

The Germ Theory of Management

Myron Tribus, Director of Exergy, Inc., Hayward, California, and Director of the American Quality and Productivity Institute

Myron Tribus constructs an illuminating analogy between 19th century medicine and 20th century management in order to illustrate why it takes so long for us to think differently and adopt new theories that are designed to improve our lives.

Summary

In the decade or so since it first appeared, The Germ Theory of Management has been republished and downloaded countless times. It has been read and reread for its acute insight into the apparently perennial problem of why we struggle to adopt new theories that are aimed at improving our lives. It is thoroughly appreciated by those people who, having gained even a modicum of understanding and appreciation of the Deming philosophy, inevitably begin to ask the question "Why is this philosophy of management not more widely practised?"

Whilst the paper was clearly aimed at a U.S. audience, many of its observations on the difficulty of changing people's beliefs apply to virtually any community globally where it may, so far, only have reached a limited audience. The paper will be well known in some quarters in Europe but here too it has not been as widely read as it ought to have been.

Myron Tribus enables us to get an insight into this complex problem by brilliantly constructing an analogy with 19th century medicine.

It begins by examining the state of medicine in the middle of the 19th century when in all likelihood doctors were killing more patients than they cured. There was never any shortage of explanation for the fre-

quently disastrous clinical outcomes of medical procedures. None of these were right but the good doctors were held in such esteem by society and were deemed to be beyond reproach. That was until the work of Pasteur and Fleming provided a theory of infection and a means of disinfection respectively. Now the difficulty begins of trying to explain to the good doctors - the pillars of society, that they had a new set of beliefs to learn. Unless they changed their practices to take account of germs - that which they could not see and hitherto could not understand, they would continue to be a menace to anyone unfortunate enough to require medical treatment. In short, they had to "unlearn" most of what they had been taught, begin to think differently and rebuild their careers around a new theory. Conveying this disturbing realisation to the medical profession - that their careers had been based on the illusion of knowledge and conversely, if you are a doctor, learning for the first time of this new paradigm, placed both sides in positions of severe discomfort.

Tribus goes on to explain how many modern organisations become infected by a virus - the virus of variability - just as contagious and ultimately as deadly as the medical variety. It makes systems sick, they become congested with waste and emaciated; competitiveness withers away. Just

like the discovery of germs it takes new knowledge and understanding to be aware of its presence. However, thanks to the pioneering work of Walter Shewhart, it can be diagnosed and a rational approach to its treatment established. Despite the work of men like W. Edwards Deming, J. M. Juran and Homer Sarasohn who, just like Lister had understood the wider implications of the fundamental work, the treatment of variation in many modern organisations too often continues to be where the medical profession was when threads were left in operation wounds to let the pus drain out. Who will tell today's managers that they are doing more harm than good?

Examples are given of how variation can infect all kinds of organisations be they in the production or service fields and how we are complicit in accepting unacceptable levels of waste - the manifestation of variation. Furthermore, it is claimed that modern accountancy practices are allowing waste to be hidden and thereby, in effect, waste becomes institutionalised.

Tribus explores some of the solutions to this massive problem such as unlearning, re-education and new learning. Indeed if we are to rid ourselves of the disease that saps at our competitiveness we will need to institute a new theory of leadership and apply all the new competencies in order to **manage for quality**.



Myron Tribus

Myron Tribus, PE, is a consulting engineer, specialising in Quality Management and Cognitive Modifiability, with special emphasis on education. He is one of the co-founders of Exergy, a company specialising in the design of advanced, high efficiency, power production systems. He recently retired from Exergy after 12 years as a director. Before starting Exergy, he retired from MIT after 11 1/2 years as Director of the Center for Advanced Engineering Study. Before coming to MIT he served as a Senior Vice President for Research and Engineering for the Xerox Corporation, where he was in charge of Research, Development and Engineering for the entire line of XeroxCopiers, Duplicators and Telecopiers. Before that he served for two years as Assistant Secretary for Science and Technology in the U. S. Department of Commerce. For eight years he was Dean of the Thayer School of Engineering at Dartmouth College, where he introduced the Unified Engineering Curriculum and led the faculty in developing a curriculum based on engineering design and entrepreneurship. Dr. Tribus served for 16 years on the faculty of the College of Engineering at UCLA and two years on the Faculty of the University of Michigan. He has worked as a design engineer for the Jet Engine Department of the General Electric Company. In 1958 he hosted the television show "Threshold" for CBS in Los Angeles.

Dr. Tribus has published over 100 papers on topics ranging from academic subjects, such as heat transfer, fluid mechanics, probability theory, statistical inference and thermodynamics, to applied topics such as sea water demineralisation, aircraft heating,

aircraft ice prevention and the design of engineering curricula. He has published two books, "Thermostatics and Thermodynamics" (which provided the first textbook which bases the laws of thermodynamics on information theory instead of the classical arguments) and "Rational Descriptions, Decisions and Designs" (which introduces Bayesian Decision methods into the engineering design process). Dr. Tribus was active with Irving Langmuir in the pioneering days of cloud seeding and has published analyses of the role of statistics in weather modification.

Dr. Tribus has also published and lectured extensively on topics of social interest such as the position of engineers in politics, the decline of US competitiveness in world trade, the role of decision theory in political decision making and the role of technology in society. He has also written and lectured on the redesign of educational systems.

Over the last 20 years Dr. Tribus has become known through his writings on Dr. Deming's philosophy of management. He is one of the founders of the American Quality and Productivity Institute, which is devoted to teaching and promoting the fundamentals of quality management. The AQPI merged its efforts with the Transformation of American Industry project of Jackson Community College to form the Community Quality Council to foster the growth and development of community quality centers across the USA. This activity has recently been merged with the activities of the Association for Quality and Participation, which continues the support of community quality centers.

About a decade ago Dr. Tribus turned his attention to the theories and practices of Dr. Reuven Feuerstein, an Israeli Psychologist who developed the Theory of Structural Cognitive Modifiability. This theory, which has been in development for the past 60 years, has been used in many countries to increase the intelligence of people suffering from various types of learning disabilities. Dr. Tribus has become a certified trainer of teachers who take Dr. Feuerstein's methods into schools in different countries.

Dr. Tribus is a member of the National Academy of Engineering. He has served on several boards of directors and been a consultant to many companies and governmental bodies. He has received five awards for technical papers and public service and two honorary doctorates. He received the BS in Chemistry from the University of

California, Berkeley in 1942 and the PhD in Engineering from UCLA in 1949.

Dr. Tribus is married and has two grown daughters and four grandchildren.

Introduction

In a recent review of the Deming Theory of Management, William B. Gartner and M. James Naughton wrote (1) :

"Medicine had been 'successfully' practiced without the knowledge of germs. In a pre-germ theory paradigm, some patients got better, some got worse and some stayed the same; in each case, some rationale could be used to explain the outcome.."

Doctors administer to the needs of their patients according to what they learn in school and in their training. They also learn by experience. They can only apply what they know and believe. They have no choice. They cannot apply what they do not know or what they disbelieve. What they do is always interpreted in terms of what they understand is "the way things work". As professionals they find it difficult to stray too far from the common knowledge and understanding of their profession. They are under pressure to follow "accepted practice". In this regard, Doctors are no better and no worse than the rest of us. We are all prisoners of our upbringing, our culture and the state of knowledge of our teachers, mentors and fellow practitioners.

Today we smile when we read that after sewing up a wound with silken thread, the surgeons of 150 years ago recommended to leave a length of the thread outside the wound. This was done to draw off the pus that was sure to follow the insertion of unsterilized thread by unwashed hands using an unsterilized needle.

Changing People's Beliefs is not Easy

Try to imagine that it is now the year 1869. Pasteur has only recently demonstrated that fermentation is caused by organisms which are carried in the air. Only a few months ago Lister tried out the first antiseptic, carbolic acid, and found that it worked to prevent inflammation and pus after surgery.

120 years ago the spread of medical information was much slower than today. Imagine you are a young researcher in a medical school in the USA. The Civil War is over and you are trying to develop your own career after army service. You are a serious young doctor who tries to learn the latest developments in the medical pro-

fession. Suppose that you have just read about Pasteur's and Lister's work and that you have been invited to speak before a group of distinguished physicians, many of them having come to fame for their heroic service as surgeons during the American Civil war. What you now understand from your readings is that these famous physicians are actually killing their patients. Your responsibility is to explain to them, if you can, that because they do not wash their hands or sterilize their instruments, they sew death into every wound. Your assignment is to persuade them to forget most of what they have been taught, to abandon much of the wisdom they have accumulated over their distinguished careers and to rebuild their understanding of the practice of medicine around the new theory of germs. Do you think you could do it? Do you think you could convince them? Do you believe they will they be glad to hear you?

Suppose, instead of being the speaker, you are a member of the audience. You are one of the good doctors who have earned respect and prestige in your village. You have a nice house on the hill, a pretty wife, a nice carriage, some fine horses and a few servants. You are part of the elite of your society. How will you feel if someone starts spreading the word that your treatments are a menace, that the theories you hold are bunk and that your habit of moving from one patient to another, laying unwashed hands on each, guarantees the spread of disease to all who are so unfortunate as to become your patients? What do you think will happen to your practice if this kind of word gets bandied about? How would you be likely to greet the messenger?

The Origin of the Germ Theory of Management

In 1865 Pasteur was in the south of France to investigate what was killing the silkworms in the silk industry of France. He not only isolated the bacilli of two distinct diseases, he also developed a method to prevent contagion. Lord Lister applied this knowledge in medicine in the same year.

Thus was born the germ theory of medicine.

In the 1920's Walter Shewhart at the Bell Laboratories was asked what to do to increase the reliability of telephone amplifiers. These amplifiers were necessary to strengthen the signals in long distance te-

lephony and were placed about a half mile apart on long distance lines which the Bell System intended to place underground.

Unlike the doctors, the Bell System wanted to be sure the amplifiers were healthy so they could bury them! If the amplifiers died, they would have to be dug up.

The amplifiers were built using vacuum tubes, which were then notoriously unreliable. Shewhart's assignment, therefore, was to discover what could be done to guarantee the life of the vacuum tubes, to keep them from getting sick, so to speak. In the process Shewhart discovered the antiseptic for the virus of variability.

When a vacuum tube is assembled, if every component that goes into the vacuum tube is the same as in every other vacuum tube, if each tube is put together precisely the same way, if each is free of contamination, and if each is subjected to exactly the same load conditions, then vacuum tubes would all have exactly the same life. Their maintenance could be scheduled. It would be possible to determine just why and how vacuum tubes failed and to increase their life. However there is always some variability in materials; in processes of manufacture, in the training of operators, in the conditions of the workplace and in a thousand other factors. No two vacuum tubes will fail exactly the same way. If engineers and scientists cannot determine why vacuum tubes fail and they will not be able to increase their life.

Just like Pasteur's germs, variability is everywhere. It cannot be seen with the naked eye. The virus of variability can only be detected by using special instruments.

Germs are controlled by pasteurization. Shewhart showed how to measure the virus of variability, how to reduce it and how to keep it under control. In short, Shewhart invented the equivalent of pasteurization.

In the beginning people thought that Shewhart's approach was only suited to the manufacture of devices.

Just as Lister understood the broader significance of Pasteur's work to the practice of medicine, so too did Dr. W. Edwards Deming understand the significance of Shewhart's work to general management. Deming was not alone. There were other pioneers, such as Homer Sarasohn and J. M. Juran who also saw the broader implications of Shewhart's work to management. These men realized that the key to better management is the study of the processes whereby things get done and through such

study to learn how to reduce its variability and to obtain predictable results from all processes, even intellectual processes such as designing, planning and budgeting.

Shewhart's investigations thus laid the foundations for the "germ theory of management".

How the Virus of Variability Makes a System Sick

The first thing that Doctors had to learn was that germs, although invisible, could be transmitted by various means from one patient to another. They had to form new images of the world. They had to learn about sterilization and antiseptics. They had to believe it was important to wash their hands. They had to learn about germ cultures and the causes of infection.

Let us consider as an example how the virus spreads in manufacturing.

When the Nashua Corporation first started to work on quality, they chose as their first project the improvement of their line of disk packs for computers. They began by investigating the variability of the aluminum from which the blank disks are made. Although all the aluminum they bought was within tolerance, they found that some suppliers produced much more uniform alloys than others. They changed suppliers. The fraction of acceptable diskettes increased.

The smoother surfaces made it possible to pinpoint problems with the conductive coating so the variability introduced in the paint preparation could now be detected and reduced. The previously concealed problems with the coating machine could be investigated. The net result of decreasing the variability of the several processes which had been infecting one another was an increase in the quality of the diskettes and their popularity in the market-

place. At the time they obtained an increase in yield from 65% to over 90%. When I told this story to a man from 3M he said, "I know. They drove us out of the business".

Nashua found that the virus of variability in the incoming materials infected the disk production process. This variability was amplified by the coating process and added to the virus of variability already in the paint. With so many unhealthy diskettes, it was impossible to detect which viruses were present, in the same way that in a dirty hospital it is impossible to say what causes patients to get sick. The variability of the materials not only infected the production process, it also infected the maintenance process and caused unpredictable tool wear, necessitating an increased inventory of expensive tools. When the variability of the aluminum was reduced, the tool wear became predictable and the inventory in the tool room was reduced.

The process of infection is easy to understand. As shown in Figure 1, if the variability of the incoming material to System A is not dampened by the system, the variability passed on to system B will be increased. This variability will be increased and passed on to each following system so that in the final output the variability may be too great and much of the output will be unacceptable. Schedules are missed, products fail to meet specifications, too much money is spent trying to correct errors. The symptom of the virus of variability at the factory floor is the size of the waste bins.

The virus can infect service activities as well. Consider for example the loading of a ship. The cargo arrives at the dock in trucks and is unloaded by hand. Then the cargo is picked up by a stevedore and loaded into bundles to be lifted by a crane. Bundles of cargo are picked up and deposited on the deck where another stevedore loads separates the bundle into separate items again. The separate items are loaded onto a fork lift truck and moved into the hold. A

colleague of mine once observed that this was the way it was done for the Nina, the Pinta and the Santa Marie. If you watch this activity for awhile you will see that the variability of cargo sizes, the variability of movement of cargo and the variability of the performance of people and machines wastes time.

The same difficulty arises whenever people have to work in series, whether it is in accounting, sales, maintenance and repair or in customer service. In service, the symptom of the virus of variability is wasted time. The trash bins are invisible, but they are there for those who have the instruments with which to look.

Sometimes the variability is so inherent in the system there is no way to improve except to change the system itself. That is why container ships have been so successful. By pushing the inefficient packing problem onto someone else, the shippers have eliminated the variability in the loading process. The turn around time for ships has been reduced to hours instead of days.

The virus can infect a personnel office if the variability of the experience of the newly hired workforce is too great. Unless system A, which provides the initial training, is properly designed, it will amplify the differences in the trainees and the results in the workplace will be disastrous. The result will be human waste; i.e., excessive turnover with all its attendant expense.

An entire city can become infected as well. Suppose you live in a small town served by a feeder airline. Suppose that the airline schedule is not reliable; that is, you cannot be sure when your airplane will take off. This variability of performance causes you to make your appointments at a distant city with considerable slack in your schedule. Sometimes, just to be safe, you travel the day before and must pay for a hotel room for one night. You dare not count on the morning flight to get you there and the evening flight to get you back. Consider the total effect on the other businesses in the community and you have a recipe for the decline of a local economy.

Too many people accept scrap, rework, delays and missed schedules as "normal". They do not know what it means to be well. A few of them go to countries where the trains run on time, the mail gets delivered promptly, the phone system works without delays, the taxis are clean and the streets are free of debris. They visit clean factories and wonder how it all happens. They

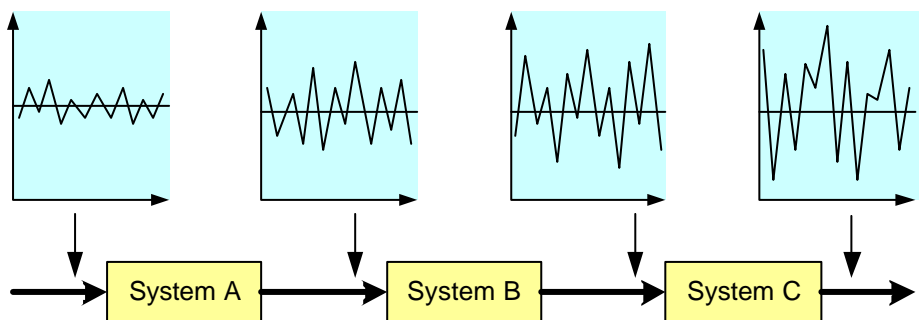


Figure 1 How the virus of variability is spread from one system to the next

marvel at the sense of good health. They do not imagine they, too, could be healthy if they managed differently. Most managers dismiss these differences by saying, "It's the culture".

When I encounter managers who persist in thinking it is the culture, I like to show them the following figures given to me by Mr. Ken Sasaoka, President of Yokagawa-Hewlett-Packard in Japan (YHP).

In 1975 an internal audit was made to examine the performance of the several divisions of Hewlett Packard. In this survey, as shown in Figure 2, Yokagawa-Hewlett Packard ranked last in both field failure rate and profitability. This turn of events was most distressing to Mr. Ken Sasaoka, President of YHP. He determined to do something about it. He and his top management team studied the new approach to management and applied statistical methods to some of their processes. He discovered for himself how the virus of variability worked. After he tried the methods out on the assembly line, he moved to other departments until finally his company was running according to "CWQC", Company

Wide Quality Control. When the next survey was run in 1980, YHP had won the coveted Deming Prize. The results of the survey are shown in Figure 3.

I like these two figures because they demonstrate that it is not a matter of culture--it is the managerial culture. As Mr. Sasao-ka will testify, the primary basis for the new way to manage was the elimination of variability, first in the factory floor and then in all departments of the company.

How much could be saved if all processes had zero variability? No one knows. Consider just this one example: In the early 1950's, to demonstrate just how quickly a house could be built, the Henry Beck company of Dallas, Texas, assembled a two bedroom, one floor house on a previously prepared concrete slab. As pictured in Life magazine, from the time they started until the house was completely assembled, finished, painted, with one woman taking a hot bath in the bathtub and another cooking dinner on the kitchen stove, was less than three hours. Think of that--three hours! The usual time is at least 30 days, often more.

Why does it take more than three hours to

build a house? It is because the activities of all the people cannot be scheduled so closely. If the painter starts to paint a board 15 hours after the board has been nailed instead of 60 seconds the time scale changes by 900. Three hours stretches into an elapsed time of 2700 hours.

No one expects to be able to schedule all the people who are required to build a house so that each one does his or her job with only seconds to spare. But the overall time can be reduced by making each process more precise. When this is done errors, goofs, flaws, and their attendant delays all begin to disappear. As the virus of variability is reduced, savings in time and money are discovered, which our methods of accounting now hide so cleverly in the "overhead" that we have grown to think that the waste is "normal".

Managers can also introduce variability into a system simply by the way they behave. One of my employees once put it to me this way: "Did you ever take an old fashioned alarm clock apart? Do you remember there was one great big wheel connected to the main spring and if you turned it just a little bit, one of the little wheels would spin like crazy? Well, you are a manager--a big wheel--and when you turn just a little bit, you make me spin like crazy".

Deming has captured this wisdom in one of his points for managers: **Maintain constancy of purpose.**

A good manager goes beyond constancy of purpose and makes sure that the purpose is understood, that it creates loyalty among the employees, and it gives good guidance in their every day work. With a carefully crafted statement of purpose, employees can be relied upon to support the purpose of the enterprise without constant attention.

People can see the waste in a factory because it is there, in the trash barrel. In the office the waste is measured by time spent in correcting mistakes, in follow up that is not required, in missed appointments, in misinformation and in tinkering with systems that should be left alone. For most people, the virus is invisible. Sometimes its cost is invisible too. It takes special accounting instruments to find viruses. You have to know how to look.

The doctors had a theory of how malaria was spread. They called it "mal-aria" to emphasize that it was the bad air, the unhealthy vapors in the night, that caused the disease. Their theory of medicine caused

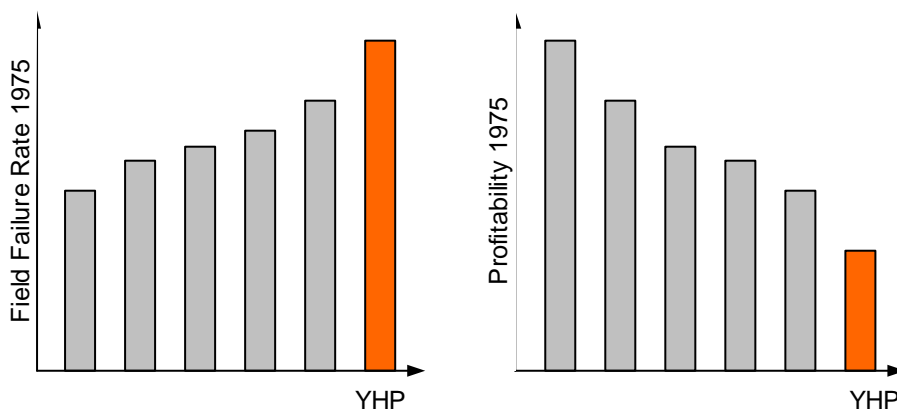


Figure 2 Field failure rate of Yokagawa-Hewlett-Packard of Japan (YHP) in comparison with other divisions of Hewlett-Packard in 1975

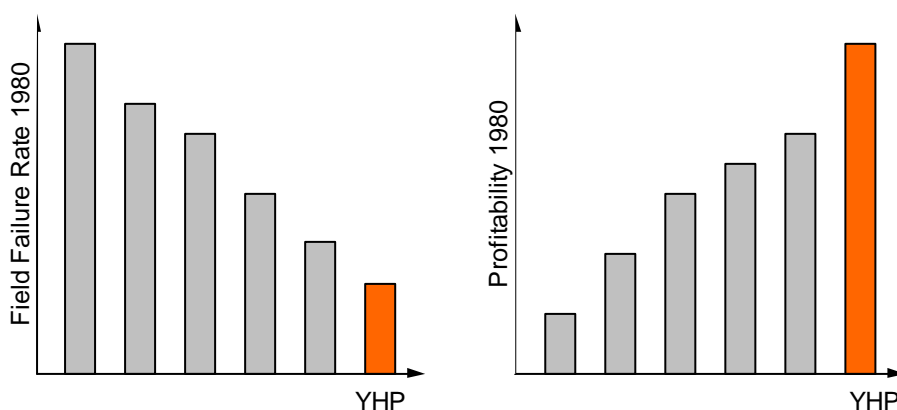


Figure 3. The same comparison made in 1980 after YHP changed its managerial approach. The work force is essentially the same as in Figure 2, only the managerial approach has been changed.

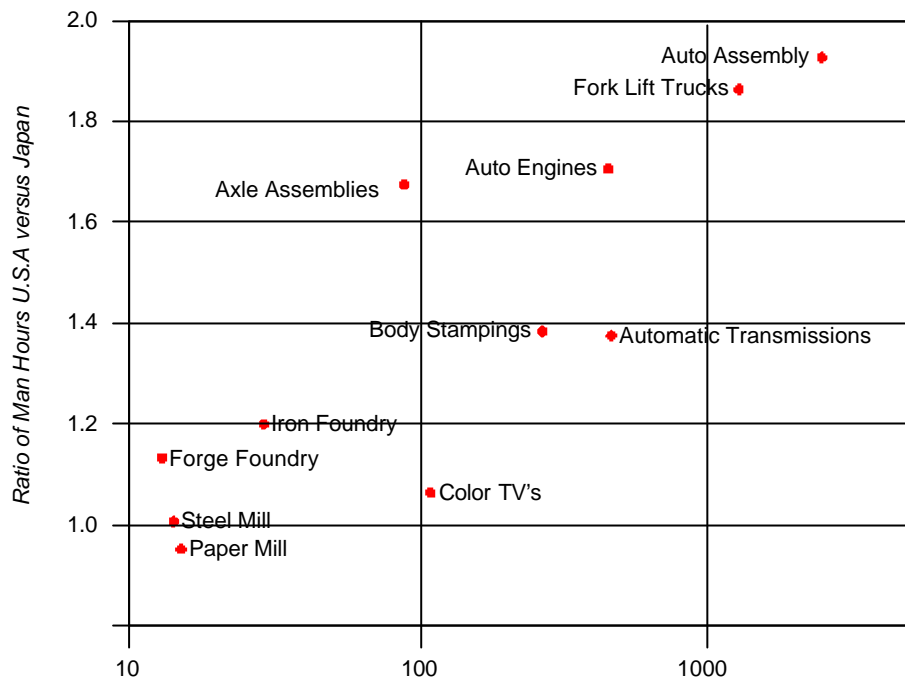


Figure 4. Ratio of number of labor hours required per unit of product as measured for Japanese and U.S. manufacturers. As the number of manufacturing steps increases, the ratio becomes more unfavorable to the US. (Data from Boston Consulting Group).

them to look in the wrong places for wrong answers to the solutions to their most pressing problems.

Today our managers often do the same. When they are up against tough international competition they look to changes in economic policy, in tax structure, in trade policy--everywhere except in their own understanding of what makes a company competitive. We hear demands for a "level playing field"--and it is true that in many markets there are unfair trade practices, which are bound to get worse as times goes on. However, as the data from the Boston Consulting Group indicates, on a level playing field the old way to manage cannot survive in competition with the new.

We are being forced to deal with a changed paradigm of management. The differences are as great as the shift from thinking the Earth is flat to understanding it is round. What is at issue is a complete redefinition of the manager's job. It is a new world and manager's need to learn how to navigate properly in it. If they think the world is flat, they will be continually worried about falling over the edge. They will be forever bound to staying very close to home, afraid to venture into new territory. Innovation will cease.

The Manager's Job has been redefined

The germ theory of management requires

managers to pay much more attention to the systems and processes for which they are responsible than before. It is time to adopt a new definition:

The People work in a System. The Job of the manager is to work on the system to improve it with their help.

There are several key words in this definition:

1. **"work in a system"**. If you accept this definition, then you should also accept that workers do not control what goes on in their work. Managing by telling people you hold them personally accountable for results flies in the face of what you really know. When you do this, you are inconsistent with yourself. "But", you are certain to protest, "If I don't hold them responsible, they won't do anything". First of all, that's not true. But more importantly, you should hold them accountable to help you to improve performance of the system.
2. **"the job of the manager"**. What did you think your job was?
3. **"work on the system"**. Do you know how to define the system upon which you are supposed to work? Do you know how to work on a system? Do you know what you have to learn to do it? Do you know where to go to learn?
4. **"to improve it"**. Do the people who work in the system have an unambiguous definition of what it means to improve? Do you? Does your definition of improvement

include removal of the virus of variability?

5. **"with their help"**. Are you prepared to let them help you? Have you trained them to do so? Do they understand the virus of variability? Do they have the tools and techniques to measure it? Do they understand what needs to be done to reduce it?

This definition proposes a new division of labor between managers and operators. Because the virus of variability is everywhere, everyone in the enterprise must be on the alert to detect variability and propose how to reduce it. To do so requires improved training, honest communications and a new spirit of cooperation between management and labor.

It also brings out the importance of another of Deming's points: Eliminate fear. I have yet to find more than handful of companies in which employees were unafraid to tell the truth.

Under the old style of management getting at the truth is almost impossible. Without honest communications, it is impossible to sterilize systems.

Just as germs are everywhere, so are the causes of variability. To sterilize a process will require someone to study what causes the variability and to remove the causes one by one. Managers are the only people authorized to tamper with the system. If you, personally, do not do this for the systems under your management, it will not get done. Your entire operation will become sick. As a manager, you cannot delegate to someone else the responsibility for the health of the processes for which you are responsible. If you can delegate this responsibility, why do we need you?

Don't Start by Blaming the People

There are many reasons why people do not all perform alike. They do not all have the same training or dexterity, for example. Shown in the Table are the records for 8 workers, all doing the same work over a 12 week period.

Good doctor, what do you make of these data?? What would you prescribe?

If you were the supervisor of these workers, what would you do? How would you go about improving things?

I have presented this table to audiences across the USA, in Mexico, in Canada, in

Week	1	2	3	4	5	6	7	8	9	10	11	12	sum
Marry	0	0	0	0	0	0	0	0	0	0	0	0	0
Joe	0	0	0	0	0	0	0	0	0	0	0	0	0
Eva	1	0	0	2	0	0	3	0	0	1	0	0	7
Fred	0	0	0	1	0	0	2	0	0	0	0	0	3
Jim	0	0	0	0	0	0	0	0	0	0	0	0	0
Ed	0	0	0	0	0	2	0	0	0	0	0	0	2
Kate	0	0	0	0	0	0	0	0	0	0	0	0	0
Carl	0	0	0	1	0	0	0	0	0	0	0	0	1

Table: Observed flaws per week over a period of 12 weeks in a working group of eight employees

Australia, in the UK and I always get about the same reaction. People suggest a good talk with Eva. They propose putting Eva alongside Mary or asking Mary to help her. They propose to fire Eva. They propose to give Eva more training.

One astute statistician at a meeting of the Royal Statistical Society in London even went so far as to observe that there was a 30 day periodicity in Eva's output and that might have something to do with things.

After the audience suggests different cures based on the common wisdom, I explain to them that the numbers in the tables were actually generated by the random number generator in my computer. The flaws were generated and assigned to memory cells, to which I attached people's names. In other words, the faults were generated entirely by the system.

In only two or three instances, out of thousands of people, did anyone suggest that perhaps the problem was in the system itself-- that the system had been infected with the virus of variability and it was not the fault of the workers. In the last four years, only three people have suggested that we analyze the data in the table to see if we could compute whether Eva's results should be expected in the light of the variability exhibited by the system.

The fact is the process itself is infected with the virus of variability. If you don't set about sterilizing the process, that is, reducing its variability, it will certainly infect the workers. Not only will it infect the workers, it will infect your judgment.

People change their views very slowly. I shall never forget the one manager who

said afterwards, "Look, I know that the numbers were generated by a computer, but nevertheless, I would still talk to Eva"!!

The output of these workers has been infected by the variability of the process over which they had no control. Suppose that the supervisor, with the objective of urging the workers to better performance decided to post the above table on the bulletin board. Of course we do not expect the workers to understand the germ theory of management. They may think that the results are their fault and they will try to do better. Do you not see how the virus of variability of the system will infect their interpersonal relations and perhaps even the home lives of the workers? If the supervisor does not understand the theory, do you not see how the system of supervision will become infected? Suppose there is an annual rating system for supervisors and the data in the above table are available to the upper management? Suppose the upper management does not understand the variability virus and therefore thinks

the supervisor should have done something drastic about Eva. Suppose the supervisor, however, does know about variability and does understand it is the system that needs to be fixed. Given this disparity in understanding, how do you think the manager will rate the supervisor?

I am not describing a far fetched scenario. I am describing what goes on daily in factories and offices all around the world. This kind of experience inspired Juran's famous maxim:

Whenever there is a problem, 85% of the time it will be in the system, 15% of the time it will be the worker.

The instinctive reaction of most managers I meet is to blame the person. Sometimes I find a manager who, when confronted with a problem will even say it is his own fault, he should have done something else. As a consultant I often find it difficult to persuade him that in fact it is the system which is fault. Many managers will persist in thinking that they need to change something in their personalities when in fact it is the system which needs to be changed.

The Fallacy of Management by the Organization Chart

Too many managers have a generic organization chart in their heads (Figure 5). They forget that the work flows across the organizational chart, more or less perpendicular to the lines of authority. They are unaware that the different steps in the process infect one another. They think that the organization chart defines how things get done. They issue crisp orders to subordinates.

Too many managers think they can divide the system into parts, along the lines of their generic organization chart.

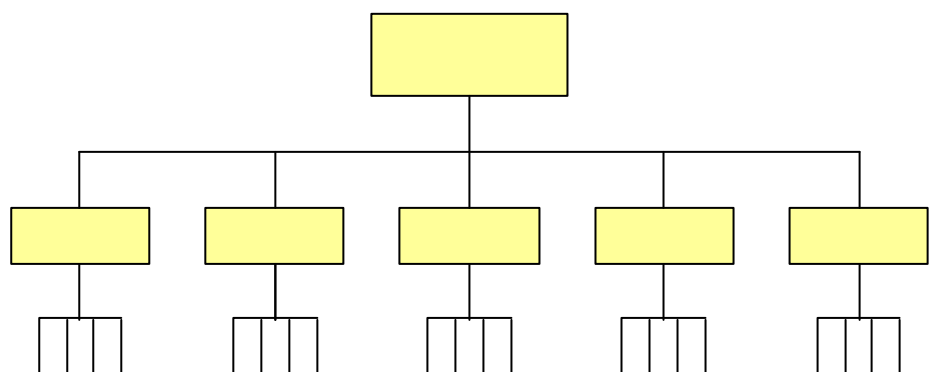


Figure 5 Generic Organizational Chart

Their managerial strategy is "divide and conquer". They see the organization the way some friends of mine in Holland see it (Figure 6).

Too many managers do not know how to recognize and define a system of processes. They do not understand what is meant by a process. They do not know how to recognize when processes which flow across an organization chart are out of control.

Seeing this discrepancy between how too many managers think about their jobs and the reality of their situation has prompted the development of the "perversity principle", which goes down hard for managers who think in terms of organization charts.

If you try to improve the performance of a system of people, machines and procedures by setting numerical goals for the improvement of individual parts of the system, the system will defeat you and you will pay a price where you least expected to (perversity principle).

Suppose you set a target for the people in one department, telling them they are to process a certain number of orders per month. Then you give another target to your sales force, consistent with the first target. It certainly matters whether the orders arrive bunched up or spread out. It matters if they arrive in a predictable fashion. In other words, even if the sales force produces the target number of orders, on average, the variability in performance day by day will cause extra expense and

waste in other departments. Setting targets for the individual performers does not speed up the process. It slows it down as each performer tries to look good at the expense of the others. Instead of just setting targets the manager should study the effects of variability and, in cooperation with the department heads, develop practices and procedures to mitigate the effects on the overall performance of the company.

This consideration emphasizes another of Deming's points: **Break down barriers between departments.** Stop thinking of the enterprise according to the organization chart and begin to think about the processes whereby things get done.

If you set targets for the people at the bottom of the system, or for the people in between, without regard for the systems aspect of the work, you are abdicating your responsibility.

The Manager as Planner -- Preventing Viral Attacks

The previous discussion has been concerned with the improvement of operations. Managers, however, should do more than work on current operations. How a manager spends his or her time depends upon the level in the enterprise at which the manager is stationed. Professor Yoshikazu Tsuda, of Rikkyo University has proposed the following diagram (Figure 7) to represent a reasonable distribution of manage-

ment time as a function of level of responsibility.

When planning future operations and designing products or services managers should pay special attention to the virus of variability. This means putting a high priority on worker training for all new undertakings. It means studying processes not just outcomes. It requires the development of quality indices, to measure the effects of variability on the quality of output.

A well trained manager, who understands the virus of variability, will consider at least the following 6 categories of variables:

- Variables controlled with precision
- Variables controlled, but poorly.
- Variables uncontrolled, but measurable.
- Variable uncontrolled, but predictable.
- Variables uncontrolled and unpredictable.
- Variables unknown and therefore unpredictable and unmeasured.

For each category of imprecisely known or controlled variable, the manager should prepare a countermeasure.

If a variable is controlled, but poorly, the manager should design the system or the product so that it is "robust" with respect to variations. Various methods can be devised to make a design or a process less sensitive to a poorly controlled variable. For example, if, due to traffic conditions, it is not possible to control the time at which employees arrive at work, the practice can be adopted of using the early hours to clean up the area or undertaking other work which does not require a full crew.

At the very minimum, managers, when examining strategies for the future, need to ask about the uncertainties in the data and what countermeasures are to be taken. They need to identify measures which provide leading indicators for those aspects of the future which are most uncertain and to develop tactical measures to take advantage of them.

In summary, then, when considering the improvement of current operations, managers need to look for evidence that the virus of variability is infecting operations and they need to find the right antiseptics. When considering the future, managers need to be certain they take into account uncertainty--both in planning what to do and in planning for products and services which will be robust-- healthy enough to

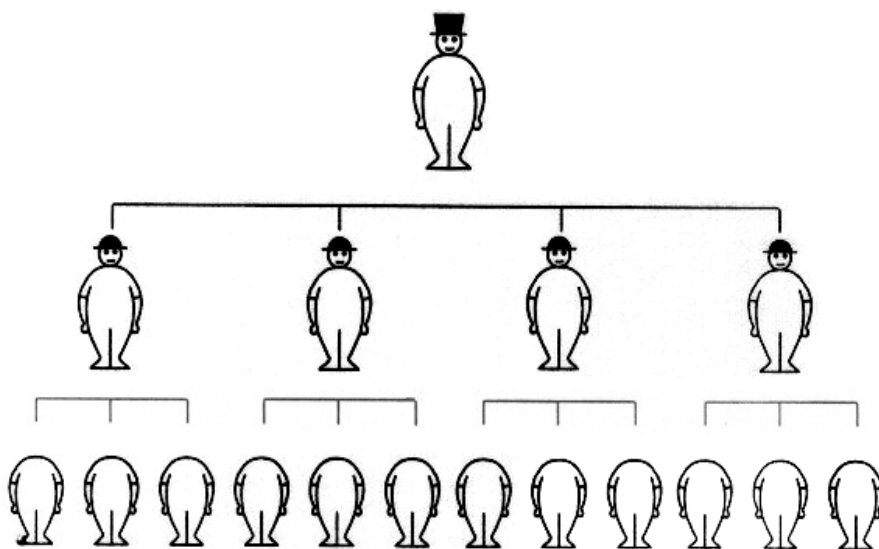


Figure 6. The hidden assumption in many manager's heads. The people at the bottom have no heads. (Courtesy of MANS Organization, The Netherlands)

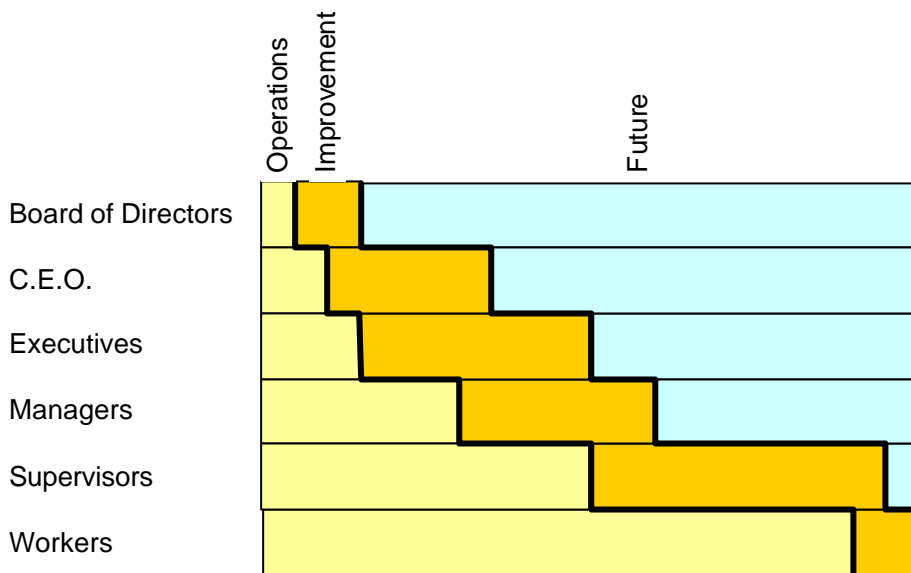


Figure 7. Recommended disposition of people's time as a function of the level of responsibility in the enterprise. Everyone works on improvement. (Chart courtesy of Professor Y. Tsuda)

withstand viral attacks--and they need to develop indicators which will enable them to respond quickly when viral attacks occur.

What the doctors were taught was not good enough. Some things they did were downright dangerous and harmful. But in time, they learned. So, in time, will today's managers? But a lot of people had to die along the way. Doctors, after all, can bury their mistakes. Unfortunately, many enterprises will have to go bankrupt before we develop a new generation of practitioners. The causes will be buried in the dead files of the bankruptcy courts.

All of the variability cannot be removed. No one knows, however, just how much can be done. Until Sarasohn, Deming and Juran applied these ideas in Japan and the results were seen on a large scale, it was not appreciated that in many instances costs could be cut by as much as 50%. The results have been seen in both goods and services.

The Task is Re-Education

The readers of this paper, of course, are different. They are the independent thinkers who deign to run with the herd. They are obviously the enlightened people. Surely they would not behave as the doctors a century ago behaved when they were told they should see that their operating rooms were sterile. They fought it tooth and nail.

"What, stop to wash my hands? Don't be silly. I have important things to do"

It was a lot of work for them to change. They had to admit they had a lot to learn. They were human. They resented the need to change and hoped in their heart of hearts that it would all blow over.

In the first place, changing the practices and procedures in the operating room was not something they could do alone. They needed nurses and orderlies to help them. They had to begin by first understanding the germ theory of disease themselves. It is one thing to learn a new theory when you are a young student in medical school; it is another when you are busy supporting your family through your practice of medicine. After they learned the theory themselves they had to teach the nurses and orderlies how to sterilize instruments and medical facilities. They could not just leave these things to chance. They had to institute practices and procedures and train people to follow them. They had to influence the training and education of nurses so that these nurses would do the right things without having to be told. Such changes could not come about over night.

Today I meet managers who do not want to learn. They are busy with mergers and acquisitions and with plant closings. They are busy beseeching the government to do something to somebody else, all the while asking to leave them alone. With their false images of how an enterprise ought to be managed, they make demands on their workers and thereby they provide job se-

curity only for labor leaders.

The task of re-education is so vast that it is difficult to see where to begin. One is reminded of the recipe for eating an elephant: One bite at a time.

A Check List of Things Managers Need to Learn

To begin, it is useful to list the things most managers are unlikely to know but which they should know to compete in the new era. The following list is by no means complete, but it does cover the most significant missing elements in most manager's education.

Every Manager should be competent in elementary statistics.

Process Flow Charting

Fishbone Diagrams

Run Charts

Histograms

Pareto Diagrams

Scatter Diagrams

Control Charts

Elementary Design of Experiments

Every Manager should learn how to

Recognize, define, describe, diagnose and improve the system for which he or she is responsible.

Diagnose the variability of a system and decide which variations are special, and require special action and which are common and will require a change in the system design and operation. The managers must be able to tell the difference between signals and noise.

Lead teams of people having different educational levels in problem identification, data gathering, data analysis and the generation of proposals for solution, implementation and test.

Diagnose the behavior of humans and distinguish difficulties which are due to the variations in human abilities (15%) and those which are caused by the system (86%) (Juran's Rule).

The Issue is one of leadership

There are not going to be enough educational facilities in the country to tend to the needs of all the managers who need to

be re-educated and are willing to learn. Every manager who learns how to manage the new way will have to teach his or her subordinates. Mentoring is an essential part of managing. It is also an essential part of leadership.

When Homer Sarasohn was on MacArthur's staff in Tokyo, he taught the Japanese to differentiate between managing and leadership. What he told them in 1948 is as true today as it was then:

A leader's main obligation is to secure the faith and respect of those under him. The leader must himself be the finest example of what he would like to see in his followers.

(Sarasohn in Japan, 1948)

Conclusion

This country is now engaged in a struggle for its existence. Its industries have been destroyed, one by one. Because the economy is in difficulty, it does not generate the revenues required to run the government. It is cutting back on services--including defense-- because it can no longer afford them. The only way to survive is through learning how better to manage resources. That's your job-- learning how to manage the right way--to manage for quality.

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There are a few general references which those who are new to quality management can read with profit. Among them are:

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