spade with no holds barred, and more than once called top management people on the carpet during his lectures to them. In 1983 at a conference of auto executives at the Society of Automotive Engineers Dr.Deming blamed Jim McDonald president of GM for 85% of GM's problems. If he felt that the 'big shot' was doing it wrong, Deming would tell him! -- that's my kind of guy. And he was invited back to give more lectures. I was determined to find out more about him, like:

Who was this man that the Japanese industrialists embraced as their Guru?

Where did he come from?

What were his theories and how did he evolve them?

This paper will attempt to answer these questions.

A Brief Biography:

Born in Sioux City, Iowa

William Edwards Deming was born October 14, 1900 (he would be 99 next Thursday)in Sioux City, Iowa to William Deming and Pluma Irene Edwards. *His maternal grandmother was Elizabeth Grant, a relative of General Ulysses S. Grant. So Deming had good solid American roots. His earliest American ancestor was a Major Jonathan Deming who was in the British Army during the American Revolutionary War. Major Deming's home was in Colchester, Connecticut, and the parlor in his house was later transported to the American Museum in Bath, England as an example of the way Colonial bourgeoisee lived.*

Moved to farm near Polk City, Iowa

Deming lived up to age two in Sioux City, then the family moved to his grandfather Edwards' farm near Polk City, Iowa. *They lived simply on the Edwards Farm, and they were **lean years** at that. Deming recalls that he and his little brother Robert were dressed in one-piece overalls which his mother made and they went barefoot around the farm. One time he stepped on a nail, contracted **diphtheria**, so he got to see his **first automobile** when the doctor came to his aid.*

Moved to Cody, Wyoming

His father, William Deming, headed west to Wyoming in pursuit of free land around 1906. The rest of the family followed taking the train all the way to Cody.

The town was named after Colonal William Frederick Cody ("Buffalo Bill"), the army scout, buffalo hunter, and then creator of the Buffalo Bill's Wild West Show. Cody, Wyoming was a lively place, boasting at least eleven saloons. William,Jr. and his brother Robert saw Buffalo Bill a lot in that small town.

The Demings lived in a boarding house on the grounds of the Irma Hotel (named for Buffalo Bill's daughter) while in Cody. William, Sr. worked as a law clerk, and his mother, Pluma Irene, gave piano lessons to augment their income. *Deming developed a love of music and learned to play piano, organ, piccolo, and flute. He retained this musical grounding throughout his life. He was a shy and bookish young man, but the music served him well later on in Japan where he recalls lots of sing-alongs during late night parties, and dinners following his management lectures.*

Moved to Powell, Wyoming

They moved from Cody to Powell about 25 miles away, where they received a 40 acre plot for their homestead. *[Powell, Wyoming was named after John Wesley Powell, a geologist, a civil war veteran, who had lost an arm, but had surveyed the Colorado River. He was also known as "father of reclamation". He advocated the US Government develop irrigation projects in barren places like Wyoming. Near Powell, construction of a 300 foot dam across the Shoshone River was underway.]* The Demings lived in a tar paper shack about the size of a freight car for 5 years or so until 1912. *His father was not a successful farmer, so he built houses on the property and sold them at a profit; he also sold insurance, drew up wills, sold land, and made loans to farmers. His mother again taught piano. Deming's little sister Elizabeth was born in 1909.* Deming contributed his earnings from after school work hauling wood and coal for a local Hotel, and from lighting Powell's gasoline street lamps.

Deming's hard scrabble childhood experiences, his awareness of the hard times around him forged a life pattern of dilegence, frugality, and abhorrence of waste that lasted the rest of his life. *In the later years of his career he would collect from each of his half dozen or so clients annual fees of $30k to $120k annually plus $40k to $100k for his four day seminars. Yet he and his wife Lola remained in the modest brick home purchased during the "depression" in Washington in Amercan University Park, near the Maryland border. Deming had his office in the basement and ran his consulting practise from there.*

Schooling, marriage and a daughter.

He earned a B.S. in engineering at University of Wyoming in Laramie, in 1921. He remained a year for more studies in mathematics, and taught engineering.

He taught physics the following year at Colorado School of Mines, Golden, then enrolled for master's in mathematics and physics at University of Colorado, Boulder. Deming courted and married a young school teacher named Agnes Belle in 1923. They adopted a daughter, Dorothy.

In 1924 a professor encouraged him to continue his studies at Yale. It was there that he earned his Ph.D in physics, in 1928. In 1927 Deming took a job with the U.S. Department of Agriculture to work in the fixed nitrogen laboratory to analyze its effect on crops.

Agnes Deming died in 1930.

Two years later Dr.Deming married Lola Shupe, a mathematician who had come to work for him. Together they authored several papers on the physical properties of gases. His second daughter Diana, was born in 1934 and his third, Linda, in 1942.

Deming Starts to Form His Theories

Between the MS studies in Colorado, and earning the doctorate in physics from Yale in 1928, he landed two summer jobs in a row at the giant Hawthorne Works of Western Electric, based in Chicago. **He was mentored by Walter Shewhart, a physicist at Bell Laboratories, author of *Economic Control of Quality of Manufactured Product* in 1931.**

Shewhart experimented with manufacturing process control charts at Western Electric and **developed the concept of continual improvement**, later to be known in Japan as the Deming Cycle. Shewhart had defined the limits of random variation in any aspect of a worker's task, setting acceptable highs and lows, so that any points outside those limits could be detected and the causes studied. **Workers could be trained to do this charting themselves, giving them greater control over their jobs** and allowing them to make adjustments on their own. Shewhart was attempting to introduce statistical process control, SPC, at Western Electric, and his theories of quality control would become the basis of Deming's later work. Deming absorbed these ideas, refined them to involve other parts of a company, and its suppliers, but he also broadened them to include the customer.

Those jobs at Western were the most formative experiences of his career, where he saw telephone equipment being assembled such as relays, and switches, by thousands of workers (there were 46,000 employed there at the time, mostly women). It was drudgery, monotonous, in hot and dirty conditions; workers complained of smoke, fumes, and extreme temperatures. Deming's ideas about job incentives and management's responsibilities to its workers grew out of work conditions he saw at Western Electric.

Coincidently during Deming's stint at Western, a group of reseachers headed by Prof. Elton Mayo, Harvard Business School, and some AT&T managers studied work conditions, workers output, and supervisor's methods right at the Western Electric plant.

The studies showed that **output jumps when resources provided to workers improved**, when **trust and cooperation are fostered** between workers and supervisors, when **fear in the workplace is eliminated**, and **monotoney reduced**. It was **counterproductive to pay workers according to a "bogey" or piecework system**, since they'll never exceed a certain level of production for fear that their pay standard would be continuously ratcheted upward.

These results ran counter to the famous, and widely used F.W.Taylor time-and-motion studies, which had been honored by many companies right up to the 1980's--companies expected workers to "check their brains at the door" when they came to work in the morning.

Deming helped to pioneer the use of statistical sampling techniques in the 1940 census.

In previous censuses, every individual had been polled, a process that was "complete but abhorrent because it was so incredibly time consuming", as Deming put it. **But the idea of sampling was extremely controversial.** His lectures on statistical sampling in the *Graduate School of Agriculture*, in Washington, influenced the 1937 unemployment survey where the survey was based on only 2 per cent of the population. The Bureau determined that eleven million had been out of work; two thirds were men, for example.

Those who remember their statistics may **recall that a surprisingly small number of random samples** (in this case they are measuring if the man is out of work or not) taken of the population **yields a "picture" of the total population** true within narrow confidence limits. [see Feller]

Deming became convinced that 100 per cent inspection was not useful nor necessary. This became clear as the 1940 census questionnaires poured in, data to be entered on millions of punch cards; they had 1750 keypunch operators and verifiers to make sure that the information was entered correctly. They inspected every single card, but since inspectors' pay was tied to volume of cards processed, encouraging speed not accuracy. Also inspectors were friendly with keypunch operators, so errors were overlooked for fear of getting friends in trouble. **Deming would sample 5 percent of operators**, analyze those results to find which ones were out of control. For those that were out, the operators were retrained.

Deming designs statistical control courses for the war effort

Soon after our entry into WWII Deming was called on to help improve wartime production. He designed a national program of 8-day and 10-day courses on statistical techniques in quality control for training engineers, and production people for the war effort. Deming based much of the work on Shewhart's methods, control charting techniques, and the four step "Shewhart cycle", a pre-cursor to the Deming cycle mentioned above. Study groups that formed at the time eventually evolved into the American Society for Quality Control.

Deming is Called to Japan

Two years after the Japanese surrender in 1945, Dr.Deming was summoned to Japan by the administration of General Douglas MacArthur, **Supreme Commander of the Allied Powers (SCAP),** and head of our occupying forces there. Deming worked with Japanese statisticians to develop their 1951 census. This would help determine such things as the amount of new housing needed to accomodate the vast homeless population as a result of our bombing raids during the war.

Deming traveled widely then and got to know Japan. He saw some of the misery on the streets there. He saw the wrecked remains of heavy industry running all the way from Tokyo to Yokohama -- twisted steel, and broken concrete. The industries were dead, but he remarked that the people were hopeful, happy, clean, and though they were hungry, looked forward to another day. Deming felt compassion for the Japanese although many of his American colleagues looked with disdain on their former enemies. *He saw a father,a little boy and girl near a bridge in Tokyo huddled together and in tatters. He went to the PX, bought two packages of doughnuts (it was all they were carrying then) and went back and gave them to the family.*

Our government and political interests were actively engaged in fostering a prosperous Japan, a trading partner, and a bulwark against the spread of communism in that hemisphere. Japanese industry **had to be wrenched around from war-type products**, to one that would produce consumer goods for the Japanese population and export.

Interestingly enough it **got its start in the communications industry**, because MacArthur issued a directive that **every second household had to have a radio receiver** to enable communication within Japan. But they didn't have the facilities to build even a fraction of the radios needed. So work began on manufacturing radios. The Civil Communications Section (CCS) of **SCAP stepped in with a series of management lectures** for Japanese communications industry people.

There was **a segment on quality control delivered by experts including Homer Sarasohn, whom I worked with later at Booz-Allen & Hamilton in 1955.** Sarasohn's point was that **quality control was to prevent rejects before they occur**, and that improving the quality of products and processes ultimately reduces costs. Pretty basic stuff, and **Sarasohn emphasized the importance of inspection; inspectors were the gatekeepers of quality.** Sarasohn's approach written up in a 36-page report became standard practice at leading U.S. companies, each with a constabulary of inspectors. The gist of it was that **you manufactured a part** that went into a product, **put the parts into a bin**; later an inspector would then take the parts one at a time and **pass or reject them on the spot**. This was a step in the right direction, since the rejects if included in the final product would have created more expensive rejects of the final product later on. But the **time sequence of the variations, showing up as trends** which would lead to taking corrective action earlier in the process, **were lost**. Not until much later in the 1980s did these industries see the light and begin using Deming's SPC model, and process control charts.

Deming Helps the Japanese Industries

In the '50s Deming gave lecture after lecture on statistical quality control methods, demystifying the more theoretical approaches presented earlier by Sarasohn's department at CCS in Japan. **He gave simple explanations**, and adequate demonstrations in his lectures *[for example the funnel experiments];* they were **so effective and persuasive they left unforgettable impressions on the minds of those attending** them. Koji Kobayashi who later became **CEO of NEC Corporation** was soon a believer in the Deming approach; others include **Shoichiro Toyoda, President of Toyota**, and top managers of companies such as **Komatsu, Ricoh, Toshiba, Bridgestone, and Matsushita.**

The Japanese companies learned rapidly, and began to use what they learned at Deming's lectures. The **Union of Japanese Scientists and Engineers (JUSE)**, a very influencial group in Japan, **created in 1951 a quality award they dubbed the Deming Prize.**

Deming wouldn't accept the royalties that JUSE had received from publishing Deming's lecture notes from his previous visits to Japan, so out of appreciation they used the money to establish the quality award. **JUSE then parlayed the Deming competition into a national event** that has played **a crucial role in shaping Japan's management agenda**, and in developing what's now known as total quality control or TQC.

Deming Theories of Management and some Examples:

The Deming quality management philosophy is summed up in four words: **plan, do, check, act.** When expanded he is saying : plan the product or service with the help of consumer research -- then do by making the product and -- check it, that is compare what you've made with what you've planned; -- act, by marketing the product or service. Then Deming closes the loop on this process back into the plan step again by getting feedback on how the quality, price, and features of the item are received by the consumers, both those who buy the product and those who choose not to buy it; from this you plan an improved product and repeat the cycle.

So the basic Deming Process for marketing "widgets" is this closed loop starting with the Consumer. As part of the planning process you do consumer research to find out what they want and plan how to make the widgets.. then do make the widgets... market the widgets... consumers buy the widgets (some do not buy the widgets).. do consumer research to find out what they liked about the widgets, or what they didn't like about, and what caused them not to buy. Then go around the loop again...etc...etc.. Each iteration of the cycle improves the product, by reducing the variation between what was planned and what was produced.

Japanese manufacturers have a name for this ..*kaisen*..meaning continuous improvement. Deming stressed the importance of viewing quality concepts as part of a holistic new management philosophy in which every member of the organization must play a part. One department acts as the "consumer" for another department so that inside a department there is a plan-do-check-act cycle.

Take the manufacturing department for example: they have worked with marketing, and engineering and developed a set of plans--manufacturing drawings, these are used by the workers on the factory floor: in the process of do-ing, they must use a quality control chart with time and date plotted horizontally, and enter each sample's dimensions along with time of sampling, for example, and check if the values drift out of the control limits. This is to be done religiously. If there is a drift in one direction say, then something has gone wrong with the process--the tool is wearing out, the incoming materials aren't what was required, etc,etc. If the variation is caused by the tool for example, then act and change the tool. But if the variation is caused by the incoming materials then other layers of management are involved, then act by getting them to make the corrections necessary. That is why Deming stresses that every member of the organization plays a role in quality control.

Now suppose the supplier of the materials that the widgets are made from did indeed change the metallurgy (for example to increase his profits); you as the "consumer" in the plan-do-check-act cycle discover that the widgets produced from this material have sharp edges or are brittle and are unacceptable (a special cause variation). As part of the total quality process you would go back to the supplier and get him to reduce the variation--change the metallurgy again.

Here the beginnings of TQM requirements start to take shape. If the supplier had been trained in the Deming philosophy of reducing variation, he would willingly work with the maker of widgets to come up with a material that would satisfy the widget maker. Early on this hadn't occured in many U.S. companies. If the widget manufacturer wants to be competitive his suppliers must be "trained" in this approach. Certainly the supplier should be willing to be trained if he wants to continue being a materials supplier to the widget manufacturer. Thus suppliers must be folded into the process in order to reduce variation. In the Deming approach a manufacturer works toward winnowing down the many suppliers to a single supplier of a particular part.

Deming said that TQM works upwards in an organization as well. He saw that many companies consisting of engineering, manufacturing, finance, sales, administration, were run by managers that were protective of their individual fiefdoms. They had built "chimneys around themselves" as once remarked by a manager in the Pontiac division of GM. Management knew they were in the business producing a good, or providing a service, yet there were barriers betweeen the different departments, petty jealousies, and inter-nicene "wars". Decision making was left to the top management. Product ideas sometimes were dictated from the top, they were engineered, manufactured and it was up to the sales group to market the product. The finance group approved purchases of materials, machine tools, and the like, always with an eye on the bottom line so that if materials, or tooling could be bought for lower prices somewhere other than where the originator had specified, they would do so. **Often there was no feedback between departments**.

Deming would have been appalled at this. His remedy is *plan, do, check, act,* and it is **applied to each department in an organization**. Quality is defined by the customer; he says 'if the product I buy is shoddy, I'll never buy another one from you'. Deming said that survival meant planning the product with the help of consumer research, and that early designs were to be based on those inputs. Market research by the sales department finds out what the customer wants, discusses this with the engineering design teams, with manufacturing to prepare them for retooling, and the financial group must be a part of it as well, for quality must not be compromised through saving a few dollars by procuring from the lowest priced supplier. Management at the very top of the organization must be committed to quality improvement and must have an understanding of the means by which systematic change is to be achieved. Their commitment sets the tone and filters down; improvement can't come from middle managers and workers just trying harder. When a company is not committed to continuous quality improvement the ones who suffer most are the employees.

With entrenchment of the old methods of management the boss tells the underling what he wants -- **without any consideration of the feasibility of achieving the goals** -- and then expects at some future time to review the results. This happens so often in industry. These bosses have arrived at their positions many perhaps for the wrong reasons. They defend their positions; there is palpable competition amongst the bosses at his level; each seeks to stride ahead of the competition; they are secretive; politicking is rampant; they avoid making serious decisions; they expect and demand "good news" from their subordinates; they are surrounded by layers of "insulation". don't answer the phone directly, a secretary guards the entrance to the office.

What Deming says in arguing against MBO is that the boss and the employee

must discuss these goals and arrive at a way that they could be accomplished, and the two of them get together along the way. Getting together along the way is analogous to the "process control chart" and sampling off the production line. This process requires that the boss's boss have worked out a similar arrangement for his goals.

An example of lack of inter-departmental communications was at Automatic Electric where the Sales department found from a marketing study it made that the largest market existed for telephone exchanges of the 2500 lines size(@ $300 per line). There was a market for over 1500 of these exchanges in the independent industry in the 1960's(over a billion dollars). Yet the EAX was being developed by the Engineering group AE (at a cost so far of 50 million dollars) to handle 25,000 lines or larger, for which there was a market of only 50 machines (about 375 million dollars). NEC was shipping the 2500 line exchanges at the time.

Deming on Merit Increases

Most managers in a large company such as A.E. are competent, and smart individuals. Typically they are rewarded on a merit system which tends to give increases according to **a bell shaped ranking curve**. At salary review time some individuals get no raises, leading to a defeatest attitude and low morale, others get big increases, while the middle group, probably 80 %, get a cost of living increase. But the problem with this approach as pointed out by Deming is that **it promotes competition within the "population" so that each person strives to be the star;** which tends to create fear, stifles communications by promoting secrecy, and erodes teamwork. This merit system is usually applied rigidly to each layer of management, **so that whole departments operate as fiefdoms** where sales, engineering, manufacturing, finance **each operate to promote their own worth** as if they were separate companies operating under the same roof.

All of the above seems so common sense, of course you say "I've heard that before"; or "it's so obvious". Well of course if it was so obvious why didn't U.S.companies practise this philosophy more? Entrenchment of old ideas like those at Automatic Electric and take a lot of time to change. Some companies don't change.

Areas where total quality management could be put into good use today are in Air Traffic Control; in Hospital management; and in Federal, State, and Local Governments.

Conclusions

Deming laid the groundwork for total quality management, after being well steeped in practical values. He had a solid education in math, physics, and statistics. He was an excellent teacher, and believed strongly in his subject matter. His presentation was not flowery nor just wind, and he could be quite ascerbic when necessary. Deming lectured at Hope College in 1992. Deming lectured to US industry right up until his death. It is hard to imagine a man 93 years old travelling to the XYZ company, delivering a lecture on SPC, and TQM. He made an impact on today's management concepts. He is gone but not forgotten.

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Appendix

Deming's Fourteen Pointsof Total Quality Management:

None of these fourteen points stands on its own. Each is part of a holistic view to building customer awareness, reducing variation, and nurturing the growth of constant change and improvement throughout the corporation. The Fourteen Points are based on the following six principal ideas:

1.Quality is defined by the customer

2. Understand and reduce variation in every process. Each job in an organization is part of a process.

3.All significant, long-lasting quality improvements must emanate from top management's commitment to improvement, as well as its understanding of the means by which systematic change is to be achieved.

4.Change and improvement must be continuous and all-encompassing. It must involve every member in an organization, including outside suppliers.

5.Ongoing education and training of all employees are a prerequisite for achieving constant improvement.

6.Abolish the merit performance ranking system. It is destructive in a company; it impedes natural initiative; it creates more losers than winners; it batters morale.

The Fourteen Points

1.Establish constancy of Purpose

2.Improve constanly and forever every system of production and service

3.Eliminate numerical goals and quotas, including management by objectives

4.Drive out fear so that everyone may work effectively for the company

5.Institute Leadership

6.End the practice of awarding business largely on the basis of price

7.Break down the barriers between departments

8.Institue training on the job

9.Eliminate the annual rating or merit system

10.Institute a vigorous program of education and self-improvement

11.Eliminate slogans and exhortations

12.Cease dependence on mass inspection

13.Adopt the new philosophy

14.Create a structure in top management to accomplish the transformation

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