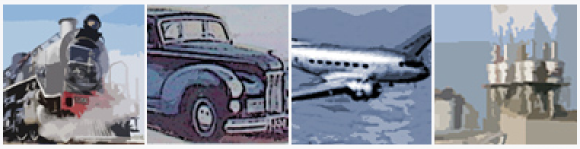
the New Science of FIXING THINGS



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"The truth is, the Science of Nature has been already too long made only a work of the Brain and the Fancy. It is now time that it should return to the plainness and soundness of Observations on material and obvious things."
Robert Hooke, Micrographia

Truth

"Truth has to conform to what exists and what is real." Pastor Mike, Sunday, August 13, Grace Church, Orlando, Florida

There is a real and objective world outside of our belief systems. What we believe does not mean it is the truth. In science, we strive for objective truth. Objective truth is in reach through governing principles in a confused world where truth is argued based on feelings.

In science (and its subset, engineering problem solving) truth conforms to physical law. The world of science and effective problem solving is described by propositions that are either true or false. Truth is discovered when the propositions we examine either line up with the world around us, or they don't. This makes the job of The New Science of Fixing Things simple. Just because it is simple unfortunately does not mean it is easy, but in the absence of applied simplicity, you will get nowhere. Applied simplicity means you need to be educated in the sciences, and trained in forcing a product or process to reveal its physical nature. The physical world of product performance is constrained by the fact that a machine can only do seven things with a power supply within and across multiple domains. Each of many serial and parallel machine functions can be described by a conjugate pair of variables, one of which is the effort variable, the other, the flow variable.[1] These variables can be plotted in the effort-flow workspace, and tested in a sweep from axis to axis to reveal the full story, allowing us to examine the performance of a chosen function at extreme levels. The ability to choose test functions provides product engineering and development the ability to test each function as designed, leading to faster and more reliable product performance. Furthermore, once independent functions are understood, the effects of field exposure as well as manufacturing deviations can be quickly identified.

That's the simple truth. Now comes the chore of exposing the truth. I am not going to tell the complete story of how that takes place here, of course. We have training workshops where we bring in a series of machines and test equipment.

I am writing this because the world of technical problem solving is not based on seeking the truth as constrained by the principles of physical law. At The New Science of Fixing Things, we don't go for this "out of the box" nonsense. We work inside the box defined by physical law to seek the truth about machine performance and manufacturing variation.

This begs the question, why are we not using physical law as a constraint on engineering problem solving? Statistical analysis, by its nature, is a departure from physical law, but is the predominant method. Of course there is a place for statistical problem solving, even within engineering problem solving, but not unless physical law is primary.

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1 EG; pressure and volumetric flow; voltage and amperage; torgue and angular velocity

Years ago, there was a problem used as a training example, where a .250 diameter shaft was to be machined to within a tolerance of ±.001. The spec limits and the control limits were shown on a graphic with the spec limits inside the control limits, meaning the process was producing scrap. I asked the trainer where the tails of the distribution stopped.

“They don’t. They go to ± infinity.”

“So I should be able to calculate the probability of producing a part as big as a phone pole or as small as a toothpick?” I replied.

Silly example? He said, “Yes.”

I then asked, “What would happen if I let go of my pen?”

He said, “It will fall to the floor.”

“What is the probability of it falling to the floor?”

“100%,” he replied.

Wrong again. There is no probability attached to such a deterministic event. I don’t have to drop my pen. I can write the law that governs its behavior. If I do test it, it might only be to determine if the measurement system I choose has the ability to see the truth. We don’t need to prove it. Galileo did.

I heard a physicist talking about particle physics once. He said that in the absence of understanding a governing principle, we must rely on probability. Once the governing principle is understood, probability analysis will no longer be needed. He then said, that the behavior he was studying would, once understood, require but a simple explanation.[2]

Hey, I’m not poking a hole at statistical analysis. I love it! If you are a real baseball-loving American, and not third world football, then you will love The Hardball Times Defensive Regression Analysis!

Nor, I repeat, am I claiming there is no place for statistical analysis in engineering. Of course, there is!

How do those who claim to be problem solvers use statistical analysis? To help find or define a problem? To figure out what to work on? To sample a set of parts to decide if it is safe to ship them? To confirm that what they call a root cause is the truth, but use a margin of error called a confidence interval, so they can claim that it might be the truth? Or is it to collect data on a process they choose to call a system to see if it is stable, operating under a system of common causes, and if not, then a special cause? Why?

2 That made it easier for me to accept that several years of work by David, Tobias, and I can be summarized onto three double sided sheets of paper and one handout.

The claim of common causes or special causes of variation does not adhere to the truth, and is of little help in fixing things. The claim that you take one set of actions for a common cause, and another for a special cause is rubbish! It would be more truthful to say "we have identified some causes (which makes them somewhat special) and lumped together the rest that we don't understand, yet".

Maybe statistical analysis has little to do with technical problem solving; it certainly should not be its foundation. Maybe the purpose of statistical analysis in manufacturing should

be limited to quality control of manufactured product. Has the quality control function encroached onto the turf of technical problem solving? Maybe it happened because good technical problem solvers were hard to find.

About ten years ago, we were teaching a workshop at a tier one auto supplier to a room full of statistician's. We were having a hard time convincing the folks in the room of the validity of our approach. Finally, it all became clear when one person raised his hand and huffed, "My job is to analyze data. In order to do what you propose, we would have to understand how stuff really works.[3]" We were never asked to return.

I think the weaknesses were discovered years ago, but the packaging was changed to six sigma and statistical engineering, with merit badges, belts and certifications.

I remember the Deming Seminars. I went to one or two in the 1980's and attended his class at NYU. I read the books, learned a lot, but didn't think highly of the camp-followers who called themselves disciples. I liked Deming. He was a good, passionate man. What he said made a lot of sense. I am not sure we are still on the track he outlined in his 14 Points, nor do I agree with all of them. Who cares if I don't agree? None of it was based on physical law, so it cannot be set forth as the truth, but instead, the world of that time and how he saw it might be managed. As is often done, consultants saw his work as "leverageable," which is consultant-speak for "will ring the cash register," and got busy doing so. One company I worked for in the 1980's knew the key to leverage was FUD; more consultant-speak. A good way to sell consulting services was based on creating Fear, Uncertainty, and Doubt in a potential client, FUD, the consequences of not hiring you. There was a lot of FUD created over control charts and fishbone diagrams. Well, it worked. Fortunes were made as the cash registers rang and rang!

We can do better. Deming would agree with trying.

There was a book I bought by Ellis Ott in the 1980's which influenced my entry into this field. His books were based on examples from his work, not on theory, but practice. In fact, I bought several copies, and used many in client factories as a guide, leaving many soiled copies behind. The examples could be followed readily, and the analysis was simple and graphical. I don't have a copy with me now.

3 Thus the name for one of our workshops, How Stuff Really Works

Those I still have are in a storage locker in Alabama with all my reference books and furniture, while I wait for a heart transplant in Florida Hospital in Orlando. No matter. I remember the important bits.

You could tell from his books that he was not only an educator, but a trainer. He said, “Theory and application must be coupled from the very beginning if we are to develop logical processes of reasoning and decision making.” I like that, and have written a few stories about how we place too much emphasis on education today, and not enough on training. As a result, we have a generation of educated people who are smart as hell, but don’t know a damn thing. We are also saddled with an even larger group who are not so well suited to education; practical men and women suited to training. We have failed them and are paying for it.

Don’t hold me to this, as I have no way to check it now, but as I recall, in the first chapter of his book, Ott emphasized the importance of collecting data, and then plotting it. The form had to be simple. He used a paper and pencil, tools that are lost today, but important in the analysis and reasoning ability of a professional problem solver who understands the power of simplicity.

Ott was a logical and practical man, and was able to solve many problems merely based on his ability to keep his analysis simple and graphical. I like the statistical work he did, which was also reasonable, practical, and always simple. Few people today know of his development of Analysis of Means, a simple, graphical test to see if the means of data were from two populations. If you google it, you will get a lot of annoying rubbish that misses the point of simplicity. Ott did the analysis with a paper and pencil, while those trying to describe his work today screw it up by using Minitab or Excel with its chart junk defaults.[4]

I think Dorian Shainin was influenced by his friend, Ellis, when he came up with Components Search. The day I asked Dorian, he got angry, which to me confirmed my guess. His sons, I suppose, would act in kind. I liked Dorian and liked working with him, and am grateful for what I learned from him. He was also a practical man who is not as well recognized for his contributions as merited, I suppose because of his son’s decisions to claim his work as a secret and their shrill threats of lawsuits.

Now, I am getting myself off track, but bear with me. I have too much time on my hands. I am in a hospital bed waiting for a heart transplant today, August 20, 2017. My life depends on machines until there is a suitable donor heart. (The rest of this article is restricted to only those who are organ donors. Sign up here.) My movement is limited to the radius of tubes from an IV pole, and an intra-aortic balloon pump. A balloon at the end of a wire tube is inserted into the aorta. It is inserted through my left shoulder and somehow is fished into the aorta. To understand how the balloon works, think of blowing up a long, thin balloon, and how the expanded part of the balloon is near your face. The bubble expands near your face, then works its way down until the entire balloon is inflated.

4 As part of our workshops, we show you how to use Excel in a powerful way, and to eliminate the chart junk that hides the truth.

The action of the balloon is a pump if captured in an artery or vein. The balloon cycles in phase with the heart and is triggered by a transducer glued to the hairiest part of the chest. The doctor can adjust the trigger point, as well as the amount of inflation. The technicians come by periodically, don't like the position of the transducer, rip it off then glue it back down.

The pump had been shutting down for two days, at the rate of about fifteen times per hour. The fault screen said there was a kink in the balloon in my aorta, which of course you can't see even with an x-ray. The fault started within minutes of being hooked up in the recovery room. The balloon was inserted in an operating room while I was awake. (They give you enough drugs so you really don't care what they do.)

The technicians who are responsible for the machine said the fault code was because the doctor inserted the balloon improperly. The doctor, of course, was not there and would have disagreed. Another person came in and explained that the balloon was inserted through my chest, not the typical path, which is through the groin. If inserted through the groin, I will not be able to get out of bed for the days or weeks while I wait for a heart.

The technician said this installation deviated from the standard procedure, thus the kink. Well, I am glad the doctor saw fit to do so, otherwise I would be flat on my back for days or weeks. With help, I can now drag the machines around for three daily walks.

I failed to sleep more than a few minutes the first night, what with all the alarms. A technician came in, and changed a few settings. He changed the trigger point for the balloon inflation and decreased a balloon setting from 50 to 30[5]. I don't know what the units are. The machine didn't shut down for five minutes or so, and victory was declared and he left. Once he was gone, of course, the alarms came back at a slightly lower frequency. They didn't seem to like that I was charting the frequency.

For two days and nights, the nurse in the ICU had to react to the alarms by hitting the reset then start button. They would not let me touch the machine and made sure it was out of my reach. Another guy came in and said I needed make sure my arms were positioned properly, that the path through the groin was straighter and less likely to kink. Everyone "knew" the truth. After all they had seen this before. The symptomatic knowledge they had gained over time told them it had to be a kink in the line.

I suppose we could have gathered a team together, brainstormed a few causes, checked out each one, one at a time. I depend on the pump for life. I am not interested in guessing. We could have gathered "all the stakeholders." There is only one stakeholder I care about…me. We could have collected some data and plotted it. I would have been for that, but under my terms. Actually, I take issue with much of what we call data collection. Ellis Ott didn't spend a lot of time on planning data collection.

5 After this was over, I asked he tech what the setting meant. He told me it was pressure. When I asked how much pressure, he said, 50. I asked, 50 what? He said, 50 CC's.

He assumed people knew what to collect. So did Shainin, spending lots of time converting attributes to variables and even had a trademarked method called Sensory Scoring Transform, essentially a waste of time.

Our workshop, d-TACTICS, centers on forcing a manufacturing process to reveal its nature through limited, but revealing small multiples. This requires careful planning, drawing a cartoon to gain insight and understanding as to what each value tells you, then collecting them serially to force a process to reveal the truth. We collect information, not data. It's fun, and how we have solved so many tough problems so quickly that have lingered for months and years.

d-TACTICS and small multiples are the ultimate in simplicity that leads to the truth.

Sorry. I am off track again. Let's get back to the balloon pump.

One of the fundamental strategies in effective problem solving of any kind is to eliminate as much as you can as fast as you can. I can make a statement that is the truth: the reason the balloon pump shuts off either lives in the pump, or the line and the balloon. I examine that proposition, know it is true, then, in many cases, find a way to eliminate one branch, and show it on a Search Tree. Problem solving without elimination is a fools game.

Given that so many had concluded that the balloon was kinked, the proposal was to send me to the operating room to have a go at straightening it out. I was vigorously opposed.

"Hang on a second, guys. Suppose it isn't the balloon that is causing the trouble. Think of the trouble we will go through to figure it out. And think of the trouble I will go through in the course of this little test. I am the one heading for the operating room."

A "who is this guy," look came over their faces.

I told them that there were certain characteristics of the machine that were of interest.

"How does the machine know there is a kink in the balloon?"

"It shows up on the screen."

"That's not what I meant. What detects that the balloon is kinked?"

"We aren't quite sure."

There is damper that pushes helium through the wire to the balloon. The damper is phased with my heartbeat, timed with the sensor superglued to my chest. The damper is a simple mechanism based on a rotating member of some sort driven by a motor.

If the balloon is plugged or twisted, then the motor current trips out, and sets off the alarm. The current drawn to push and release the damper which creates the balloon inflation/deflation action cannot be totally dedicated to the damper itself. The motor and mechanical parts have their own impedances, which, if the performance decays, will use more current. The current limit device does not know the difference between the power consumed to operate the damper and that lost to the impedance of the rest of the machine. All it knows, if the total exceeds the limit, it shuts down, and puts two or three codes on the screen that might be what's wrong. The folks who operate the machine think the list is exclusive, and the truth. I could hear that the machine was noisier than is should be. Just the noise of the machine kept me awake for two nights. The noise is a function of mechanical impedance, which, as we now agree, is not free.

The doctor heard the end of this discussion and said, “Go get another machine.”

We made the switch. The doctor said that the inflation profile, the pressure profile in the balloon, looked much cleaner. He increased that unit less value from 30 back to 50, and adjusted the trigger point.

I said, “I wish I had taken a photo of the screen from the other machine. Can we put it back? It only takes ten minutes.”

The answer was a sharp rebuke. “NO.”

The machine has now been running for three days. That is an efficient search, and I stayed out of the operating room. We eliminated the line and the balloon quickly and efficiently, and saved a trip to the emergency room.

Suppose we had no spare, and couldn't swap out the pump. We would gather some information. It would be the current profile on a few, and just a few machine cycles, following the principles and constraints of d-TOOLS and small multiples. This is what I would have preferred to do. It is more revealing, more fun, and really gets us closer to the truth.

I would like to say there is never an excuse for collecting lots of data, but that is a categorical statement which I can only back up based on many years of experience. Therefore, I must state that large data samples should be rare in engineering problem solving. Lots of data is a sign of someone who is a poor problem solver. Once again, we never collect data. We only collect information to execute a search, the purpose of which is to tell us the real story, the truth, about what is happening.

I don't blame these folks at the hospital at all. If you watch them, they are good folks, overworked and likely underpaid. They are kind and want to do their best. They are part of the team of people who saved my life, for which I am very grateful.

They have many jobs to do and work in a medical world which is complex, and cannot be constrained by one set of governing principles. A given action is not deterministic in medicine. Technical problem solving is easy compared to what they do to save lives day after day. We are constrained by a few principles and a few functions, which if properly monitored and measured will reveal the truth.

If you want to know more about how we solve tough technical problems and our workshops where we teach you do to the same, contact us through our website www.tnsft.com

For those of you who are familiar with our work, I look forward to seeing you soon…with a transplanted heart.

Thanks

John Allen
www.tnsft.com

