**Data-Driven Machine Inspection & Results**

**Tal Wagstaff**

All right, let's go ahead and get started. Thank you again to everybody for attending today's Redlist webinar. We're excited for our guest speaker today. Just as a quick reminder, I'll kind of show you how to use your team’s interface in case you're not familiar with it. Up at the top, there are a few additional features that you see that you may not have seen in a team meeting before. There's a Q&A button where you can ask questions. There's also the chat button. Feel free to use either tool, but most questions go through the Q&A button and we will answer your questions at the end. We're excited about our guests today. We've got Chris Endruhn from peak reliability with us. Chris and I've had a few experiences together. A great friend and a very knowledgeable professional. We're excited to learn from him today. He's going to be walking us through data-driven insights. Kind of gathered through machine inspections. And Chris, we're super grateful that you're joining us today. I'm going to turn the time over to you. I'm going to go on mute. You may see me pop in now and again to interrupt you and ask questions. So the time is yours, Chris. Thanks for joining us.

**Chris Endruhn**

All right, thanks, Tal. Good morning, everybody. If you're, if and if you're on the East Coast, then good afternoon. Tal, I'm in them in the future here by a couple of hours of the day is good. So my name is Chris Endruhn and I've got 30 years of experience industry in experience from corrosion engineering to technical sales process, engineering operations, and maintenance. And so just, you know, the last 15 years, my experience has been developing training that integrates operators into the reliability process. The last two years I've spent focusing on precision maintenance, course development, and instructional design, and so recently I've gone to peak reliability and I have shifted from what I used to do to telling people what to do with peak reliability. Now I'm either helping them do it or doing it for them and so I get a lot of personal satisfaction from helping others achieve their goals. And, you know, I've had the benefit of lots of years of experience in target-rich environments. And so we're working on paper machines that were underfunded. Lots of rotating equipment. Lots of breakdowns. Lots of opportunities to learn and if you didn't do something different, the beauty of maintenance, you're going to get to relive that experience because you're going to get another opportunity to work on things. And So what I have found over the years is that, umm, data can help us drive to get better results from the inspections that we already do. One of the things that, uh, if we don't have data to help guide us a lot of times when we make emotional decisions and sometimes they're toxic emotional decisions, they may not be the they may not be the ones that are made in our best interest. And So what I want to do is go through some of the some of the items that we need to do or need to have in place to take advantage of the data that we might already have and maybe we'll find out where some of the gaps might be in some of our systems and some of our process and how we go about taking care of that. So we'll go through kind of step by step.

**Chris Endruhn**

Here's what I got. Here's what we need to do. Here's why I think you should do it, and we'll move on from there. But really, it's all about trying to get better. When we do machinery inspection, the purpose of machine inspection is not just to inspect, it's to find a potential failure at functional failure at the potential breakdown and get it fixed before it actually does. That's the purpose of inspection, I think. Sometimes what I've seen, and in industry, I've gotten to go to lots of different lots of different companies, oil and gas, pulp and paper, pharmaceutical, food, and beverage, you name it. So whether it's at the nuclear plant or the chicken disassembly plant, the purpose of the inspection is to get stuff fixed. And not to complete that inspection and check the box. If you stop there, you're going to have the most expensive inspection, which is where we do all the work and get the inspection. Collect the data and the machine still fails. OK, that's disappointing to everybody.

**Chris Endruhn**  
In the last two years, I've gotten to work with a lot of military and they do an excellent job of communicating. So one of the things that they would give me is they would give me a bluff and I'm like, what does that acronym Stand for? Bottom line up front, so if you only have the 1st 5 minutes, you get called away on something else and you've got to go and put out a fire in your area. Here's what we're going to be covering, you know.

**Chris Endruhn**  
Here's the bottom line up front and #1 the fundamentals. If you want to take care of or employ data and doing inspections, it's fundamental to have an accurate list of your asset IDs and functional locations with criticality attached. Having the criticalities attached will allow us to avoid overwhelm because we'll be able to use kind of paradoxes real. We'll be able to focus our efforts on the highest business-critical machines. First, we'll get to the others later, but let's start there. You need data-driven decision making processes. We can be and they should be action-oriented.

**Chris Endruhn**  
What are the results you want from doing an inspection? Somebody says motors are hot and they find a motor hot. What do you want them to do with that? Do you want them to just write that down? Do you want them to clean the motor? Do you want them to? You know, do you want the bearing repaired? What are the things that won’t have those have that decision-making process already lined out as to what you want to do is it, is it going to go from finding something that's wrong? First, fix it myself #2 if I can't fix it myself, do I hand it to shift resources if I have those then hand it to shift. If the shift can't do it, then write a corrective work notification. OK, so your decision-making process should drive you to the results that you want. OK, the processes that we have should incorporate the different types of data.

**Chris Endruhn**  
There are subjective, objective data. There's text, there's pictures, there's video data. There is time series we can use all of that, not just some of it. We want to remove the barriers that restrict access to data. I didn't know. We tracked that. How many times does that happened? When you're looking for something, you find out that another department has got it. So we want to be able to be able to query all the data that our companies and our businesses gather, not just have it siloed off.

**Chris Endruhn**  
Oh, this is operations data. This is predictive maintenance data. These are the lubrication analysis. So you can't see those. You have to ask me for those. We've got to remove that. It slows us down. Automate the rules, automate and use the rules whenever possible. OK. That's a big one, but already have enough to do. If we can automate things perfectly and you know Pareto's rule focuses effort, praetor’s rule is that you'll get 80% of the results from doing about 20% of the things. OK.

**Chris Endruhn**  
And so that's the bottom line up front. We’ll move into. Do you know why? Why should we go through this? Why should we do data-driven decisions? OK. You know, there's a lot of things that happen when you don't have a process in place. We don't always make the best and most rational business decisions, OK? That can be left to chance. There's a gentleman, an economist by the name of Richard. OK. And he won the Nobel Peace Prize in Economics in 2017 for his contribution to behavioral economics. And that's a subfield that challenges the traditional economic assumption that humans act consistently and in ways that make themselves better off. And he came up with that was he saw he was having a dinner party and he put out a bowl of cashews while everything.

**Chris Endruhn**  
And you know, his appetizer had a bowl of cash and shoes. He put it out there and he noticed all his guests were wolfing down the cashews to the point that they were actually going to spoil their appetite for dinner. So he went ahead and took the cashews away. Well, one because he didn't want to spoil the dinner, and #2 cashews are expensive and they're eating a lot of them. So I'm taking it away. When he took the cashews away, people thanked him. And that doesn't make rational sense. You know it shouldn't be possible to make a rational individual better off by denying them some options. Have you ever had somebody just take you know where you thank somebody and we're taking the food away or taking the cake away? Cause. Well, I'll just have one more piece, you know, and it doesn't matter whether something, whether it's his research, is whether we're trying to lose weight, stop smoking safe or torment document and overheating mode or document a leaking gearbox.

**Chris Endruhn**  
What's the easiest thing for me at the moment is probably just to check the box, not necessarily follow through and go do the extra mile of what is right and what's going to make it better for me in the long run. And so one of the things with the dated day that driven decision making is let's go ahead and narrow people in to0 show them the path of pushing them towards the behavior that we want. What's the action that we want them to do? Do we want them just to check the box that the motor is running at 240 degrees Fahrenheit, or do we want them to troubleshoot it? Try and fix it myself. You know, pass it on to shift or put in a corrective work notification that's driven towards results. Drive towards getting things fixed.

**Chris Endruhn**

We're going to go give you a, you know, just a brief. A brief yeah story of. Data collection that I had to do my third child was born on October 26th, 2014. It was 9 pounds. It was very chill, and very relaxed when he was born, so much so that my wife was like both of our other children in the previous student, 2 girls. They were pretty spunky. You know, something isn't something isn't. Something's off, but he was very relaxed. We’re getting ready to be discharged. Everything he was having difficulty nursing. But he's a 9-pound baby, so the nurses were like, well, he'll just work off of his fat reserves and all that stuff. And that should all work out very well, you know?

**Chris Endruhn**

Don't worry about it. Well, come 36 hours later he was getting lethargic. He was getting cold. He was getting unresponsive. What is going on? Our new nurse came on duty. She took a look at him, and did a blood check. His blood glucose was down to 22 milligrams per deciliter, which the bottom end of that the machine doesn't read anything below 20. Your normal blood sugar is probably anywhere between 80 and 100 or so. OK, so he was going through Rhabdomyolysis, which means that his body was beginning to fuel him and keep him alive. His body was beginning to consume his muscles. And what we realized very quickly was that metabolically he was a black box when something begins to happen like that, I learned from paper mill experience, you just start taking notes.

**Chris Endruhn**  
You just start taking notes and these are the notes I took that are scrolling their madly is like everything that happened every test that was taken. Every injection. What? How many milligrams per deciliter over how much time concentrations? Visual inspections, everything documented all because you don't know, you don't know the value of your notes until after the fact.

**Chris Endruhn**  
OK, in retrospect is when you go oh I have that happened and that happened and that happened. We were sleep deprived for the next, you know, many, many days. We didn't get any sleep at all. We're dealing with Ph.D. genetic metabolic. People at Emory University are a great help, and they're asking what happened, what happened, what happened? I said can I just send you my notes? They said you have notes. I said absolutely. I learned this the hard way, so I had all the notes. That and, you know, they put two and two together and basically we found out that the boy was a metabolic black box. I didn't understand what was going on inside, you know? Come to find out, there was a problem somewhere in this process right about here, but this is the metabolic process of how you go about producing energy. And he had some hitches in this area right here, but we didn't know that at the time. All we knew was we want to get him home. We want to keep him alive.

**Chris Endruhn**  
Everything we found out about what he has potentially was. CPT. Two, it's like, OK, he's not. He was born on October 26th. It doesn't look like he will make it to Thanksgiving, so we know what's going in, but we don't know how to monitor them, they said. Well, if something seems off just bring them into the hospital. Yeah, I can't do that. It's like I know statistical process control and So what you have here is a recreation of my son’s blood glucose levels with the one standard deviation 2, standard deviation 3, standard deviation error bars, and what we needed from being sleep deprived was we needed to know when to do something.

**Chris Endruhn**  
So we had an I put this chart 20 inches by 30 inches on the kitchen wall and I plotted the data points. Figured them out in Excel and then I plotted the data points and colored everything in and made the error bars on there so that when you're sleep deprived, you're feeding him every three hours for the next. I was. We fed him every three hours for the next year, but we needed decision points, a single point outside the control limit where we have the red line. That's where if we're doing something, we got to do something now. That's one standard deviation below when we got 2 standard deviations below, we're going to the hospital to hide blood glucose. These were when he was in the hospital a couple of times and you could see those. That's from Ivy's glucose. But having these gave us reassurance of what we need to do well. We followed the rules, OK, and I got to say, it worked out pretty good because there's, there's Matthew right there. He's seven years old now. Super energetic. We've got him through. We've got him figured out. He's no longer a black box and there he is with his, with his little sister. Just so happens she's just turned 4 years old. She also got the genetic anomaly genetic metabolic inborn error that Matthew has, and we were able to use all of our notes. All of our learnings that she had a much easier flight path, we knew exactly what was going to happen.

**Chris Endruhn**  
We told them that we went to the Children's Hospital for delivery. We laid out. Here's the plan. They just let us run with it. She was. It was awesome. So that's where the notes and everything else can make a huge difference. OK, so let's take a look at data types. You have subjective and objective data types. OK, here is a precision maintenance form that I've put together we have both subjective and objective types and we have what I've done is put for the subject. That means oh I feel objective means we've got hard numbers. OK, for the object of the learning, we have hard numbers. Hey, let's put limits on it. Let's put the error. Put. Let's go ahead.

**Chris Endruhn**  
If it's greater than if the motor is running greater than 160 Fahrenheit, let's go ahead and we've got it's going to flag it. We're going to head and do something for the subject of where we feel or we're asking for somebody to look at something, go ahead and put, pass, fail. It's either good or it isn't. If it isn't, what's the call to action? And that's where sometimes the automation if you're using a handheld device and stuff, can really help lead you in a good way. OK. And so you know, that is a very helpful thing. So we have subjective and objective data and then we have a list of all the other different types. Use the mall. OK, I wasn't going.

**Chris Endruhn**  
You know you wouldn't wait for hard data numbers if you felt chest pains after dinner after Memorial Day dinner, he had chest pains and shooting like you've never had before. And then shooting, shooting pains, going down your arm, you're not going to wait for some numbers. I think you're going to go ahead and say, hey, let's. I think we ought to go to the hospital real fast and see what's and get myself checked out. OK. So those are the different data types. What is the purpose of inspection?

**Chris Endruhn**  
OK, I mentioned this earlier in the bottom line up front. The purpose of the inspection is to identify the signs of failure. Visual, audible, and tactile inspection instrument inspections, are inspections that are done by mechanics, operators, specialists, and managers. I don't care who's looking at it, but we're doing the inspections in order to identify something and get things fixed. If you want to get a program off the ground and really want to get people engaged into reliability, this part right here, getting stuff fixed, that's the most important. That's where the real leverage point is.

**Chris Endruhn**  
OK, you know what? Kind of things. Can we see, you know, we go out and we see? This is why pictures are not showing up. There we go. So here's a few there are a few items. OK. What can we see in the results?

**Chris Endruhn**  
How we might find out that the sprockets are completely worn, but only on one side, So what the sawmill will do is they'll turn the sprocket. We might find that the support at the base, the machine itself, looks good up here, but look, it's being it's on a foundation of trust when that gives way, it's going to end in tears, you know, here we have a motor where we've got carbon steel Shim mixed with stainless steel shims, undersized bending, corroding stacks of washers. And installation and we've got a Jack bolt that's type. What's the call to action man, if you had all that documented down so that when the next time would go work on that machine, we could go ahead and have that, that would be fantastic.

**Chris Endruhn**  
You've already got a worklist there, but if it's on a piece of paper, what are the chances that it's going to get shared or it's going to get transferred into the work order system? That's where we end up. Sometimes we sometimes end up with these, we end up in a data desert. I kind of think of it as there are three places we could be. We could be in a day to desert where we don't have any data at all. We're just flying by the seat of our pants. We could have a data mirage. We think we got stuff, but we maybe don't have access to it. When you really need it, you try to find it and then you don't have access to it, you know, and then there's the.

**Chris Endruhn**  
Then there's the third one, which is going to be where we end up with all the data we can, we can want OK and. And so that's, that's where we really want to be. We don't want to be data deprived. Here we can see we've got here we have, you know, oil lubrication. Take a look at the Lube oil down here. The oil and the sight glass. It's Milky. It's white, it's high, and if you look up above, you'll see the drips of water that are just dropping Murphy's laws. Then they drop right beside the breather in order to contaminate the rotating element. You know you have to be really lucky sometimes to have failures piling up on you like that. But you know these things will happen and they're out there and visual inspection is data too. And you want to be able to take advantage of it.

**Chris Endruhn**  
You know, just like if you go ahead and take a look at a, take a look at this subjective inspection. These were operators. They went out onto a hot oil machine. They there, I've. I've numbered. There are about 15 defects in that hot oil pump. OK, some of the ones that to me were kind of concerning were high vibration, missing foot bolts, and hot oil leaks. Open conduit. No grounding strap. Now I don't know what a fire looks like, but that looks like it has all the precursors to something going boom. You know this is not good. Uh, what do you think the chances are of all of this data right here? That was handwritten, getting put into a well-written work request survey says. Yeah, it's a small chance. What would happen if we had instead of pen and paper?

**Chris Endruhn**  
If that was done on a tablet or on a device where that's captured now we have 15 items that could be transferred into a notification very quickly so that it's not lost that the next time would go work on it. Here are 15 items that we can work on while we're at the machine. Well, we get them all fixed right now. Maybe not, but we ought to have a shift. Go ahead and add a grounding strap and take care of that open conduit and let's see what we got to do about hot oil leaks and the, you know, the unsafe slippery conditions in there. So there's, you know, that's the type of inspection data that if you're digitally distraught, you're running on pen and paper.

**Chris Endruhn**  
You know, this is these are the things that we’re not being able to leverage and maybe our competition is and you know if we're if they're ahead of us and we're trailing in behind that might be one of the reasons why, OK. So if we take a look at the inspection cycle, you know this is inspecting for the signs of failure, right? A. Find something. Write a work notification. You know, get it into the planning and scheduling so you know to repair, get the repair, the failure, track the cost avoidance. Rinse and repeat. OK. And a lot of organizations well and in several, let's say, not as many as we'd like. The role of identifying work is everybody else other than maintenance. Maintenance is there to fix, repair and improve. What do you want your maintenance people doing?

**Chris Endruhn**  
You know, fixing, repairing the backlog of identified work, and sometimes there's enough there to keep us busy for the next 20 years, OK. Or do you want him out identifying more work to be done and you can't be out identifying more work and fixing at the same time so you only have limited resources and there's opportunity cost? So how do you engage the operators?

**Chris Endruhn**  
How do you engage the predictive group and everybody to do all of the inspection and have the maintenance do what they're best at and where they can add the most value fix and improve and put things in a precision state so that we don't have to go and relive those failures again. So you know the best, the best, the sometimes most effective way to go through is, hey, let's go ahead and get maintenance on that. But you know, operations identification of failures, maintenance it, rapid elimination of failures. So we need to do data-driven. We need an accurate list of assets that is fundamental. If you don't have that with a good bill of materials, it's going to. It's going to slow you down tremendously, so it is fundamental to success and you know if you don't have it, we need to do some asset mapping, physically walk down the equipment to try and find out what the, you know, collective machine types, the IDs, the locations and stuff that is going to be imperative.

**Chris Endruhn**  
And then once you have the assets mapped, get the equipment criticalities for each what do I mean by that? Well, if that machine goes down or that asset goes down, how does it affect your business? If it's a sort of thing, So what? Who cares? It's not business-critical, so we put a numerical number on it. We go ahead and assign that criticality. The criticality helps us in order to, in order to prioritize what we're going to work on next, OK. So if you've got the current, you don't have the criticalities you know Pareto’s rule probably 20% of your assets are the most critical ones you might have to do.

**Chris Endruhn**  
Perform failure modes and effects analysis. You know on those ones, but the for the balance of plant, the other 80% just put together a cross-functional team using the FMA tools and go ahead and assign the criticalities. The main thing is not to be 100% right, it's relative, OK. And so you just want to be able to rank so that you can start working on the machines that are most important to your business. And then those ones make sure that they have good bills of materials.

**Chris Endruhn**  
Every improvement and thing that you're trying to get fixed has to go through the work order process and it's much more difficult to do it if you don't have a good, solid bill of materials. And so you know what? What we'll end up with at times in a lot of facilities is when end up with having a data silo where separate teams and departments over time have naturally made their own collections of data. OK. And, you know, things have evolved organically. And if you've ever tried to get the predictive maintenance data and access to it, it can be pretty tough.

**Chris Endruhn**  
But it sure would be nice to correlate things from 1 silo to another. And you know, it's one of those things, you know, how do you know if you're in a data silo? You might have data sources as you know you might have data silos if you rely on loose Excel spreadsheets, you're unable to access data quickly, you're, you know, random software is used and shared selectively. You have to dig through your personal records upon request. You might have a data silo.

**Chris Endruhn**  
If you're unsure of the metrics your teams are using, OK, they're operating like separate businesses and it makes it hard to see the big picture and it's you have inconsistent data, you have errors that sometimes don't get corrected when you have silos, you lose that collaboration between areas. No, no, that's my data. You can't have it. You're not allowed to see my data. I mean, that's what’s so 1992. You know, we need to, we need to move on from that in order to remain competitive. All right. But you know that's the, you know, the data silos.

**Chris Endruhn**  
They are. They slow us down and you know it. The storage of them. If you're working off of Excel sheets, I don't know if you've suffered from spreadsheet risk where somebody has edited, deleted, UH formatted, filtered incorrectly, and jumbled up all the data. It can go. Bye-bye pretty quick. But when we look at when we're looking at equipment and we're doing inspections, the view from within each style of the operators go look at this pump and the view from that is well, there's one thing that's questionable, but we'll give it a pass. We'll give it a pass, but the lubricators like, well, it's dripping oil.

**Chris Endruhn**  
We'll give it a pass. Maintenance goes and looks like maintenance history. Well, we will fix and repair that every six months, but you know that's the only problem. We see it predictive is like, well, you know there's high vibration on the inboard bearing. Umm, you know from within each silo the machine looks OK. If you could look across the get rid of the silos and look across you start to see that there's there are problems that each group is seeing and as a whole now we can say, you know, that's not really the best intention.

**Chris Endruhn**  
That's not as good as it could be, and so removing the silos is what we want to do and whether that is, you know, at the corporate level or the enterprise level creating a data warehouse or a data lake or all the data lives, we all know what data we have up there and we can query it without causing it to go. Bye.

**Chris Endruhn**  
We can pull it and then you know, try and find correlations that help us move the needle. Help us get better. There's and integration platforms as a service. Again, that's probably going to be more at the corporate or enterprise level. You know, if you don't have that kind of stroke or horsepower, what can you do with the plant level, use an all-in-one solution and try and find a single platform. You know that holds and contains most of the data and removes the barriers and makes it transparent and that we can dashboard from and create reports.

**Chris Endruhn**  
You know, that's sometimes the simpler one at the facility level to get funding for because that might be within your decision rights to go ahead and get that. However, you do it though, you know, getting the information out of the protected and proprietary silos to where we can all see it and use it make a huge difference to your daily life. Things are starting to get

You might get more sleep through the night. You know you won't get it. You won't get those opportunities that frequently to go in on the long weekend and put Humpty Dumpty back together again. OK.

**Chris Endruhn**  
The other thing is, once you have the data we need to use, I think we need to use processes to drive decisions. OK. So and I'll get data-driven decisions, but follow a process just like we did with Matthew. We didn't have to do it with Charlotte because by then we could. follow processes to create those decisions. And then act pass fail on subjective data. What you want to do is spur action in the direction that you want to go. You may not always get there right off the bat, but where is it that you want to get to?

**Chris Endruhn**  
All right, so here's a quick list of the processes that I think you need to have now. This is assuming that you've got your assets mapped, you've got your criticalities. You need to have a planning and scheduling process. All the improvement work and repair and replacement goes through planning and scheduling. If we suck at planning and scheduling, it's going to affect how much we can get done. OK, so what is your process for your meetings?

**Chris Endruhn**  
When do you get the schedules? That one is, how do we go through the planned work? How do we go through the outages? How do we go through the new requests that are entered? Have a process for that so that we steer things in the way that you know, sometimes the path of least resistance. Well, we'll skip that getting that done, it's going into a long weekend. We don't have to have that posted, you know, need to have the weekly schedule posted. I locked in and posted by noon on Friday for next week.

**Chris Endruhn**  
So everybody knows what they're coming into in the next week. You know, how do we have? Do we have a process for entering a complete well-written work request? You know, do we have how work requests are entered? Do we have job steps on a work order? OK, you know that is a process, you know? FM EA for assigning equipment CRITICALITIES that is a process, though it would put those together, and then we're all following something consistent when you go through, you know, want to do what's right for the business, not necessarily what's right for Chris or what's right for a towel.

**Chris Endruhn**  
All right. And so what's most important, we're all a bit selfish. I like to have my scorecard go green. Sometimes I make it go green at the expense of operations, or at the expense of predicted seeing it happen all the time. And you, you watch. Not everybody's rowing in the same direction, and there's no doubt why the boat is spinning. Doing circles in the lake.

**Chris Endruhn**  
It's like because people are focused on their personal stuff, so doing that by process makes sure that the criticalities are right for the business and you know, not just, not just for you. What are your inspection processes? Do you know what is, what does a lubrication technician going to be looking at? How are operators going to be performing their inspections? How is? How are the predictive inspections done?

**Chris Endruhn**  
How will they be handled? And I think, you know, probably the one that processed their number 5, the one that is probably the most overlooked is what kind of feedback mechanism are you going to have to the people who are doing the inspections, who have found stuff to let them know the status of what they found, whether the work order or work request was accepted or rejected if it was rejected, why it was rejected, that communication is so important. And then sometimes the results of like, hey, we fixed it, and here's what we found.

**Chris Endruhn**  
And now we've got this thing in a precision state. If you don't, sometimes that feedback process is a way of almost like walking somebody over to the machine and saying, hey, we got this one because if you don't do that, people, the human nature, human nature is such that I don't, you may have taken care of it and fixed it and that's the best thing in the world. But I don't care. It's like, yeah, but what about this other one over here that my brain is focused on the next one that's killing me?

**Chris Endruhn**  
I have to walk you over to show you, like, hey, we got this one taken care of. It is done. We no longer have to fight this machine, you know. So what? We'll go through them quickly. What should your inspections consist of? Your inspections, your process should be hey, let's inspect for those failures that have happened in the past that are likely to happen again in the future. That might be subject to some sort of PM and those failures, although unlikely, they're unlikely to happen, but they have such severe consequences that we can ignore.

**Chris Endruhn**  
Those are the things that we go and inspect for. You can inspect yourself to death. OK, but at some point people have to go back to running the plant or fixing stuff. So it's a good way to go ahead and look at those. What are those? What are the failures you want to what? You want to check for and then how are you going to handle them when we find them? Because too much data is going to be parallelizing, so resist the temptation to collect everything just because you can. OK. And you know the purpose of the inspection is to get stuff fixed.

**Chris Endruhn**  
So whether it comes from subjective data or objective data, don't fall into the trap of going ahead and inspecting, and we find the problem and it's an age-related problem. We know that it's worn out. It's lasted as long and then we go ahead and say, well, we'll just inspect it again on the outage and confirm what we already know to be true. And then we'll fix it in another outage later. So don't do that. You know, use the inspections to drive improvement and get things done. Set up the triggers appropriately. OK. But again, the feedback process, it's vitally important.

**Chris Endruhn**  
It often gets overlooked, but it's what drives people to do the right things when they see the changes happening. It really does. It really does make the difference and so don't you know, some of the best processes I've seen. It's like, OK, just like blog posts. It's like we're going to write up what we're what we've been doing and finding how many corrective work orders have been written, how many inspections we have found in the work, in the, in the newsletter.

**Chris Endruhn**  
It's going to be in the newsletter. Whatever the results are, it's going to be on the TV around the facility. I'm going to talk about it during safety meetings. You know those sorts of things. It's really underappreciated. So you know, we want to break down those. We want to break down those silos and. Umm, you know, in order to help us get there. So I know I've gone. Relatively quickly, but you know when it comes to data driving data-driven machine inspection and results, you know we'll go back over the, the, the, the fundamentals got to have an accurate list of asset ID with criticalities assigned.

**Chris Endruhn**  
If you don't have them, we've got to walk him down and get that. That's going to keep you from, you know, not going after the next shiny object. OK. That is, that is important. OK, assigning criticalities sometimes people think that that's pretty tough. I mean, you probably know you know which mission-critical machines, if they go down, it's going to cost the business a lot of money. That's what criticality means. It's going to cost you a lot of money to either fix or repair. OK. Is it going to cause safety and environmental or production consequence?

**Chris Endruhn**  
That's probably a mission-critical machine. OK, we have to use some, but that one is that one at the top of the priority, you know, for the balance of plant machines. OK.

**Tal Wagstaff**  
Hey, Chris, can you go a little bit, I think there are some questions around this like we've seen a lot of. I guess different criticality scales were used. Yeah. Could you maybe give us your opinion of what the most common is that you see out there? Is that one to five? Is it 1 to 10 or is it are people using words? Yeah.

**Chris Endruhn**  
Yeah, that's.

**Tal Wagstaff**  
What's the best way to do this in a normalized way?

**Chris Endruhn**  
OK, here's Chris’s method of doing it, and we did this on a paper machine back in 2006. All right, actually, probably 2003 over we knew what our mission critical was. OK. So scale one to 91 being So what? Who cares? It goes down, not missing a beat, OK. no overlap. But we just did a scale of 1 to 99 being like, Oh my goodness, all hands on deck. If this thing goes down, this we're having a safety environmental or production consequence, OK and you can say like you know nine is it's going to impact the business and it and it might be for 30 days or so or something like that or you know impact the business marginally and you can find all these different scales.

**Chris Endruhn**  
But there's no right or wrong now. That's contentious because as soon as I say that's something to say you're wrong. My opinion is if you want to get to the finish line, you know, find your mission-critical, give them sevens. 8 nines. Whatever it is. And then you do a sliding scale after that and honestly what we did was to get through a paper machine and a reasonable amount of time. So we could do something with those numbers.

**Chris Endruhn**  
We went and had lunch and learned we all sat around the table, mechanics, operations E and I, PDM, SMEs, leaders, you know, and we sat around the table and we had the printout of all our functional locations and then we said, OK, well, OK then the dry stack, how important is that? That's the nine. OK. Then we're down to some other pump downstairs that's got 3 spares. Somebody says that's a 9. It's like, no, it's not.

**Tal Wagstaff**  
Right.

**Chris Endruhn**  
It's got. It's got spares. That's a 5 at best, and then sometimes you do some horse trading and eventually it's like, well, I'll give you a 6 for that. But you got to give me a four for that one over there, OK. And it goes back and forth, but it doesn't matter what the numbers are at the end of the analysis. If you're consistent, it all filters out. Maybe you'll never give out any knives. You know, it's just like you'd never get a perfect score, but it all filters out. And we've done this. I have done this exercise with engineering engineers and leaders in the classroom. Many, many times and it doesn't matter which scale you use.

**Tal Wagstaff**  
Hmm. He.

**Chris Endruhn**  
Eventually, the assets almost always end up in the right order of criticality, OK. And so it makes people. It makes people feel ungood, you know, doing it that way.

**Tal Wagstaff**  
Sure.

**Chris Endruhn**  
But I promise you it's one of the few ways to get to the finish line.

**Tal Wagstaff**  
Yeah.

**Chris Endruhn**  
You know if go ahead, Tal.

**Tal Wagstaff**  
No, I was just going to say I think I think you've mentioned a few of the kinds of the questions you're answering as a team and then you're in your head as you're as you're as you're designating criticality.

**Chris Endruhn**  
Yeah.

**Tal Wagstaff**  
Could you maybe go into a little more detail just like I mean one of them you mentioned is, does this machine have spares another one is like how much is this going to cost if it goes down? Like what else is going through your head as you're assigning the criticality?

**Chris Endruhn**  
Yeah, right, right. So if I'm doing pure RCM reliability, centered maintenance, and resource-consuming monster, how much the machine is worth? Doesn't even play into it. OK, but let's do it from a practical standpoint. Yeah, I'm taking into consideration how much is it going to cost to repair this. How long are we going to be down? OK. Is this a? Is this a gearbox that on this that although it's just, you know parallel shaft gearbox, it's only cast once every two years in Germany?

**Chris Endruhn**  
Yeah, I've had one of those and you have to baby it to the next time. You the next time they're going to cast it. So you know, even though it may not be the most important part of the machine if you can't replace it quickly and you have to do A, you know, a reengineering you start, it's for me, it's criticality just went up a little bit. OK. But those are the, you know, safety, environmental consequences. OK, so if it's a chlorine dioxide system then it's like it's not.

**Chris Endruhn**  
I don't need it to produce, but if that system leaks and it gases the control room and I kill three people, that's bad. That's a bad day. We're all going to jail. So you know that that plays into it. So safety and environment Tal and production consequences put the dollar figures to each of those, and then you start getting into how long does it take to fix, how you know is the failure is hidden? How easy, how detectable is it, and things like that? You know that that kind of fits in there in the, in the FM EA, but those are the big ones.

**Chris Endruhn**  
Safety, environmental and production consequences put dollar values to it. How much is a life worth?

**Tal Wagstaff**  
Like.

**Chris Endruhn**  
Well, that makes it pretty expensive. We know what our downtime is worth. It's $15,000 an hour. You know, we know how much the cost is for a place, so that's what's going through my head.

**Tal Wagstaff**  
Like. No, that's good. Thank you.

**Chris Endruhn**  
No, no sour.

**Tal Wagstaff**  
I apologize to interrupt your flow there, but that was I think that was a great, great, great explanation. I'll let you keep going.

**Chris Endruhn**  
Yeah. No, no. That's uh, that's, that's what. That's what I'm here for. It's, you know, the processes that we go through, you know, data-driven should always be action-oriented. What are the results that you're looking for? If you're going to do this inspection on the machine, you're going to ask somebody to go take a temperature on the state. Or So what if it fails? Think that through in advance.

**Chris Endruhn**  
What is the what? What are you driving towards? Are you trying to get something fixed or trying to get something repaired? Do you just need to build up data like what is? What's the reason for doing it? OK, but drive towards the outcomes you want and you know, automate and use rules whenever possible. We're already all busy enough, you know, with paper inspections. They're great. They're easy to get off the ground. What's the hardest part of paper inspections? Managing the paper inspections.

**Chris Endruhn**  
What's the hardest part of managing? You know, 10 pages of precision maintenance, dock precision maintenance paperwork. It's managing the paperwork, so put it into a system where you know you can use the. You can use the data and you know move from a data desert through the data mirage to the data Oasis. OK, you know, use Pareto’s rules to focus your efforts. It's real. You know, Pareto was 18th while he was.

**Chris Endruhn**

I should say 19th-century Italian economist, and they found he did as he did studies and he realized that it's like OK, 20% of the people own 80% of the land, 20% of the people held 80% of the wealth and you start finding out that Pareto’s rules kind of, you know, 20% of the, 20% will get you 20 if you focus on 20% of the stuff will get you 80% of the results. So that you don't get overwhelmed that's why having criticalities on your assets and identifying what's mission-critical will get you most of the way there.

**Chris Endruhn**  
Then focus on what's going to get you the most bang for your buck. But always automate and use rules. You know, whatever whenever possible. And if you do that and step through those, you know it's you'll get incremental improvement, you will, you will move towards a better day and that's really what it's all about. You know operators, they just want their stuff to run. OK. You know, they don't really care necessarily how it runs, how you make that happen.

**Chris Endruhn**  
They just want their stuff to run and you know, when I was in maintenance, I just wanted to fix their stuff. And then I realized it's like, man, if I fix it and get rid of all the and try to do, we do our best as a crew to get rid of the installation errors. I might even get I'm full night of sleep where they don't follow me to come back out, you know? So these are the ways that it can drive results both from a business standpoint and from a personal level. When you know that you've gone through and followed the process and everything has been done right, people begin to have more confidence in machines that it's been fixed, right that we've looked at it correctly.

**Chris Endruhn**  
So those processes, whether it's standard operating procedures for how we do inspections, standard operating procedures for how we start machines and warm them up, all those things will help us drive results. So, that's really where I want it to get to. So all right, Tal, and we'll do, we got questions.

**Tal Wagstaff**  
Yeah, I think I think a few more.

**Chris Endruhn**  
Umm. Yeah.

**Tal Wagstaff**  
One of the things just kind of going back, finishing up on your final slide there and the criticality assessment, I'm curious to know if assume that I'm finishing up this assessment and taking that Pareto’s rule into account if I do a check and I look and I see that I'm way off from that kind of that 8020 splits in either direction is that like a safe rule of thumb for someone to say hey, maybe I should, you know look at the way I'm doing this or are there some facilities that maybe don't fit the mold and have like they've really they've engineered it really well, there's not that much critical equipment or the other way around?

**Chris Endruhn**  
So you know the nuclear power plants and stuff, you know, they don't get to use RCM light, you know anything with the word light on it or FM, FM, EA light. You know that's not our CM. OK, they're doing it zero-based from the ground up and the results are what they are for the rest of the industry. You know, unless we're shooting rockets to the moon and stuff like that, you're it's usually going to be somewhere around 20%. If you've got more than that, likely that you know you're you need to tighten up on your what constitutes mission-critical safety, environmental and production consequences.

**Tal Wagstaff**  
Umm.

**Chris Endruhn**  
That, and I've seen it go too far the other way, where it's like OK, chlorine dioxide, you know, a chlorine dioxide system. This is a potential problem if you have one. If you have statisticians trying to apply criticalities that have no experience and have never been gassed by H2S or CO2 or chlorine dioxide, if you've been gassed before, you'll understand that it's important.

**Tal Wagstaff**  
Yeah.

**Chris Endruhn**  
And so the biggest variable modeling in modeling reliability and the biggest problem with model reliability models is there's no way to accurately account for human behavior.

**Chris Endruhn**  
It's the biggest wild card because what's important to me is not necessarily important to tell.

**Tal Wagstaff**  
OK.

**Chris Endruhn**  
It's not that it's different than what's important to Dallen, OK. And so we all have our personal things. And so that's, you know, that's the bowl of cashews. You know, it's like somebody has self-control and they stop and they go ahead and say no, no, I'm not going to have anymore.

**Tal Wagstaff**  
Right.

**Chris Endruhn**  
You know, I'm going to do what's? I'm not going to ruin mine. I'm not going to ruin my dinner. Out the person just can't stop themselves.

**Tal Wagstaff**  
Sure.

**Chris Endruhn**For whatever reason, right? It's like, man, I just taste too good. Just one more drink.

**Tal Wagstaff**  
Yeah.

**Chris Endruhn**  
You know, hold my beer. Watch this.

**Tal Wagstaff**  
Right.

**Chris Endruhn**  
So you know, but that is a, you know, a big area. That's why you have to, you know, you try to account for it as best you can and practice. You got to do it practically because there are all sorts of impractical ways where we never get to the finish line. How can we get results in, in days and weeks as opposed to months and years?

**Tal Wagstaff**  
Yeah.

**Chris Endruhn**  
You know that's, that's the thing. And using the data using the tools you can set yourself up limits and try to and you know hold by them. And like I said in, in the end, if there's a bit of horse-trading, I'll give you that one A7 versus. But you got to give me a 6 on this one, not the five that it's at. OK, it'll likely all filter out criticality and tells you where to begin your improvement efforts. Not that you won't get to the other ones eventually, it just gives you an idea where to focus your efforts. Right now you know, Pareto charts give you an idea of hey, what's the first thing we should focus on?

**Chris Endruhn**  
You know, it's like, hey, Barron, failures are a big deal for us. OK, let's go and take a look at the root cause what's causing or contributing to all the bearing failures? And let's go and hammer that one. Maybe we don't have the right tools. We don't have a bearing heater. We don't have. We have been trained on how to install a bearing correctly. You know, it's like the bearing won't go on the shaft. Well, well after I hit it with this claw hammer. Enough, you know?

**Tal Wagstaff**  
Yeah, right.

**Chris Endruhn**  
So you know, those are now using it's doesn't have to be you know it doesn't have to be A0A 0A0 sum it you know it's just a place to it's a place to start.

**Tal Wagstaff**  
Yeah. One of the things I thought was fascinating, just with kind of the best way for the maintenance team to I guess kind of prime the pump and get more information from their operations or mechanics was through a good feedback process.

**Chris Endruhn**  
Yeah.

**Tal Wagstaff**  
I'm just curious, I'm just curious about your experience. Have you seen teams that do this well? How have they done it?

**Chris Endruhn**  
Yeah.

**Tal Wagstaff**  
I guess I think if you have any examples that would be great.

**Chris Endruhn**  
Yes, they were. They were picking every form of communication that you have inside the gate. Use those if there are social media. If there's an internal social media or so slack channels or things like that, whatever channels you can pound things out. But it's like it, you know, it was one on one communication feedback. Hey, when I see somebody. Hey, here's the status of this. It is. It is, you know, automatic feedback going back to email. It's like, hey, here's the status of your notifications.

**Tal Wagstaff**  
Sure. Yeah.

**Chris Endruhn**  
Putting it in the newsletter, the results of what's been going on, posting it on the blackboard on the bulletin boards, posting it, posting results near the coffee pots are usually pretty effective because everybody visits that, you know, the Monster Energy drink cooler on the TV's, you name it, you can, you know, the 3Cs of reliability improvement, communication, communication, communication. Communication, communication, communication.

**Tal Wagstaff**  
Yeah.

**Chris Endruhn**  
You cannot over-communicate results, but you have to. You have to do it because people's default is to look at the next thing you remove. The one thing that's been killing them, they don't. We won't notice it. We won't take notice of it.

**Tal Wagstaff**  
Right, Yep.

**Chris Endruhn**  
We'll notice. Oh well yeah, but what about this will be the answer, you know.

**Tal Wagstaff**  
Right, yeah.

**Chris Endruhn**  
Hey, we fixed that, and in the operator, yeah, but what about this?

**Tal Wagstaff**  
Yeah.

**Chris Endruhn**  
It's like, yeah, no, no one at the time.

**Tal Wagstaff**  
Right. Makes sense.

**Chris Endruhn**  
We'll get there and that's why we work down the criticalities right to make sure that we're working on the most important first.

**Tal Wagstaff**  
Yeah. No, it's the same thing in software. You know, Apple releases a bit of code that makes you know, makes it 2 seconds faster to send a text message.

**Chris Endruhn**  
Yeah.

**Tal Wagstaff**  
You won't even remember that yet tomorrow after your it's you got to.

**Chris Endruhn**  
You're like, what? What's with my battery life? You know that's.

**Tal Wagstaff**  
So yeah, exactly. Exactly.

**Chris Endruhn**  
Umm Yep.

**Tal Wagstaff**  
Umm, we've only got a few minutes left, Chris, so I wanted to just maybe take the last couple minutes and let you promote peak.

**Chris Endruhn**  
Yeah.

**Tal Wagstaff**  
Tell us about your company yourself and how you're helping folks in this industry, and we'll, we'll just for everybody's information, we'll circulate the deck and Chris's contact info. So nobody has to write anything down.

**Chris Endruhn**  
Yeah. And if you, you know, if you, if you email us. I'll send you the 100, the 102, the seven phases, and the 102 things to look at for doing you know, a precision alignment on a directly coupled machine pass-fail what a record. But yeah, you know, this is all about helping people, you know, do the reliability improvements, whether it's asset mapping, whether it's Lube charting, whether they just want to they want to call and find out. Hey, I've got a question on this.

**Chris Endruhn**  
You know that is part of it. I get a lot of enjoyment out of helping people, mentoring people, whether it's in person, walking down equipment, or, you know, doing it over the phone, doing it via distance to have a question about it.

**Chris Endruhn**  
Well, how could I go about doing this? You know, there's, you know, there's a lot of data out there that needs to be brought together. There are a lot of different spreadsheets and a lot of different things, and unfortunately, it only gives you a snapshot when you bring all those different spreadsheets together. You have a snapshot of where you were when you pulled data two weeks ago, but things have changed already. So how do we get better?

**Chris Endruhn**  
We do predictive maintenance. We go out and do boots on the ground collecting of information as well as data analysis, and one of the things we're you know that that is really interesting is you know there's all these Internet of Things, you know, remote vibration monitoring. But there's not a lot of people. And what we offer is there's not a lot of people going out there and looking at the installation and saying is this going to give you the data you need?

**Chris Endruhn**  
Is this going to cover the failures? Is it going to give you information on the failures you wish to control?

**Tal Wagstaff**  
Right.

**Chris Endruhn**  
Otherwise, if the sensors are mounted incorrectly in the wrong position, you'll have 24/7 vibration data and the machine will catch fire and seize anyways because it's in the wrong spot. So now those are some of the things we just want to help. I just want to help people get better.

**Tal Wagstaff**  
It's great, Chris.

**Chris Endruhn**  
Yeah.

**Tal Wagstaff**  
Well, thank you so much for joining us and teaching us today. I think we all learned today and we're grateful for your presentation. As I mentioned, we'll make sure that Dallen and the team get it posted and available for everybody who attended and also for our customer base.

**Chris Endruhn**  
Yeah.

**Tal Wagstaff**  
And we look forward to working with you in the future, Chris.

**Chris Endruhn**  
All right. Thanks, Tal. Thanks, Dallen. Thanks, everybody. Appreciate you.

**Tal Wagstaff**  
Thank you. Yep.

**Chris Endruhn**  
OK, bye.

**Tal Wagstaff**  
Thanks, everybody. See you.