Q

CONTRIBUTIONS FROM BALAJI REDDIE

Contributions from Balaji Reddie

FOUR PRELUDES AND A CODA

and

SOME LESSONS FROM HISTORY

These contributions to the "12 Days to Deming" course are based on a series of 25 short newspaper articles written by

Balaji S Reddie

Founder of the Deming Forum of India

FOUR PRELUDES AND A CODA

An introduction to a System of Profound Knowledge

When Dr Deming was asked what it was that the Japanese learned from him, one of his answers was that he taught them a different way of perceiving things around them. He pointed out that, although people *see* the same event, they may nonetheless *observe* different things. In the opening paragraph of Chapter 4 in *The New Economics*, Dr Deming described the purpose of that chapter using these words: "The aim of this chapter is to provide an outside view—a lens—that I call a system of profound knowledge".

The System of Profound Knowledge is the interaction of four substantial areas of thinking and understanding. Deming referred to them using titles such as

A. Appreciation for a system
B. Some knowledge of theory of variation
C. Theory of knowledge
D. Knowledge of psychology.

Our Preludes here respectively contain some introductory thoughts and illustrations on each of those four parts:

Prelude A: Understanding a System - - - - - *page 1*
Prelude B: Understanding Statistical Thinking - - - *page 7*
Prelude C: Understanding Learning - - - - - *page 15*
Prelude D: Understanding People - - - - - *page 20*
Coda - - - - - - - - - - *page 26*

PRELUDE A: UNDERSTANDING A SYSTEM

What exactly did Dr Deming mean by a "system"? On *The New Economics* page 35 [50] he provided this description: "A system is a network of interdependent components that work together to try to accomplish the aim of the system". That says a lot in just a single sentence! Note in particular "work together" and the "aim". Let's first consider the "aim" of a system.

The aim of a system

Simply stated, the *aim* of a system is what the system tries to do. If we are designing a system then it makes obvious sense to first consider carefully what we want its aim to be, and then design it with that preferred aim in mind. With systems that already exist and affect us, it makes sense to learn and understand what their aims are.

Take the case of that beautiful but fearsome animal: a tiger. Besides procreation, let's consider three possibilities for its aim:

1. To regulate the number of animals in a forest;
2. To regulate the number of humans in a settlement;
3. To land up as a carpet in someone's house!

Each aim turns the tiger into a different system: it will behave differently, it will do different things. In the first system the tiger becomes a predator. It stalks smaller animals and has to chase them, outrun them, and finally slay them. In the second system the tiger becomes a man-eater. Now it has to out-think and outsmart a human who is not as strong nor as fast as the tiger itself but is intelligent and has some ability at self-defence. In the third system the tiger becomes the hunted!

Similarly, any individual, organisation, group, or even country has an aim—intentional or otherwise. The aim gives the system a reason for its existence. For example, the Walt Disney company has the aim: "Make every child smile; there is a child in every adult". Bill Gates and Microsoft have the aim: "A computer in every home, on every palm, on every lap, and on every desk". Steve Jobs had the aim: "To offer every product to the customer like a piece of art".

On *The New Economics* page 36 [51], Dr Deming included a suggestion for the aim of a system in which human beings are involved. It was "for everybody to gain ... over the long term". Of course, this immediately raises a good question: why on Earth would you expect people to "work together" to achieve any different kind of long-term aim?

Interconnections

That immediately brings us back to the earlier part of Dr Deming's description of a system: "a network of interdependent components that work together". Everything in any system is interconnected. There are no wholly isolated parts in any system. An obvious example is the human body. Every organ is connected to others: no organ exists in isolation. Further, every organ performs a primary function. But it is also likely to perform one or more secondary functions which often remain largely unrecognised by the person whose body it is. For example, the eyes and the ears, along with the sight and the hearing functions that they primarily perform, are also responsible for the body maintaining its balance.

As a consequence of its interconnectedness, it is important to realise that we cannot hope to understand a system by simply breaking it down into its separate components and studying those components in isolation. One cannot learn much about water by separately studying the properties of hydrogen and oxygen. As you know, these are both highly inflammable gases—but when they come together they create something that *quenches* fire! This is an example of a particularly interesting aspect of interconnectedness that is known as *synergy*. I found this definition of synergy in a dictionary: "mutual reinforcement or complementariness". Using simpler and shorter words, such togetherness is often described as being where the result is greater than the sum of the parts. Another example is sugar. Sugar is a hydrocarbon. It may not be advisable to try to taste either hydrogen or carbon, but sugar is pleasant to taste.

A tree is a further interesting example of interconnectedness. If we ask a child to draw a tree, the child (or, for that matter, an adult) would normally draw its trunk, some branches and some leaves. That's because this is what we see. What we do not see are the roots that grow under the ground. In fact, the roots generally grow deeper under the ground than the trees grow above the ground! Another lesser-known fact is that roots, even those belonging to other trees, entwine underground. Scientific study has also proved that not only do the roots entwine but they also *enjoin* underground.

This was documented by a very famous quantum physicist named Dr Fritjof Capra. He wrote extensively about this in his 2002 book: *The Hidden Connections*. There he described his surprise at finding that, irrespective of where trees are physically "rooted" or what kind of trees they are, underground they behave as though they are one! Underground they seem to *share* everything—that's surely *real* togetherness! This concept was echoed by Dr Deming long ago in Japan. In 1950 he advised the Japanese Government to collaborate with industry, education and healthcare and to encourage and enable them to all work together as a system to bring Japan out of its crisis. It is thus no surprise that the complete title of his final book is *The New Economics for Industry, Government, Education.* More togetherness.

The "most important" part of the system

Dr Deming was once asked this question: "What is the most important part of a system?". His answer was not anything like "In the case of a human being it's the heart" or "In the case of an organisation it's the boss". No, his striking answer was simply: "The part that is not working".

In one sense, of course, the heart or the boss *could* be regarded as the most important. But that is in a *negative* sense: the sense of "Which part causes the most harm if it doesn't function as it should?". In contrast, Dr Deming was answering in a *positive* sense. He was thinking in terms of what he called optimisation of a system—"optimisation" means it is working in the *best possible way* to try to achieve its aim. And, in that positive sense, no one component of the system *is* more important than any other: they are interconnected. If *any* part does not function as it should then the plain fact is that the system is not working in the best possible way. What do we mean by "function as it should"? We mean "help the system as best it can to try to achieve its aim".

So, thinking in terms of optimising the system, i.e. positively, no one component in any gadget is more important than any other: they are interconnected. In industry, again thinking positively, no one function is more important than any other: they are interconnected. In the market, thinking positively, no one organisation is more important than any other: they are interconnected. In the world, thinking positively, no one country is more important than any other: they are interconnected.

Further, thinking positively, is this not also the truth with individuals? A family is a system. Could you point a finger at one of them and say that he or she is the "most important" member of the family? Could you? At first, the answer to that question may seem paradoxical—but give it time! If you realise that you *cannot* choose the "most important" member then you're thinking *positively*, i.e. in terms of *optimising* the system.

But if you believe that you *can* do so (i.e. one person is most important, all the others are less so), you're thinking *negatively*. Which way do you prefer to think? From his answer to that question about the "most important" part of a system, Dr Deming's preference is clear.

We can take our reasoning yet a further step forward. Not only do different parts of a system exist *for* each other—they also exist *because of* each other. Every part of a system has an identity both *for* and *because of* the other parts of the system—it's a *two-way* interconnectedness. So, thinking positively yet again, isn't it wrong, illogical and foolish to try to choose the "most important" part of any system?

Let's consider a further example of interconnectedness. Take the case of a classroom in a college where a lecture is to be conducted. Some obvious components of this system are the classroom, the equipment, the students, the teacher, the topic, the time slot, etc. Let us imagine any one of these components disappearing and examine what would happen to the system. Without students, the lecturer could only talk to the walls. That would not be a lecture: that would be madness! Or without a lecturer, i.e. with only the students staring at the board and nothing going on, it is not a lecture: that is collective madness! Without a classroom, that would just be a gathering, not a lecture. Without equipment, maybe a lecture can be conducted after a fashion, but it is unlikely to be as intended given the fact that nowadays people use technology and "smart" classrooms. Irrespective of considerations about what might be the "most important" part of this system, the point is that, in *every* such case, the system's aim is most certainly *not* being achieved.

This example also provides another illustration of different parts of a system each having an identity both *for* and *because of* each other. A teacher is called a teacher because there are students to *teach*. Students are called students because they are *studying* under a teacher.

Cause and effect may be far apart

We tend to react to things as they appear before our eyes, in the here and now (rather similarly to drawing that tree, as described on the previous page). But surely it makes sense to delve deeper. For example, if we observe some event then, for better understanding, we need to identify interconnections between that event and other matters, rather than merely jumping to a conclusion based on what appears "obvious" right now. That is, we need to respond to what *caused* the event rather than merely reacting to the event itself.

Finding the cause(s) of an event may, of course, be easier said than done. One reason is that cause and effect are not necessarily closely connected in either time or space. The root causes of an event which occurs right before our eyes may have been somewhere far away and in an altogether different time-frame. Conversely, decisions that we take today may well have consequences in another place and at another time (recall in particular Rules 3 and 4 of the Funnel on Day 3).

As an illustration, consider somebody who has been riding a motorcycle for a couple of years. One day, on his way to work, he goes over a little bump and then finds that his motorcycle has abruptly stopped and refuses to budge. He takes it to a mechanic who tells him that the clutch wire has broken. He might immediately react to this in an annoyed fashion by asking: "One little bump and the ***** wire breaks?". The truth could be that, because of his habit of "riding the clutch", the clutch wire has been gradually getting more and more frayed throughout all those two years. Finally, when he went over that little bump, it snapped—it was bound to, sooner or later. The fraying had started from the day he bought the bike. So where was the fault? That habit of riding the clutch could well have begun when he was young and received poor instruction when first learning to ride a motorcycle.

Let's consider a longer illustration. A senior manager in a company is taking a walk in the workshop and notices a puddle of oil on the floor underneath a machine. He asks: "What is that puddle of oil doing on the floor?". Immediately a cleaner is called and the oil is removed. The manager is happy. A few hours later,

the people notice a fresh puddle of oil has taken its place. The question is repeated: "What is that puddle of oil doing there?". This time they realise that the oil is leaking from the machine. They investigate and find that a bolt has come loose. It is tightened and no further oil leaks out. Great! A few days later, yet another puddle of oil has appeared, and the question is asked for the third time. The bolt is again found to be loose. Now what? Upon further investigation it is found that a washer has broken. The washer is replaced and the bolt is tightened. Excellent: no more oil leakages … until … a week later … another puddle of oil. Now it is found that the washer was of the wrong type. When this is checked in the Parts Store they discover the sad fact that there are 5,000 such washers in stock—all quite useless. Reason? Well, the Purchasing Manager had given instructions for "cutting costs", and so cheap washers had been bought. When the Purchasing Manager is asked why he was cutting costs, he promptly replies that, over a year ago, the Vice-President had told him to. The consequence was that oil kept leaking onto the floor—which turned out to be far more costly than the correct washers would have been—another classic case of cause and effect not closely related in time and space.

A typically perceptive observation from Dr Deming was: "There are no isolated events, but eventualities".

Comparing, competing, ranking, rating

Every person, every part, everything has its importance in a system—else why is it there? Some parts may be able to do absolutely nothing on their own yet have important synergistic relationships with other parts of the system, i.e. help *them* to work better for the system, help the system to achieve its aim.

This brings to light another attribute of a system: since every person or thing has its role to play in the system, how can it be justifiable to compare that person or thing to any other person or thing in the system? It's like, as the saying has it, comparing apples to oranges. We have already argued that (thinking positively about optimisation) it does not make sense to choose a "most important" part of a system, e.g. the heart in a body—nor the brain, nor the kidneys, nor the fingernails, nor the skin, nor the hair on our skin! They're *all* "most important" because they *all* contribute to optimising the system, and their contribution is different from that which other parts contribute. Also notice that these parts do not in any sense "compete" against each other to try to show their supremacy. Instead, they complement each other: they "work together". This observation becomes particularly pertinent when we consider the human beings in a system.

In the 1970s there were four spin-bowlers in India's cricket team. Each spinner had a certain role to play, a role which was different from the others' roles. Bishen Singh Bedi was a left-arm leg-spinner who always attacked the batsmen, thus forcing them to make errors. Bhagwat Chandrashekhar had a polio-stricken arm and was freakishly unpredictable: thus he was very effective at confusing the batsmen! Erapalli Prasanna was an off-spinner with a lot of variety; he was also deadly accurate, thus tying down the batsmen. Finally Venkataraghavan, who was supposedly the "weakest link" of the four, was actually even more deadly because he beguiled the batsmen to gain false confidence by allowing plenty of runs to be scored off his bowling. There were yet more subtle differences between them, but the point is that they all had their particular roles to play. People made the grave error of comparing these great spinners to each other—who was the "most important"? The easiest way to answer would be to give that credit to whomever had taken the greatest tally of wickets. But how could one justifiably give the credit on that basis when they used to plan the dismissals *together*? It wasn't a competition: it was collaboration, cooperation, working together. None of them was the "most important". Or, if you like, they were *all* most important. Take your pick!

There is something worse than choosing *the* most important—and sadly it is very common. It is ranking or rating. This is not just choosing the "most important" or the "best", etc, for that's only choosing Number 1. "Ranking" means choosing not only Number 1, but also Number 2 and Number 3 and all the rest! "Rating"

is similar but on a cruder scale. If just choosing Number 1 does not make sense, how much more senseless is ranking or rating (unless you're thinking *negatively*)? We have seen that, since a family is a system, it is silly to talk of the "most important" member of the family. In a family consisting of Mother, Father and three children, how much more stupid would it be to rank them as Numbers 1 to 5?

Indeed, ranking and rating are not just senseless—they are harmful. Reflecting the question posed on page 1, why should people "work together" (for the advantage of the whole system) if sometime soon they are going to be compared in a way which inevitably produces winners and losers? Ranking and rating involves the creation of some kind of scoring operation (such as the tally of wickets for the spin-bowlers). But how can you score "working together"? Any scoring operation needs something to measure or something to count. Especially if some sort of reward and punishment is involved for the winners and losers, the inevitable consequence is people *competing against* each other instead of working together. Worse still, there are always methods for increasing one's score by doing *harm* to the system rather than working to its advantage. A salesman can increase his sales (which is likely to be his "score") by lying to potential customers about how good the product or service is. Someone who works in a call-centre can increase her number of calls per hour (if that is her "score") by not giving the caller sufficient time to explain the problem properly, or by quickly passing the caller onto someone else, or even by cutting off the call as soon as it has been counted, maybe even before she has uttered a single word! If hospitals are negatively scored by the number of deaths during operations, that number is easily reduced by only carrying out less risky operations.

Worse still are examples in education. Children's capabilities are confused with how well they answer the questions in a patterned questionnaire (i.e. a questionnaire whose format and content are largely known beforehand). If schools will be scored and league-tabled according to their students' number of passes in national examinations, the school can train their students to pass examinations rather than developing genuine knowledge and understanding of the subject matter.

When Dr Deming was speaking to Japanese industrialists in the early 1950s, he warned them that they would be in danger of destroying each other if they focused on competing against each other rather than focusing on the customers. "We must learn to cooperate instead of trying to compete."

Optimise or maximise?

Thus, in summary, we have emphasised that the different parts of a system need to optimise their combined performances ("work together") rather than maximising their individual performances (as measured by their "scores"). Nature tends to optimise, whereas mankind, especially under bad management, tends to maximise. This, of course, takes us straight back to the salesman and the lady in the call-centre and their good scores for which they were probably rewarded despite causing harm to the system as a whole. Such cases where one part of a system is maximised, but in a way which is to the detriment of the overall system, are what Deming referred to as "*suboptimisation*". If that part of the system is human (an individual, a group, a department, etc), such suboptimisation may be deliberate (again especially under bad management). There are other examples. Proteins are good for the body, but an excess of proteins can actually harm the body by destroying the bones and the nervous system. Oxygen is needed by the body, but an excess of oxygen can actually eat into parts of the body, thus causing decay.

Many years ago, in the early 1970s, if people were diagnosed with high blood pressure, some research showed that this was often related to the blood containing a high level of cholesterol. Very soon, pharmaceutical companies created medicines which they called "cholesterol killers" and released them onto the market. These tablets provided instant results: those blood pressures started dropping dramatically.

However, a few months later, these same people started complaining of low energy levels and low resistance to diseases. The research laboratories went into overdrive and were appalled by what they discovered. There exist *two* kinds of cholesterol: high-density lipoprotein and low-density lipoprotein. High-density lipoprotein is most surely good cholesterol: this cholesterol is needed to provide the body with energy. On the other hand, low-density lipoprotein is light and floats in the blood: it sticks to the inner walls of the arteries, thus narrowing them. This makes it harder for the heart to pump blood around the body which then results in raised blood pressure. This certainly means that, in order to reduce this stress on the heart, *something* must be done about the low-density lipoprotein. But now the researchers also realised that, since the low-density lipoprotein was present, it must be there for a purpose. They discovered that it was present because it acted as a filter to toxins in the blood. This implied that the low-density lipoprotein needed to *regulated*, not *destroyed*.

People's contributions to a system also need to be regulated. A favourite example of Dr Deming's was that of an orchestra with 140 players who are all there to work together and support each other. Supporting each other produces harmony. But how loudly each plays needs to be regulated. If any players simply tried to play as loudly as they could then it would result not in harmony but in cacophony. You can probably see some analogies with the lady's number of calls per hour and the salesman's sales.

In the early 1970s, there was a writer-duo in the Indian Film Industry: Salim Khan and Javed Akhtar, often abbreviated to Salim-Javed. Each was a master of his craft, but it was the joint optimisation of their talents that resulted in some phenomenal scripts being written which are remembered and admired to this day. Salim Khan was excellent at creating plots, sequences and characterisations. Javed Akhtar was a poet who wrote lyrics and dialogues for these plots, scenes and characters. Together their results were mind-boggling. Unfortunately they eventually decided to split up, causing sadness to many.

Subsequently they tried to achieve individually what they had done together, but they never succeeded. Javed Akhtar continues to write poetry and dialogue and has won some awards for these but has never really scaled similar heights again. Salim Khan has dabbled in writing a few times but is fairly inactive these days.

Performing "within limits"

Finally, let me bring together a few of the important illustrations we have described. First, the salesman who lied was in all probability selling more than could reasonably have been accomplished had he spoken the truth rather than lying to potential customers. Second, the lady in the call-centre chalked up more calls per hour than would have been possible had she been giving good service to her callers. In both cases those "good scores" were beyond the limits of what would have been possible if they were doing their jobs properly.

Third, in the case of low-density lipoprotein, its destruction had disastrous results: instead, it needed to be regulated to stay within appropriate limits (not including 0!). Fourth, the amount of proteins and, fifth, the amount of oxygen both need to be regulated rather than maximised: i.e. they also need to be kept within appropriate limits. To put it mildly, too high or (of course) too low amounts will be damaging.

Long ago in your *12 Days to Deming* course you became familiar with the importance of a system or parts of a system or processes performing "within limits"—it was called a state of statistical control. So these thoughts naturally lead us into Prelude B: "Understanding Statistical Thinking".

PRELUDE B: UNDERSTANDING STATISTICAL THINKING

Normal and abnormal variation

The final section of Prelude A was: "Performing 'within limits'". The study of whether a process is or is not performing within its limits, and what that implies, is called "Statistical Thinking". Let's refer to those limits as the process's "natural" limits or simply the "process" limits.

So here, as pointed out at the very end of Prelude A, we have an immediate strong link between our first two Preludes. The salesman who lied to the customers and the lady in the call-centre who did not provide adequate help to her callers were both performing *outside* the natural limits. And we know why. Recall the section in Prelude A headed "Optimise or maximise?". As opposed to being encouraged by their management to work toward *optimisation* of the system, which is to *everybody's* benefit, they were instead being encouraged (by the reward system instituted by the management) to *maximise* their personal "scores", i.e. to simply work toward *their own* apparent benefit irrespective of any harm thus caused elsewhere.

You will recall that this topic of Statistical Thinking was born in the 1920s due to the brilliant insights of Dr Walter Shewhart. He made a discovery about processes, something which we take for granted these days but was not as well understood all that long time ago. He said that no process in the world gives you an absolutely constant steady output. This applies to both natural processes and man-made processes.

Your body temperature is an example of what I call a "natural" process. Its optimum value is said to be 98.4^{o}F (or 98.6^{o}F, depending on the country in which you live). But the truth is that it keeps fluctuating during the course of the day. The same is true of your blood pressure, your pulse rate, all the various quantities that are measured when you have a blood test: blood count, glucose level, cholesterol, etc, etc.

On the other hand, probably all the figures reported at monthly management meetings are from what I call "man-made" processes. Obviously, they are reported at the monthly meetings because they fluctuate from month to month—there wouldn't be much point in reporting them if they always stayed the same! The time taken for me to reach my place of work (e.g. school, college, office, factory) from home each day is a "man-made" process. The time taken does not remain constant: it keeps changing from day to day. We'll consider this process in detail in the next section.

Of course, some processes fluctuate so slowly or over such a small range that they may be regarded as "constant" for practical purposes. But be sure that, if you examine them at more precise levels of measurement, you'll eventually see some small changes. (If even that isn't true then you're not dealing with a "process" at all.) However, with most of the processes that affect us in important ways in our work or elsewhere in our lives, the fluctuations and their consequences are unfortunately all too easily seen and experienced. Those are the processes that we are interested in studying and working to improve if at all possible.

What causes processes to fluctuate? If we consider man-made processes, there is usually a host of "built-in" causes: the way the process has been designed, the way it has been set up, the way it is affected by the circumstances and environment in which it is operated, the way people have been trained to carry it out, the way those people are managed, and so on. Such causes are inherent to the process: they will always be there—at least until the process is changed, hopefully improved. The same is largely true of natural processes except that man hasn't had such a direct hand in their design.

It is when processes are *only* being affected by such inherent causes that they fluctuate between their natural process limits. We say that processes are "normal" or "behaving normally" as long as their data

remain within these limits. But when they go outside the limits then we conclude that something "abnormal" has happened: the process is then behaving "abnormally".

Walter Shewhart referred to both types of fluctuations as "variation". By a process behaving "normally" we mean it has "normal" variation. (Incidentally, in case you know about such things, that's nothing to do with the statistician's "normal distributions"—here we are simply using the word "normal" in its ordinary English sense.) When the process is varying within its band of normal variation, we have just argued that this is simply because of the inherent properties of the process. Shewhart referred to such causes of variation as "constant causes"; Deming called them "common causes". So, in fact, *all* processes have common causes which produce the normal variation in the way that they fluctuate. But what is going on when a process is "behaving abnormally"? "Behaving abnormally" means that some of its values are now outside the process limits. In that case, something out of the ordinary or "abnormal" has arrived on the scene, something that has pushed the process outside its natural limits. That "something out of the ordinary" is what Shewhart called an "assignable cause"; Deming called it a "special cause". "Abnormal" variation is the consequence of special causes.

> You will probably immediately recognise that what I describe as behaving normally or abnormally are respectively the same as what Drs Shewhart and Deming called being in or out of statistical control.

Getting to work on time

So how does all this help us?

I'll illustrate that very simply with the time it takes me to travel to work. Suppose that I have been keeping records and have carried out some simple calculations. I've found that, on average, it takes me 20 minutes to drive to work, and that the lower and upper process limits, i.e. the anticipated minimum and maximum times, are 15 and 25 minutes respectively. (I'll remind you of how to calculate these limits in the next section.) I usually need to be at work by 9.00 am. The upper limit tells me that if I leave my house at 8.30 am then, in normal circumstances, I will always be at work on time and with at least five minutes to spare—time to snatch a coffee!

But one day I didn't get to work until 9.10 am—it took me 40 minutes to get there: the traffic was awful! Since 40 minutes is way above the upper process limit, something abnormal (a "special cause") must have occurred, such as a serious accident somewhere up ahead. Perhaps I'd better find out, so that I can make my excuse to the boss.

Now, maybe I haven't quite told the truth there. Perhaps the truth was that I'd overslept and actually didn't leave my house until 8.45 am. In that case the lower process limit (15 minutes) immediately tells me that, although it is still faintly possible that I could just get to work by 9.00 am, it's highly unlikely. So, if I'm honest, I would have to give a different reason to the boss for my late arrival. The usual process, in the different circumstances that I had now given it, just could not get me to work on time that day.

There was another possibility. I also have a motorcycle. I don't often use it to get me to work, since it's more stressful—both to me and to the car-drivers as I weave in and out between them! But I also know the process limits for the journey using the motorcycle: the lower and upper limits are 12 minutes and 20 minutes respectively and the average is 16 minutes. If I were to use the motorcycle then I would have *some* chance of getting there on time, although it would by no means be certain. That day I was lucky—I just made it! That fits in with what the process limits told me: they told me that if I used the motorcycle then it would be *possible* for me to get there by 9.00 (but with little time to spare) although the odds would be against it.

Notice how much weaker this whole account would have been if I had *only* calculated averages rather than the process limits as well. Yet the average is all that most people would bother with. The small amount of extra calculation to obtain the process limits can be very valuable!

Computing the process limits

Do you remember how to compute those natural process limits? Deming usually called them the "control limits". You saw how to do it on Day 3. Day 3 may seem a long while ago—you've covered a lot of ground since then! So here's a reminder in case you need it. But you're very welcome to skip this—you will not need to do any such calculations either in these Preludes or in the rest of the course.

Here are the times in minutes taken for me to drive to work, Monday to Friday mornings, over two consecutive weeks.

Mon 11	Tue 12	Wed 13	Thu 14	Fri 15	Mon 18	Tue 19	Wed 20	Thu 21	Fri 22
21	18	20	20	22	23	19	21	19	17

To determine the average time taken we add up these times and divide by the number of data, i.e. 10. This gives the average time taken as 200 ÷ 10 = 20 minutes.

Then we determine the differences between successive times, the "moving ranges", shown in italics below the data:

Mon 11	Tue 12	Wed 13	Thu 14	Fri 15	Mon 18	Tue 19	Wed 20	Thu 21	Fri 22
21	18	20	20	22	23	19	21	19	17
	3	*2*	*0*	*2*	*1*	*4*	*2*	*2*	*2*

The moving ranges add up to 18. There are nine of them and so the average moving range is $\overline{MR} = 18 \div 9 = 2$ minutes. Then, if you recall, we compute the distance on the control chart between the Central Line (the average of 20 minutes) and the process limits as $2.66 \times \overline{MR} = 2.66 \times 2 = 5.32$. So the process limits are 20 – 5.32 and 20 + 5.32. These give us 14.68 and 25.32 or, rounding to the nearer whole numbers, the lower and upper process limits are respectively 15 and 25 minutes.

This method of determining process limits can be used for many kinds of processes. For instance, it has been used extensively in the field of medicine. When we go to the doctor's surgery for our blood tests, there is a lower and an upper process limit for the haemoglobin count. There is a lower and an upper process limit for the glucose level. A complete blood count includes a host of further measures, e.g. the percentages or numbers of red cells and white cells per litre, the numbers and average sizes of platelets, and so on. The analysis of the test results that we receive are based on comparisons of all such measurements with one or both of their natural process limits.

What we've covered so far

So, to summarise. When a process is operating within its natural process limits, we should not be surprised by any particular value it produces. There is a collection of common causes, often very many of them, for the behaviour of any process, and no value within its process limits can be regarded as unusual. There is no point trying to discover any reason or cause for any such value since it's the kind of value which the process produces entirely naturally. If you don't like the range of values between the process limits and want to do something about it, really you have only two options. If it is a process to which you have some access, you should get to work on improving that process, i.e. with the objective of changing the range of variation indicated by the current process limits to a range with which you'd be happier. Alternatively, if

you do not have any access to the process, all you can do is to increase your protection against the consequences arising from that process. But, at least, if the process is in statistical control then you can predict what you are likely to be faced with, and that will help you to figure out how much and what kind of protection would be wise.

However, when one or more values clearly fall outside the process limits then the situation is wholly different. (Note that I am not talking about a very occasional value which *just* squeezes outside the limits—this isn't an exact science, and couldn't be.) If you have clear departures from the norm then there is now something abnormal or "special" producing a definite change in the process's behaviour. In these circumstances there is rather little point in trying to improve the process even if you are able to: for, however much you improve it, such special causes are still likely to continue seriously affecting the process's behaviour from time to time. So now the sensible action is to try to identify the special cause (or causes, but often there is only one important one) which has produced the extra disturbance. And, because use of the process limits has alerted you about *when* to look for it (i.e. when you get such clear departures), it often turns out to be relatively easy to find. Then presumably you will eliminate it if at all possible, or take some other appropriate remedial action.

Mixing up the two situations is dangerous—and very easy to do if you are not using process limits. "Gut feel" is not very reliable. Trying to find and eliminate specific causes—"doing something"—just because of seeing a particular outcome almost invariably does more harm than good when the process is actually behaving normally (recall the Funnel Experiment). On the other hand, ignoring special causes of abnormal variation when they are present will, of course, mean they are likely to continue giving you trouble.

Two true stories

Let's look at a couple of true stories to illustrate these important matters.

Some defective items were being made in a manufacturing operation. The HR (Human Resources) Manager felt that this was due to the "improper attitude" of the workers involved in that operation. She was considering implementing a so-called "reward and recognition" scheme based on the average number of rejects that each of them was making. Here are the data, recorded over four days:

	Day 1	Day 2	Day 3	Day 4	Average
Worker 1	9	11	7	8	8.75
Worker 2	6	11	11	9	9.25
Worker 3	12	7	5	5	7.25
Worker 4	11	10	13	9	10.75
Worker 5	14	8	9	11	10.50
Worker 6	4	11	12	12	9.75

The HR Manager calculated the average: 9.38. Ah: we see that the first three workers all produced less than the average number of rejects, the second three produced more than average. In particular, Worker 3 was much better than the others while both Workers 4 and 5 went into double figures. Going by the HR Manager's logic, Workers 4 and 5 and maybe even Worker 6 should be blamed for poor performance whereas the other three, especially Worker 3, should be praised and perhaps rewarded.

But you will probably have already recognised this as equivalent to a table from the Red Beads Experiment. So, thinking back to Day 2, you know the sort of process limits to expect if you compute them appropriately. In this case they are 1.1 and 17.7 or, rounding, 1 and 18. Yes, none of the 24 counts of rejects is anywhere *near* either process limit, let alone beyond it. If the HR Manager had had her way then the

workers would have been praised or blamed for the quality of their work which was, in fact, entirely beyond their control. Her intended "reward and recognition" scheme would have been even worse, with rewards and punishments being involved, all presumably with the aim of "motivating" the workers to improve their performance. It wouldn't work: it couldn't work. They were at the mercy of the system.

After much convincing, the HR Manager was finally persuaded that it might just be the process that was creating the rejects, not the workers. Upon investigation, it was found that the material used in the process was faulty. When that problem was corrected, along with some other changes made to the method and equipment, rejects were virtually eliminated.

Once people have become familiar with Statistical Thinking, it alters their way of thinking and acting even when they are not using any data. Here is an illustration:

An organisation had a process whereby the drivers of their cars would fill up with petrol from a petrol pump that was installed on the organisation's premises under contract with an oil company. To obtain petrol from the pump, drivers had to insert a voucher which had been signed by a manager. At the end of each month the vouchers were collected from the pump and the organisation then paid the oil company for the petrol that had been used.

But at the end of one month it was discovered that the vouchers and the amount of petrol taken did not match up. This meant that some petrol was being taken illegally. The Finance Manager reacted to this by creating a new process whereby the drivers had to use vouchers signed by the Vice-President of Finance in order to fill up with petrol from the pump.

One day, one of the managers was being driven back home when the car suddenly stopped. The manager asked the driver the reason the car had stopped: he was promptly told that the car had run out of petrol. When the manager asked why, the driver replied that the Vice-President of Finance was not in his office and so he had been unable to obtain his signature in order to fill up with petrol.

Using elementary Statistical Thinking, what should have been done instead? The organisation should surely have investigated to see if the problem was occurring with *all* their cars (a system fault, i.e. common causes) or with only one car (a fault external to the system, i.e. a special cause). If the inconsistency was occurring across all cars then the organisation would indeed have needed to change the process—though acquiring signatures from the Vice-President of Finance would hardly have been a useful change! But if it was occurring with only this car then the relevant driver should surely have been questioned and warned to stop stealing.

Knee-jerk reactions

We face many such instances in life where we simply react to what has just occurred—sometimes called a "knee-jerk reaction"—whether at home or in our place of work. With knee-jerk reactions one does not stop to investigate whether that occurrence is one of the many feasible consequences of the system or process while it is behaving normally or whether there could actually be an identifiable special cause for what has just occurred, justifying an appropriate reaction. In the former case, a knee-jerk reaction is far more likely to make things worse rather than better (the Funnel Experiment again).

Here is another example of knee-jerk reactions: hastily-made decisions based on what has just occurred without consideration of why:

Ravi is a member of staff in a Credit Control department. One month he was told by his manager to collect money from different retailers after their predetermined credit period had ended. He was given a target: it

was to collect Rs. 5 lakhs every day. How did the manager decide on this target? Simple! During the previous month, another member of staff who had been given the same task had collected an average of Rs. 4 lakhs per day. Great!! The manager decided to set a "stretch" goal to "motivate" Ravi.

But then something funny happened. One day Ravi managed to collect no less than Rs. 20 lakhs! Now, your guess is as good as mine as to whether he reported this. Oh, what did you say? OK, you're right: he did not! Instead, he did not even come to work during the next three days except when he had to deliver money to his manager.

What would have happened if Ravi *had* reported his collection of Rs. 20 lakhs? Chances are that his manager would have promptly revised his target to Rs. 21 lakhs per day!! The "logic" would have been that if Ravi could collect Rs. 20 lakhs today then, with a little more effort, he could collect Rs. 21 lakhs tomorrow. Working for such a manager, I'd say that Ravi was much more sensible to take his three-day holiday!

However, suppose that Ravi had been working for a different manager, one who had some understanding of the fact that (irrespective of whether or not he set a target for Ravi) there are limits as to what a process is normally able to accomplish. Then, presuming he had set a target which was somewhere between those process limits, he would have appreciated the fact that sometimes Ravi would be above target and sometimes below target. For example, suppose the process limits were 1 lakh and 8 lakhs. But when Ravi collected that total of 20 lakhs, which was of course far above the upper process limit, clearly something "special" (abnormal) must have occurred. As a result, it would have been sensible for the manager to sit down with Ravi to discuss what had happened and why—there was clearly something to learn.

Dr Deming often pointed out that people working in a process may know everything about that process except for realising the importance of what they know! By discussing the matter, this second manager could probably discover why Ravi had managed to collect so much. He might then be able to help him to replicate that success. Indeed, he might learn something that could be incorporated into the process so that *everyone's* results would improve.

Which type of manager would do the better job for the organisation: the one who understood something about Statistical Thinking or the one who didn't? And which one would you rather work for?

How *not* to manage a process

When a process is performing "within limits", it is essentially the *process* which is producing the results. But nevertheless, even when this is the case, people are often still compared against each other in terms of "their" results. This happens at the place of work, and in schools and colleges and universities. But it just isn't logical to make comparisons between two numbers and judge people accordingly when those numbers are in effect simply being produced by the *process* or the *system* within which they are working.

Sadly, we do not have to look far to see innumerable examples of this being done. Children are ranked and graded by comparison with the average marks obtained. Those with marks above the average are termed "above-average" students, and the others are termed "below-average" students. It would be much more logical to determine the natural process limits of the marks and only subsequently judge whether a student is "inside" or "outside" the system. If outside the system then it could be on either the good or the bad side. In the latter case the student would need some special attention; in the former case the student might have some special talent or some special knowledge which could, with advantage, be shared with others. Indeed, being aware of that special knowledge might help the teachers improve their teaching: the system would thus be improved. Simply slotting the children or students into different grades does none of these things: on the contrary, it often has the effect of ruining their confidence.

Similar situations can and often do occur in the workplace. We have already discussed the possibility of a "reward and recognition" scheme being introduced which is based on the last few results without consideration of the system as a whole. In such circumstances, comparing the results of two or more people and then either applauding or reprimanding them is pointless, misleading and wrong.

In summary, it is futile to try to evaluate the performance of a system or process by merely estimating its average output and trying to manage the process accordingly. Also, when a process is performing within limits, it is harmful to react to every output of the process or to compare two outputs from the process with each other (remember the Funnel Experiment yet again).

More wisdom from Dr Shewhart

Dr Walter Shewhart's writing was often not easy to understand—as Dr Deming readily agreed! But Deming saw a purpose in Shewhart's style of writing—it was to help make his readers *think*. The importance of encouraging people to think rather than always spelling things out in the clearest imaginable terms was a style which Deming himself sometimes adopted—as you may already have noticed from time to time during this course! Be sure there will be more of such style to come—and for the same purpose—particularly on Days 10 and 11.

Amongst many profound observations from Walter Shewhart were the following, and they all relate to matters upon which we have already touched:

- Data have no meaning apart from their context *[e.g. precisely how were they recorded, and under what conditions?]*.
- Comparison between two numbers has no meaning except as part of a larger comparison over a reasonably long period of time.
- Averages and other static measures of a system can lead the observer to come to incorrect conclusions about the process under consideration compared with watching how the process behaves over a passage of time.

As I said, these all relate to matters we have touched upon during this Prelude. Can you think about them and see how they do so?

Discussion

Let's now collect together some of the important learning from our first two Preludes and then consider some of the consequences of that learning. We have seen that systems are generally composed of several interlinked parts, maybe very many, which combine to produce the system's output. But we have also learned that the performance of each part of the system is never constant but subject to variation: this is because each part of the system is involved with one or more *processes*, and processes keep on fluctuating. The system's overall output depends in some way on all of these very numerous fluctuations. So it must follow that the system's output, i.e. its "performance", is also never constant but keeps changing.

Actually, it's worse than that! Of course, each individual process has its own varying output. But the different parts of the system are interlinked in various ways—and that means their processes are interlinked as well. That interlinking also has some effect on their outputs. The interlinking between any two processes may be of all sorts of different types: it may be strong, it may be weak, it may be somewhere in between. There may be what's called "positive correlation" between the outputs of two processes: this means there is a tendency for one to increase if the other does. Or there may be "negative correlation" which means the opposite: there is a tendency for one to go down when the other goes up. And that's only considering the

interlinking between *two* processes. But there is also likely to be three-way interlinking: the values from two processes may both have an effect on, and/or be affected by, the values of a third process. And there may be some four-way interlinking. And five-way interlinking …

Could we ever be able to figure all this out? The very thought makes the mind go numb!

But don't worry: Deming knew this too! He never claimed that we could ever have complete knowledge about a system and its performance. Indeed, instead he claimed the opposite was true: complete knowledge would *never* be possible.

That may sound pessimistic! But is it? Can we predict with exact precision the output of any process, e.g. our pulse rate at any moment? No, we cannot. Nobody can, and nobody will ever be able to. The best we can ever say is that the pulse rate will usually vary within certain limits. The same is the case with the time taken to reach a destination, the time taken to complete a certain task, and so on.

Again, is all this really as pessimistic as it sounds? No, it is not. Although it is not possible to gain "complete" knowledge about a system, there are most certainly ways of thinking logically and learning plenty about it, often sufficient to make considerable improvements to it—which in many ways summarises the purpose of both Drs Shewhart's and Deming's lives' work. Statistical Thinking is very helpful in this respect. And so is the third part of the System of Profound Knowledge: "Theory of Knowledge".

In order to make progress with the Theory of Knowledge, we must first understand what the word "theory" really means. If you ask people the meaning of "theory", many will say something like "theory is the opposite of practice". There are many who believe that theory is unimportant, that real understanding instead comes from practice, examples, experience. Deming agreed that these are important—*but not on their own: only when related to theory.* (This may ring a few bells from what you learned early on Day 6.)

So Deming had a very different take on the word "theory". Theory is not the "opposite" to practice: to him, the purpose of theory was to guide *better* practice. Theory is not some additional complication to all of those problems raised above: instead, it helps us to deal with them. Theory does not provide exact solutions to those problems: nothing could—again, this is not an exact science. Instead, theory is the salvation which helps us to overcome them. These observations take us straight into Prelude C: "Understanding Learning".

PRELUDE C: UNDERSTANDING LEARNING

At the end of Prelude B we introduced some thoughts about the word "theory". Dr Deming emphasised that all theory leads to knowledge, indeed that no knowledge is possible without theory.

The following sentence (*The New Economics* page 69 [102]) is a summary of what Dr Deming saw as necessary for conveying knowledge (as opposed to information):

> "The theory of knowledge teaches us that a statement, if it conveys knowledge, predicts future outcome, with risk of being wrong, and that it fits without failure observations of the past."

His exact wording would change from time to time, but that phrase "with risk of being wrong" was always there. He was an honest man! There is little in life that is absolutely certain to occur. But Part C of his System of Profound Knowledge largely focuses on *reducing* that risk of being wrong as much as possible. (Interestingly, that's effectively the same objective as Dr Shewhart had when deciding upon his "control limits".)

Let's illustrate some of this with the aid of an example.

What makes the scooter start?

A man rides to work every day on his Bajaj scooter. Most mornings, his young son watches him leave. The son is curious to know how the scooter starts. He notices a lot of things that always happen, one after the other:

- His father puts his bag on the scooter's handle;
- then he moves the scooter off its stand;
- he wheels the scooter to the front of the yard;
- he sets the scooter back on its stand;
- he then kicks the lever; and
- the scooter starts.

After observing for a long time, the boy realises something. It is only after his father kicks the lever that the scooter starts. So he has a theory: "Kick $\Rightarrow$ Start" (where the symbol "$\Rightarrow$" means "implies").

Is the theory true? One morning he is lying down on his bed, and so isn't watching his father. But he hears his father kicking the lever. Because of his theory he tells himself: "Now the scooter will start". Indeed, the scooter starts. His theory is correct! Or is it?

At the weekend, when nobody else is around, he decides it would be fun to start the scooter himself. He knows what to do—he has the theory: "Kick $\Rightarrow$ Start". So he goes to the scooter and starts to kick the lever. But, to his horror, the scooter does not start. How can this be? His theory is wrong! Obviously he has not observed properly.

So the next Monday morning he starts watching even more keenly. Does his father do anything that he hadn't noticed before? After a week or so he spots something. His father does not start kicking the lever until he has inserted and turned a key in a slot on the scooter. Could this be the missing step? His observations confirm this. So now he revises his theory; it becomes: "Key + Kick $\Rightarrow$ Start".

Three further days of observation appear to confirm his new theory. But he is a little wary about this since he recalls how, on the previous occasion that he had tested a theory, it turned out to be wrong. So, the next time he was alone at home, he took the key and inserted it into the slot on the scooter. He turned it, then kicked the lever. Lo and behold: the scooter started! His new theory was correct: "Key + Kick ⇒ Start".

However, one day he saw his father kicking away at the scooter but the scooter did not start. Remembering his theory, he thought to himself: "Looks like he has forgotten to turn the key!". So he went down and asked his father: "Have you turned the key?". His father smiled and said: "Yes". "Then why is the scooter not starting?", he wondered to himself. What was the reason? He asked his father the same question. But his father was just as puzzled.

So his father then approached their neighbour, an elderly gentleman who often solved their problems. He listened patiently while the boy's father explained the difficulty to him. Then he nodded his head knowingly and did something which left the boy baffled. The neighbour first ran with the scooter, then he jumped onto it while it was in motion, and then he jerked the clutch handle. Lo and behold: the scooter started!

So the boy's new theory of "Key + Kick ⇒ Start", which he thought he had confirmed, did not hold good after all! He asked his father to explain. His father replied: "When you get older, you will learn".

Information and knowledge

Now, after some years, the son reached the eighth standard. His question of "How did the scooter start?" had remained unanswered. One day in class, his teacher spoke of Newton's Laws of Motion. When she reached the law:

Rate of Change of Momentum = Force,

this was mere information for every other child in that class. But, for the boy, this statement became *knowledge*.

There is a difference between information and knowledge.

When *information* answers a question that has come from *theory*, it becomes *knowledge*. Now the boy understood that, when he or his father kicked the lever or the neighbour ran with the scooter, there was a rate of change of momentum which generated a force that in turn made the scooter start.

A further improvement to the theory

A few years later the son inherited the scooter. Every time he encountered starting problems, he would run with the scooter to make it start. But, one day, even running with it failed to make it start. Frustrated, he took the scooter to the mechanic down the road. The mechanic patiently heard out the problem. Then he bent down, put his hand underneath the scooter, and took out a little contraption called the "spark plug". He then pointed out how dirty it had become, proceeded to clean it, put it back in its place and kick-started the scooter into life.

So now the young man's theory became as follows. "When I kick the lever, or run with the scooter, there is a rate of change of momentum which results in a force. This force gives rise to a spark, and it is this spark that ignites the petrol which in turn makes the scooter start." Now the theory had become comprehensive, practical, and more successful than before.

Let's sum up this little story. First, the more the boy was proved to be wrong, the more he learned. Every time he discovered he was wrong, it gave him the chance to create a better theory. He was able to convert information into knowledge because he already had a theory. His theory encouraged him to ask questions. This is the only way to create and advance real knowledge.

Let's take a look at a couple of shorter illustrations. They have some differences from this first one, and are also different from each other; but it will be useful to study what's *similar* about them all.

Why is the Sun so bright?

A little girl comes to you and asks you why the Sun is so bright. You promptly reply: "Because it is very hot". ("Very Hot ⇒ Bright.") Very quickly she associates "bright" with "very hot". The next time she sees something bright she comes and tells you that it must be very hot. You then gently point out her error and say that not everything which is bright is very hot (i.e., although "Very Hot ⇒ Bright" is true, "Bright ⇒ Very Hot" is not necessarily true). The child understands and so now has greater knowledge. Are we not all familiar with this? Children between the age of two and four come to us with so many questions that they flood our ears!

Then, one busy day, in sheer impatience and exasperation you may just say: "It's like that because I *told* you so". That is the day the child stops asking questions, stops creating theories, and stops learning. Maybe all of us have experienced this as children at home and in school, as teenagers in college, as employees at our place of work. Sometimes, the moment we start asking questions, we are labelled as "weird", "crazy", self-indulgent, or just a nuisance. Worse, we also find some people reacting by saying something like: "You think I am an idiot for doing this for the past 30 years?". Well, my answer to them is this: "The fact that you have 30 years of 'experience' doing the same thing does not necessarily imply that you were learning for all those years. It could be just one year of learning multiplied by 30. Think about it!".

A theory may only be a hunch

Suppose we are studying a particular process. Let's assume we know of five factors that are likely to be affecting its performance. After observing the process for some time, we have a hunch that one factor affects another factor in a positive way. (With language similar to that used in Prelude B, we think they may be "positively correlated".) This hunch could have come from having previously seen something similar, or from something that we may have read somewhere, or from something we have studied. No matter that it is just a hunch: as Dr Deming pointed out (*DemDim* page 247), a theory "may only be a hunch, and the hunch may be wrong". The important point is that it can still be used as the starting-point for learning.

The next step is to test our theory. How? We create different situations where we vary the factors and see how they behave with each other. If the effect in which we are interested still appears to be true, we should test it yet again to check whether our findings were just a fluke. We could also repeat this to try to confirm that we hadn't missed anything out. If at any time the effect is contrary to what we expected, we haven't "failed"—we have just learned something: we have learned that our current theory is wrong and that accordingly we need to look for something different. I repeat: this isn't "failure"—instead, it is new and better knowledge. Theory gives us a method to create knowledge from observations. Theory provides a way of *generalising* as a consequence of *specifics*.

Theory: the starting-point for learning

Theory is the ground upon which knowledge and practice are founded. There can never be any knowledge or learning without theory. The children are using theory even if they don't know the word. Adults can

learn without realising they are using theory. But they are. And their learning will be helped and enhanced if they do realise it.

So how do we create theory? How do we start? We have seen some different ways. First, the young boy observed the scooter starting and wondered: "What makes it start?". Then the little girl knew that the Sun was so bright that it was dangerous for her to look at it—and wondered: "Why is it so bright?". In the case of our five-factor process we had the hunch that two of the factors were positively correlated. And we wondered: "Is that really true and, if so, why?".

These were the starting-points in the three cases. Then what? In the case of the young boy, he began to observe carefully and eventually came up with his initial theory: "Kick ⇒ Start". The little girl came and asked you a question. She didn't quite understand the answer because, as we can see from what happened next, she came up with a theory which was not correct: "Bright ⇒ Very Hot". But remember, the young boy's initial theory wasn't correct either. In the case of that five-factor process, our initial theory was just a hunch—again arising from observation. But, nevertheless, that hunch soon *led to* questions, just as in the other two cases. That's exactly as Dr Deming often simply stated: "Theory leads to questions" (*Dem-Dim* page 275). In the case of the five-factor process, the hunch resulted in some experimentation to find out whether that initial theory (the hunch) was in fact correct and generally to learn more about the process.

Notice that, without the initial theory, there would have been no learning! If he hadn't started with his theory: "Kick ⇒ Start", the young boy would not have observed more and more keenly, would not have asked questions, and almost surely would *not* have eventually finished up by understanding that:

> "When I kick the lever, or run with the scooter, there is a rate of change of momentum which results in a force. This force gives rise to a spark, and it is this spark that ignites the petrol which in turn makes the scooter start".

The young boy's simple and wrong initial theory eventually led to some considerable knowledge which many people do not have. Without her initial theory, the little girl would not have learned that "A ⇒ B" does *not* imply that "B ⇒ A"—a mistake which many adults (including some politicians and managers) continue to make. Without our initial hunch, we wouldn't have learned what we subsequently learned about that five-factor process.

So this summarises the sequence of learning, of acquiring knowledge. Actually, we could even have begun the sequence one step earlier. Why did the little boy—or the little girl, or we ourselves—observe what was seen in the first place? The answer must surely have been interest and curiosity. Children have both of them "in spades", as the expression has it. Hopefully, so do we.

Here are some typical questions that could well arise from observation and can thus lead to theory which may then be examined, tested, modified, then re-examined, retested, modified again, and so on, all the while developing learning, understanding, knowledge:

- Why is it that ice floats on water although it is "thicker" than water?
- How come a piece of iron sinks in water but a ship made of iron floats?
- How come when I eat only one ice cream I catch a cold but, when my friend eats ten ice creams, nothing happens to him?
- Why does my television set not start?

Without doubt, you can think of many more good examples.

Summary

Let's summarise more generally what we have covered. We have seen how theory is the basis of all learning and development of knowledge. We have seen that theory begins by observing or asking questions or, more usually, both. When we, because of our interest, inquisitiveness and curiosity, observe and/or ask questions, we lay the foundations of a theory that we can then test, confirm, expand upon, or indeed abandon. In every case, we learn. In every case, we need theory. A beautifully concise way in which Dr Deming said all this was: "Experience teaches nothing without theory". Similarly, he often stated that "Examples teach nothing without theory".

We have also emphasised that all of us are born with a natural desire to learn—it's a normal characteristic of human beings and, indeed, of other animal life. We see children, from a very young age, asking questions. Why are they asking questions? It is not for a prize, it is not to be top of the class, it is not for an increase in their pocket-money. Those are all what psychologists call "extrinsic motivators"—motivators that are nothing to do with the questions and the learning themselves. Children ask questions simply because they want to know, they are curious, they want to learn, they enjoy learning. These are "intrinsic motivators". Unlike extrinsic motivators, intrinsic motivators are intimately connected with the questions and the learning. It is so important that this learning be encouraged. It is sadly common that we, as their elders, crush this learning by unsympathetic and inappropriate reactions to their questions.

Where are we now? We have just mentioned matters to do with psychology. "Knowledge of Psychology" is the fourth and final part of the System of Profound Knowledge. Yet again, while discussing one part of the System of Profound Knowledge, we have effortlessly glided into another part! That is the very nature of Dr Deming's System of Profound Knowledge. Do you remember the opening words of his introduction on Day 9? They were simply: "The System of Profound Knowledge appears here in four parts, *all related to each other*".

What is psychology? My dictionary defines it as "the science concerned with understanding and explaining mental processes and behaviour". I think this can be simply abbreviated to "Understanding People". And that is Prelude D.

PRELUDE D: UNDERSTANDING PEOPLE

As you know, these four Preludes respectively introduce some of the concepts in the four parts of Dr Deming's System of Profound Knowledge which you will study more fully on Days 10 and 11. At the end of Prelude C we again recalled that Deming emphasised these four parts are "all related to each other". It should therefore be of little surprise that, during this final Prelude, we shall see several important links to all of the earlier Preludes.

"What is the job of a teacher?"

For a start, a particularly important issue which arose in Prelude C is that we are all born with the natural desire to learn. Dr Deming most certainly subscribed to this belief, but also pointed out that "people learn in different ways, and at different speeds" (*DemDim* page 278). Some learn by watching. Some learn by doing. Some need a combination of watching and doing. Some need to read. Some need to hear. For some, one word is enough. For others, after ten attempts, the person understands during the eleventh. Some learn faster and some learn slower. Which of all these and other possibilities characterise you? Whichever they are, are they not also things that you were born with?

Further, in Prelude A we saw some of the difficulties and indeed harm caused by ranking and rating. And now we surely see yet more. As there are so many different inherent ways of learning, is it then even *possible* for you or anyone else to sensibly rank people Number 1, Number 2, Number 3, ... ? Are you not effectively ranking what those people were born with and perhaps, to some extent, how they were brought up? That doesn't sound very fair—they are not responsible for either. In any case, what determines "better" or "worse" as far as you are concerned except for what happen to be your own personal preferences? For example, is the quick learner "better" than the slow learner? Why? The slow learner may well finish up understanding more deeply. So again, what determines your choice between "better" and "worse"?

But are we not subjected to this kind of illogicality throughout our lives? When you brought your report-card home from school for the first time, wasn't the first question asked: "Who came top of the class?". Even worse, maybe you were then told: "Go and study with her/him next time". Why? What is the theory behind such thinking? Is it that if I studied with that person then I would be top of the class too?

Well, if that is the case, this can be harmful in at least two ways. First: trying to be someone that you're not. Second: crushing your *natural* learning process. I leave it to you to figure out which is worse. And imagine the despondency all around if you *still* do not finish top.

So what should be done instead? As seniors—parents, teachers, managers—our real job is to *discover a person's natural learning process*. That person could be your child, your student, your colleague. Is there some standard method of doing this? Well, some psychologists claim that such methods do exist. Maybe. But I suggest that simply spending more time with the children or the others, getting to know them and thus making it possible to discover their natural learning processes, would be a good place to start. How? Watch and find out what makes that child get excited, what makes that student's eyes light up, what makes that person at your place of work go the extra mile to get the job done. Those are the signs we need to look out for. Those are the things that keep people awake at night. Those are the feelings we need to hone. Those are the sparks we need to ignite and keep burning.

Dr Deming was once asked: "What is the job of a teacher?". He replied that a teacher has three obligations to his students: (1) to make them fall in love with the subject, (2) to provide thorough subject-matter knowledge, and (3) to discover their inherent learning processes so that the subject makes more sense to them. I think we need to read and re-read that reply and apply it to our lives. Through that reply, Deming

not only clearly defines the importance of discovering a person's natural learning process but also then the need to sharpen the point of that discovery to where that person may start *enjoying* his work and learning. In so doing, Dr Deming has also clearly defined our jobs as teachers, parents and managers. Be prepared!

Does pay "motivate"?

When we discover and understand people's learning processes, whether they be our children, our students or our colleagues at work, and then we put them on the right jobs or give them something appropriate to study, it often becomes hard to *stop* them working! We will then have given them what Deming had no hesitation in describing as "Joy in learning" and "Joy in work".

During this course, you have doubtless become used to the fact that Dr Deming sometimes came out with statements which could be described as "startling"! There will be at least two such statements during this final Prelude. There is, of course, a risk in producing a statement that people may find startling. They may react by jumping to the conclusion that the statement cannot be true and therefore that the person making it doesn't know what he's talking about! Hopefully, by now, you know enough about Dr Deming *not* to jump to such a conclusion, even if you do not understand right now *why* he said something. He would make such "startling" statements for a definite purpose: to challenge you, to make you *think*, and think hard—much harder than if he always came out with something "tame", something with which you would instead readily agree. You may recall from Prelude B that he learned the importance of teaching in this manner from none other than Dr Shewhart.

During one of his seminars at General Motors in Michigan, Deming came out with such a "startling" statement about pay. It was:

> "Pay is not a motivator!"

In *The Deming of America* video, he repeated those exact words. This certainly startled Priscilla Petty, his interviewer! Deming then recalled that occasion at General Motors, and continued:

> "Sure you have to have enough to live on, and to live right. Beyond that, pay is not a motivator. Remember Norb Keller's statement which I think is famous. On the 7th of November 1987, Mr Norb Keller of General Motors at a meeting stated that, if General Motors were to double the pay of everybody commencing the 1st of December, nothing would change. Performance would be exactly what it is now."

(This statement is revisited on *The New Economics* page 74 [109].) So if *your* salary were doubled, starting tomorrow, will your work improve? You would doubtless be pleased, but would your work *improve*? By comparison, Deming believed that if your learning or your opportunities to learn were increased even by just a little then yes, your work would improve, maybe by a considerable amount—even without any extra money!

He often recalled "someone in history" (never named as far as I know) who apparently stated that (1) if we want to work then we go to an office, whereas (2) if we want to study then we go to school, and (3) if we want to play then we go to a playground. He would then ask whether there was any law to say that we couldn't also have fun and play at our place of work.

Now, don't start jumping to wrong conclusions here. What he meant was that, if my learning process were known and understood, and I was therefore put onto the appropriate kind of job, I would start *enjoying* what I do and begin to constructively "play around" with my work, thinking differently, looking for improvements and creating ideas for innovation. Rather than merely doing the same old thing day in and day out, I would be focused all the time on helping to make things *better*. I would also need to *study* my product or

process in order to enable this to happen. Wouldn't I now *look forward* to going to work every day in such circumstances? It would certainly be far more fulfilling and exciting!

One of the most important reasons that the Japanese became so successful was that they did understand this. They focused on putting the right people in the right jobs and, as a result, saw unparalleled results. They were fostering and building upon people's *intrinsic* motivation. Intrinsic motivation lights a fire *inside* people so that they continue to perform what they are doing without really feeling the heat!

But what do we see in the name of "motivation" these days? We get *extrinsic* motivation. Managers and others think that people get motivated by dangling a carrot in front of them or by comparing one with another and creating artificial competition. Well, in contrast, this seems to me to be akin to lighting a fire *underneath* people rather than inside them! The consequence is that, the moment you remove the fire, they will stop doing what you want them to do. Why not, if you have removed the only reason they were doing it? Can you expect anything new or innovative in those circumstances? In such circumstances, people will not take risks since they will be too fearful of going wrong. In contrast, in the better approach, the whole concept of learning encourages people to be interested and to experiment and to take risks, and often this leads to huge successes. Did any useful innovation ever come about without some "risk of being wrong"? (Recall the beginning of Prelude C.)

The most damaging effect of extrinsic motivation is that it so often kills off that priceless intrinsic motivation with which we were born. We train children from a young age that, in order to get a "reward", they must behave well, or do their homework, or finish their chores. So their reason to do such good things is no longer that those things are good: the reason is to be given the reward. They will no longer behave well, do their homework, or finish their chores for the satisfaction of doing good things or for the pleasure given to others for their so doing.

Rather than dangling that carrot in front of a child ("If you do that then I'll reward you like this"), were we instead to give them the privilege of enjoying their learning, their reward would be in the learning itself. Does that sound altruistic and far-fetched? It is not. It is scientific, systemic, emotional and logical, all at the same time. Besides, of course, it has been done before. Why stop now? It can be done again.

Competition

During Day 8 you have already seen another "startling" statement, this time on *DemDim* page 219 when reading about competition in Chapter 15. It was:

> "Competition has ruined us."

At least, I imagine it startled you at the time: it has that effect on most people. Hardly surprising. Many regard competition as the salvation, the panacea, for all economic woes. If Governments consider there to be too little competition in an industrial sector, they introduce laws to increase competition. In schools or in a company's Sales Department, there are methods for ranking the pupils or the salespeople, with prizes awarded to "Number 1", the "winner".

During Day 8 there was much emphasis on the advantages of cooperation over competition. The Major Activity there was an effective demonstration of the gains that cooperation can produce—so much so that Dr Deming later included a version of that demonstration in *The New Economics*. In the "Comparing, competing, ranking, rating" section of Prelude A we have already introduced some thoughts about competition and its effects. We shall now build on those thoughts and include a number of illustrations. What is particularly relevant to the current Prelude is the effect on people when they are *forced* to compete.

You will probably be familiar with Charles Darwin's famous expression: "Survival of the Fittest". People have often interpreted this in the sense of "Red in Tooth and Claw". That is a misunderstanding. Instead, Darwin said something quite different in *The Origin of Species*: that the species which will survive is the one that can adapt itself fastest to its ever-changing surroundings. But such a misunderstanding has resulted in our believing that we can only survive by eliminating the others around us. Agreed, in a game or in a beauty contest, we knew before we started that there could be only one winner—that's the rule. However, later on you will see Deming's concise explanation of the type of situation which he wanted to create, for example in Business and in Education. It was: "Everyone will win; no losers". In case you find that concept too much to accept at first sight, we have already seen (e.g. on Prelude A page 1) Deming instead using the word "gain" in a similar context. Business and Education can have more than one winner—and they need to. It depends on how you define "winning". In fact, even in a game or a sport there can be more than one "winner".

That was the original concept of the Olympic Games. The Greeks created the Olympics for a very different purpose from "one winner". They had travelled far and wide and learned that there were many, many different countries with many, many different kinds of people. Wouldn't it be wonderful if people from all over the world could come together and learn about each other's cultures, habits, rituals, knowledge and understanding—besides, of course, making new friends? *Everybody* would win. That is why and how they conceptualised the Olympic Games. They wanted a joyous event with indoor and outdoor games where people would learn and gain from each other. But, somewhere down the line, it turned into just a competition. It is rare that we see any sharing and learning between the athletes today. Rather than sharing and learning, they simply regard each other as rivals because now there can be only one "winner".

This has led to a relative scarcity of "winners". People no longer engage in sport for the purpose of remaining fit and healthy throughout their lives: they just play to win. This has led to their using all kinds of means —fair and unfair—in order to win. Nowadays one can name numerous athletes who have consumed unnatural substances so that they could become physically more capable of winning than their counterparts. Today, where are these athletes? What is their physical and mental state? Are they "fit and healthy"?

One genuinely fit and healthy athlete does come readily to my mind. That is the great Dara Singh, who always believed in being fit and healthy the natural way. The bouts that he won were not won because he trained to *win*: rather, he trained to be *the fittest*. The winning was a natural *by-product* and *consequence* of his being so fit. Sadly, I regard him as being something of an exception.

Competing against or competing with?

It is useful to consider competition in two forms: competing *with* and competing *against*. One might term them *friendly* and *unfriendly* competition respectively. In effect, we have just seen both cases. The Olympic Games began in the spirit of competing *with*: competing with each other *for everybody's benefit*. The Olympics later degenerated into merely competing *against*.

There are other types of beneficial competing *with*—including competing with oneself! Vijay Amritraj is one of the best tennis players that India has ever produced. Every player in his era, including Borg and Connors, was wary of him. I would like to tell you about a Davis Cup match that he played toward the end of his long career. It was the last of the five matches to be played in a contest which was currently tied at 2–2: so Vijay just *had* to win it. His opponent was a young seeded player who was half his age and twice as fast. Vijay lost the first two sets. In the third set he was 1–4 down and then on his serve he was 15–40 down. From this precarious position, he went on to win the match 3 sets to 2.

In the post-match conference, he was asked what was going on in his mind at the instant just described. His answer was simple: "I was too focused on trying to beat the other player. I suddenly realised that, if

I had to compete, it had to be with *myself*. I needed to be improving my own game. So I began focusing on myself. Suddenly I found that I was winning and, before I knew it, the match was in my pocket."

He was making the point just mentioned: he had been competing *against* instead of competing *with* and thus was losing out. When he reversed his thinking, everything—including the match—turned in his favour. Deming taught the same thing to the Japanese. He taught them that, instead of focusing on the other company (competing *against*), organisations should be focusing on the customer and how close they can get to the customer (competing *with*): that was the only way they would be able to put out better products and service.

I remember a nasty joke one of my students blurted out when I mentioned this in class. He said: "If you keep looking at your competitor and what he is doing when you are in business then your product will end up looking like the competitor's backside!" I think that summed it up most aptly!

Is it "natural" to compete *against*?

Understanding the distinction between "competing with" and "competing against" can make all the difference between success and failure. But, if we look around us, we find that we always seem to be involved in competition *against* someone in some form or other. Children compete against each other for the attention of their parents at home and their teachers at school; grown-ups compete against each other to attract the attention of their bosses; friends compete against each other to grab attention in a group. We see and experience this competition and manifestations of this competition all around us. Many claim that we are born with these traits. Deming argued otherwise. His claim was that, instead of being born with such traits, we *acquired* them because of the way we were treated while and since we were children. We have been taught from a young age that, in order to get ahead, someone else has to lose.

Let me tell you about a fancy-dress festival organised as part of a school gathering at a famous school in Pune. All the children came dressed in the most ridiculous of outfits and were having a great time pulling each others' legs and making jokes with each other. They were really enjoying themselves—until the Chief Guest decided to turn this into a fancy-dress *competition*. That's when everything went haywire. Children started fighting each other, some of them started spoiling another child's dress so that they themselves could win. Then the *parents* started fighting each other! The organisers had a tough time controlling the crowd after that. It all got really out of hand when the results were announced. Many of the parents complained bitterly of being cheated out of a prize. There were also cases where the parents were yelling at their children because they did not say their "dialogues" right.

What do you think—is this trait of competing against each other and its consequences *born* with us or was it *acquired* by us? I am sure that very many of us have faced similar situations, only we did not look at them in this way. The children's joy of participation was replaced by the despair of having lost the prize. Do children *really* need to be bribed by what we earlier learned to call "extrinsic" motivators? Would it not be better to instead build upon their natural *intrinsic* motivation?

I believe I see parallels between this sequence of events at the fancy-dress festival and the above history of the Olympic Games.

Finally in this section, I cannot help but recall the times when, in school and college, there used to be prizes and "stars" for the work that we did. Those who were awarded the highest marks were decorated with these prizes and stars. This was done to supposedly motivate the other children. But did it *really* do that? I think not. I remember spending sleepless nights wishing the others in the class would do badly so that I would get the first prize and be decorated with a star. Was this "motivation"? And what about the others? What do you think they were wishing for every other student? Going to school became a nightmare.

Today I see people leaving for their places of work without a smile on any face. They go there and spend the day trying to outdo the others in order to catch management's attention. One doesn't rise up the ranking without being noticed. Deming said that the place of work should be like a playground. But what has the workplace become? No longer a playground: instead, a battlefield. In Deming's eyes, the "unfriendly" type of competition, competing *against*, destroys individuals.

So, as we shall see on the next page, in *The New Economics* Dr Deming said that our need is to "restore the individual, and do so in the complexities of interaction with the rest of the world". He saw that failure to do so would be a major obstacle to a nation's growth. As an important contribution, he taught the Japanese that a manager must understand that, in an organisation, people work *in* the system whereas the job of managers is to work *on* the system, in order to improve it. How? Encouraging and enabling people to take pride and joy in their work is fundamental. For this there needs to be continual learning. This is the combination that results in continual improvement. He had already advocated the removal of the dreaded "performance appraisal" system which actually does not really "motivate" a person at all. How many do you know that look forward to their annual appraisal? So how *could* it be "motivational"?

Are we no better than rats?

The notion that people always need a "reward" for doing good things has become so deep-seated that Dr Deming occasionally fell into the same trap himself! He referred to this mistake as "overjustification". Toward the end of his days he often told his audiences at four-day seminars of the occasion when he had arrived on a flight from America to England. He was tired, frail, stooped, clearly very old. An air-hostess at Heathrow was kind to him and carried his luggage for him all the way to the exit. When they reached the exit, Deming put his hand into his pocket and fished out 50 dollars to pay her for this extra service that she had provided. His intention was, of course, to make her happy with this gift. Instead, she politely declined and went away. He realised later that he had hurt her. She had done it for the joy of helping someone in need, and he had turned that joy into sadness by thinking about her the way that he did. He writes with clearly deep regret about this and other similar occasions on *The New Economics* pages 75–77 [110–113].

This sad way of thinking and acting is encouraged by the work of a very famous psychologist who, to quote the author mentioned below, "conducted most of his experiments on rodents and wrote most of his books about people". How strange! To think that we are being compared with rats in our behaviour patterns. Think about it! I will not name that psychologist here, but be sure he did *not* contribute to Deming's "Knowledge of Psychology" (the fourth part of the System of Profound Knowledge). However, if you would like to know who he was and read more about him, I refer you to the opening pages of Alfie Kohn's fascinating book: *Punished by Rewards* from which the above description is taken.

One of the experiments the said psychologist conducted was the famous "Rat and Cheese" test. He would put a piece of cheese on a platform in a rat cage, following which the rat would come out of his little block in the cage and walk down a path leading to the cheese. He would take it and go back into his block. This led the psychologist to believe, and make others believe, that nobody would do anything without being shown some cheese, or the equivalent thereof.

Alfie Kohn wrote the whole story of the "Rat and Cheese" from the viewpoint of the rat! He went on to describe how the rat concluded: "Whenever I come dancing down the path to fetch the cheese, the man puts out yet more cheese for me". So—who was really controlling whom? Might it not have been that things were happening the other way round?!

CODA

Even before Prelude A began, we observed that Dr Deming, the man who largely catalysed the industrial turnround of Japan after World War Two, thought differently about how to look at things happening around us. Such a different way of thinking, he said, would lead to a transformation. He often summarised this transformation as a "metamorphosis": a change of such magnitude as a caterpillar turning into a butterfly. After that, there can be no going back to the old way of being. Here, in his own words, is a comprehensive description of that transformation (from *The New Economics* page 85 [123]):

> "The transformation will take us into a new method of reward. We must restore the individual, and do so in the complexities of interaction with the rest of the world. The transformation will release the power of human resource contained in intrinsic motivation. In place of competition for high rating, high grades, to be Number One, there will be cooperation on problems of common interest between people, divisions, companies, competitors, governments, countries. The result will in time be greater innovation, applied science, technology, expansion of market, greater service, greater material reward for everyone. There will be joy in work, joy in learning. Anyone who enjoys his work is a pleasure to work with. Everyone will win; no losers."

Thus he envisioned the transformed world. He, of course, did not live to see it happen. Sadly, much of what he taught has not been accepted by the premier institutions of the world, including those in his own country. Harvard, Wharton and Stanford Universities discarded his teachings and labelled them "absurd". But all good things have their time. Maybe the current generation might comprehend the power of his wisdom, and work hard toward bringing it to use.

Dr Deming touched many lives both directly and indirectly. One amongst those, as you know from Day 6, was James McIngvale of Gallery Furniture. I finished my series of short newspaper articles (on which these introductions to Dr Deming's teaching have been based) with the closing words from Mack's own story as told to you on Day 6. I cannot imagine that you will have forgotten them. Whether you have or not, please look back briefly to Day 6 page 16 and read them one more time.

I still shiver slightly when I read those final words. We who have the privilege to now be learning about Dr Deming's unique and priceless teaching, so long after he passed on, do indeed bear a heavy responsibility. Can we, will we, live up to it? If I am convinced of one thing—and I am—it is that we must surely try.

SOME LESSONS FROM HISTORY

Introduction - - - - - - - - - *page 28*

"... but they don't know what to copy!" - - - - *page 29*

Kaizen - - - - - - - *page 29*

Quality Circles - - - - - - *page 30*

Just In Time - - - - - - *page 31*

Six Sigma - - - - - - - *page 32*

Summary - - - - - - - *page 33*

Back to Deming's Legacy - - - - - - - *page 34*

India's Missed Opportunity - - - - - - *page 36*

INTRODUCTION

I'd like to set the scene by repeating some brief extracts from the Psychology part of the System of Profound Knowledge that you have been studying on Day 11:

- One is born with a natural inclination to learn and to be innovative.
- There is innate need for self-esteem and respect.
- Some extrinsic motivators rob employees of dignity and of self-esteem.
- Management that deny to their employees dignity and self-esteem will smother intrinsic motivation.

Dr Deming believed that we are born with great willingness and desire to learn. But, sadly, in time we may become largely conditioned by rewards and incentives, and thus soon "sell" ourselves to those rewards and incentives and actually feel bad when we do not get them. Worse, we are told to *compete* for them, thus destroying the reasons to live life to the full. The result is that self-esteem and the enthusiasm to learn decline and die.

The Japanese understood Deming's beliefs on these matters and were guided by them. One might remark that, in a way, they took a leaf out of religion—and to a remarkable extent. They observed that "All places of religious interest were always built in inaccessible areas because *the journey is more fulfilling than the destination*". If we look further, we find that they did indeed act in line with this thinking. Temples were built at the tops of mountains. Churches were built in the outskirts of settlements. Mosques were also built way out of reach. The Gurudwara in Amritsar was built in the middle of a lake. A similar interpretation is: "The process of *doing* something is more fulfilling than the *result* of doing it".

However, that way of thinking is not at all familiar to us in the West or in India. Most people in these countries are *results*-oriented: results, and the sooner the better. They are looking for the "quick fix", something to copy.

"... BUT THEY DON'T KNOW WHAT TO COPY!"

For many thousands of people, the first (and, unfortunately in many cases, maybe the only) time they've seen Dr Deming on television or video was in the 1980 American documentary: *If Japan Can, Why Can't We?.* A hard-hitting but surely accurate observation from him during that documentary was:

> "I think that people here expect miracles. American management thinks they can just copy from Japan—*but they don't know what to copy!*"

You can probably immediately recognise what he meant by that. It's well-summarised in his words on *DemDim* page 250:

> "People go to Japan, and learn nothing, for they have no theory to learn with."

which is then immediately followed by:

> "To copy without knowledge of theory a company that is doing well is to invite destruction."

Now, having nearly completed this course, you are hardly likely to fall into that kind of trap! But you still need to be wary. Many consultants and other "experts" specialise in initiatives, approaches, methods, tools, techniques, etc originating in Japan, yet are seemingly unaware of the part that Deming played in laying the foundations upon which those initiatives were built. The consequence is that, when companies try to implement them, guided by "experts" who lack that knowledge, the results may be disappointing.

I would like to give you some background concerning four such well-known initiatives in order to indicate what can go wrong if they are attempted without Deming's wisdom solidly underlying them. Forewarned is forearmed.

KAIZEN

This Japanese term is composed of two words:

KAI, which means "nothing stays the same"; and

ZEN, which means "a system that is growing beneficially".

Putting these two together, the true meaning of "KAIZEN" is *"creating a beneficial change in whatever we do"*.

One often sees shorter translations of those two little words: simply KAI = "change" and ZEN = "good". These miss the depth of the true meaning as expressed above. Thus many companies have tried to copy this concept from Japan but without understanding what it really means. The difference with the genuine approach is that this beneficial change is done *purely* for the sake of making a beneficial change *without* any other motive.

However in America, for example, an improvement is not considered to be an improvement unless there is a "visible figure" to support it: some cost reduction or return on investment—but yet the approach is still sometimes referred to as KAIZEN. Even in my country, many say things have improved only if we have saved some money. Worse, there even exist competitions: how *much* money? What a pity! The real concept of KAIZEN is that you carry out an improvement (a beneficial change) simply because you *want* to carry it out—you don't *need* recognition or reward from anybody for having done it. It also encourages improvements for the benefit of the *system*, the *organisation*, not just for yourself—indeed not necessarily for yourself at all.

Let me relate a sad experience I had whilst visiting a very famous company in Pune. I came across a poster on the shop-floor which supposedly described KAIZEN. First of all, I was aghast at how the whole concept was being so horribly misrepresented in that poster. I was still trying to digest what was written there when a worker who spotted me staring at the poster came to me and asked me (in the Marathi language) what I was doing. I counter-questioned him about his understanding of the word KAIZEN. His answer amused but saddened me: "Kaahi Jan kartat mhanun KAIZEN". This translates to say that it is called KAIZEN because only a select few carry out this activity! He showed me another poster which carried the words "Quality Circle", so I also asked him what he understood by this. His answer was simple and again horrible: "It is another way to blame us (workers) for everything that goes wrong".

I felt so sad that two of the most powerful concepts which had been inspired by Deming's teachings in Japan were being so horribly misinterpreted and implemented by us here in India. In the Western World I have seen both these terms being badly written about by so-called experts. Again, just as with KAIZEN, competition enters those wrong interpretations of Quality Circles.

Quality Circles

As far as I know, the Quality Circle movement originated in Japan around 1962. Some companies started to encourage informal groups who, during their breaks and free time, would come together to learn from each another and to solve problems. This became very popular and spread throughout Japanese industry.

In 1974, a famous organisation in India was tying up with a Japanese company for exchange of technology and know-how. To impress the Japanese, the then-leader of this famous organisation visited the headquarters of the Japanese company. During a speech, he tried to demonstrate to the Japanese how strict they were in his company about quality by boasting that they employed no less than 300 people in their Quality Control Department. But the Japanese, instead of being impressed, were utterly shocked by this statement. Puzzled, he asked the Japanese managers why they were shocked. One of them stood up and asked him: "Is your quality so bad that you need all those people to inspect it?". He was completely flummoxed by this question. So he asked the Japanese what they did. They answered: "We have Quality Circles who come together to solve each others' problems and continually improve processes and products. We have improved so much that whatever we do has quality built into it. We do not need inspection except to confirm to us that things are still going fine". Of course, he misunderstood this and proclaimed: "But my workers are useless! They need to be like your workers". The Japanese laughed. "Workers are not useless. If they *appear* to be useless, they have been *made* useless. You use their hands: we use their brains."

This leader did not learn from what was said there, and nor have many others. Today, there exist prizes for the "best" Quality Circles in India. Do you really think that these people are carrying out improvements for others and sharing their knowledge? I have doubts, very serious doubts.

Quite simply, the Quality Circle concept was created as one of many ways to promote cooperation and learning. Let me now take this a step further. I would like to tell you about an Indian man who went to Japan in 1964 and worked in a Japanese company as part of a course that he was undergoing there.

The course was of six months' duration. In the morning sessions the students had classroom interactions with the teachers. Then, in the afternoons, they worked in the company assigned to them—this was, of course, to enable the students to implement what they had learned. It was also in consideration of the fact that many people feel sleepy after lunch so that they might not be able to absorb mentally but could surely carry out some physical activity to keep themselves awake. On the first day that the Indian man went to the company to which he had been assigned, he was introduced to a Quality Circle during the tea-break. He was told that he would be welcome to join in their discussions if he so wished.

On the following day this man was given a job of carrying out some soldering. All he had to do was to take a board with components on it and immerse it in a vessel containing the molten solder metal. If the board was immersed for too long or too deeply, it would develop some superficial cracks. Although these would not generally impair the performance of the board, they could cause problems under extreme usage by a customer. The Japanese instructor demonstrated the process to this Indian man at least 15 times before allowing him to try it. During the demonstrations, he continued to explain why and how the process was to be carried out. Finally he let the Indian man carry out the process himself several times until he became confident. He then explained to the Indian that if, by chance, he made a faulty piece with one or more cracks on it then he should pull a cord which would set off an alarm and switch on a red light indicating to the supervisor where something had gone wrong.

The Indian man started carrying out the process alone. After about ten pieces, a fault occurred and a crack appeared on the surface. He was now in a quandary. Should he pull the cord? It was only his tenth piece. What would this Japanese supervisor think about Indian people? Besides, the crack was just superficial. (What would you, the reader, have done in this situation?)

Good sense prevailed and he pulled the cord. The Japanese supervisor came running. He saw what had happened. Very coolly he went on to demonstrate the process again until the Indian man properly understood it. He removed any remaining doubts in the Indian man's mind, and then left him alone again to continue carrying out the soldering process.

After about an hour, it was time for the tea-break and for the Quality Circle to get together. The supervisor started talking about something. Since almost immediately everybody present started staring at him, the Indian man realised that the talk was centred around the mistake he had made! After the supervisor finished what he was saying, they all applauded and shook hands with the Indian man. He was amazed. What was it all about? So he asked one of the people to translate what had been said and why they had clapped their hands. The answer which came was that the supervisor had greatly appreciated the fact that he had pulled the cord and alerted him of the problem. The Indian asked: "But why?". The man continued: "It was because we have a saying here that if, after I have explained something ten times, the person listening still has not followed, then there must have been something wrong with the way I explained it".

Imagine this scene in a Quality Circle in India or perhaps in your company. I leave it to you to think what could have happened. By the way, what do you think this Indian man did when he made another mistake?

There is one detail that I have not mentioned to you. This Indian man was none other than my late father. I did not understand the importance of this story when he narrated it to me. I do now.

Just In Time

Here is one more very famous Japanese invention, in this case originating in the Toyota Motor Company. Americans named it "Just in Time" because they did not understand what they were witnessing. The Japanese were not responsible for that description.

What exactly is it? Let's assume that Toyota makes 5,000 cars per day. (In fact the number is much larger, but 5,000 will suffice for this illustration.) They have more than 70 models with different variants (colours, powered windows, power steering, automatic gears, satellite navigation, and many other options). If, as an individual customer, you call them up at 9.00 am and tell them about the model you want, the configuration you want, the extras you want, and so on, they can manufacture the car as per your requirements and deliver it to you within four hours without disturbing their regular production of the 5,000 cars. Besides, they do not stock any inventory for such individual orders. But—where did all this come from?

Thoughts for this concept were in the making for over 80 years. The first recorded instance was when Eigi Toyoda (one of Toyota's founders) came home late from work on three consecutive evenings and ate the food that had been waiting for him on the table. Of course, it was usually cold by this time and so he would never finish it. The food was getting wasted and Toyoda's mother did not like this.

On the fourth night when he arrived home late, he was surprised to see his mother sitting and waiting for him at the table. She said to him: "I was angry that you were wasting food. But I realised that the fault was mine since nobody likes to eat cold food. So I decided to wait and prepare your meal after you got home". Toyoda was amazed. He said: "How do you know what I want to eat?". "I don't—but why don't you tell me now? I'll prepare it right away." So her son told her what he would like, she made the dish, and he ate every morsel. She was happy; he was happy.

When he went to work the following day, he told his trusted aides, Taichi Ohno and Shiego Shengo, what had happened. They were puzzled. "What do you want us to do?" His reply was: "If my mother can make a meal upon request almost straightaway with no wastage and no real stocks, I want to be able to make a car upon request almost straightaway with no wastage and no real stocks". It took the Toyota Motor Company another 30 years before they were able to achieve this.

People who do not understand what had been happening have confused this by calling it "Zero Stock" production. That is not what it is. Zero Stock is the *effect* of the Toyota Production System. As usual, people who do not understand have been doing the wrong things under this name with no awareness as to the true depth of what had been going on in Toyota. There are more than a hundred books available on this miraculous way of manufacturing cars. Would you believe that none of the authors are Japanese and most are American? These authors have no clue about how and why this works. But look carefully. Is there not much to learn from our womenfolk at home? Do they "stock" more food than necessary? Do they provide "bad quality" of product? Don't they "organise" themselves at home so that there is no waste?

Toyota has become one of the most admired companies in the world. But recently, when they recalled many of their cars worldwide, people started pointing fingers at them. Guess how many complaints they had received which prompted them to recall over 15 million cars? The answer: two!

They have such a strong process and work ethic that they did not hesitate before recalling the cars. Will our Indian companies copy this from the Japanese? Will the American companies copy this from the Japanese? What do you think?

Six Sigma

Just one further example of poor understanding—although this one is not from Japan. In 1995 I embarked on a course in Management of Quality which was titled: "Postgraduate Diploma in Quality Management". That was where I first heard of Drs Deming and Juran. It was an exciting period of my life. Whenever I reminisce about those times, a smile appears on my face. I so much wanted to know about everything happening in the world of Quality. I remember how I would ask many questions in class. Unfortunately, some people (both my classmates and my teachers) misinterpreted this as arrogance. I was, of course, unphased by this.

One evening (it was an evening course), the discussion topic was "Zero Defects". The gentleman teaching us was trying to motivate (provoke?) us by giving us examples from NASA, ISRO, the medical field, etc, telling us how you need to avoid errors altogether.

In the flow of his lecture he said something like " ... and you can then aim for Six Sigma!". He then stopped and said: "I hope you know what I'm talking about—Six Sigma? Six Sigma?".

We, of course, had never heard of it. He then went on to tell us how Motorola, the famous electronic component giant from the USA, had started a Quality initiative in 1985 which they called "Six Sigma". He said that when you attain (?!?) Six Sigma, the proportion of your errors would be minuscule: something to the tune of 3.4 errors in a million products!

All of us were in a state of disbelief! 3.4? ... in a million? Did we hear that right? He was, of course, most pleased with himself for having given us a shock! I remember all of us looking at each other, shrugging our shoulders, scratching our heads, etc.

I then raised my hand. I wanted to know where the 3.4 came from. The professor looked in my direction. The expression on his face gave away what he might have been thinking: "Oh no! Not him again!". I proceeded to ask him: "Where does the 3.4 come from? Is it something to do with the Control Chart?". He seemed offended at this. His reply was: "Do you think I'm a liar? You think I'm a fool? Why would I want to share this if it isn't true?".

Well, he never answered my question. Some five years later, a certain Henry Neave (who had by then taken me under his tutelage via some serious correspondence) was writing a series of articles for the BDA titled *SPC—Back to the Future*. Part 7 of that series covered the topic of Six Sigma. When I read that paper it was then that, at last, I understood where 3.4 in a million came from—and what nonsense it is!

I had the good fortune to meet Dr Juran in 2002. He gave me further insights on how people distorted important and valid ideas to create such monstrosities. He said that the Japanese improved continually and never stopped at any numerical target (3.4 errors, etc). He was puzzled about how and why Six Sigma had become so popular.

The explanation of the fallacy behind the whole thinking was so beautifully laid out by Henry in that paper that I thought it best for you to read about it in the way that he wrote it. So, at my request, he has included it in the material for *12 Days to Deming*: it begins on Appendix page 43.

Today, when I teach my students about how Dr Deming's teachings have been abused, I talk to them about the "Six-Sigma Superstition". I'm sure you'll love the way Henry explains it so simply. I quote Henry completely from that paper. Nobody explains it better. Let me tell you, it's very difficult to explain such things in a way that is easy to understand ... but Henry does it.

Summary

We have discussed some of the errors made when those without knowledge have tried to copy KAIZEN, Quality Circles, and "Zero Stock" or "Just In Time".

It is such a trite error to imagine that, by merely copying a few Japanese words and trying to copy a few of their concepts (excluding Six Sigma—this was a Western invention) without knowledge of where they came from or why, others could become as efficient and effective as them. There is no "short cut". Those Japanese concepts result from long chains of thought and learning and efforts.

As you know, the Japanese began their major learning from Dr Deming in 1950. We have pointed out that Quality Circles started to develop in 1962. Practices recognised today as KAIZEN date back to the 1970s.

So the Japanese were already well-steeped in what Deming taught long before these practices came into existence, and thus they were able to develop the concepts in ways that were wholly in line with his teaching. That learning has mostly been lacking by those who have supposedly adopted them in the West and in India—so it is small wonder that they have often made such a mess of them.

BACK TO DEMING'S LEGACY

After writing so much on what can and does go wrong, let's return to the System of Profound Knowledge. In case you might find it helpful, I would like to give you my own brief summary, rather along the lines of the expanded version of Peter Scholtes's diagram that you saw on Day 9 page 22: three important issues for each of the four parts. In particular, I think you may find it useful to refer to both summaries when you reach Activity 12–b on Day 12 page 9 *[WB 216]*.

Appreciation for a System

- Understanding the importance of a common aim or purpose for the system;
- Understanding that cause and effect are often not closely related in time and space;
- Understanding that outputs are the results of a myriad of inputs.

Some Knowledge of Theory of Variation

- Awareness of the distinction between common and special causes of variation and of how to interpret control charts;
- Learning how to ask the right questions;
- Understanding that reducing variation is synonymous to improving quality.

Theory of Knowledge

- Understanding the importance of theory in interpreting observations (experience);
- Understanding the importance of the relationship between theory and practice;
- Understanding how to learn faster and better.

Knowledge of Psychology

- Understanding that people are inherently good: they *want* to do a good job;
- Understanding that different people learn differently and hence think differently: working with people's learning processes rather than exhorting them will be better for us all;
- Understanding that ranking and competition destroy people.

Along with all of this knowledge, we have seen something of how the Japanese not only learned from, but also *interpreted* and *applied*, Deming's teaching. They learned from him and he, in turn, also learned from them. He never "knew it all" as some teachers and consultants pretend they do. Quite the opposite: he was always keen to continue learning. What an example to us all! The Americans, and thereafter the rest of the Western world, have not been able to experience the extent of success that the Japanese had. Perhaps the reason is that they have never really understood that we need to apply *all* of the above four sciences *simultaneously* in order to see things the way they really *are* rather than how we *imagine* them to be.

Many here in India have instead been trying to copy the Americans and others elsewhere in the West without really getting into the depth of things. If they were only to look carefully at what you have been learning in this course, they would instead recognise a lot of genuine, traditional Indian philosophy and approach in Dr Deming's teaching.

Deming told Japan's leadership that industry, government, education and healthcare must come together as a system and work toward getting Japan out of their crisis. They applied his thinking to these sectors and brought them together with stunning effect.

After Japan faced the repeated wrath of the tsunamis and earthquakes in 2011, they managed to resurrect themselves remarkably quickly. A note was sent from the W Edwards Deming Institute in America which expressed their concern and solidarity with the Japanese at that time of tragedy. The note ended with: "At that time you had Dr Deming: this time you still have his teachings. You have come back from worse."

That note was written by Dr Deming's elder daughter, Diana. One of the most distinguishing features of the Deming philosophy is the understanding of the pros and cons respectively of cooperation and competition. The Japanese were quick to imbibe and were successful in implementing this learning. They began by developing lifetime employment schemes with training that sometimes lasted as long as 12 years! However, of late there have been reports from Sony and briefly from Toyota when these schemes were discontinued. The results have already been seen. Sony had invented a new market for music players when they launched the Walkman in 1979. In 2010 they finally shut down production of that product. Apple came up with a new product called the iPod, and Sony has been trying to play "catch up" ever since. In the television market, they've lost out to Samsung.

So some are forgetting the lessons learned from Dr Deming more than 60 years ago. In 1985, he visited Japan for the annual Deming Prize Ceremony. While there he began to notice some things which considerably disturbed him. When his turn came to speak, he said the following:

> "Western management operates on management by numbers, management by objective, QC Circles, quality of work life, employee involvement, daily reports on people, and/or rating on performance of people.
>
> It is important that Japanese management remain strong, not weakened and diluted by adoption of some of the practices that are largely responsible for the decline of Western industry. It is possible for a strong body to become infected, to become weak. Japanese management has responsibilities to continue to be strong and not to pick up infections from Western management."[a]

Quite some message for his audience! Did he have a premonition of things to come? I think so. Even at Toyota, things seemed to slip "off the rails" for a while. Fortunately, the great-grandson of one of the founders is back at the helm. He is causing things to move back to their older and better ways. Despite reports to the contrary, the Japanese are not finished—not just yet!

> The "Epilogue" on pages 241–244 of Mary Walton's book *The Deming Management Method* contains a much more substantial account of Dr Deming's presentation at that Deming Prize Ceremony. The above extract comes from page 243.

INDIA'S MISSED OPPORTUNITY

Dr Deming had critical words for our Business Schools and Engineering Schools. He described them as preparing students for the past rather than for the future. Their students are not being taught how to *contribute* or how to *learn.* Instead they are merely being taught how to *earn*.

Well, there is nothing wrong with earning; but there is a need for people to understand that they also have a duty to make a contribution—be it to industry, to government, to education, to healthcare. Remember how Deming told Japan's leadership that these same four sectors must come together as a system. They made considerable progress with this. This is one of the greatest things for which the Japanese are famous. But Dr Deming had similar feeling and faith for India.

In 1936, when he was in England studying the theory of statistics with Sir Ronald Fisher at London's University College, he befriended a very famous Indian statistician by the name of Prashanta Chandra Mahanalobis. Dr Mahanalobis became the first Chairman of independent India's First Planning Commission. He also established the Indian Statistical Institute in 1945, even before we received our independence. When he became Chairman of the Planning Commission, one of the jobs he wanted to carry out was a country-wide census. Recall from Day 1 page 33 that in America Dr Deming "was appointed Head Mathematician and Adviser in Sampling at the National Bureau of the Census" in 1939. Subsequently "his work there, particularly with the 1940 American Census, turned out to be supremely successful, and it was in this capacity that he first attracted some international attention". So it is hardly surprising that in 1946 Dr Mahanalobis invited Dr Deming to India and, as the result, Dr Deming visited India as a Consultant in Sampling early in 1947. This was when he was also *en route* to Japan as Adviser in Sampling Techniques to the Supreme Command of the Allied Powers in Tokyo.

Dr Deming was very impressed with the quality of Indian statisticians. On his return to this country, he told Dr Mahanalobis about his visit to Japan and how he would like to work with Indian statisticians as well. He was keen to teach them what he had just begun to teach the Japanese. Dr Mahanalobis was very open to the idea! But Deming wanted a high authority to lead this work since he felt that the reason he had so far failed in his native America, other than with his work for their Census, was that the top people were not involved. Mahanalobis understood this. So he spoke to the then-Prime Minister of India, Pandit Jawaharlal Nehru, about Deming.

However, Nehruji was not very keen to meet Dr Deming. He feared that Deming was a capitalist and a typical "ugly American". Besides, the Americans were not exactly liked nor respected after dropping the Atom Bombs on Hiroshima and Nagasaki. He did allow an appointment with Deming, but did not listen to him. In fact, Deming once told a very good friend of this writer that Nehruji did not allow him to speak a word! Whatever was the truth, it is tragic that we missed the opportunity to learn from Deming what he taught the Japanese in the following few years. We can only speculate as to what the effects would have been. But I feel it is not too late even now.

There are a lot of efforts now being carried out to teach Dr Deming's work in schools and colleges here in our country. One such school exists in Lucknow: the Vidyatree Modern World College. This college was founded in 1979–80 by Mr Rakesh Kapoor who has been primarily responsible for the emphasis on Dr Deming's work and is now the school's Dean Emeritus.

The students at this college are taught from a young age about Dr Deming's wisdom. The four principles on which the school is run, and which appear in its Mission Statement, are:

- Learning without Cramming;
- Excellence without Distress;

- Discipline without Fear; and
- Caring without Conditions.

Children are taught the importance of *understanding* a subject. Teachers are taught how to help a student *love* a subject. There are video cameras in every classroom, not to "keep an eye" on the students as is usually done elsewhere, but to see whether the teaching methods are really effective. With these kinds of efforts being made, I feel that we can quickly learn and adapt to what Dr Deming taught. In his own words:

"There's so much to learn: it's exciting, fun!"

It is in the television documentary having the tongue-in-cheek title *Doctor's Orders* that Dr Deming is seen uttering those words. I feel the same. But I am still only half the age that he was when he said them. Will I still feel the same if and when I reach his great age? I believe so. I would like to conclude by hoping and trusting that the same may prove to be true of you, dear reader.

Approvals, Acknowledgments and Information

[a] (page 35) This quotation from *The Deming Management Method* has been included with the approval of Mary Walton.