NCC_BSL_DavisBalestracci_1_10232015

Welcome to a session on Plot the Dots, which will be about Run Charts. So, what I'm going to try to do is tell you why all the statistics you learned in school, aren't really applicable in the real world. So, traditional stats go out the window. I will tell you, "Forget everything you've learned." And many of you will say, "Don't worry, we already have." Well, good. And the most important thing with the type of statistics I will teach you as you will see in this and the other three lessons, is to plot, plot, plot your data. Something that might become a shock to you, or to many of the people you work with is, I'm going to show you why trend lines are worthless, yes, worthless. So, what part of no more trend lines ever, don't you understand? And I'm also going to kind of introduce you to the fact that, I know many of you are knee-deep in root cause analysis, and I might have a way to show you whether you're making a difference or not. So, with that, there are the objectives, the power of plotting data over time. I've done these in groups as large as two hundred, and I had everybody on the same page within about ten seconds for a different conversation.

And the important lesson here is to introduce you to the concept of common cause. There are two kinds of variation: common cause and special cause. You treat one as the other, you actually make things worse, and it is the human tendency to treat all variation as special, and you'll get a lot more about that as I go on.

Okay, so here's some made up data. I'm going to get all your former habits out of your system. Let's say this is thirty weeks of data and this is your typical six month, how are we doing meeting on length of stay. And let's say, you have three hospitals and their computer system all interconnects so everything is defined the same. And at the end of the week, they somehow put in patient numbers and patient days and come up with an average length of stay. So, this is the sixth month meeting to say, how are we doing, regarding that. And as you will see, here is a summary. And right now all of you are looking at the three means, and some of you are ranking them, one, two, three. Some of you are saying, ah, there's no difference. Some of you say, Gee, I'd like more data. And many of you, because you've been to meetings like this are going, [snoring].

So, let's see if you – and all of you probably have belts of some kind, yellow belts, black belts, who knows, going around your organization. And they might want to get their hands on this data. So, let's see, let's do the three histograms. Well, look at the shape, and this is the other thing you remember in your statistics class. Notice, they're all bell-shaped. Yes, the normal distribution. And, oh yes, we do have tests for normality, and they all passed. So, what someone might say is, "Because they all passed the test for normality, I can do the analysis of variance, and there is your all-mighty P-value, and the ninety-five percent confidence intervals. And from this P-Value since it's greater than .05, we can say statistically, there is no difference between – among these three hospitals." That's what you might think.

Well, when you do a statistical analysis, you are making an assumption about how the data were collected. And in the real world, that assumption is not always safe. So, one thing we do know about this data is, it's weekly data, thirty weeks of data. And the most important thing you're going to learn in the real world is, why don't we just plot our data over time? So, for each of the three hospitals, let's plot the data over time, and just take a look. So, we just concluded no difference. What would you say now? Now, here's my point, within about five seconds, all of you said, "Whoa, there's no difference here." And by looking at the shapes of the graphs, you're going to start asking some questions. Now, I want to ask you, just given this summary, what do you ask? Given this, what do you ask? Given this, what do you ask? And my point is, there is no fancy statistics here. All we did was plot the dots. But we're going to have a much more productive conversation. So, I hope you're intrigued.

I had a friend who was implementing a guideline in a five state area, and she sent me this data. She called me, and she said, "Davis, I want to know how I'm doing." This is a true story. And I didn't do this, she didn't do this, but I know some places you'd go and you would see a poster session where they would put the data, and put a trend line in and said, okay, her goal was to get from fifty to seventy-five percent, let's take a look. Well, let's take a look. Look at this, look at this, and it looks like in about three to four more months, she's going to make her goal. And you have things like an R-squared, you have that wonderfully significant P-value, and it's wrong, and I'll show you why. Here's your bread and butter tool. It's called a Run Chart. You couldn't make it any simpler. And all it means is, you plot your data over time, and you put the median in as a reference point. Yes, the median. The question we're trying to answer here was, did our process have one needle? You'll hear me refer to the process needle quite a bit, which is sort of its center line.

Okay, so simple concept, and I want to define one thing because the word 'trend' is bandied about quite a bit. I'd like to banish it from corporate language. Let's consider three data points. They can manifest in one of six different ways. Now, if you'll look at the top one and the bottom one, they fit our prejudice as to what would be a trend. So, think about this, if I want to call three points a trend, can't you see, that's two out of six possibilities randomly? So, in other words, if I want to call three data points a trend, there's a one in three chance I could be wrong. And we see this every month. We go to meetings and we get, this month, last month, twelve months ago.

What about the ten months in between? Or you have quarterly review meetings where you get the three months of the quarter. And you get this quarter, last quarter, same quarter last year, with the, this month, last month, twelve months ago, and who knows what else. And bar graphs and trend lines. Here's my point, three points tell you nothing. And I'm also going to re-define for you what a trend is. Mainly to show you what a trend is not.

So, when we get the Run Chart, we're going to have two different tests to apply. Number one is the trend test. And the way a trend is defined is six successive increases, or six successive decreases. And you're going to find this to be quite rare. And what I'm going to show you using

my friend's data, is it usually indicates a process that's in transition. In other words, it's not going to continue. So, that's the trend test, and you're rarely going to see it.

Okay, here's the test you'll use the most. You plot the data, and if you can circle a group of eight points either all above the median, or all below the median, that indicates that the process is at a shift. And if you think about improvement, what you're trying to do is shift your process to a more acceptable level. So this is going to be your most common test, and it's also the reason why in improvement work, I don't want a huge, random sample. I want more frequent samples over time. That's going to be the biggest change I'm going to ask you to make. So, you might have quarterly data, in which case, I'd say, "Give me the three months." Or, even, "Give me the twelve or thirteen weeklies." And this is where people get a little nervous and say, "Well, you know, it won't be very accurate." That's okay because as you're going to find with my kind of statistics, as long as the number is defined in a way that is consistently inconsistent, we can work with it. And you'll see why I want multiple dots, this is one reason. Because you want to know very quickly if your process changed. And if you make a very good change, of course, you'll want to detect it as quickly as possible.

So, bear with me and let's go on to the next slide and apply it back to my friend's data. So, let me make a Run Chart of her data. Well, first of all, there is the Run Chart, now let me show you how I got the median. Here's my friend's data. What I did in this column was to sort it. So, we had twenty-three numbers, so I sort them from high to low – sorry, we had twenty-two numbers. And since it's an even number of numbers, if I come to it from each side, they're going to meet in the middle. So the median in this case would be the average of the middle two numbers. If you have an odd number of numbers, it will literally be one of the numbers. So I draw my friend's data, and notice how your eyes act totally different from before when we had the data without the connecting line and added the trend line. You can sort of see here that she was at fifty percent. She had the intervention here, well let me – let me continue. Let me continue.

So, she intervened right here. Now notice, one, two, three increases. It's not the six increases we'd need to declare a trend. So, we can't use that rule to declare a special cause because she was trying to create a special cause, an intervention that got her greater compliance. So the trend rule doesn't help.

Well, now you notice that if you look here. The first nine points are below the median, that is a signal that there was a shift. Now notice also that the next ten points in a row are above the median, and that is also a signal of a special cause. She tried to create a special cause. All I need is one of these signals, I happened to get two. So, this is the evidence that her intervention has, shall we say, bumped the needle. Now, one of my favorite expressions and I'll probably say it several times over the course of these four lessons, is your process is perfectly designed to get the results it's already getting. So for example, here she had a process that was perfectly designed for fifty percent. She made an intervention, and it transitioned to what it was, perfectly designed given the new input. And if you kind of mentally draw a little needle in there, you'll notice it leveled off at about say, 68%.

So, here's my point, the trend line said, three or four more months, she'll have the goal. Well, what this says is, if she continues to do what she's doing, she's going to stay at about 68%. She needs another intervention. So that's an important point. And also the reason, this also shows the reason why I use the median, can you see that taking the average of all this data doesn't make sense? So, by putting the median in for the Run Chart, it answers the question, did this process have one needle while we studied it? Or in other words, was there a shift or not? Because if there was, it doesn't make sense to take the average. This is like saying, I put my right foot in a bucket of boiling water, my left foot in a bucket of ice water, on the average I'm pretty comfortable. So, this is what we use the Run Chart for, to say, can we take the average?

So, as I just said on the chart, and this shows it more visually, we had a process that was perfectly designed for 50%. She intervened, there was a transition, and it leveled off to where she is now, perfectly designed for 68%. So I now have a baseline, so that if she makes another intervention, we can see whether she bumped that needle to achieve her 75% goal. Now, what it's going to take in this case is, a common cause strategy, which will be my lesson four.

So, we use to determine, and here's the point about a good intervention, it changes too fast to observe the trend and that's a good thing. And that's why we have this backup test, which is what we're going to use the most. And which, as you see, is why I'd rather you plot more dots.

So to kind of summarize to interpret this situation with my friend's data, the intervention is trying to create a special cause to improve the performance. We only saw three increases, so we can't use the trend rule to determine it because the process changed too fast to observe six. But we did observe nine in a row below the median, pre-intervention because we were trying to increase the compliance. And that in and of itself is a signal that the intervention worked. We also have ten in a row above the median, post-intervention, which is another special cause signal to say, the intervention worked. All I needed was one of those, I happen to get both.

Now, you've all been at these meetings. This is real data and of course, Bacteraemia's, hospital acquired infections are big news these days. And I've been at meetings like this, maybe you have too, where boards are very nervous about this. So I can see one board member, if this is presented, kind of saying, "Hey, look, you trended down, and that was really good. And you went back up and I want to know why?" Probably something, the table and the process. So, he's very disturbed about that up-tick, that upward trend now. Okay, now from the trend rule, is that really a trend down? Well, just using the rule, it's not fixed, I can't call that a trend. That could happen randomly. And the fact that it went back up, well that could happen randomly. So it's really difficult to tell what's going on at this point.

Now, you also see the reason why I want more points. If all I had were those five data points, I can't tell a whole lot at all. Luckily, luckily, I have all nineteen quarters. Thank goodness. Oh yes, and let me tell you what they did every quarter. I was given this data. This is a place in England. As you see, the current quarter's result is five, so you know what they did every

quarter? They would have a meeting, and in this case, they would pull those five charts, go over every single one individually, and say, here's what we should have done differently.

Now, let's go back to my definitions of variation. Can't you see they're treating each infection – now, infection is undesirable variation, right? They are treating each infection as if it's unique, as if it's "special", and that's what you do in a root cause analysis. You are considering the event you are analyzing as special, unique. But at this point, we don't know that. So, I'm going to do something with this data that will allow us to determine that, and to say – they've done, I think about a 149 root causes if you add those all up. Is it working? Okay, so – oh yes, and you usually have a benevolent board member who will say, "Well, what's the overall trend?"

Okay, you tell me. How many meetings do you go to like this by the way? Okay, so let's plot those nineteen dots. So here is the data in its time order. Okay, I have nineteen data points. I sort them to get the median. So, nineteen data points means that the tenth in the sorted sequence is the median because there are nine smaller, nine bigger. So I'm going to plot these nineteen numbers, and put the median in.

So, if all these 149 root causes were successful, we're obviously trying to drive fewer bacteraemias, so we might see a trend of six successive decreases, going down. Do you see that anywhere in this data? I think the biggest one you see – well, here's two. Here's another two. Nothing is even close, so we can't use the trend rule to say, we made a difference. Okay, let's use the other rule. If we made a difference, then I might see a special cause, eight in a row above the median early in the data, and/or eight in a row below the median later in the data. We see neither. What has the net effect of those 149 root causes been? You've added more complexity and no value. I'm guessing there have been new rules, new forms, you've had awareness seminars, and it hasn't made any difference because you're treating every infection as special. Whereas this says, and I know this is going to bother some of you, you are perfectly designed to have this level of bacteraemias. Now, that's sounds flippant, it is not. The bad news is, you are perfectly designed to have bacteraemias, but that's also the good news, as you are going to find as this series of seminars goes on. You don't need a lot of data to solve it. So, no special causes and a lot of work.

This summarizes what I said before. Did we see six successive decreases anywhere? No. Did we see eight in a row above the median early in the data? No. Did we see eight in a row below the median later in the data? No. This is common cause, it's systemic. So, we've been treating common cause as special cause. In fact, the famous Quality Giant, W. Edwards Deming, had a specific term for that. He called it, 'Tampering.' The human tendency is to treat all variation as special. So in other words, every difference between these data points is treated as special. Whether we went up is considered special. Whether we went down is considered special. Every inspection is considered special. That is the human tendency. By plotting the dots, we're saying, no, this is common cause. We're perfectly designed. Don't worry, we can deal with it.

As a matter of fact, I'm going to put your brains to work in a different way. Rather than ask, why did we have thirteen this month and seven last month? Oh my gosh, we doubled the number of infections. Find out why. You're smart people, you're going to find out why. That's a waste of your energy.

So, they have now done 142 Root Cause Analyses, and we didn't observe any of these special cause tests. The alleged downward trend that the board member was upset about from the year 2002 to 2005, is not a trend. All this work has made no difference, probably added complexity. So now, the common cause strategy – I know some of you are wondering, "Well, what do we do instead?" What this means is, since the same process produced it, you can take all of these bacteraemias, put them all together, and then slice and dice them. So in other words, I don't want your brains to tell me, why do we have fourteen verses why we had seven? I want to say, give me some ways we can take these bacteraemias and pull them apart because quality improvement theory also says, we need to apply the Pareto Principle. What are the twenty percent of the reasons that account for eighty percent of these bacteraemias? So, kind of a change in mindset. Otherwise, we apply a lot of vague solutions to a vague problem, and we get vague results. And oh boy, are you going to hear me say that a lot.

In my next lesson, I will show you that we can also – you've got to say, "Well, Davis, there's got to be a point at which the difference between two consecutive months is too much." And, "Look, given that we're fluctuating, how many could we expect in a quarter, in terms of a maximum, or a minimum? I kind of want to know then, then what do we expect?" Okay, I'm glad you are all sitting down. If you do the math, and that's what my next video is about, you will find that the average I think is about 8.4, and you are designed to get between zero and twenty bacteraemias in any one quarter. And that one quarter can differ from the previous quarter by as many as seventeen. Now, you may not like those numbers, but those are the numbers. That's what you are perfectly designed to get. You don't have to panic because despite all that variation, it is not out of control. You can do something about it, and I just told you what to do. You put all those bacteraemias together, and find ways to tease them apart. I have a saying, I'm the statistician, I know nothing. You're the healthcare people, you know too much. That makes us a good team. I've kept you out of the data swamp of chasing your tail.

So there you go. Any one quarter, zero to twenty. If all you do is continue to do what you're going, tick, tick, tick, there's a twenty waiting for you. If all you do is continue to do what you're doing, tick, tick, tick, there's a zero waiting for you. You'll probably buy everybody pizza and say, "You did it that month, do it again." Well, guess what, you were lucky.

And the math to do this, as you will see in the next video, is so simple it will astound you. It is a matter of, can you subtract two numbers? Now here's the most advanced technique I'm going to teach you, it may involve some borrowing. So, can you subtract two numbers? Can you sort a list of numbers? Can you multiply and add? That's the only math, I require. And watch your conversations change.

This is a true story. Somebody once gave me this graph and put in a trend line to show their improvement. And yes, they had the scale from zero to a hundred. I took their data – now, here's their data presented as a Run Chart. Now, notice, do you see two bumps to the needle? And I plotted the data, and I went up to them and I looked at this data, I said, "What did you do there?" And they went, "How did you know? We had an intervention." I said, "Oh." And I looked here and I said, "And you had another one there?" And they said, "How did you know?" Well, I plotted the dots. So you see, things don't happen as a trend. Things happen as bumps as you change the process. As a matter of fact, if you look here at the end, they have some increases, one, two, three. If that continues, they might have a trend upward toward more improvement. We don't know yet, which is why we want more dots.

So I know a lot of you are very enthralled with bar graphs, everybody is. Here is three – four years of data – or not four years of data, a year of data on attrition at a hospital. And there were four hospitals, and as you notice for January, see, there's the attrition rate for each hospital. So for every month, they put the four hospital's attrition rate. And the overall attrition rate as a line graph. Now, isn't that helpful? Have you seen some graphs like this? Sure, you have. Okay, well this is data I was presenting to a group of Australian executives, and after they saw my, first part of my presentation, they cringed and said, "Okay, Davis, do your stuff."

Within two minutes, I went from this to this. I plotted the four hospitals attrition rates, and the combined hospital. Now, you'll notice, do you see the bump in the needle at the same place for every hospital? And I asked them – I noticed it happened in July, once again, I know nothing. I said, "Ladies and gents, what happens in July?" And I got a sheepish, "That's the start of our new fiscal year, and we changed the definition of attrition." Indeed, a process change and you can see it at all four hospitals.

Now, look at this, and look at that. What's going to have the more productive conversation? Okay.

Dr. Donald Berwick, and I'm sure you've all heard of him, might be the leading physician advocate of quality improvement in the world, now this is a speech he gave in 1995, which I happen to think is his all-time best. And he just talks about the power of plotting data over time. You are smart people, you can read that up there as I make my point. What I like, is just by doing this, the conversations you need to have. Now notice, he says first, you have to ask what data to plot. Where are the data? What do they mean? To whom? Who should see them? Why? Think about what you learn when you answer these questions. So, I hope I've convinced you to start plotting the dots.

Here's none more true story, then I'll wrap up. This was a poster at a conference I was at that talked about reducing NICU infections. And these people had done a 149 root cause analyses. And well, of course that had to make a difference. And it was just a matter of, oh we have to display the data. Well, let's do it this way. And you've all seen these graphs where the bars are the number of infections on the left scale. The number of patients is on the right scale and they

represent that with a line. And they figure, there, no one is going to question it. Look at all this hard work we did. Well, I happened to see this graph and I went over there, and I copied the numbers the best I could, and I created a rate. That's the thing with counts, there's a window of opportunity. When you have a count, you always have to create the rate to analyze it. So, by looking at the rate of infection, here's a Run Chart on the bottom. So, do you see six going down? Do you see a group of eight above the median early in the data? Do you see a group of eight below the median later in the data? What's been the net effect of all this work? Nothing detectable. So what they should now go back, is take these 149 root cause analyses and do a root cause analysis of these root cause analyses. Now they're going to get somewhere.

Now, I hope you're intrigued. At least, you'll start plotting your dots. And as you'll see, this will create a common language, as I hope you have all concluded by looking at this. We want to change conversations. You want new results, you need new conversations. So, you need to be able to assess the situation, determine whether you need a special cause or a common cause strategy. Right now, we all tend to default to a special cause strategy that every variation needs an explanation. And you also have a baseline for determining whether your interventions work. The Juran Institute did some research several years ago, and one of its conclusions was, many improvement projects failed because there was no good baseline estimate for the extent of the problem. So, in other words, we apply vague solutions to vague problems and get vague results. I hope I've shown you of a way to focus.

So, I hope you'll – you can tell I like what I do a little bit. I welcome correspondence from you. There is my email address. I have a website, which has links to articles I've written. I've written a book, 'Data Sanity,' and I thank you.