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How Can Companies Stop Their Machines Failing?

Let a Plant Wellness Way EAM System-of-Reliability End Your Business Risks Forever

Abstract

How Can Companies Stop Their Machines Failing?: Plant and equipment failures are business process failures. Plant stoppages and breakdowns result from failure-causing practices built into business processes and from leaving the right reliability practices out of them. Processes may superficially look okay because they have documentation, charts and records, but if you suffer a steady stream of failures, problems, and rework, then your processes contain unforeseen 'traps' into which your people and equipment regularly fall. Failure was not intended when your processes were chosen and designed, but failure is what happens when they are used.

Keywords: work quality assurance, work process management, work management process

Have You Got a Stable Failure Creation Process in Your Company?

We know everything about why industrial machines and equipment fail. No further investigation is needed. All the causes and all the answers were known in 1985. Most of them we knew by the end of the 1930s. The reason your machines and equipment continue to fail, and do not perform reliably, is because your company breaks them. It is your company's work management processes that make them fail. Four common examples illustrate the effect.

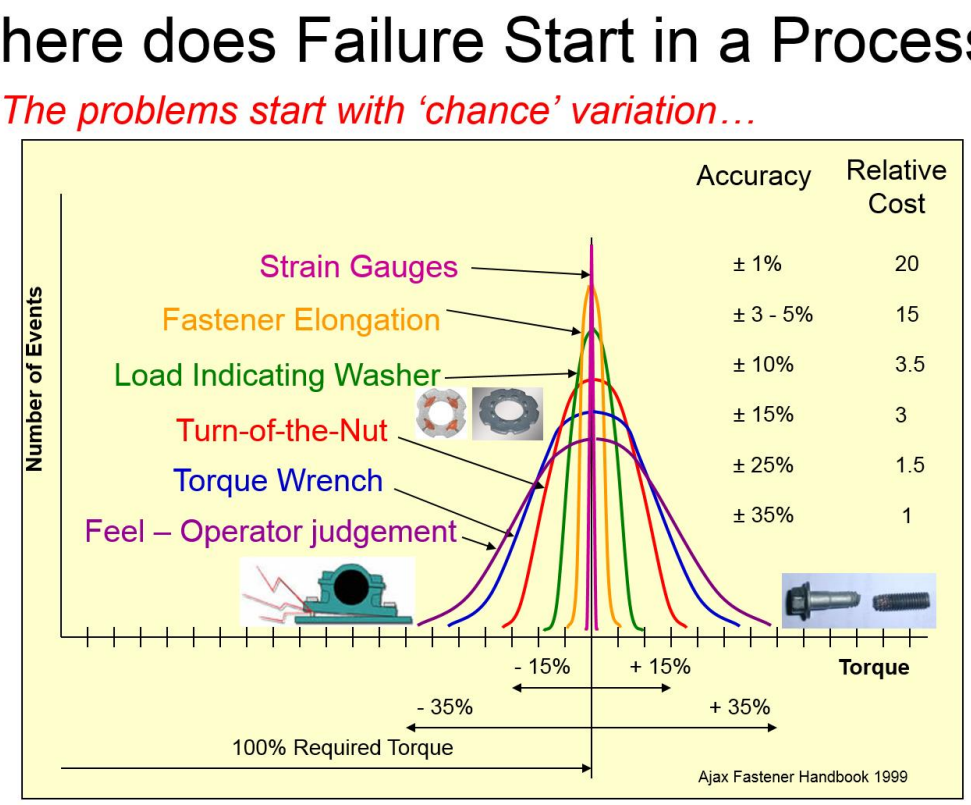


Figure 1 Variation in Fastener Tensioning by Various Processes

Figure 2 shows the seven main causes of mechanical equipment breakdowns. We have known about all of them—how they arise, what situations cause them, and what to do to stop them—for many decades. If these problems arise in your plant and equipment it is because your work

management processes have failed you. Not one of these problems is difficult to address successfully if you have the right reliability creation processes and practices in place and in use.

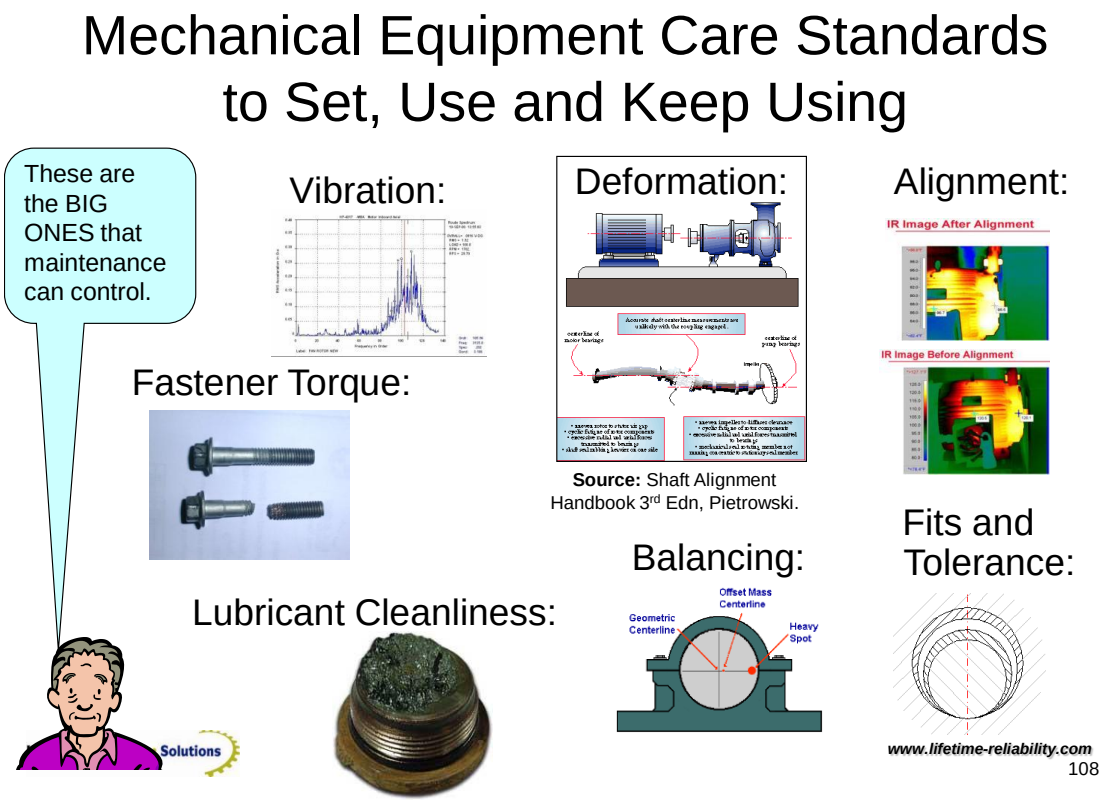


Figure 2 Seven Major Causes of Mechanical Equipment Failures

The photo of Figure 3 makes an interesting 'knowledge failure indicator' test to give to supervisors, engineers, and managers in industrial operations. How many breakdown creating practices can you find in the photo? There are at least nine failure causes clearly in view.

Figure 3 How Many Breakdown Creating Practices Can You Find in the Photo?

Unwittingly this company is using workplace practices that will fail the machine into which any bearing in the photo is installed. Because the bearing repair procedure you see is a 'standard business practice' approved by its supervisors, engineers and management, the company has 'intentionally' designed failure and breakdowns into their business.

Figure 4 shows the machine failure causing practices used in this workshop. The work management practices built into the company's procedures will lead to regular failure of their operating machinery and a never-ending stream of production downtime losses.

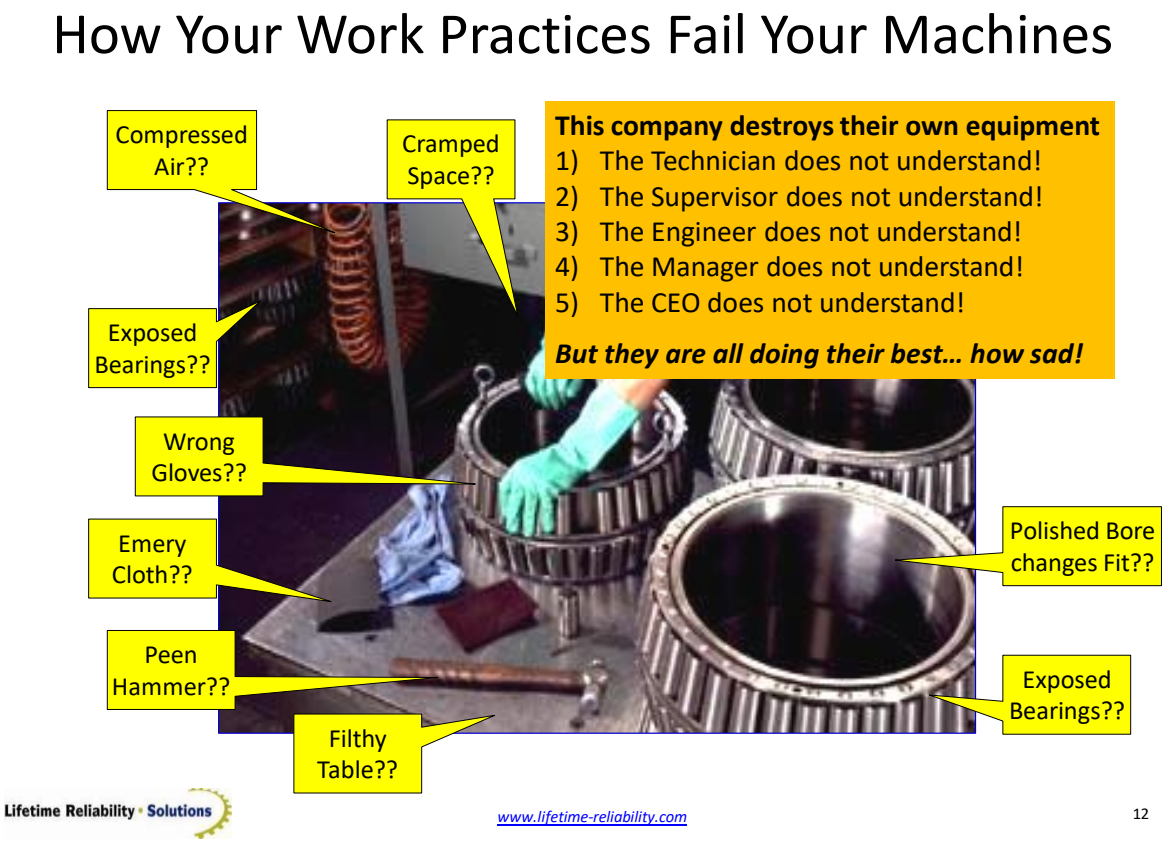
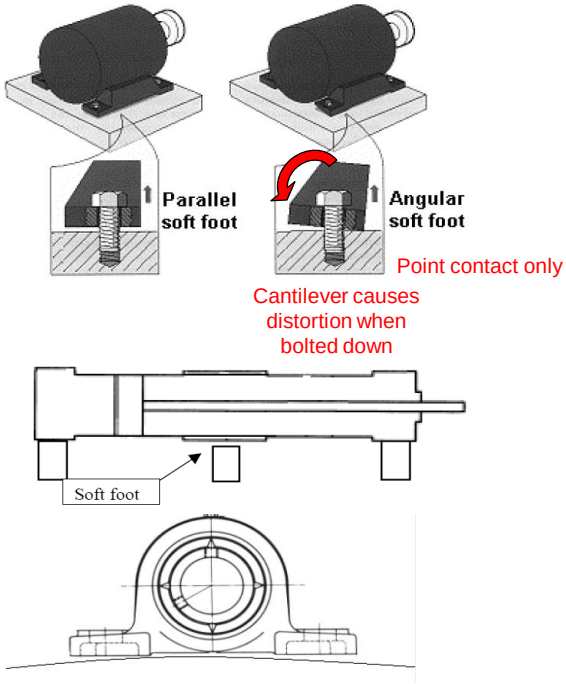


Figure 4 There are at Least Nine Breakdown Creating Practices in the Photo

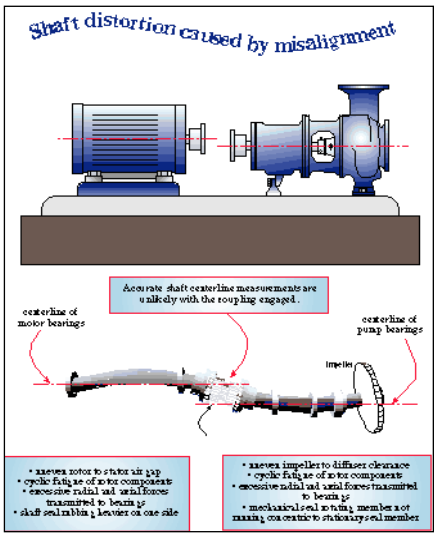
The left-hand side of Figure 5 shows common situations where machinery soft-foot occurs. If the items are bolted down without fixing their soft-foot problem the equipment is distorted out-of-shape, or the mounting feet do not fully contact the base and cannot properly support the forces created when the equipment is used.

On the right-hand side of Figure 5 is another common problem with machinery—shaft misalignment. It distorts and bends shafts, which in turn overstress the shaft bearings when motor and machine is operating with normal duty loads. For every increase in operating force the bending stress in parts rises by three (3) times and the torsional stress by sixteen (16) times. Once parts are distorted, then machine failure is close behind!

Stress from Distortion



Far too common examples of soft-foot problems!



Shaft misalignment distorts and bends shafts which in turn overloads the shaft bearings

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Figure 5 More Breakdown Creating Practices Commonly Used in Industrial Operations

If any of the above problems shown in Figure 1 to Figure 5 happen regularly in a company the operation will suffer a steady stream of failures. Failure events will arise seemingly randomly. No matter what the company management tries to do the bad practices in use feed defects into the plant and equipment. These defects await the opportunity to produce breakdowns. It is only a matter of time before one or more of the defects start another failure.

BUT OF COURSE, IT WAS NOT THE DEFECT THAT CAUSED THE FAILURE, IT WAS THE BUSINESS ITSELF, BECAUSE IT APPROVED THE WORK PROCESSES IN USE.

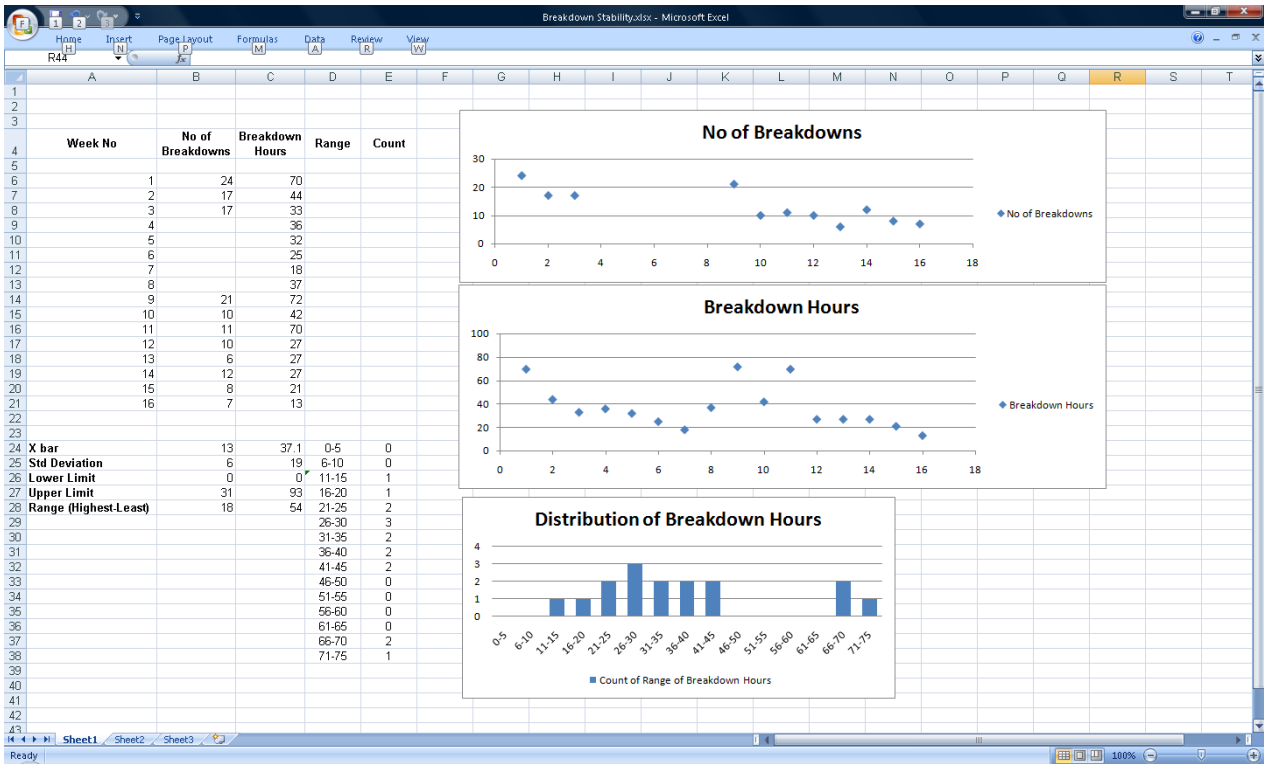
How to Discover if Your Business Processes Cause Your Failures

We know exactly what to do to make plant and equipment exceptionally reliable. All has been known since the mid-1980s. What we have not been able to do successfully is to bring those right practices into use and to make them 'standard practice'. Yet it is easy to do once your processes are intelligently designed and you have the skills to faithfully apply them.

Figure 6 shows two scatter plots developed from a plastic pipe manufacture's plant maintenance history. The top plot is the number of breakdown work orders raised each week over a four month period. The bottom plot is the number of maintenance hours needed to fix those breakdowns. The distribution curve at the bottom is of the frequency of hours spent each week on breakdowns. The breakdown distribution curve is telling—this company has a stable process that each week creates breakdowns. The distribution curve has 'settled' around 26-30 hours of breakdown a week and will remain there forevermore. The distribution plot warns us that within this operation there are regular and on-going causes of equipment failures which randomly arise to take-down the plant.

Everywhere within their production machinery are defects waiting to become production problems. In time, the defects become the failures shown on the weekly breakdown graphs.

Analysing if Your Business has a Stable Process of Causing Breakdowns



Week No	No of Breakdowns	Breakdown Hours	Range	Count
1	24	70		
2	17	44		
3	17	33		
4		36		
5		32		
6		25		
7		18		
8		37		
9	21	72		
10	10	42		
11	11	70		
12	10	27		
13	6	27		
14	12	27		
15	8	21		
16	7	13		
X bar	13	37.1	0-5	0
Std Deviation	6	19	6-10	0
Lower Limit	0	0	11-15	1
Upper Limit	31	93	16-20	1
Range (Highest-Least)	18	54	21-25	2
			26-30	3
			31-35	2
			36-40	2
			41-45	2
			46-50	0
			51-55	0
			56-60	0
			61-65	0
			66-70	2
			71-75	1

Figure 6 Business Processes that Cause Equipment Failures and Breakdowns

None of the breakdowns had to happen. They resulted from a bad reliability creation process. If truth be told, this company built themselves a breakdown creation process—they never had a reliability creation process.

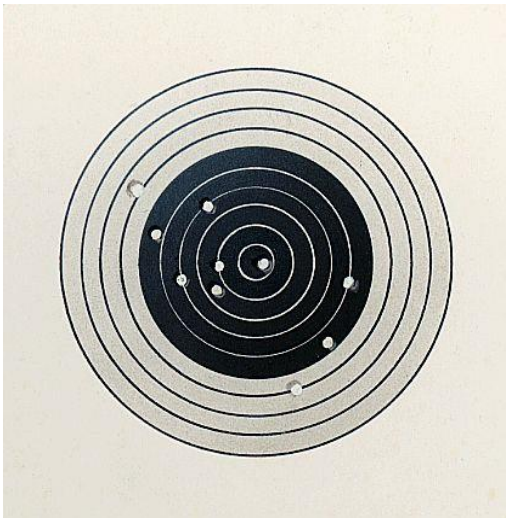
Had there been a true reliability creation process in the operation then not one failure would have occurred. For this business, its breakdowns were a natural result of the way the company worked. The company involved is now a much better company, but they had to change their maintenance and reliability processes to do that. To stop failure, they changed to methods that prevented the causes of breakdowns; they stopped the defects starting.

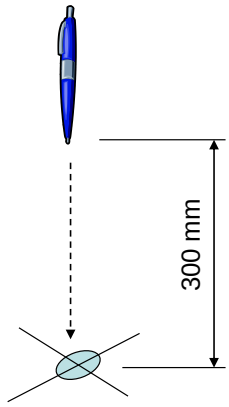
The Business Process Outcome is a Result of the Business Process Design

From time-to-time I play a game in my training courses called the 'Cross Hair Game'. It is a simple tabletop game that helps you understand why variability is a problem. It is a great introduction to seeing the effect of variability in processes. The game uses two lines crossing at 90^{o} with a 10mm diameter circle centred on their intersection. You sit at a table and drop a pen by hand into the circle from a height of 300 mm; much as indicated in Figure 7. A hit within the circle is the required 'process' outcome. People repeat the targeting and drop procedure ten times. After the ten drops I ask them how many times did the pen fall into the 10mm circle?

The Cross-Hair Game:

Observing Business Process Outcomes





Cross-hairs and
10 mm diameter
circle

How do you hit the bulls-eye every time?

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Figure 7 Hitting a Bullseye Needs the Right Process

So far, I have played this game with about 1000 people. When about 500 people had played the game, I used the results to plot the distribution of the process outcomes shown in Figure 8.

'Cross Hair' Manufacturing Process Results

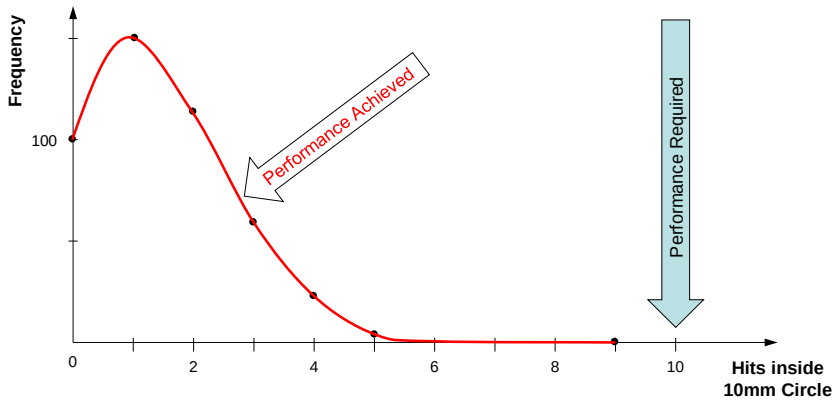

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Figure 8 The Process Used Produces the Results You Get

One person in 1,000 has dropped the pen in the circle nine times out of ten. Most people get 0, 1 or 2 drops inside the circle. It is very unlikely that any process using human hands to drop a pen within a 10 mm circle from a height of 300mm has sufficiently accurate control. Using human

hands cannot meet the required accuracy needed for a process that must get 10 out of 10 hits inside a 10mm circle. You could tell the person dropping the pen to 'try harder', to 'improve the quality of their efforts', but that will not work because it is the process that cannot do what is required, not the person. To get the pen consistently within the circle requires the creation and use of a totally different process that removes the variability caused by the human hand.

An answer jokingly suggested from time to time is to open the circle up to 50mm diameter and then everything will be on target. The suggestion totally defeats the purpose of having a process that delivers the intended results. Unfortunately, many businesses unwittingly select it as the process solution to their problems. They chose to 'widen the target' and accept any result, good, mediocre or disastrous, rather than set high quality standards and improve their processes to match them. Any business that does not purse excellence in their activities will not last[1]. As soon as their competitors get better than them their customers leave and go to the competition.

How to Change the Distribution of Outcomes in Work Management Processes

I want to end this white paper by giving you a way to hugely improve your work management processes without spending a cent of Capital on new equipment or hiring new people. The principle of the Accuracy Controlled Enterprise (ACE) solution to use is shown in Figure 9.

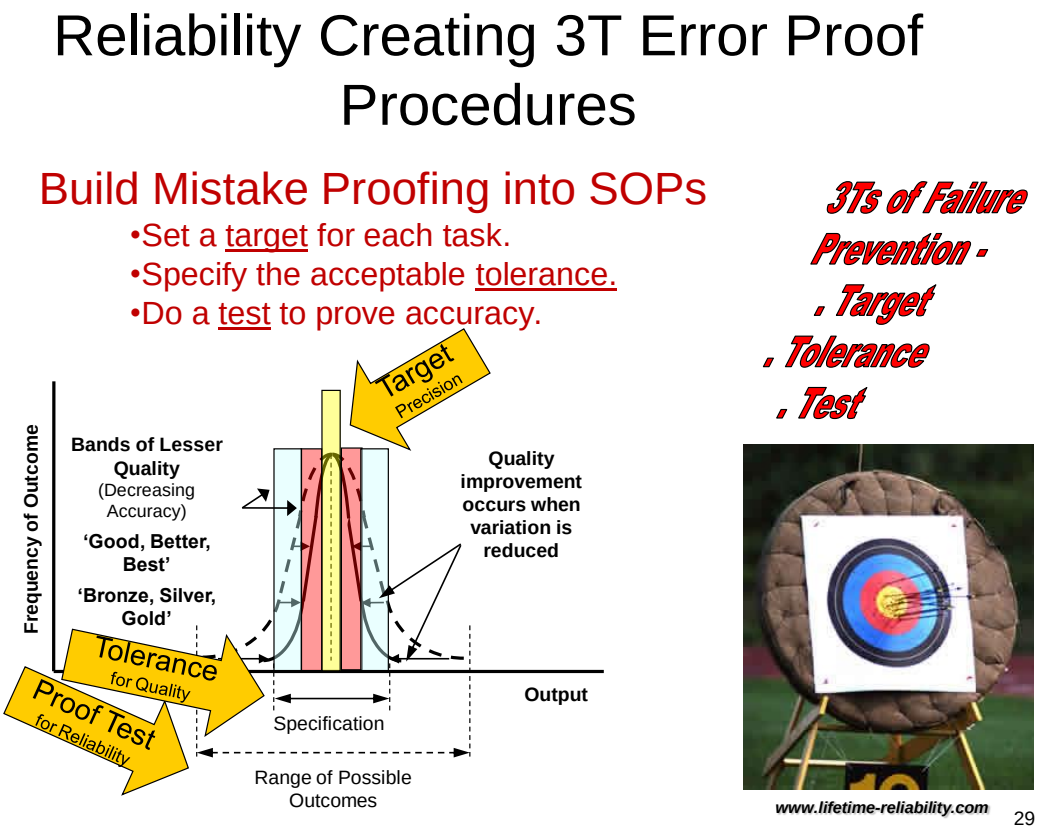


Figure 9 Principles in Accuracy Controlled Enterprise Work Quality Assurance Procedures

The Accuracy Controlled Enterprise (ACE) approach to work process management makes work into a game. The work procedures are written to challenge people to lift their skills to the 'master craftsman' level of ability. Once the work tasks are done correctly, as they would be done by a master craftsman, the process quality outcome naturally follows.

[1] Denove, Chris., Power, James D. IV., 'Satisfaction – How Every Great Company Listens to the Voice of the Customer', Penguin, 2006

The ACE 3T technique is an error-proof methodology that gets people to spot their own mistakes and correct the errors, so defects are not left in the work that they do. Human beings will always make mistakes. What ACE 3T adds into your standard operating procedures is both work quality control and work quality assurance. You saw the effect of using more exacting processes in the fastener tightening slide of Figure 1. As the process changed to become more exacting, so too did the results become more and more accurate, and the targeted outcome became ever more certain of being delivered. This is the logic of ACE 3T procedures—specify the exact quality requirements needed and you will deliver great work process outcomes.

The reason the 3T error proof method works is shown in Figure 10. ACE 3T makes it clear what a great result looks like (i.e. quality control) and also when a result is inadequate (i.e. quality assurance). The outcome required from a process task is made clear with the best 'bullseye' value—the Target. The worst result allowed is made clear with the Pass-Fail limit—the Tolerance. Unless the measured result—the Test—is 'on-target' the task is repeated until it meets the necessary tolerance. In this way the work process outcome is error-proofed and controlled so that task-by-task the result required of the job is surely achieved.

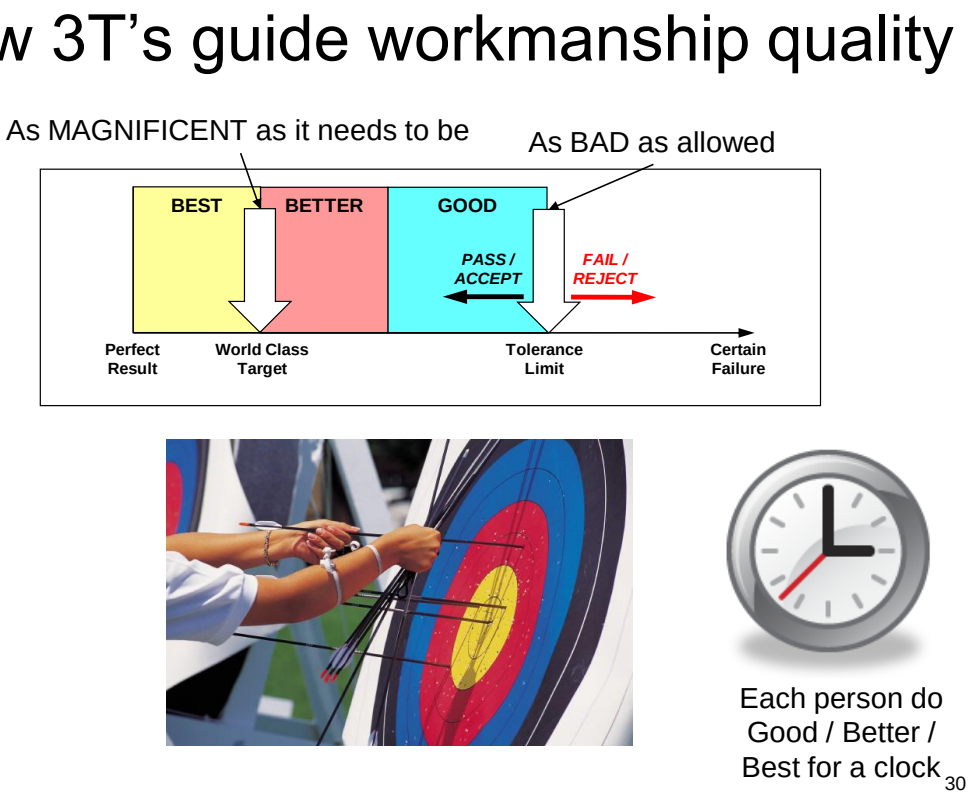
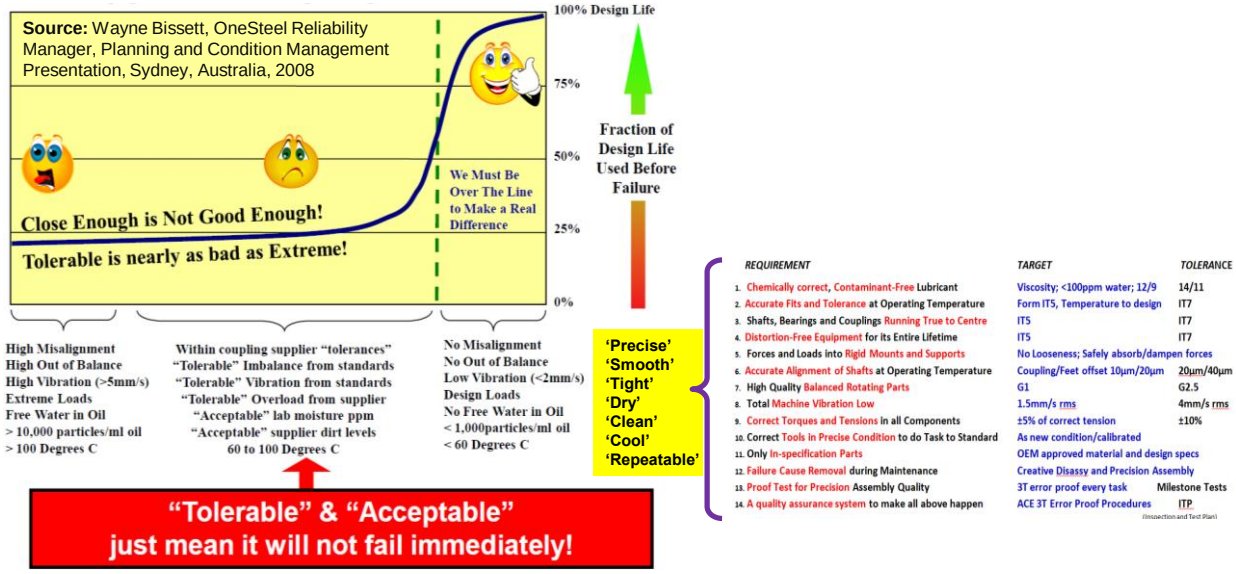


Figure 10 ACE 3T Creates Bullseyes to Hit with its Target-Tolerance-Test Error Proofing

Once an Accuracy Controlled Enterprise ACE 3T standard is specified you are required to measure the outcome and prove that the process you used has achieved the standard. The 3Ts—Target, Tolerance, Test—make quality measurable and give you true data and information on its achievement. In our minds the 3Ts act like a target. They challenge us to hit the bullseye and become world class. The 3Ts let us rate and improve our performance to the accuracy needed for the best quality results. The 3Ts go far beyond the quality control method used in an Inspection and Test Plans (ITP). ITPs only give one-sided limits—they tell us how bad we are allowed to be. ACE 3Ts provide two-sided limits. You have a 'bulls-eye' to tell us how good you need to be to deliver world class results, and you have an error limit after which you must correct the defect.

ITPs use chance and luck to deliver world class results because they never tell you what world class performance really is! They only tell you on how bad the defect can be that you can leave behind and get away with it. But of course, you have not got away with it—the defect just waits in your machinery and equipment for the next opportunity to fail.

Standards for World Class Equipment Reliability



"Only world class standards can produce world class results."

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Figure 11 Only 'Bullseye' Quality Creates Reliability

Figure 11 combines many important messages. Exceptional reliability requires a very tight and narrow zone of high precision quality. This level of quality minimises component stresses. Once you remove stress from machine parts by putting them in the 'precision quality zone' you get a massive step-change improvement in machine reliability. The difference can easily be 10 times fewer failures with commensurate savings in operating and maintenance costs.

Figure 11 is the learning from the experience at an Australian steel mill who improved plant availability from 58% to 77%. They changed their original business processes that were causing failure and began applying reliability creation practices. Their reliability journey took them to world class performer. They learned that it is not sufficient to be 'acceptable' or' tolerably' close to the precision zone: FOR LASTING HIGH RELIABILITY, EVERY WORKING PART MUST BE IN THE PRECISION QUALITY ZONE FOR ITS ENTIRE WORKING LIFE.

It is necessary to know what are the vital factors that affect your machinery parts reliability and the value of the 'precision quality' needed for each part to be in its 'precision quality zone'. Setting those values is the foundation of successful physical asset management strategy because with those values defined you have a target at which to aim your reliability creation process. You then develop in your company the life cycle processes needed to surely deliver outstanding reliably to your plant and machinery forevermore.

Your machinery parts must always be in their 'precision zone'—their least stressed environment—else the high reliability that you want is impossible to achieve. The Requirements Table in Figure 11 gives you fourteen standards your reliability creation process needs to deliver to your machines to get their parts into the 'precision quality zone' and keep them there.
These quality standards are demanding values; achieve them and you will get world class reliability. Put them into ACE 3T procedures and you will proactively control your reliability because there will be very few defects created in your machinery.

Since 1985 all the engineering, technical and scientific answers to plant and equipment failures have been known, most were there in the 1930s. For decades we have known what to do to create outstanding machinery reliability, but we cannot get companies to do what is necessary. The most valuable job that you can do for your business is to change your work management processes to include the right answers that prevent failure and that ensure the right practices are used by everyone all the time.

If you need help to become a world class operation, then send us an email. We are here to help you to become a world leader in your industry. It is why we created the Plant Wellness Way EAM methodology for world class reliability.

My best regards to you,

Mike Sondalini
www.plant-wellness-way.com