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Understanding and Misunderstanding Variation in Healthcare: Case Study

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Abstract

In a paper presented at the 20th Annual Deming Research Summit, the author described how Dr. W. Edwards Deming's management philosophy was being applied in healthcare through efforts to learn and emulate the Toyota Production System style of management, referred to as "lean" (Stoecklein, 2014). That paper focused on the principles that were being emphasized and how these principles could be traced to the System of Profound Knowledge described by Dr. Deming. This author pointed to one apparent exception – understanding and managing variation, which seemed to be largely absent in the discussions. Five possible reasons for this absence were proposed, but not explored. This paper is an attempt to explore this question further, to verify the possible causes, to identify any additional possible causes, and to describe the consequences for not understanding variation for managers of healthcare organizations who wish to transform their culture to one of continual improvement. The paper includes a summary of interviews with 40 individuals from 33 healthcare organizations and consulting companies regarding three areas of inquiry: 1) the current state of healthcare management's understanding and responding to variation when they have data, 2) their current understanding of how the principle of variation applies when data are not present (including the management of people), and 3) a description of what is being taught and advice given around the principle of "understanding and managing variation."

Outline of Paper

1) The question – Why am I not hearing about "understanding and managing variation?"
2) Why is understanding variation important? (So what?)
3) Healthcare is learning about lean (But does this also mean they are learning about continual improvement?)
4) A common pattern for learning about lean
5) Principles and knowledge
6) Copying without aid of theory
7) Guiding principles for enterprise excellence
8) The principle of "understanding & managing variation"
9) Building new knowledge
10) Key findings from interviews – current state of understanding and managing variation in healthcare
11) Conclusion

The Question – Why Am I Not Hearing About "Understanding and Managing Variation?"

In the 2014 paper (Stoecklein, 2014) the author identified examples of the application of Dr. Deming's System of Profound Knowledge in healthcare organizations that were learning and applying lean (Toyota Production System) methods. It was not too difficult to make connections

to the three components: appreciation for a system, theory of knowledge and psychology (and their interactions), but the weakest connection seemed to be in the component of "understanding and managing variation." This seemed odd, given:

1) Understanding and managing variation was at the core of what Dr. Deming brought to Japan beginning in 1949 (Kilian, 1992) (Deming, *Out of the Crisis*, 1986).
2) Dr. Deming's contributions to the foundations of the Toyota Production System, including understanding and managing variation could be traced back to the 1960s forward (Shimokawa & Fujimoto, 2009).
3) Understanding and managing variation seemed to fit the criteria for designation as a "guiding principle:"
    a) Principles are universal, based on fundamental scientific, logical truths arising from observation and experimentation. Variation exists, everywhere and in everything. There are common causes of variation and special causes.
    b) Principles are objective, not persuaded by emotion. Principles do not depend on the beliefs or feelings of any person or group of persons – they are resistant to changing shifts of opinions. A process that produces stable output (common cause variation only) will continue to perform at that level in the near future. A person may not like the level of performance, but that does not matter. Only changes in the system or the process will produce improvement.
    c) Principles govern consequences. Regardless of personal understanding or belief in the principle, it still enforces a predictable outcome or consequence (positive or negative). A person who reacts incorrectly to common cause variation (asking for reasons for the random ups and downs) will feel the effect of the consequences of this misunderstanding because best efforts will only make matters worse (more variation).
    d) Principles are predictable. By understanding the consequence of the principle, we can accurately predict the logical outcome. A person does not need to test the consequences of tampering (reacting inappropriately to random variation). The consequences are predictable (Raymer, 2014).

Some potential reasons that this principle was not being discussed were described in the 2014 paper:

1) Toyota managers developed a deep understanding of how to handle variation over many decades. They developed systems and tools to react to variation, but those who have tried to copy Toyota may not fully understand the thinking behind the creation of these systems.[(i)]
2) Knowledge about variation was not fully understood (especially as it relates to the management of people), so it was not taught.
3) The topic of variation was viewed as a technical matter and placed in a "container" (a "six-sigma thing") and separated from lean.
4) Those who teach and advise in lean methodology did not fully understand the knowledge behind the systems and methods, so it was not taught.

5) The way our minds work (intuitive system 1) causes us to see and act quickly on patterns and assumptions, which we think require our immediate action. Understanding variation (and thinking systemically) requires engagement of what Kahneman calls "system 2" in our mind. We can do it, but it requires time and effort. We tend to avoid this and take the path of least resistance by relying on system 1 (Kahneman, 2011).

Why Is Understanding Variation Important? (So What?)

Knowledge about variation and how to manage variability is one of the core concepts that Dr. Deming introduced to the world. Variation exists in people, processes, and systems, and in the outputs produced by systems. Without an understanding of variation, people are likely to tamper with systems and processes and thereby make matters worse. The consequences of not understanding and managing variation include: management adding waste into the system, increased variation in outputs, increased frustration throughout the organization, and disrespect for individuals. The problem occurs in management's reaction to figures and measures, but also in reaction to events and behaviors (when there are no figures). The higher a person resides in an organization's hierarchy, the broader the implications (the more waste and frustration they produce). Dr. Deming saw the most important application of knowledge of variation in the management of people, in other words, when there were no figures to observe or to plot on a chart (Deming, The New Economics, 1993).

Healthcare Is Learning About Lean (But does this also mean they are learning about continual improvement?)

Healthcare organizations have seen improvement programs come and go over the last several decades (TQM, CQI, Six Sigma, reengineering, benchmarking, Baldrige). None seemed to have the "stickiness" factor that ultimately led to sustain improvement in value to the patient. Nearly every improvement effort that held initial promise seems to end up as "flavor of the month."

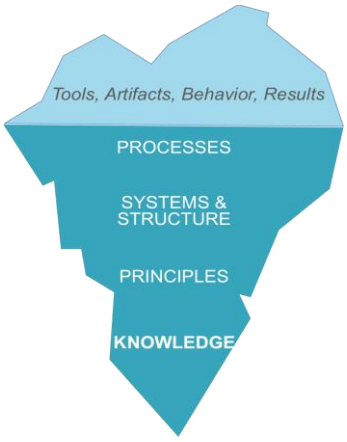
In the late 1990s and early 2000s, a few healthcare organizations embarked on serious efforts to learn and apply lean thinking in healthcare. These organizations learned from other industries that were willing to share lean management philosophy, methods and tools. Several influential books provided insight and guidance into the Toyota style of management. [(ii)] About this time several consulting organizations began to engage with healthcare consultants. [(iii)] In 2008, the ThedaCare Center for Healthcare Value was formed. This not-for-profit organization educates healthcare management about healthcare transformation. One component of the Center is the Healthcare Value Network, a peer-to-peer learning, sharing and connecting network. [(iv)] Several books have been written and published about the application of lean philosophy and methods applied in healthcare. [(v)]

The term "lean" was first used to describe the management philosophy and methodology used by companies like Toyota and Honda in 1987 by John Krafcik, working with Womack and others, and described more completely by Womack, Jones, and Roos in 1990 (Womack, Jones, & Roos, *The Machine That Changed the World*, 1990). The group named the management system for what it does: needed less human effort to design, make, and service products; required less investment for a given amount of production capacity; created products with fewer delivered defects and fewer in-process turn backs; utilized fewer suppliers with higher skills; went from concept to launch, order to delivery, and problem to repair in less time with less human effort; could cost-effectively produce products in lower volume with wider variety to sustain pricing in the market while growing share; needed less inventory at every step from order to delivery and in the service system; caused fewer employee injuries, etc. "It needs less of everything to create a given amount of value, so let's call it 'lean'" (Womack, *Gemba Walks*, 2011).

A Common Pattern for Learning about Lean

Figure 1 uses the metaphor of an iceberg to describe the relationship between things we see on the surface in an organization (like tools, behaviors and measurable results) and the things we don't see (under the surface), but need to be understood. We can go to any organization and notice things "on the surface" by watching and noticing - without asking any questions. These are the visible artifacts (white boards, vision statements, graphs showing results, the behaviors we see throughout the organizations). By asking a few questions, we might start to see just under the surface, we might see processes, which are the repeated steps that people take to get things done. By asking a few more questions, we might be able to see the systems, which are the interdependent components (including activities and processes) that accomplish a common aim. If we were to ask more questions about why people do what they do, we might begin to see the principles behind the systems that are put in place. The knowledge behind the principles is at the deepest level. This could also be called "shared beliefs."

Figure 1



Organizations that attempt to learn about and apply lean methods seem to do so in the following common pattern:
Phase 1, "Let's Look Into This" – The process seems to start with dissatisfaction with the status quo in the organization, frustration that desired results will not be achieved (with current methods), or concern about navigating the uncertainties of the healthcare terrain. Another driving factor can be a crisis in terms of cost, quality or service. There is some realization that what seemed to work in the past, might not work in the future. The organization feels it is forced into action as a matter of survival. After some initial fact-finding and research, the organization reaches a point where they decide to put some serious time, effort and money into learning about exploring these promising lean concepts in their organization. This step might include some

initial experiments where people "learn by doing" after reading books, visiting other organizations (healthcare and non-healthcare), or networking with some local lean resources that are willing to share what they are doing. They've looked at what they've seen "on the surface" (Figure 1), they like what they see (improved quality and lower cost) and would like to have the same results that other organizations are achieving.

Phase 2, "Initial Demonstration Projects" – The organization will typically designate an Executive Champion to head up this effort. A few areas are targeted to demonstrate that this method will work in the organization. These often seem to be in areas where the managers are open to the approach and willing to learn and to adjust their personal management style. The guidance for these initial demonstration projects often comes from an outside consulting firm that is engaged for the effort. Ideally, this group also provides guidance to top management regarding their new role in the lean transformation. Another source for the guidance is to hire and/or train employees to serve as advisors and consultants to the effort. Although some didactic classwork time is included in this initial awareness-building phase, much of the work is "learn by doing" and "learn by failing." The approach includes the introduction of various tools and methods (value stream mapping, improvement events, data gathering, observation, problem-solving tools, check-lists, visual boards). Terms like: gemba, andon, kanban, and standard work are often introduced. This phase often produces results such as improved throughput, less waste, reduced cost, and improved customer experience. Evidence of reduced cost seems to be the primary indicator of success. The primary goal of Phase 2 is to demonstrate that this approach works and is worth pursuing. If it goes, well, then more teams and projects are deployed.

Phase 3, "Pushing Lean (Tools) Into Existing Systems" - Positive results from Phase 2 signal approval to proceed with additional project areas, and it's not uncommon for the organization to double (or triple) their efforts. The "tool and event-based" Phase 2 seems to be a necessary learning step for all organizations, but it inevitably produces new problems which will need to be addressed if the organization is not going to give up. One problem is that organizations have many existing systems (and the people that manage these systems) that do not and will not readily assimilate this new way of thinking and managing. One interviewee provided this example, "Current systems were designed with different outcomes in mind that are now competing with the principles and values of lean thinking systems. The most destructive systems to lean thinking are financial reporting and human resources. Our recognition systems were built around the financial reporting systems not guiding principles. Although the Whiz Kids at Ford[vi] may have saved the company from bankruptcy in the 1950s with their new labor and overhead budgeting system for financial reporting, the systems rewarded the wrong behaviors in managers that continue to this day and cause people to be wary of lean. Until the financial reporting systems and recognition systems change, lean and its desired behaviors will continue to struggle and introduce more variation into organizations."

Another problem that seems to occur at this phase is that the improved results from the initial demonstration efforts are typically not sustained. Some organizations try to copy not just the tools, but the systems they see in other organizations or read about in books, but this too

typically leads to frustration. Most people do not realize that Dr. Deming predicted this kind of outcome. On June 24, 1980 an NBC program aired "If Japan Can, Why Can't We?" to try to explain why American companies were not successful competing in the world market. Dr. Deming was featured in an interview near the end of the program as much of the success from companies in Japan had been attributed to him and his work beginning in the 1950s. In the interview Dr. Deming stated, "I think that people here expect miracles. American management thinks that they can just copy from Japan – but they don't know what to copy!" (Deming, *If Japan Can, Why Can't We*?, 1980).

Many organizations do not seem to make it past this phase possibly because (as Deming stated) they don't know what to copy. They have viewed lean as a new toolbox (typically for the front line staff to use). Top management views lean as something that can be delegated and they typically do not change what they do. Perhaps they do not realize the full scope of what they are trying to do. Perhaps they don't realize that introducing new knowledge and management principles, without letting go of what Deming called "the prevailing style of management" will only lead to frustration and delay. Most likely, they don't realize that what is really required is "transformation of management" (Deming, *The New Economics*, 1993). This is discussed in the section on "Copying Without Aid of Theory."

Principles and Knowledge

In Chapter 2 of *The New Economics*, Dr. Deming makes the comparison between present practice and better practice as shown in Table 1 (Deming, *The New Economics*, 1993). Many of these are behaviors and practices, similar to what you might see on the surface of the organization (referring back to Figure 1).

Table 1

Present Practice	**Better Practice**
Reactive: skills only required, not theory of management	**Theory of management required**
Lack of constancy of purpose. Short-term thinking. Emphasis on immediate. Think in the present tense; no future tense. Keep up the price of the company's stock. Maintain dividends. Failure to optimize through time. Make this quarter look good. Ship everything on hand at the end of the month (or quarter). Never mind its quality; mark it shipped. Show it as accounts receivable. Defer till next quarter repairs, maintenance, and orders for material.	Adopt and publish constancy of purpose. Do some long-term planning. Ask this question: Where do we wish to be five years from now? Then, by what method?

Ranking people, salesmen, teams, divisions; reward at the top, punishment at the bottom. The so-called merit system.	Abolish ranking and the merit system. Manage the whole company as a system. The function of every component, every division, under good management, contributes toward optimization of the system.
Incentive pay. Pay based on performance.	Abolish incentive and pay based on performance. Give everyone a chance to take pride in his work.
Failure to manage the organization as a system. Instead, the components are individual profit centres. Everybody loses. Individuals, teams, divisions in the company work as individual profit centres, not for optimization of the aim of the whole organization. The various components thus actually rob themselves of long-term profit, joy in work, and other desirable measures of quality of life. The circumstance is in my experience accompanied by failure of communication. People have lost their understanding of the relationship of their work to the work of others, yet they do not talk with each other.	Manage the company as a system. Enlarge judiciously the boundaries of the system. The system must include the future. Encourage communication. Make physical arrangements for informal dialogue between people in the company regardless of level of position. Encourage continual learning and advancement. Some companies have formed groups for comradeship in athletics, music, history, a language, etc., and have provided facilities for study-groups. The company can well afford to underwrite the cost of social gatherings in outside locations.
M.B.O. (management by objectives)	Study the theory of a system. Manage the components for optimization of the aim of the system.
Setting numerical goals.	Work on a method for improvement of a process. By what method?
M.B.R. (management by results). Take immediate action on any fault, defect, complaint, delay, accident, breakdown. Action on the last data point.	Understand and improve the processes that produced the fault, defect, etc. Understand the distinction between common causes of variation and the special causes, thus to understand the kind of action to take.
Buying materials and services at lowest bid.	Estimate the total cost of use of materials and services – first cost (purchase price) plus predicted cost of problems in uses of them, their effect on the quality of final product.
Delegate quality to someone, or to a group.	Accountability for quality rests with the top management.

The principles behind the “better practice” side of Table 1 are represented by the 14 Principles for Transformation of Western Management (14 Points) that Dr. Deming described (Deming,

Out of the Crisis, 1986). The knowledge behind these 14 principles is what Dr. Deming outlined as the System of Profound Knowledge (Deming, *The New Economics*, 1993). A similar list shown in Table 2 (below) describes a comparison with a healthcare perspective. Both doctors and healthcare administrators have been trained and educated as the "captain of the ship" for the care of their patients. John Toussaint, MD, CEO of the ThedaCare Center For Healthcare Value, coined the term "white coat leadership" to describe the attributes of this style of management that was (and is) used in medical schools. The attributes are not that different from those that are drilled into traditional healthcare administrators. Table 2 below describes the difference between "white coat leadership" and "improvement leadership" (Toussaint, 2013).

Table 2

White Coat Leadership	Improvement Leadership
Exhibits an "all knowing" attitude	Demonstrates humility
Adopts an "in charge" posture	Exhibits curiosity
Demonstrates autocratic tendencies	Facilitates improvement efforts
Adopts a "buck stops here" approach	Teaches others
Shows impatience	Learns from others
Blames others	Communicates effectively
Controls others	Perseveres

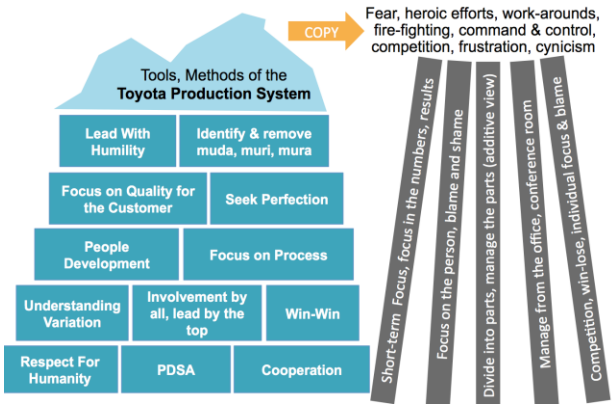
The behaviors and actions of the left-hand side of Tables 1 and 2 seem to be rational outcomes of the way we have been taught, what we have been taught and how we have been treated (in schools, colleges and universities and in companies where we have worked). Making more lists showing the limitations of the prevailing style of management (left-hand side) and contrasting that with better practice (right-hand side) does not, by itself, produce different behaviors or different thinking. It seems that something more is needed – individual transformation.

Copying Without Aid of Theory

Figure 2 (below) illustrates the challenges that face organizations if they attempt to merely copy the tools and methods (and even systems) from other companies, without fully understanding the principles and knowledge "beneath the surface." On the left we see the foundational knowledge and principles that are built through experimentation by many people over many years. It seems that over the course of several decades, companies like Toyota and others experimented with methods based on what they had learned from Deming and others in the early to middle of the 20th century (Shimokawa & Fujimoto, 2009). As a country with few natural resources, they had to learn to be efficient with their time and resources. They built new knowledge to make this happen.

The situation was different in the United States after World War II. Our problem was "quantity"- how to meet the demand for goods around the world. Many of the methods for productivity and efficiency that helped to win the war effort were not continued. Dr. Deming described the prevailing style of management that emerged as the "mythology of management" (left-hand side of Table 1). It is the prevailing style of management in many U.S. companies today, including healthcare (Deming, *Out of the Crisis*, 1986) (Deming, *The New Economics*, 1993).

Figure 2



When people try to merely copy the methods, they find that they cannot put these methods and tools into a system that is built on the principles and knowledge of the prevailing style of management (right-hand side). Rather than see sustained improvement in value for the customer, the outputs that are more likely to result are: fear, heroic efforts, work-around, firefighting, command and control, competition, frustration and cynicism. In short, it becomes another "flavor of the month" program and is eventually abandoned.

Guiding Principles for Enterprise Excellence:

If organizations wish to make it past Phase 3, they will need to discover the principles that are behind the methods and tools they have tried, and they also need to harness the leveraging power of systems to sustain the gains. Top management will need to realize that understanding and using these principles is their responsibility, one that cannot be delegated.

A principle is defined as "a fundamental truth or proposition that serves as the foundation for a system of belief, or behavior, or for a chain of reasoning" (Oxford University Press, 2010). In any profession or any endeavor, it is important for people to learn the principles behind their actions. For instance, a physician undergoes years of study of the principles behind the human body, diagnosis of diseases and treatment. Physicians learn about: chemistry, physics, psychology, biology, anatomy and physiology, biochemistry, etc. Fully understanding these principles guides them every day in the work they do. The same is true for any profession (building, architecture, electronics, engineering, chemicals, pharmaceuticals, etc.). Just as there are principles that guide the actions in these professions; there are proven guiding principles for management who wish to pursue enterprise excellence. These principles (and suggested definitions) are listed below in the categories of: 1) align 2) enable, and 3) improve:

Align:

Create Value for the Customer – Focus all aspects of the organization on activities that

consistently create measurably better outcomes of lowest cost, highest quality and are valued by the customer. The primary customer of focus in healthcare is the patient.
Create Constancy of Purpose – Provide a simple, unified purpose focusing and aligning all areas of the enterprise on achieving long-term goals.
Think Systemically – Understand how and why all the enterprise components work together, and how the interactions between all of the components need to optimize the whole.

Enable:
Lead With Humility – Seek input, listen to understand, be open to new ideas and to feedback. Realize and admit that we do not know it all.
Respect for Every Individual – Foster the continual development of skills and talent in people to create an environment where individuals and teams are actively engaged in improvement. Provide a physical and emotionally safe environment.
Learn Continuously – Learning does not cease upon graduation. Change is occurring at an exponential rate. Continue to deepen our understanding and share learning with others. See flow of knowledge as a competitive advantage.

Improve:
Focus on Process – Focus improvement efforts on the processes, not on blaming or fixing the people who work in the processes.
Embrace Scientific Thinking – See improvement as a series of experiments. Surface and test theories about current state, and what might provide improved value. Use the Plan, Do, Study, Act (PDSA) cycle for improvement and for learning.
Flow and Pull Value – Study and adjust processes so they create flow of value for the customer. Minimize and coordinate upstream and downstream connections that are triggered by the customer. Minimize batching.
Ensure Quality at the Source – Stop, correct and eliminate defects and problems before moving to the next step of the process, department or customer. Minimize the use of inspection to provide value.
Seek Perfection – Constantly seek ways to improve systems and processes to provide value. Challenge the status quo.
Understand and Manage Variation – There will always be variation – in people, in processes, in systems and in output. Understand what the variation in systems and processes is telling us. Understand and react appropriately to common causes of variation and special causes of variation. Apply this principle in situations where there are no figures, in particular in the management of people. [(vii)]

The Principle of "Understand and Manage Variation"

Dr. Deming recommended that "some level of understanding of variation" is needed in order to optimize a system, and realized that knowledge about variation is incomplete without knowledge of the other three components of the system of profound knowledge: theory of knowledge,

appreciation for a system and psychology. He was not advocating widespread use of statistical process control (SPC). He actually warned against this *(Deming, Out of the Crisis*, 1986) (Deming, *The New Economics*, 1993).

Variation and Causes

Every system and process produces variation in output. The causes of the variation can be distinguished between common causes (random) and special causes (assignable). Common causes come from the system or process, the components and how they interact. It is not feasible to try to identify the causes (root causes) for each output when the source is common cause variation. Special causes can be identified through tools and methods to signal when it does make sense to investigate outputs that are significantly different (toward the "good" as well as the "not good").

Appropriate and Inappropriate Action

When the variation appears to be primarily due to common cause variation, the appropriate action is to study and improve the system that is causing the variation. This includes testing ideas for improvement using the PDSA cycle. When a process shows common cause variation only, it has a defined capability (for the near future). Based on conversations with interviewees for this paper, the concept of "capability" is rarely discussed in healthcare settings. Just because the common causes are the primary source of variation does not mean that "doing nothing" is appropriate. A process that is influenced primarily by common cause variation may be producing output that is undesirable. However, it makes no rational sense to look for, or ask for, causes for the variation of individual data points. Taking this type of action will actually increase variation. When there are signals of special cause variation, it does make sense to look for the possible causes. The special cause can be variation that is producing outputs that are more or less desirable. Not all special causes are bad.

Table 3

Applications:	Has penetrated?	Magnitude
Overall business strategy and planning	Not yet	
Company wide systems (personnel, training, systems of reward, merit pay, annual appraisal, pay for performance, legal, financial, purchase of materials, equipment and services)	Not yet	Here are the big gains, 97% waiting
Unique processes that produce figures	Yes	3%

Understanding and Managing Variation When There Are No Figures

The most important application of this principle may be largely not understood and therefore, untapped. In his 1993 book *The New Economics*, Dr. Deming explained this as follows: "Differences there will always be between any two people, any two salesmen, etc. The question is, what do the differences mean? Maybe nothing. Some knowledge about variation (statistical theory) is required to answer these questions. Ranking is a farce. Apparent performance is actually attributable mostly to the system that the individual works in, not to the individual himself. A simple equation will help to understand the futility of attempts to rank people. Let 'x' be the contribution of some individual, and (yx) the effect of the system on his performance. Then suppose that we have some number for his apparent performance, such as eight mistakes during the year, or sales of $8,000,000. Then x+(yx)=8,000,000. We need x. Unfortunately; there are two unknowns and only one equation. Johnny in the sixth grade knows that no one can solve this equation for x. Yet people that use the merit system think that they are solving it for x. They

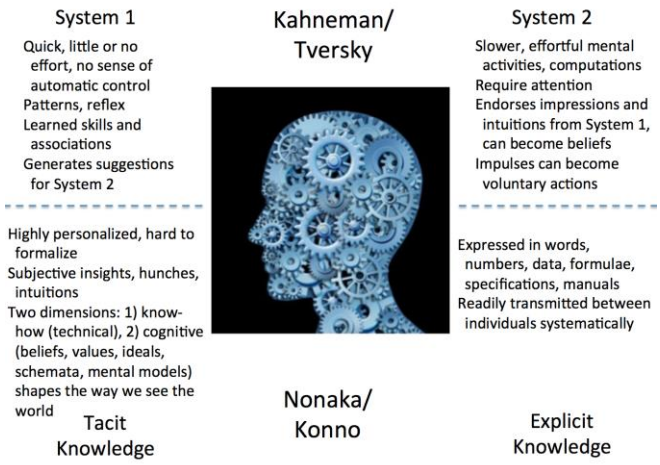
ignore the other term (yx), which is predominant" (Deming, *The New Economics*, 1993).

Table 3 (preceding page), from *The New Economics* helps to illustrate the level of penetration of Deming's management philosophy. "Somehow the theory for transformation has been applied mostly on the shop floor. Everyone knows about statistical control of quality. This is important, but the shop floor is only a small part of the total. Anyone could be 100 percent successful with the 3 percent, and find himself out of business. The most important application of the principles of statistical control of quality, by which I mean knowledge about common causes and special causes, is in the management of people" (Deming, *The New Economics*, 1993). When we understand that systems drive behaviors, we will understand that the first question we should ask when we see variation in behaviors and events is "what systems might be causing that behavior or that event?" This is a primary task for management, as they are the ones who manage and can improve the systems.

Building New Knowledge

Since principles and knowledge reside in the minds of people, it is helpful to know about how the mind works. Just as companies like Toyota built new knowledge over many decades (left-hand side of Figure 2) we need to know how to build new knowledge, not merely copy what we see on the surface. Figure 3 represents two similar models that might help us understand how we build knowledge. The top of the figure represents some of the key points described in *Thinking, Fast and Slow* (Kahneman, 2011). This represents what goes on within the individual. The bottom describes the relationship between tacit and explicit knowledge (Nonaka & Konno, 1998). This represents what goes on between individuals and within organizations.

Figure 3



Kahneman/Tversky Model

The human mind is "wired" to see and react to patterns. This helps us to function every day, but it can and does lead us to erroneous conclusions and incorrect actions. We create correlations and causation and make models about how things work which drives our thinking and actions through the actions of two agents labeled as "system 1" (fast thinking) and "system 2" (slow thinking). For instance, we do have the capacity to "think statistically," but it is not intuitive and

requires effort. Kahneman refers to this type of thinking as "system 2" that allocates attention to the effortful mental activities that demand it, including complex computations. In contrast, system 1 operates automatically and quickly, with little or no effort and no sense of voluntary control. There are advantages to the "fast thinking" process, such as: a) speed and certainty, b) from samples we generalize to the whole, c) we develop heuristics (rules of thumb). However, these heuristics are subject to multiple biases. Here are some examples of the automatic activities that are attributed to system 1:

- Detect that one object is more distant than another.
- Orient to the source of a sudden sound.
- Complete the phrase "bread and…"

The operations of system 2 are often associated with the subjective experience of agency, choice, and concentration. The highly diverse operations of system 2 have one feature in common: they require attention and are disrupted when attention is drawn away. Here are some examples:

- Brace for the starter gun in a race.
- Focus attention on the clowns in the circus.
- Focus on the voice of a particular person in a crowded and noisy room.

Relative to understanding variation, our tendency to see patterns in randomness is overwhelming. When people follow their intuition (system 1), they will more often than not err by misclassifying a random event as systematic. Humans appear to be far too willing to reject the belief that much of what we see in life is random, and our predilection for causal thinking exposes us to serious mistakes in evaluating the randomness of truly random events. "Regression toward the mean" is one of the foundational elements of what Dr. Deming called "common cause variation." Explaining this concept requires the engagement of system 2 as well as "unlearning" many of the beliefs generated by system 1. If the topic of regression comes up in a criminal or civil trial, the side that must explain regression to the jury will most likely lose the case. The main reason for the difficulty is a recurrent theme in Kahneman's book: our mind (using system 1) is strongly biased toward causal explanations and does not deal well with "mere statistics." When our attention is called to an event (engaging system 2), associative memory will look for its cause— more precisely, activation will automatically spread to any cause that is already stored in memory. Causal explanations will be evoked when regression is detected, but they will be wrong because the truth is that regression to the mean has an explanation but does not have a cause (Kahneman, 2011).

The interaction between the two systems indicates that handling difficult concepts (system 2) can be eventually handled reflexively and habitually by system 1. This seems similar to the relationship between explicit and tacit knowledge in the Nonako/Konno Model. For instance, recall what it was like to learn to drive. System 2 was initially called into action to learn how to operate the car and navigate the highways and roads. Eventually, the process of driving becomes more or less habitual and reflexive (system 1).

Nonako/Konno Model

The Japanese word "gemba" has become part of the vernacular for some organizations that are trying to learn about and apply lean methods in their organization. Gemba means "the real place," or more specifically "the place where work is actually being done or value is being created." Nonako and Konno introduced another Japanese concept "ba" which roughly translates into the English word "place." *Ba* can be thought of as a shared space for emerging relationships, providing a platform for advancing individual and/or collective knowledge. Nonako and Konno use this term to explain their model of knowledge creation. Knowledge is embedded in *ba* (shared spaces) where it is then acquired through one's own experience or reflections on the experiences of others. If knowledge is separated from *ba*, it turns into information, which can be communicated independently from *ba*. Information resides in media and networks. It is tangible. In contrast, knowledge resides in *ba*. It is intangible. The key platform of knowledge creation is the "phenomenal" place. Such a place of knowledge can emerge in individuals, working groups, project teams, informal circles, temporary meetings, e-mail groups, and at the front-line contact with the customer.

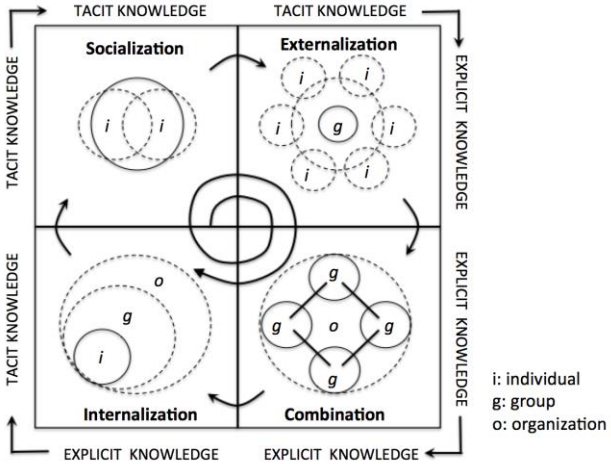
Knowledge is intangible, boundary-less, and dynamic and if not used at a specific time in a specific place, it is of no value. The use of knowledge requires the concentration of the knowledge resources in a certain space and time. For example, the sharing of knowledge organizationally means that the staff is able to apply and develop the necessary inherent knowledge.

There are two kinds of knowledge: explicit knowledge and tacit knowledge. Explicit knowledge can be expressed in words and numbers and shared in the form of data, formulae, specifications, manuals, etc. This kind of knowledge can be readily transmitted between individuals formally and systematically. This form of knowledge has been emphasized in the West. Many Japanese view knowledge as primarily tacit, something not easily visible and expressible. Tacit knowledge is highly personal and hard to formalize, making it difficult to communicate or share with others. Subjective insights, intuitions and hunches fall into this category of knowledge. Tacit knowledge is deeply rooted in an individual's actions and experience as well as in the ideals, values, or emotions he or she embraces. Tacit knowledge has two dimensions: 1) the technical dimension which encompasses the kind of informal person skills or crafts often referred to as "know-how," and 2) the cognitive dimension which consists of beliefs, ideals, values, schemata and mental models which are deeply ingrained and which we often take for granted. This cognitive dimension shapes the way we perceive the world.

The SECI Model

Knowledge creation is a spiraling process of interactions between explicit and tacit knowledge. The interactions between these kind of knowledge lead to the creation of new knowledge. The combination of the two categories makes it possible to conceptualize four conversion patterns, represented in Figure 4. The SECI model describes a dynamic process in which explicit and tacit knowledge are exchanged and transformed.

Figure 4



Socialization involves the sharing of tacit knowledge between individuals, through joint activities (being together, spending time, living in the same environment) rather than through written or verbal instructions. Disseminating tacit knowledge is another key aspect of socialization.

Externalization requires the expression of tacit knowledge and its translation into comprehensible forms that can be understood by others. Externalization is supported by two key factors. First, tacit knowledge is articulated (converting tacit to explicit) through words, concepts, metaphors, narratives and visuals. Dialogue (listening and contributing to the benefit of all participants) strongly supports externalization. Translating the tacit knowledge of customers and experts into readily understandable forms is the second factor.

Combination involves conversion of explicit knowledge into more complex sets of explicit knowledge. The key issues are communication and diffusion processes and the systemization of knowledge. The combination phase relies on three processes: 1) capturing and integrating new explicit knowledge, 2) transferring this form of knowledge directly by presentations or meetings where new knowledge is spread among the organizational members, and 3) editing or processing of explicit knowledge making it more usable (e.g., plans, reports, market data).

Internalization of newly created knowledge is the conversion of explicit knowledge into the organization's tacit knowledge. This requires the individual to identify the knowledge relevant for one's self within the organizational knowledge. Internalization relies on two dimensions: 1) explicit knowledge has to be embodied in action and practice, 2) there is a process of embodying knowledge by using simulation or experiments to trigger learning by doing processes (Nonaka & Konno, 1998).

Ed Chaplin, MD elaborated on some of Kahneman's work in his presentation at the 2014 Deming Fall Conference, "It Takes An Enterprise: Current Neuroscience and Knowledge of Psychology." Some of the key points from his presentation include:

1) We assume that we act on what we consciously see, but this turns out to not be true, at least not all of the time. Our brain has fast (dorsal) pathways for reacting to what we see,

and slow (ventral) pathways. Some of our behaviors occur before we have a picture, and our emotional system is triggered before we have a picture.

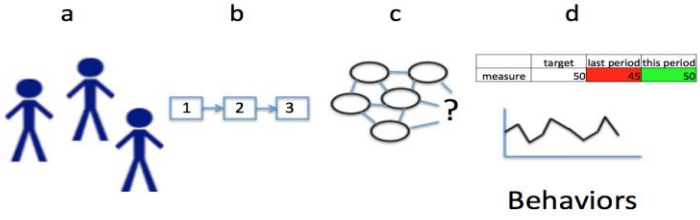
2) We assume that rational man: thinks, selects a plan, and then acts. However, studies have shown that we are often acting before we engage in the thinking. For instance, when we learn a task (e.g. learning to drive) we begin with "slow thinking and processing," but as we become competent it becomes second-nature (doing things we are not consciously aware of). Most (probably more than 95%) of our habits are reflexive.
3) The root cause of many problems in our organization is a contradiction between how we do what we do and our beliefs about how we do what we do. The neurophysiological evidence indicates that we think and act emotively, not rationally (as we assume).
4) Education (didactic and informational) alone does not change behavior or improve performance. If we were completely rational, we'd respond to logic, but we are not completely rational. We are emotionally attached to our behaviors. However, different systems and structures (including reminders, prompts, audits and feedback) DO change behavior and improve performance.
5) It takes more than knowledge and skill, and more than reward and consequences to affect behavior. Systems with attributes such as environmental cues and hard and soft stops, address the realities of our fallible memories, selective attention and limited capacity for vigilance.
6) We are pattern generators and live within our patterns. We are hypothesis makers creating mental models about what we see and how things work. We can't help but do this. We see patterns that are not there. We see what we are expecting to see. We see things that are impossible. We need to understand these limitations and capacities when we design and redesign systems.
7) Our experience creates patterns in memory systems. These perceptual models become stable and are wired into our thinking. We often force fit our experiences to fit the model. Our frames will trump our sensory input.
8) We experience our present out of our past, and are trapped in patterns from our past. Our past always shows up to us through our future expectations. What we see in the present is always filtered by whatever experience we have had in the past. For instance, narratives such as "blame the worker" have been handed down from generation to generation. We see these events through the lens through which we learn. We are addicted to our beliefs and our habits. In some (special cause) situations we reflect on the past, and reject and modify our beliefs. Rarely do we stop the process, reflect and look at the "common cause" beliefs, assumptions and narratives (Chaplin, 2014).

One definition of an organization's culture is "what happens when nobody is looking." The behaviors that are exhibited by a group of people are the sum of the experiences of the group (growing up, from school, from work life). The primary way to change behavior is through different experiences, which will eventually start to change the behavior, which then starts to move the culture. If we want to better understand variation in healthcare, then we need a culture that can value and manage it, and this will likely be a culture that we need to create ourselves over time.

Findings from Investigation of the Current State of Understanding of Variation in Healthcare

This section is a summary of interviews with individuals from healthcare organizations and healthcare consulting companies related to the primary topic of this paper – the current state of an understanding of variation and how to react to and manage variation. The findings are summarized in four categories as depicted in Figure 5:

Figure 5



a) Variation as it pertains to people who work in various roles in healthcare. This includes how people have been introduced to variation and how to interpret it.
b) Variation in processes, and how people tend to respond.
c) Variation and systems, including: 1) processes as part of systems, and 2) how systems are being developed to help to understand and manage variation.
d) Variation in outputs, including how variation in: 1) measurable outputs is being displayed, interpreted and analyzed, as well as 2) variation in behaviors.

People in Top management and their World

For the purposes of this paper, "top management" is defined as the CEO and those who report directly to the CEO. Sometimes these people have clinical backgrounds (doctors, nurses, etc.). Achieving results is a primary focus for executives, and healthcare is no exception. Success in achieving measurable results is a key factor for evaluating individual performance and for promotion. Healthcare executives tend to have many (too many) goals and objectives with related performance measures to manage. Metric and data overload appears to be a challenge at this level, and seems to get worse at the mid-level management level (multiplicative effect).

Many of these measures are requirements from outside agencies (government, insurance companies). Failure to perform on these measures (quality, safety, patient experience) results in lower reimbursement (revenue). For instance, the primary motivator behind focus on patient satisfaction data appears to be concern about losing money from government or insurance reimbursement. However, good patient satisfaction data may not necessarily mean good healthcare. Managers are asking themselves if these "compliance measures" are the right measures that tell them how we are doing on the important things. Because so much comparative data exists in healthcare, it is possible that management becomes enamored with improvement of the current state. If the organization is performing at the target level (compared to a relative percentile ranking), top management tends to conclude that performance is "good enough." The

revenue streams (dependent largely upon government and insurance companies) are based on comparison to others, not on improvement from an organization's current state.

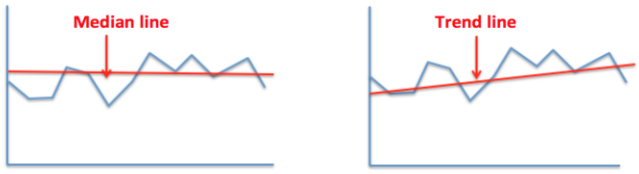
Many of these measures are lagging (30, 60, or 90 days old), and stale, and are sometimes so retrospective to be at the point of "who cares?" The view is like a "foggy rear-view mirror" which tends to be about data that top management can't do anything about (the data are not very actionable.)

Interpreting the data often requires effort and explanation. Some systems seem to be created to confuse people. Data can be segmented and looked at in many ways, but it is not always apparent to management what matters. Synthesis of the data is not there. One interviewee stated, "You need to have a Ph.D. in Press-Ganey to know what is going on. Management says they need data, but what they have is overwhelming or can't be located. You need a smart person to sort it out."

Understanding the causes behind the variation is often based on assumptions or anecdotal sources. The discussions often take place in a conference or boardroom, not where the processes occur. In some organizations, some preliminary analysis is provided prior to the executive-level discussion. A quality or finance department may conduct this analysis. Some organizations have decision-support departments to try to organize and make sense of data.

Actions taken on one-time variations or apparent shifts or trends have led to some significant miscues for some organizations. The interviewees described multiple examples of tampering (Deming's term) for acting on common cause variation as if the individual instances required action. Some of these examples involved decisions that led to damaging and costly long-term outcomes. In retrospect, there was some realization by some about the fallacy in their thinking, however there was also unwillingness by top management to admit the mistake, to learn from it and adjust for the future. Egos seem to prevent "leading with humility." Most organizations don't seem to have a common agreement about how to react to variation. Several interviews described fluctuations within their organization – management going from one extreme to the other, depending on the measure and who it might affect. Many interviewees reported the use of excel-generated trend lines that can cause people to see trends and shifts in the data, when in actuality it is random variation only. Figure 6 shows the correct way to view data on a run chart (on the left) compared to the incorrect way (on the right).

Figure 6



It is common to respond to the latest data point by putting in lots of fixes to address the situation. Some interviewees identified two problems with this approach: 1) the data are already pretty old, and they cannot be sure what the causes are, and 2) the last data point may not be the problem. Several interviewees who took the time to plot data on a run or control chart found that the processes were stable (due only to common cause variation). Using terms such as common cause

or special cause is very rare or non-existent for top management. Many will refer to events that cause differences worth note (e.g. a physician is on vacation). Not many seem to have what one interviewee called a good "statistical eye" to understand variation. Talking about understanding the causes and impacts of variation becomes futile when top management (the key decision-makers) don't even understand the process that makes variation visible for manipulation in the first place.

Interviewees did identity a few (rare) instances where top management has some understanding of variation (the distinction between common and special cause variation) and hazards of acting inappropriately to random variation (in particular the focus on an individual). In these situations, the individuals had some exposure to concepts from education, or from background in another industry.

People in Middle Management and their World

For purposes of this paper, middle management is defined as the people who report to top management, and will often include people with clinical backgrounds (e.g., managers and directors who have been promoted from the ranks). Several interviewees report that many of these managers may not be very data-driven in the beginning of their tenure as managers. Many tend to rely more on their understanding (gut feel) of what is going on in operations, especially if they have operated the department for many years.

Newer managers (some with advanced degrees) are described at being more adept at using data. However, having an MBA or advanced degree does not mean they have been introduced to the principle of understanding and managing variation. With the exception of individuals who attended a "process management" or "process engineering" course, most of whom had exposure to statistics in school were introduced to "enumerative studies" not "analytic studies" (the branch of statistics that Dr. Deming was referencing when he described some understanding of variation).[viii]

Many interviewees report their middle management is getting crushed from improvement work, with little time to study and adjust. Each time that top management adds another goal, objective, project or initiative, there is a multiplicative effect in the organization. Middle management seems to bear the brunt of this. They are overwhelmed with all of the data choices and sources, and have difficulty sorting out what will be helpful.

Interviewees also report that many people at the middle management level tend to do what top management tells them to do and tend to focus on variation that their superiors want them to focus on. Some of this seems to be related to how a person became a manager. Some were promoted from within the organization. Some have had education and training about being a manager, many have not. Rarely does the education or training involve an introduction of the principle of understanding and managing variation. Just because they have a good day or bad

day, does not mean they have to act on that. This tends to overload the system with work that doesn't need to get done. Most take their cues from their boss, which can mean that the inability to NOT do something is a problem. Because of fear, middle managers can't defend the idea that sometimes doing nothing is the best option. Interviewees reported that many in middle management struggle with explaining variation to their boss. For instance, they may obsess over missing a goal (e.g., number of ideas per employee, per month). Many tend to live in a "black and white world" – either they made the goal, or they didn't. There is no sense of, or understanding of, variation. The goals and targets seem to drive the wrong behavior. Some get caught up on precision. Was the result 4.0 or 4.1? How many decimal points are needed? Some of this is likely traced back to what their supervisor wants and pays attention to. One interviewee stated, "Understanding variation is the secret sauce that we don't yet understand. If we did understand it, management would be more relaxed. We would realize that not everything requires an 'all hands on deck' response." Top management often drives this "black and white" behavior (e.g., the need to explain every "off-target measure"). There needs to be an understanding that not everything is "zero tolerance." The concern of reporting out and reporting up produces stress when asked to explain random variation.

Many in middle management find themselves primarily in firefighting mode, and have not yet moved toward problem solving. Many tend to be good at firefighting (being a good fire-fighter got them rewards and recognition in the past). It is logical for these managers to push back when they are encouraged to slow down and look at data, or try to understand root causes of the problems. Many don't see they are putting out the same fires over and over again. Putting out fires is their world – their job. Top management asks, "what are you doing about it?" and people feel like they need to do something, so they try to fix something to show that they are doing something. Again, doing nothing is not an option.

Healthcare Workers and their World

The questions for the interviewees focused primarily on top management and middle management relative to their understanding of variation. Some conversations led to discussion about other roles in the organization. For purposes of this paper, this group of people includes those in healthcare organizations who are either providing direct patient care (inpatient or outpatient) or are in roles that support direct caregivers. The interviewees provided some insight about various subgroups as it relates to the topic of this paper: understanding and managing variation.

Physicians and clinicians receive years of education and training using the scientific method for diagnosis and treatment of patients. They are trained in the use of data. They are likely to have an understanding of enumerative statistics (study of a frame), but may not have been exposed to analytic statistics (study and improvement of processes). This may cause them to ask about the "statistical significance" of a set of data. Some doctors have become notorious for "pushing

back" on data about their performance. This seems to be a logical response given their experience with misuses of data in the past.

Some organizations have involved physicians in the study and improvement of their clinical processes. By working with collaboratively and in a non-judgmental approach, some have shown steady improvement in clinical outcomes by reducing the variation in some of the clinical processes. While they seek out evidence-based better practices, they are developing their own agreement about better internal processes. The common lean term for this is "standard work" which is not intended to be a straightjacket to limit physicians in the care of their patients, but rather an agreement on the best current way they will do certain things.

Nurses often learn to become very good at problem solving, handling multiple challenges at the same time. Several interviewees described the nurse's role as: "the people who mop up after everyone else" and they are complimented on, and congratulated for, the tough cleanup role that they play. The data that nurses work with are primarily "vital sign" data for their patients, or other clinical data (test results, medication dosages) about their patients, not process data. They typically don't think in terms of process, they focus on the patient, or the doctor, trying to remember it all and avoid getting in trouble when things don't go well. They take on the role of "filling in the gap" many take it on personally. They "fill the breach" and many have become adept at this.

People who are trained in "discrete events" will likely react to variation differently than a person who has been introduced to the idea of work as a process. For instance, in healthcare, clinicians are trained in, and tend to work with, discrete events (e.g. this patient, this diagnosis, this disease). Contrast this with a person who is trained as an engineer where they are exposed to, and learn about processes (e.g., step 1, step 2, step 3 …) and the variation that the process produces.

Processes and Measurable Output

A process is a series of steps or procedures that accomplish an outcome. Processes are usually depicted horizontally as a series of steps or procedures as in Figure 7. If the output of a process can be measured, it can be placed on a time series chart to understand how the process is behaving (e.g. stable and predictable, or unstable and not predictable). Figure 7 represents a simple 3-step process and the output from the process on the right. By understanding how the process is

Figure 7

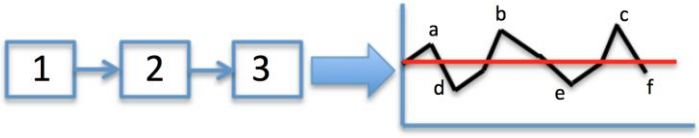
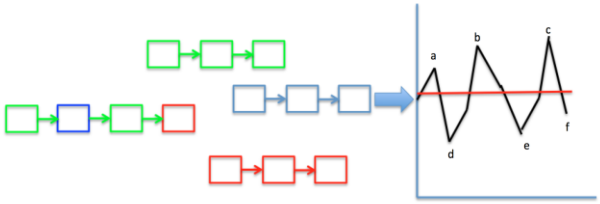


Figure 8



performing, people can understand whether the causes of variation represent common cause (random) variation, or if there are special (assignable) causes. In the example, it makes no rational sense to explain why points a, b or c are different from points d, e and f. The process that produced the high points produced the low points as well. We may not like the average where the process is performing (red line), or the amount of variation around this average, but improvement will only come from studying and improving the process (steps 1, 2 and 3) and testing improvements. By taking action on (or asking explanation for) the individual points, we are likely to make matters worse.

Viewing work as a process, or series of processes is a relatively new notion for healthcare workers. Typically, many different processes have been allowed to occur. Some of this may be due to the craft nature of healthcare. For instance, one physician does something in one manner, another in a different manner. The same appears to have occurred with other healthcare professions. It has gone on so long that people may not even be aware of the variation. It's just "the way we do things here." Helping people see their work as a process, or series of processes, is often one of the first steps for an organization that is introducing lean methods and techniques into an organization. Gaining agreement on the current best way to do something is referred to as "standard work," and it is an idea that can be very new to healthcare, but can be one of the necessary first steps for reducing variation. Another way of looking at what might be found in healthcare organizations is depicted in Figure 8. By asking questions, plotting the process output and mapping the process, it might be that there are more than one process at play (in other words, there is no agreement on the current best way to do something).

Studying the output of processes can help to see the variation and drive the effort to collaborate on one common way to do a certain thing (standard work). Plotting data on a run chart can help people see the variation and understand some of the causes. Some healthcare organizations are teaching people to do this, and in some (rare) instances the ideas of common causes of variation and special causes of variation are introduced. However, in healthcare every point of variation seems to be special (every event is "one of a kind") and people may see a cause or an explanation for each event. In actuality, most of the variation is likely to be due to causes that are common to the system and the work place (e.g., the proliferation of many different processes is common cause variation). Reacting to a single point of random variation (making corrections) is typical tampering. Several interviewees reported that they see this repeated over and over in the healthcare system (e.g., reacting to individual medication errors).

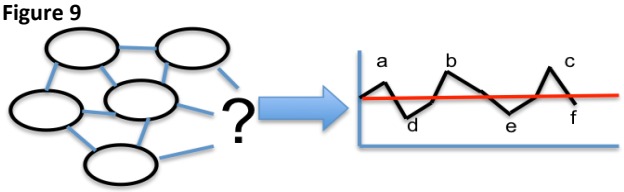
Dr. Deming pointed out the fallacy of trying to chase down the causes of random variation, "Our engineers never stop until we find the cause of every defect. The engineers were confusing common causes with special causes. Every fault was to them a special cause, to track down, discover, and eliminate. They were trying to find the causes of ups and downs in a stable system, making things worse, defeating their purpose" (Deming, *Out of the Crisis*, 1986). There is an important difference between "seeking perfection" and "demanding perfection." People might discover that there are methods for improving processes, and there are tools that help them see where to improve, but if they ignore those and react emotionally, they won't experience long-

term, sustained improvement. In other words, there are consequences for not understanding variation and how to react to it.

Systems and Measurable Output

A system is a network of interdependent components working together to accomplish the aim of the system (Deming, *The New Economics*, 1993). While processes tend to be linear, systems are not. A system can be comprised of multiple processes, and also includes people, methods, and other elements. It's possible that some components of a system are unknown, yet they are impacting the system. Figure 9 is a depiction of a system and its output (if it can be measured). The same principles apply (reacting to individual data points) as with processes, however, it seems that some additional principles must be applied when looking at system-level data if the time periods between points are monthly or longer. In other words, looking at high-level system performance over time with run or control charts needs to be considered relative to the importance of "leading processes" that can be measured in shorter time increments (i.e., daily or weekly). For instance, the operational definition of a "shift" is seven data points in a row above or below the median. If management were to wait for seven months before they studied a potential special cause signal, it would likely be too late to take action to identify and address the causes.

Figure 9



A common method for viewing system-level data in healthcare organizations is through excel-based scorecard view as shown in Table 4 below. The various parts of the organization (departments, divisions) are displayed in rows, and the performance on various measures (monthly, quarterly) compared to a target, or goal is shown in columns. Color-coding (red, green and sometimes yellow) indicates "on" or "off" target (variation from the goal).

Table 4

Department & Measure	Goal	January	February	March	April	May	June	July	Aug	Sep
Med Surg Unit A - Patient Sat	>/= 90%	0.83	0.91	0.8	0.95	0.91	0.9	0.86	0.82	0.89
Med Surg Unit A - Productivity	</= 8	7.5	8.1	7.9	8.2	8.3	7.3	7.8	8.1	7.9
Med Surg Unit A - Avg LOS	</= 3.5	3.7	3.8	3.5	3.9	4.1	3.85	3.4	3.9	3.7
Med Surg Unit B - Patient Sat	>/= 90%	0.91	0.91	0.89	0.8	0.9	0.83	0.82	0.95	0.91
Med Surg Unit B - Productivity	</= 8	8.1	7.3	8.3	7.9	7.8	8.1	7.3	8	8.2
Med Surg Unit B - Avg LOS	</= 3.5	3.8	3.9	3.85	3.5	3.7	3.9	4.1	3.7	3.4
Ortho Unit - Patient Sat	>/= 90%	0.82	0.95	0.91	0.89	0.91	0.95	0.83	0.82	0.9
Ortho Unit - Productivity	</= 10	10.1	10.2	9.8	9.7	10.3	10	9.5	9.9	10.25
Ortho Unit - Avg LOS	</= 9	8.8	9.5	9.3	9	8.9	8.7	10	9.5	9
Laboratory - Client Sat	>/= 90%	0.91	0.82	0.95	0.9	0.89	0.82	0.95	0.91	0.82
Laboratory - Productivity	</= 17.6	18	17.5	17.8	17.65	17.9	18.1	17.4	17.6	17.9
Laboratory - Cost per test	</= 1.12	1.1	1.18	1.2	1.11	1.14	1.17	1.09	1.13	1.12
Outpatient Rehab - Patient Sat	>/= 90%	0.82	0.95	0.82	0.9	0.91	0.89	0.9	0.82	0.95
Outpatient Rehab - Productivity	</= 11	11.1	11.8	10.8	10.9	11.2	11.3	11.5	10.9	11
Outpatient Rehab -Avg. FIM Score	>/= 2.5	2.6	2.7	2.4	2.3	2.2	2.8	2.6	2.35	2.5

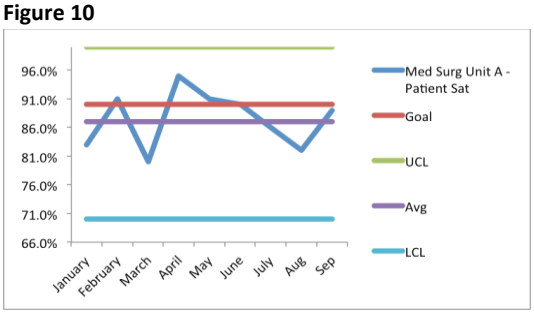
The method for analysis and taking action varies within organizations and between organizations. A common response to the question about analysis and action from interviewees was "it depends." For some organizations (or some executives within the same organization) every variance from target (red) requires an explanation and action plan. For others, no action is required until two (or three) periods of red are seen. When asked, "what does red mean?" interviewees stated that executives often say they know the reasons why. In answer to the

question, “how do they know?” the common response was, “they know.” Many state that they “look for trends, others say they talk about all the reds every month. Others say that if the measure is red for several months, they do a ‘deeper dive.’” Sometimes this method for study is specified, other times it is not. The definition of a trend varies widely. Sometimes trend graphs are used in the analysis. These might be run charts (performance with an average or median line), but more often the graph shows actual performance with excel-generated “trend lines” included. One interviewee stated that three months of red in a row is the determinant. When asked, “where did three come from?” the answer was “the CEO.”

Whether it is one, two, or more months, being “red” (off target) is not desired and for many is associated with poor management (failure). The reaction depends on the manager. People feel different about what red means. Many interviewees stated concerns about people (managers and staff) “hiding the red.” It appears that the stated value is “we view red as an opportunity for improvement,” but the actual value that people experience is “red is bad, green is good.”

The patterns of red and green shown in Table 4 actually represent random variation. The chart was generated by taking random data, and marking when the points went above (or below) an arbitrary target line. Figure 10 is a control chart made from the data for the patient satisfaction data for the Med Surg Unit A (first row from Table 4). The actual data (blue line) represent random variation. This process performs at an average satisfaction level of 87%. It may go as high as 100% and still be within the limits of random variation. It may go as low as 70% for any given month, and still represent random variation. Management may not like that the process is performing at 87%, but placing an arbitrary goal of 90% (red line) and marking the months that it goes below this level as red will not lead to improvement. The same system that produced the low points also produced the high points.

Figure 10



An Example of Healthcare Processes and Systems

Here’s a healthcare example that incorporates these concepts of processes and systems: A patient who goes to a hospital’s emergency department will experience at least one work system: the diagnosis, treatment, and discharge system. In actuality, there are many inter-related work systems involved. Within these systems, the patient would experience processes (e.g. the triage process, diagnosis process, and perhaps phlebotomy - blood drawing - process, to name just a few). Output of the total system can be measured (for instance, total time from when the patient comes to the ER, to the time that the patient is discharged). This data could be plotted daily, weekly, or monthly to determine how this work system is performing. Staff involved in each of the processes might also choose to measure and study the performance of the many processes.

Studying and improving key processes through daily management is one of the kinds of activities we are seeing in some healthcare organizations.

Understanding and managing variation is new thinking for top management. Since it is new for them, it has not permeated down to the next levels (middle management and the front line staff). However, many healthcare organizations have started to experiment with daily management. This can include plotting daily process measures, identification of trends, and use of Pareto charts to try to understand some of the causes for the variation they see. One interviewee described the current focus on three questions with daily management: 1) what are we trying to accomplish today? 2) how well did we do yesterday? 3) when there is a gap, what are we doing about it? She admits that they are still struggling with question #1.

Some organizations have made connections from high-level outcome measures to daily measures and trending. Some have logic to this (they know that waiting seven months to act would take too long and be too late). Some have daily measures, and systems to track the leading (process) indicators in more real-time before waiting on a lagging indicator. In many instances these are hand plotted trend charts (without an average or median line added). In most of these situations there is a goal identified. A few (very rare) have access to measures (updated daily) on computer with signaling for needed action (Western Electric Company[ix] rules for identifying shifts and trends). Some interviewees state that their top management often falls into the trap of constant comparison of one unit to another (on the numbers) without fully understanding what is going on.

Most organizations admit that there is not (yet) a consistent approach for looking at variation across the entire enterprise. Trying to look at a standard measure across all of the different units may not make sense. Some organizations have identified some areas (e.g. clinical laboratory) that might have more experience and understanding of the daily data and performance, and are even trying to distinguish random variation from special cause. This level of use and understanding is only occurring in a few departments, but the desire is to expand the application from there. Often times it depends on the manager, and how deeply they have been involved in process improvement efforts. Readiness to look at data over time, and trying to understand variation also seems to depend on the process. Some interviewees stated that a process like the scheduling process does not require an investigation of each instance of variation, but the central line infection process might. Some processes are more critical to mortality or morbidity.

Interviewees reported some strategy deployment (alignment) systems in their organizations, which help management and staff to focus on a few (true north) measures. These measures are connected to daily measures and (improvement and engagement) systems at the front line through daily management and regular staff huddles. A few have some definitions of trends at a top management level (any “red” requires action) or “two red months” in a row.

Responding to Variation when there are No Measures (behaviors, events, management of people)

Based on the interviews conducted for this paper, the concepts of random variation and special cause variation in the use of measureable data are new concepts for managers and staff who work in healthcare. Some of the organizations that have tried to introduce these concepts have experienced challenges. Interviewees report that introducing run charts is one thing, but the idea of control charts (with upper and lower control limits) can be too much too soon for some people. This seems to be particularly true at the front line level.

Another potential barrier is the distinction between enumerative and analytic studies described previously. If a manager or clinician was introduced to the enumerative field of statistics (including concepts such as t-tests, p-values, statistical significance, degrees of confidence), they will likely have a difficult time understanding the field of analytic studies (process performance, stability, random variation, common cause variation).

The idea that the concepts of common cause and special cause variation pertain to situations when there are no data seems to be even more of a foreign concept to managers and staff in healthcare. Indeed, the idea seemed to be a foreign concept for many of the interviewees. Some stated that they "always use data." In other words, they did not see how the idea of common cause and special cause variation apply when there are no data to measure. For instance, if you were to observe some person acting in a certain manner (observe a behavior), the inclination is to focus on (blame) the individual. Some examples:

- A nurse or nurse assistant taking a long time to respond to patient's call button.
- A phlebotomist needing to stick a patient several times to obtain a blood specimen.
- A pharmacist miscounting a medication dosage.
- A doctor taking longer than normal to dictate orders.
- A nursing clerk transcribing orders for the incorrect patient.
- A nursing aid not returning a piece of equipment to where it belongs.
- A manager missing a deadline for budget data input.

The examples go on and on. In each of these examples, the person (individual) interacts with systems. It is impossible and unfair to immediately attribute the behavior to the person. Was the behavior (variation from the norm) due to common causes (system effects) or was it due to special causes? You cannot know unless you ask these types of questions, and you cannot know the types of questions unless you have some understanding of the principle of understanding and managing variation.

One interviewee reported that she tries to focus on the process, not the person, but it is easy to lapse on this. She cited one example with an orthopedic surgeon and his infection rate, which seemed to be higher than his colleagues. There were lots of theories about the cause, but the predominant one was that the problem was the surgeon's technique. To their credit, the team went through the process review and found defects within the system and not with the individual.

In the end, the infection rate improved. We realize there are situations where it IS the individual at cause. This is the delicate part. Do your best to pay attention to the issues. One interviewee who understood these principles stated that once he realized these concepts, he has yet to find a variation in behavior or outcome that could be attributed with 100% certainty to the individual. Even if you get to a certain point in the root cause analysis, you end up asking questions like "were they trained correctly?" or "what's our hiring and training process?" This supports Dr. Deming's assertion from page 33 of the *New Economics*, "in my experience, most troubles and most possibilities for improvement add up to proportions something like this: 94% belong to the system (the responsibility of management) 6% are attributable to special causes" (Deming, *The New Economics*, 1993).

Conclusion

Some potential reasons that the principle of "understanding and managing variation" seems to be absent in discussions and application of lean in healthcare were described in the 2014 paper. These five reasons are listed below, along with some additional comments, as well as some additional possible reasons:

1) Toyota managers developed a deep understanding of how to handle variation over many decades. They developed systems and tools to react to variation, but those who have tried to copy Toyota may not fully understand the thinking behind the creation of these systems.[(2)] **Update:** Most people who are introducing lean to healthcare organizations were not working at Toyota in the early development years. They have experienced mature lean systems at Toyota and related companies. While it is possible that these systems and tools may be helping healthcare organizations to appropriately manage variation, how would they know? If there is no understanding of the principle, how can they know if the systems are minimizing the likelihood of tampering, adding waste and making matters worse? All interviewees emphasized that "time is a premium" for everyone. If systems can be designed to help guide appropriate action, it would seem to be a worthwhile contribution to the optimization of healthcare.
2) Knowledge about variation was not fully understood (especially as it relates to the management of people), so it was not taught. **Update:** This seems to still be a valid reason. While some people can understand the concepts of common and special cause when working with measures, translating the concepts to situations when there is no data seems to be an additional "stretch" that many people have not taken (or may not be willing to take).
3) The topic of variation was viewed as a technical matter and placed in a "container" (a "Six Sigma thing") and separated from lean. **Update**: Several interviewees brought up the term "six sigma" in the discussions. It is apparent that some people have placed the concepts of common and special cause variation, and placed them into the box they call "Six Sigma," which is viewed as a highly technical (and mysterious) toolbox that does not help them solve their daily problems. Several interviewees described their organization's temporary pursuit of Six Sigma as an improvement methodology turned

out to be a major distraction and some are still dealing with the aftermath of helping managers and staff to understand lean principles and methods. Solving problems to root cause appears to be mistakenly seen as an exercise for Six Sigma when the need for this approach is very rare.

4) Those who teach and advise in lean methodology did not fully understand the knowledge behind the systems and methods, so it was not taught. **Update:** There is wide variation in the approach and methods that various consultants use in the introduction of lean into healthcare. Most (if not all) teach while introducing tools and methods for improvement. This might include value stream mapping, improvement events, with multiple tools with the aim to demonstrate results (removed waste, better efficiencies, higher value for the customer). The tools may or may not include plotting data in time series (the beginnings of a run chart). Introducing control charts early on is very rare. We are now seeing healthcare organizations going beyond improvement events, and starting to create systems. This might include: visual management systems, standard work systems, idea generation systems, and problem solving systems to name a few. Strategy deployment systems are being introduced by some organizations, which is critical if an organization wants to help everyone to focus on the vital activities that will provide value to the patient. In summary, we see tools, then the building of systems. But are people connecting to the principles behind the systems? And if so, is "understanding and managing variation" one of the principles that is being connected? While the marketplace is filled with consulting organizations that purport to be able to provide guidance, it seems that there is a lack of capable teachers to properly guide healthcare transformation. Much of what is seen in healthcare is a tool-based approach, with little system development, and no explanation of guiding principles.
5) The way our minds work (intuitive system 1) causes us to see and act quickly on patterns and assumptions, which we think require our immediate action. Understanding variation (and thinking systemically) requires engagement of what Kahneman calls "system 2" in our mind. We can do it, but it requires time and effort. We tend to avoid this and take the path of least resistance (Kahneman, 2011). **Update:** Understanding how our brains (and our minds) work seems to be critical knowledge for anyone that is engaged in enterprises involving people. There are some people who seem to be more adept at "thinking with a statistical view." How did they develop that way of thinking (system 2)? What systems in their background shaped their understanding? Is it possible to design systems and experiences for others so that they might minimize the likelihood of missteps, and mistakes in reacting to data, and more importantly, when there are no data? Understanding how knowledge is built (Nonako/Konno Model) seems critical if we are going to have a full and deep understanding of guiding principles.

Additional possible causes:

6) Many people associate "understanding variation" with "statistics," and they associate this with their experience of a course from school (most likely college, or graduate school). The branch of statistics that they were most likely exposed to in these courses is "enumerative studies," which is not the same as "analytic studies" that Dr. Deming and

others were referencing related to improvement of processes and systems. Once you have associated understanding variation with concepts such as t-tests, p-values, degrees of significance, and others, it will difficult (if not impossible) to undo that association.

7) Computer programs like Microsoft Excel are helpful tools, but the use of trend lines and other features can mislead people into thinking they are dealing with a shift or trend in their process, when in actuality they may be looking at random variation only. The ability to generate tables with color-coding of red and green likely leads us down the wrong path. One interviewee stated that their organization went through "scorecard mania" for a few years. In the end, it was just another activity (waste) that was not understood and not discussed. The activity added no value.
8) People who coach and advise about the application of lean methods and principles may see "understanding and managing variation" as an important principle. However, it is possible that they also have a prioritization process that guides them regarding which principles to introduce and readiness for the learners to assimilate and internalize the principle. Some principles may be easier to grasp and have more immediate application for healthcare (e.g. focus on process, respect for every individual, constancy of purpose, embrace scientific thinking). One interviewee shared his most common "continuum of training": 1) create standard work, 2) introduce the idea of "andon" (signal when there is an unusual condition or variation from the standard), 3) "poke yoke" (try to mistake proof the process).
9) Flow in healthcare is still a foreign concept. The operational areas of healthcare are still structured to support the documentation needed to bill and code the clinical encounter for payment—not for patient care flow. EMRs are built to capture the necessary data to maximize revenue for each individual part of the encounter.
10) Healthcare organizations suffer from fundamental gaps in basic problem-solving capability. While many interviewees cited examples of "people solving problems every day," these examples appear to be solved to direct cause, not to root causes. There seems to be an absence of a simple, common process for understanding and addressing root causes. It is unlikely that understanding and managing variation will happen in an organization that cannot trace and address problems to root causes in a simple manner.
11) The overwhelming amount of data (most of it stale and not real time) makes it difficult to support problem solving or sound decision-making. Understanding and managing variation is unlikely to occur in an organization that cannot have a supply of information that directs the efforts to solving problems to root causes.

Notes:

[i] John Y. Shook, CEO Lean Enterprise Institute, personal correspondence, January 2014.

[ii] *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*, Jeffrey Liker, McGraw-Hill, 2004. *Lean Thinking*, James P. Womack, Daniel T. Jones, Simon & Schuster, 1996 & 2003. *The Hitchhiker's Guide to Lean: Lessons from the Road*, Jamie

Flinchbaugh, Society of Manufacturing Engineers, 2006. *Real Lean* (Volume 1), M.L. "Bob" Emiliani, Center for Lean Business Management, 2007. *Learning to See: Value Stream Mapping to Add Value and Eliminate MUDA*, Mike Rother and John Shook, Lean Enterprise Institute, 1999.

[iii] Joan Wellman Associates (www.jwaconsulting), Simpler (www.simpler.com), Lean Healthcare West (www.leanhealthcarewest.com).

[iv] ThedaCare Center For Healthcare Value (createvalue.org).

[v] *On the Mend: Revolutionizing Healthcare to Save Lives and Transform the Industry*, John Toussaint, MD, Roger Gerard, Ph.D, Lean Enterprise Institute, 2010." *Lean Hospitals: Improving Quality, Patient Safety, and Employee Engagement*, CRC Press, 2008, 2011 (2nd Ed.), *Leading the Lean Healthcare Journey: Driving Culture Change to Increase Value*, CRC Press, 2011, *Transforming Health Care: Virginia Mason Medical Center's Pursuit of the Perfect Patient Experience*, CRC Press, 2011, *Beyond Heroes: A Lean Management System For Healthcare*, Kim Barnas, ThedaCare Center For Healthcare Value, 2014.

[vi] The Whiz Kids were ten United States Army Air Forces veterans of World War II who became Ford Motor Company executives in 1946.

[vii] http://instituteforexcellence.org, http://www.shingoprize.org

[viii] Enumerative studies are used to describe the material in a frame, and in which action will be taken on material in a frame. Analytic studies are used to study and improve a process, for purposes of predicting future performance. Dr. Deming wrote on page 100 of *The New Economics*, "Tests of significance, t-test, chi-square, are useless as inference-i.e., useless for aid in prediction. Test of hypothesis has been for half a century a bristling obstruction to understanding statistical inference". (Deming, The New Economics, 1993) More on this topic can be found on pages 131-132 of *Out of the Crisis* (Deming, Out of the Crisis, 1986), and pages 329-330 of *Understanding Statistical Process Control* (Wheeler, 1992)

[ix] http://www.sqconline.com/western-electric-company-weco-rules

Works Cited

Chaplin, E. (2014). It Takes An Enterprise: Current Neuroscience and Knowledge of Psychology. Deming Institute Fall Conference. Los Angeles.
Deming, W. E. (1980, June 24). If Japan Can, Why Can't We? White Paper. (L. Dobyns, Interviewer) NBC.
Deming, W. E. (1986). Out of the Crisis. Cambridge, MA: MIT Press.
Deming, W. E. (1982). Quality, Productivity and Competitive Position. Cambridge, MA: MIT, Center For Advanced Engineering Study.
Deming, W. E. (1993). The New Economics. Cambridge, MA: MIT Press.

Hacquebord, H. (1995). When 2+2 Does Not Equal 4. Ohio Quality and Productivity Forum. Cincinnati.
Huntzinger, J. (2005). The Roots of Lean Training Within Industry: The Origin of Japanese Management. Retrieved from Lean Enterprise Institute: http://www.lean.org/Search/Documents/105.pdf
Improvement, I. F. (n.d.). IHI History. Retrieved 2014, from ihi.org: http://www.ihi.org/about/Pages/History.aspx
Kahneman, D. (2011). Thinking, Fast and Slow. New York City: Farar, Strauss and Giroux.
Kilian, C. S. (1992). The World of W. Edwards Deming (Second ed.). Knoxville, TN: SPC Press.

Nonaka, I., & Konno, N. (1998). The Concept of "Ba": Building A Foundation For Knowledge Creation. California Management Review, 40 (3).
Oxford University Press. (2010). The New Oxoford American Dictionary (Third ed.). New York City: Oxford University Press.
Pande, P., Neuman, R., & Cavanagh, R. The Six Sigma Way: How GE, Motorola, and Other Top Companies are Honing Their Performance. New York City: McGraw-Hill.
Raymer, J. (2014). Principles. Retrieved from Institute For Enterprise Excellence: http://instituteforexcellence.org/discover/
Reason, J. (2013). A Life In Error: From Little Slips to Big Disasters. Burlington, VT: Ashgate.
Shimokawa, K., & Fujimoto, T. (Eds.). (2009). The Birth of Lean. Cambridge, MA: Lean Enterprise Institute.
Stoecklein, M. (2014). Understanding and Application of Deming's System of Profound Knowledge in Healthcare. 20th Annual International Deming Research Seminar. New York City: Deming Institute.
Toussaint, J. (2013). A Management, Leadership, and Board Road Map to Transforming Care for Patients. Frontiers of Health Services Management (Spring).
Wheeler, D. (1992). Understanding Statistical Process Control (2nd. ed.). Knoxville, TN: SPC Press.
Womack, J. (2011). Gemba Walks. Cambridge, MA: Lean Enterprise Institute.
Womack, J., Jones, D., & Roos, D. (1990). The Machine That Changed the World. New York City: Free Press.