

The World Economy in Turmoil: How to Work Smarter*

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With the world economy in turmoil and Governments pouring hundreds of billions of dollars to alleviate the crisis, it is critical that everyone, from heads of state to corporations, to individuals must do all they do in the best possible manner. Here is how.

Reading newspapers & magazines, watching Television news, surfing the net, and on your job, do you wonder if things could have been better? For example, could the 2000 US Presidential elections in Florida and the 2006 Mexican Presidential elections have been better organized and operated? Using the financial institutions' own criteria, could wiser choices have been made on who got the home loan? Is 60% graduation rate from US public institutions the best universities could do? Could the terrorist attack on the Indian Parliament in 2001 have been prevented? There is of course an upper limit to achievable performance but in the absence of the methodology we describe in this paper, we may be doing considerably worse and it may be possible to improve the performance, perhaps appreciably. This paper describes how.

How to Work Smarter.

Defining an activity consisting of a series of steps as a work process, the methodology we describe (we call it *WorkPerfect*) may be used with any repetitive work process. From the time we wake up, to the time we go to bed, including much of what we do at work, being a series of repetitive work processes, the methodology can improve the performance of any of them. In fact, you will see that the methodology is really for life, meaning that everyone must think, work, and live consistent with its principles. The rewards of following the methodology are as great as are the catastrophic consequences of not following it.

Now, every repetitive work process has an outcome or outcomes by which its performance is judged by those whom the process serves. Typical outcomes are quality, cost, and task-time. The performance of a repetitive work process is judged defective if the quality is subpar, costs are high, or the task-time is unreasonable. Defects in any outcome of interest occur for three reasons as depicted in Figure 1. Some defects occur due to causes that are unknown, uncontrolled, or uncontrollable within the scope of the process or transaction you are working with. Some occur due to measurement system errors, while the rest arise due to causes that can be discovered.

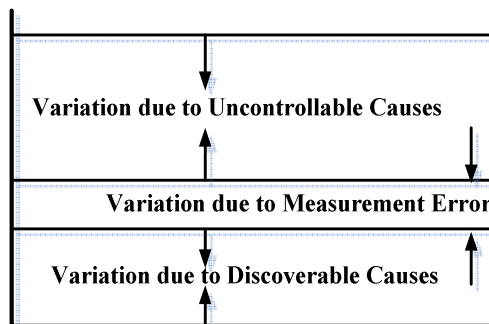


Figure 1. Nature of Variation in Outcomes

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Should the outcome of a work process have unacceptably high defect levels, corrective action becomes necessary. Of course, if all the defects were due to causes that are beyond control, then no improvement is possible. However, it is only after the investigation has been completed when we will come to know how many of the defects were due to uncontrollable causes and how many were due to discoverable causes. If it turns out that unacceptably high defect levels have persisted even after the discoverable causes have been worked on, then what it means is that the existing process is incapable of delivering the desired performance! We would have to go back to the drawing board and consider such issues as suppliers, raw materials, business models, technology, equipment, and the like, as appropriate to achieve improvement. This aspect notwithstanding, our confidence in the ability to improve the performance of repetitive work processes is due to four fundamental laws of nature.

1. The Law of Karma (India, ~1500 BC): The first natural law states: *All that we do have causes and effects. Furthermore, the effect of one cause is in turn a cause for another effect.* The endless web of causes and effects is called *Karma*. For our work, this natural law has been adapted to say: *“For every effect, there must necessarily be a cause (or causes).”* The effect represents the outcome of a work process by which its performance is measured and whose performance is sought to be improved. Although the law of *Karma* does not identify what the causes are, it should nonetheless be a source of great comfort to anyone aspiring to improve the performance of work processes knowing that there are *causes* influencing the outcome. If these causes could be found, and there are found with the methodology being presented, we would work on them to improve the performance. Fundamentally, there are four types of causes and their description necessitates access to three other laws of nature.

2. The Law of Natural Variation (Germany, 19th Century AD): The second natural law, adapted from the work of German scientist Frederick Gauss, stipulates the first type of causes. It states, *“All processes and transactions exhibit a certain amount of inherent variation no matter how well they are designed.”* This natural variation occurs due to a host of unknown, uncontrolled, or uncontrollable causes. Perfection therefore (zero defects ad infinitum) is not in the plan of nature. However, adherence to the principles of the methodology described herein will ensure that the defect levels are as small as this natural law permits them to be.

3. The Law of Discoverable Causes (USA and Japan, 20th Century AD): The third natural law adapted from the work of several American and Japanese quality control professionals (Shewhart, Deming, Juran, and Taguchi, among others) specifies the next two types of discoverable causes. This law states, *“The inherent variation in the outcomes of work processes due to causes that are beyond control is worsened by causes that are discoverable. Denoting these causes as impact factors, tracing and then eliminating them (causes of the second type) or setting them at correct values (causes of the third type) as appropriate will return the process or transaction to its natural state.”*

4. The Law of Variation due to Measurement Error. Measurement errors, causes of the fourth type, further increase the variation in the outcomes of work processes and therefore defects. To achieve the desired improvement, measurement errors must constitute a very small fraction of the outcome variation due to all discoverable causes.

Figure 2 graphically illustrates these ideas for a hypothetical example. The desired value of the outcome in Figure 2(a), graduation rates from US public universities, is 100%. Figure 2(b) shows that unknown, uncontrolled, or uncontrollable causes not only can prevent us from achieving the desired performance but they also introduce variation as per the second natural law. The graduation rate is depicted to be 67.8% in Figure 2(b) due to these uncontrollable causes. The

natural variation in the outcome is worsened by measurement error and by impact factors (for example, the mean may veer off target, variation may increase, etc., as per the third and the fourth natural laws (see Figure 2(c)). The mean graduation rate shown in Figure 2(c) is now 62.3 and the variation around the mean is much larger than that in Figure 2(b). The goal of the methodology here is to return the process or transaction outcome to its natural state as in Figure 2(b).

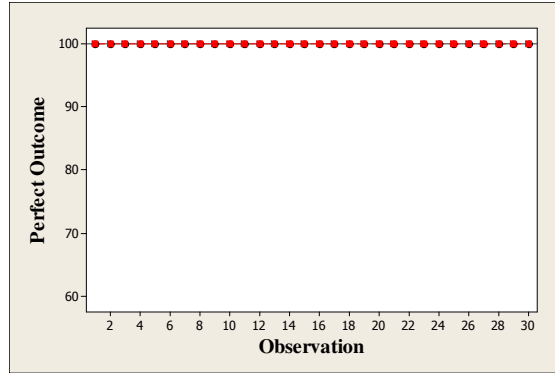


Figure 2(a). Desired Outcome is 100 (All entering students graduate in four years)

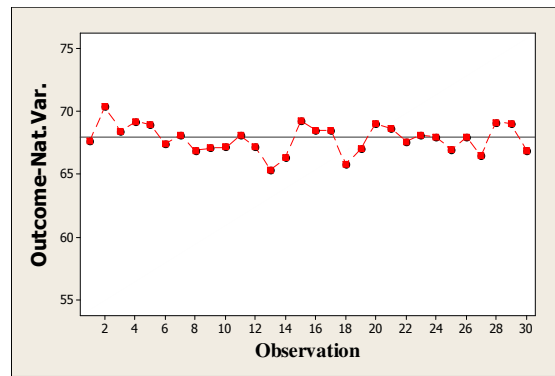


Figure 2(b). Graduation Rate with Natural Variation Due to Uncontrollable Causes (Mean = 67.8; Std. Dev. = 1.136)

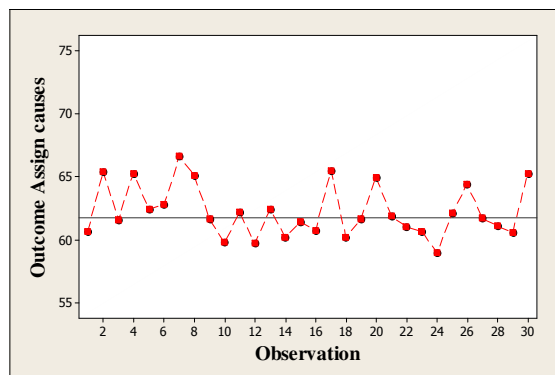


Figure 2(c). Outcome Worsened by Measurement Error and Impact Factors (Mean = 62.3, Std. Dev. = 2.06)

Figure 2. Outcome Influenced by Different Causes

Armed with these natural laws, it is possible to write down a data-driven methodology for improving the performance of any repetitive work process. Before beginning to use the methodology though, you must be able to identify the repetitive work process whose outcome you are interested in improving, know all the steps that comprise the process, who the process serves, and what is important to those being served. The eleven-step methodology is described in the following paragraphs.

Step 1 is to **State the Problem** articulating what is giving rise to defects (e.g., 35% of train arrivals are more than 10 minutes late).

Step 2, Here, we define the outcome of this work process (e.g., **Arrival Time, Minutes from Target**).

Step 3, In Step 3 we state the project goal (e.g., **Reduce Late Arrivals, by 50%**). The desired improvement is speculative at this point since we do not know the extent of natural variation in the process. An estimate of the financial benefits if the targeted benefits are realized, should be included.

Step 4 In Step 4 we **prepare a graphical display** showing all the steps in the process including the linkages between steps. The display in the case of the train travel process will include all the steps from the time the train leaves the origination station until it arrives at the destination station. Figure 3 depicts the graphical display of the illustrative train travel process.

The *Karma* concept states the outcome of this process, Arrival Time, is impacted by causes. It does not tell us what the causes are. We wish to determine what the causes are so that we may work on them to improve the outcome performance. Dissatisfaction with the outcome has emerged as an issue because there is excessive variation in this outcome, that is, the average arrival time is not where it should be and the variation around the average is too large. Some of the observed variation in the outcome will be due to causes beyond our control within the scope of the problem under scrutiny, but a lot of the variation will be due to causes that we can do something about. Every step on the graphical display is a possible impact factor, i.e., a possible contributor to the variation in the outcome and therefore defects. In a future step, we shall determine which of these possible causes are in fact responsible for the variation in the outcome.

Step 5 is to **Validate Measurement Systems**. The central idea here is that the variation in the outcome should come from discoverable causes (any one or more of the steps on the graphical display) and not from errors in the measurement systems. Measurements of outcomes and of all possible impact factors must be accurate over the operating range of interest and over time and must produce consistent results when repeatedly performed by one or more individuals or instruments. Take the case of a financial institution considering a home-loan application as an example. An important issue connected with the loan application is the amount of loan sought. If the appraised value of the home turns out to be substantially more than its fair market value, the lender could face undue risk. Now, this measurement, appraised value of the home, itself is an outcome impacted by uncontrollable causes consistent with the second natural law and discoverable causes consistent with the third natural law. You can see how several appraisers could produce appraised value measurements that are within the margin of natural variability. It is extremely important to validate measurement systems before proceeding to the next step in the improvement strategy.

Step 6 is to **Collect Data on the Outcome(s)** for the purpose of determining the starting defect levels.

Step 7 is to scrutinize the data collected and **Establish the Current Defect Levels**. It is important to establish the current performance so that improvement can be properly catalogued.

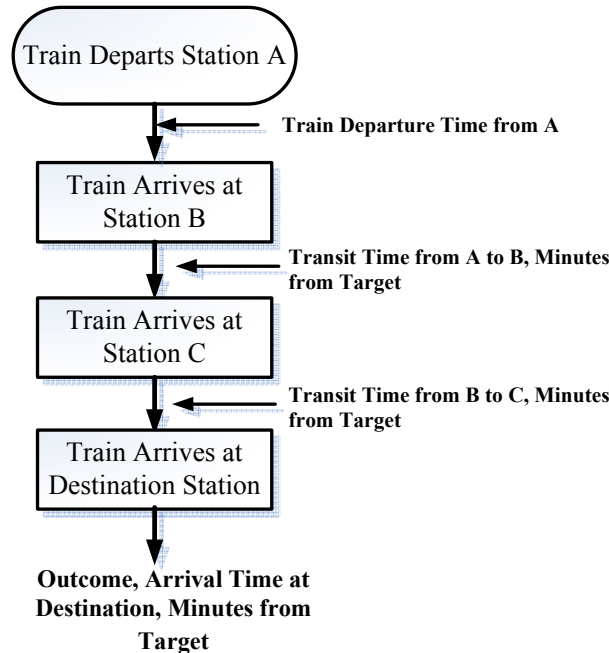


Figure 3. Graphical Display of the Train Travel Process

Step 8 In Step 8 we collect the data on the possible impact factors and the outcome(s). As previously stated, every one of the steps on the graphical display is a possible impact factor.

Step 9 involves analyzing the data collected in Step 8 for **Identifying Impact Factors**, the causes that are responsible for introducing variation in the outcome. For example, the outcome of interest in the graphical display of the train travel process in Figure 3 is arrival time, minutes from target. The data analysis will reveal which of the steps are responsible for the variation in this outcome. Here, the familiar 80-20 rule applies, meaning that 80% of the variation in the outcome occurs due to 20% of the possible impact factors (steps on the graphical display). Once you have determined which of the steps are incurring unreasonable transit travel times, you would focus on these steps and investigate the root causes for why the transit times are unreasonable. These are the Impact Factors to work on to achieve improvement in the outcome.

Step 10 In Step 10 the **Impact Factors** so determined are either set at the correct values or are eliminated as appropriate. For example, if the unacceptable outcome were due to say lack of proper operator training, the negative effect of this impact factor can be mitigated with proper training. On the other hand, some impact factors may not be at the correct values. When both of these types of impact factors are corrected, the average of the outcome moves in a favorable direction and the variation around the average reduces and all the benefits of the effort are realized.

Step 11 The last step is to put in place a plan to **Monitor Outcome(s)** so that the benefits of the improvement effort are sustained and the problems once fixed, stay fixed.

Dos and Don'ts of Working Smarter:

There are a number of do's and don'ts of working smarter to insure that we are doing the best we can in all that we are doing. The first author states at the outset that prior to comprehensively understanding the profound implications of the suggested methodology a decade ago, he and some of the Fortune 500 clients he was working with, shot themselves in the foot by not following the methodology rigorously resulting in failure.

- This being a fundamental methodology for improving the performance of every repetitive work process, highly complex work processes can be tackled. However, it is advisable to breakup the processes into tractable pieces so the project can be completed in a reasonable amount of time.
- Using the eleven-step methodology is a powerful way to achieve profound improvements that would otherwise be unattainable. Far too often, problems are articulated and solutions proposed more or less in the same breath thereby skipping the nine steps in between. Here are few examples:
 - The High Court of a major democracy noting that too many pending cases were clogging up the courts decides to ban lawyers from going on strike. The lawyers respond by going on strike!
 - The US Government has identified improving education as a critical area to focus on for national wellbeing. The CEO of a major corporation suggests watching the videos of best teachers in action to improve teaching.
 - Reacting to the growing number of railway accidents the Transportation Secretary of a major democracy remarks, engine drivers are too old.
- A repetitive activity should not be commissioned without first validating measurement systems. The errors due to measurement systems must be a small fraction of the variation (defects) in the outcome due to discoverable causes. Failure to do so can lead to catastrophic results. Here are some examples.
 - Consider the Voting Process involving voters coming into a polling booth for voting in an election. Here, voters fill out ballot papers that are processed by a vote-counting machine, and the interpreted results are generated. Clearly, we would want the variation in the outcome (Interpreted Results) to come from discoverable causes (Voter Intent) and not from errors in measurement systems (confusing ballot paper design, error-prone vote counting machines). In fact, such errors must be a very small fraction of the margin of victory between the top two candidates or else the election results would be suspect.
 - Terrorist attack on the Indian Parliament in 2001 might have been prevented had the measurement validation systems been more effective. An "official looking" car permit used by the terrorists was able to breach the security to enter the Parliament premises.

- In the aftermath of the Mumbai terrorist attacks in November 2009, The President of Pakistan reported receiving a threatening phone call from the Indian Foreign Minister. The Indian Foreign Minister responded, he never placed the call.
- You are encouraged to watch the movie, *The Sum of All Fears*. Of course, it is a fictional account, but it is too scary to think measurement validation problems have the capacity to unleash such horror.
- Correlation does not necessarily imply causality because of the possible presence of unknown factors. If there is causality, there will always be correlation but if there is correlation, there may or may not be causality. It is only with the methodology outlined you will be establishing whether there is a causal link between a perceived cause and an effect. Consider an example:
 - Someone published an article in a reputed science journal awhile back to suggest that those who are out of control engage in such acts as stomping their feet before a presentation in the belief that their presentation will go well. We suggest the tendency to infer causality where there is only correlation is much more widespread and needs to be avoided.
- Relying on a single measurement of the outcome before and after the project to assess whether there is improvement is problematic because the outcome has variation due to uncontrollable causes. It is best to work with average of measurements before and after, which nullify these variations, to assess if in fact an improvement has been achieved. Let us take up an example.
 - Suppose you are investigating if an exercise regime involving a set of ancient breathing exercises called Pranayam might lower your blood pressure. Suppose you measure your blood pressure prior to undertaking these exercises and it is 140/90. After a month of diligently pursuing these exercises, you take the measurement again and it turns out to be 130/85, and you are delighted. Unfortunately, your sense of joy might be misplaced because had you taken the average of a sufficiently large sample of measurements, before and after, you might not have seen any perceptible improvement. It is important to work with average of measurements because the outcomes are subject to natural variation (Natural Law No. 2).
- Stratified sampling must be used to determine the defect levels in an outcome of a heterogeneous population containing several subgroups each with a different mean and variation around the mean. For homogenous populations where there are no subgroups, simple random sampling is appropriate. Let us take an example.
 - Suppose you are desirous of investigating how many financial institutions are in need of help. Taking a simple random sample could lead to a result that is not reflective of reality because many institutions are small, some medium, and few very large. Taking a stratified random sample would be prudent.
 - Some years ago, the first author was working with a client on improving the product quality from a batch process in a manufacturing plant. Product quality measurements from one batch served to adjust the impact factors for the ensuing batch for improving quality. The project was a failure because in hindsight we realized we were dealing with a

heterogeneous population and the operators were taking a small number of simple random samples for inferring product quality.

- If someone asserts that their process cannot be improved, they are implicitly telling you that the entire variation in the outcome of their work process is due to uncontrollable causes. As we have shown in the paper, you only come to know how many of the defects were due to uncontrollable causes in hindsight, only after the improvement project has been completed, not before. Let us take an example.
 - The average graduation rate from US public universities is reported to be under 60% after six years. Not embracing this methodology for improvement is tantamount to the assertion that no improvement is possible because the entire variation in graduation rates is due to uncontrollable causes. Note that a known source of natural variation in college performance is incoming students. In the light of the first natural law, therefore you would agree that the methodology has to be adopted by all previous institutions from high schools to kindergartens. The remaining variation in graduation rate will then be due to uncontrollable causes (parents).
- If the concepts in this paper are to be applied to systems that evolve, then there are some additional considerations:
 - When it comes to human health, each of the 6½ billion of us is a unique entity with a unique natural variability in health parameters that arises due to heredity factors. Furthermore, the natural variability in health parameters indicative of good health gradually worsens from the time of birth to the time of death. We compound our difficulties by adopting unhealthy life-style choices (lack of exercise, improper diet, inability to cope with stress, etc.) starting at an early age. Consequently, the natural variability further degrades. The methodology described here is appropriate to use to investigate the impact of improvement systems (allopathic, Ayurvedic, homeopathic, Pranayam, etc.) for restoring health to one's own state of natural variability provided we refrain from extrapolating the results to the wider population.
 - If you are evaluating a possible improvement in an outcome reflective of health due to a specific cause, ensure that all other impact factors have been constant or else the extent of improvement from the cause under investigation cannot be properly assessed. Sophisticated methods that allow for making simultaneous changes in numerous possible impact factors are available in the literature for those who may wish to dig deeper.
 - If you are working with a process whose outcome is the stock market in some sense, beware that it too is not a stable system. The natural variability here not only changes with time but also its influence on the outcome is often far in excess of known impact factors.
- Absence of integrity can add excessive uncontrollable variation to the outcomes of many work processes. It is essential to cultivate 2Cs5DsPR (commitment, concentration, determination, discipline, driving decisions based solely on data, perseverance, resolve) for success.

Discussion and Concluding Remarks.

Defects in all products and services distinguish developed nations from emerging and developing nations. This being the methodology for defect reduction, emerging nations desirous of joining the ranks of more developed nations and developed nations desirous of maintaining their competitive positions really have no choices but to embrace the methodology if their goals are to be realized. Virtually anything of interest is an outcome and associated with that outcome there is likely a repetitive work process and the methodology described can improve its performance. This is why the potential opportunities for the methodology are so widespread and cut across all discipline boundaries. The concepts are transformational; embracing them could change you forever!

Not long ago, the first author was conducting a training program on this methodology for the Ministry of Higher Education and Private Colleges & Universities in Kuwait. Among the attendees were former Deans of Engineering, Business, and Admissions, as well as professors and administrative staff of various institutions. On day 1 of the program, the President of the Arab Open University made a discouraging remark, "*This methodology appears to be inappropriate for higher education*". The participant holds a doctorate in literature. One day after much of the material had been completed, the participant came up, gave a hug, and remarked, "*I withdraw my comment*". He has since prodded the first author to simplify the concepts. The authors have attempted to do this and hope, have made some progress.

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