

# Lesson 3: Steps to create Smart Charts

## Transcript

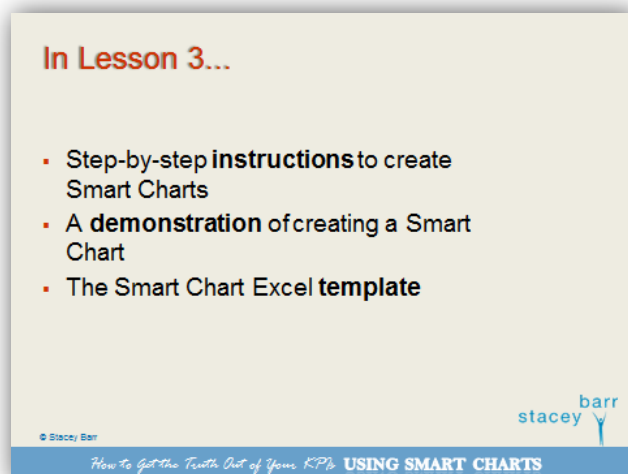
Well here we are at Lesson 3 in the Using Smart Charts course and Lesson 3 is where we get into the nitty gritty of the course.

This is where we look at the exact steps to create Smart Charts for your KPIs.



Now, I am going to do this with a demo. We are going to not necessarily look at the instructions in theory; we are going to look at the instructions as I demonstrate them for you, so a little bit more of a practical approach.

As I do demonstrate these instructions for creating Smart Charts in a sense what I am doing is building the template that you have already. If you haven't got it already you will be able to download it after you listen to this Lesson. That way you will be able to understand how that template works and why it's set up the way that it is.



I really believe that familiarity with the slightly more technical bits is such a valuable thing when you are doing an analysis technique like Smart Charts that really has to be done the right way. There are multiple ways of doing it; it's a scientific approach not an

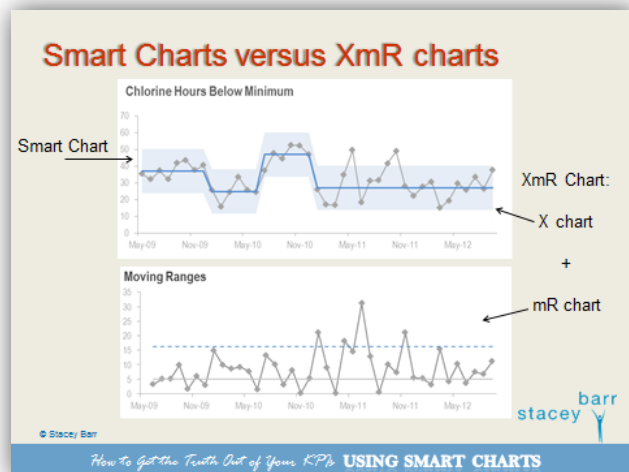
artistic approach. When you understand how that template works you are much more likely to use it with greater reliability and accuracy into the future.

## Smart Charts versus XmR charts

Now, when I take you through these instructions you are going to notice in the template there is another chart there.

It's not just one chart like the chart type we have been looking at over the first 2 Lessons.

The chart you are used to looking at is the one at the top. It has the measure's name at the top and then you've got a grey line going up and down and that's the values and then you have the bold blue Central Line and the pale blue range of routine variation which is bounded by what we call the Natural Process Limits. So you are familiar with that and we looked at the anatomy of that back in Lesson 1.



The second chart is a slightly different chart and its most definitely related to the top one and in classic XmR chart theory, which is the theory that Smart Charts are based on really; there are two parts to the XmR chart.

The top one, which we are calling the Smart Chart, in XmR theory is called the 'X' chart. Now X is a standard variable that has been used in statistics for a long, long time to simply mean a variable or a measure of some kind. So for us our X is our performance measure.

The mR part of the XmR chart stands for 'Moving Range'. Now I'll show you how we are going to calculate the values in that chart but that second chart complements the top chart. The Moving Range chart helps us do a slightly stronger interpretation of what is going on in that top chart.

Now I'm not going to dig into that right now. That will be something we talk about as we go through the steps of creating both the charts.

## More about the mR chart

So, a little bit of anatomy about this Moving Range chart.

Those grey values are not values of your performance measure. They are values of the **successive differences between your performance measure values.**

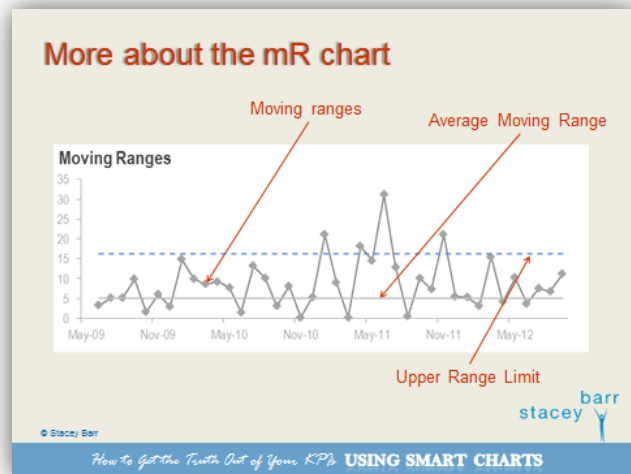
So if your first measure value is 10 and your second measure value in your graph is 14 then the difference between 10 and 14 is 4 and that is the value that is plotted first on the mR chart.

So your first value in your time series for your measure is 10 and the second value is 14, if the third value is 16 then the second value plotted in your Moving Range chart would be 2 – the difference between 14 and 16. That's how it goes.

There is a Central Line as well for the Moving Range chart which you are familiar with and we call that the **Average Moving Range.**

We also have something like a limit, like the Natural Process Limits in the Smart Chart, and it's called the **Upper Range Limit.**

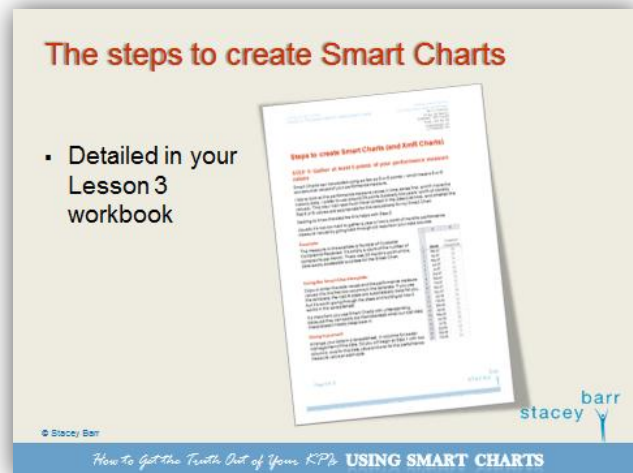
So these sorts of things are kind of parallel to what you have become familiar with in the Smart Chart but, like I said before, they complement the Smart Chart and they give a different edge to the interpretation.



## The steps to create Smart Charts

Now, the instructions that I am about to demonstrate for you to create a Smart Chart are detailed in the Lesson 3 workbook.

There will be page after page explaining each step in the procedure for creating a Smart Chart and those instructions also provide an example and they tell you how that step happens in the template. But they also explain how you could do it for yourself if you were going to start from a blank spreadsheet – that is, not using the template I have provided you.



There're also tips in there for how you could do that. And that's really what I am going to be modelling for you now through the demonstration: is starting with a blank spreadsheet so you can see how it builds up from there and it will eventually look like the template that you are going to use.

So before I do get into demonstrating these steps I would love to hear from some of you to find out what sort of KPIs you are going to be creating Smart Charts for.

### What kinds of KPIs are you creating Smart Charts for?

So if you would like to tell me by speaking with me you could raise your hand and I will un-mute you, but feel more than welcome too if you just want to type it into the Q&A box. The question I am asking is what is the KPI that you are planning on creating Smart Charts for?

While I give you a chance to do that I'm going to go and open up the spreadsheet getting ready to do our demonstration.

Okay, so Anita says she's going to be doing a weekly traffic score looking at the Number of Customers, so that will be great. That's a great measure to put in a Smart Chart.

Atchara is interested in an On-Time Delivery measure.

Elke is too – On-time and In-full Delivery Performance. Melinda is looking for visitation to our website. Atchara is looking at on-cost, so something that is a cost related measure.

Gordon says:

*“We will be using this for workforce FTE for executive reporting.”*

Elke is saying that her measure is a monthly measure. So Elke, yours was On-time and In-full Delivery Performance by month.

John says:

*“We have a KPI on-time to pay claims to customers. Currently this is 14 days and we measure this on a monthly basis.”*

Great, so that’s an interesting spread of performance measures or KPIs that you are going to use Smart Charts for. It’s all brilliant.

Now the more I’ve learned about Smart Charts the more I have realised that they really do apply to a very wide range of types of performance measures.

There are a few challenges that come along and that’s what we are going to talk about when we come back for Lesson 4. What we will do now is go through the very basic steps of creating Smart Charts for well-behaved performance measures. Then when we get together for Lesson 4 we’ll look at how we can make adjustments or deal with situations where our performance measures or KPIs are far less well behaved.

For example, they might have a seasonal effect in them or they might be a continual growing trend or even for some of those KPIs that are rare events – they’re not very frequent and it doesn’t make sense to measure them or you just have a whole lot of zeroes in your chart and then a one here. So there are performance measures that don’t behave particularly nicely but we can do things with them to still make them appropriate for Smart Charts.

*The remainder of the transcript is best read while watching the live demonstrations during the Lesson 3 video.*

## Live demonstration

So what I have in front of us now is a simple empty spreadsheet and I have two columns of data in this spreadsheet.

### STEP 1: Gather at least 5 points of your performance measure values

Firstly I have the column of month – this happens to be a monthly performance measure – and the second column is my performance measure data.

Live demonstration...

	A	B	C	D	E	F	G	H
1	Month	Customer Complaints						
2	Mar-97	38						
3	Apr-97	28						
4	May-97	34						
5	Jun-97	41						
6	Jul-97	30						
7	Aug-97	28						
8	Sep-97	35						
9	Oct-97	43						
10	Nov-97	37						
11	Dec-97	36						

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How to Get the Truth Out of Your KPIs USING SMART CHARTS

Now this performance measure is a simple count of customer complaints. Nice and easy. So in March 1997 we got 38 customer complaints, in April of 1997 we got 28 customer complaints etc. So that is really the starting point for creating your Smart Chart.

**I like to lay my data out vertically like this in columns.** I do know that some people do it in rows. I don't know whether it's quirky thing about me or whether there really is some kind of underlying efficiency about it but I find that when I work with columns I can see more of the data more easily and I can manipulate it a lot more easily. I'm not going to request that be your only option though. If you want to work with rows you are more than welcome to but it would mean that you would need to modify the template and shift it into something that is lined up horizontally rather than vertically like I have this here.

Now, that's essentially step 1 of creating a Smart Chart. **Gather at least five points of your performance measure values.**

Now **what happens if you have just started measuring something and you've only got three or four points, or one value?** Well truth is you are not ready for a Smart Chart. You've got to wait until you have that minimum of five points and I really like to have more than that. So if I have decided to create a Smart Chart for something we've already been measuring in the business for a while what I'll often do is I'll go back and collate probably a year or two of past history of that performance measure or KPI and that will be my starting data for my Smart Chart.



## STEP 2: Calculate the performance measure Central Line

**Step 2 is where we calculate that Central Line on the Smart Chart.** You remember that bold blue line that's horizontal that goes through the centre of your up and down fluctuations of your performance measure values? That is the Central Line and we calculate that using the average statistic.

So let's create a column called the Central Line. To calculate the average, I'm not sure how familiar each of you are with using spreadsheets but I just type the formula straight into the cell. Now what do I want to average? Generally what you want to **average is the first five or six points that you have in your performance measure time series.** I'm going to use six here. If you only have five points in your time series so far then five is just fine. I'll hit the enter key and that will calculate the Central Line for the Smart Chart.

*Now, when you add more data to your Smart Chart you absolutely do not update that Central Line value!*

If that Central Line value looks like it absolutely fits the data then you just leave the calculation like that. I stick with just the first five points and then what I do is I copy down the value of the Central Line because what I want to create in this third column here is data that will go onto a graph that will draw that line for me. So just keeping the average value there in just that first row is not going to achieve that. It will only put one single point on my graph rather than a line right across the whole length of my time series for the performance measure.

So the way I copy this down is I hit the '=' sign and I reference the cell above which means I am saying 'Look at the cell above and duplicate that value here.' So once I hit enter you will see the value 33.16667 appear in that cell as well. What that has done is it's going to make each subsequent row look up and take a copy of the Central Line value and then it's really easy just to copy that down to the length of my time series and I do that simply by grabbing the square in the bottom right hand corner of that cell I just created and dragging down. When I let go you can see that it's copied that value of the Central Line all the way down the time series of my performance measure. So I'll scroll back up the top and I'm going to hit save, which would be a wise thing to do.

Now, do you need that many decimal points? Probably not and if you are pedantic like I tend to be I would probably format that column and get rid of so many decimal places. I'm probably happy enough with one decimal place. That just tidies it up a little bit. I think visual clutter causes cluttered thinking, so that's why I'm a bit pedantic about it. So there you go – that's the Central Line created.

**Something else I like to do in my spreadsheets is colour code things for easy reference so I know what I'm doing.** You'll notice that I have colour coded my performance measure value in column B as a grey colour and that's because that's the same colour it's going to be when it ends up on the Smart Chart graph.

You will recall that from the Smart Charts you have already seen through the course. You'll also recall that when I did the Central Line in my Smart Charts I give it a bold blue colour and that's the colour that I'm going to give my Central Line, just so that it matches. I hope that makes sense. The colour of the data in my data sheet will match the colour of the way that line is presented in the chart. Again, that's me being a little bit pedantic but I always believe that if you can make something obvious, do it.

That is step 2 in creating a Smart Chart. We've got our measure values and now we have our Central Line.

### STEP 3: Calculate the performance measure's moving ranges

**To create the Natural Process Limits we've got to do a few calculations first** and this is where that second graph I showed you before, the Moving Range graph, it becomes important because it's those Moving Ranges, those subsequent differences, between each of our performance measure values that go into the calculation for the Natural Process Limits.

So what we are going to do here in our column D, our fourth column, is to calculate the Moving Ranges for our performance measures value. So I'll call this the Moving Ranges column and we actually have to start not in row 2 where our first measure value is, we have to start in row 3 where our second measure value is because it's only in row 3 that we now have two measure values that we can take the difference between.

So it looks like this: Again, the '=' sign. I'm going to use a function here called 'ABS' which is the absolute value which means 'Let me look at the value and if there's a negative sign then strip the negative sign away because I'm only interested in the size of the difference between successive measure values, not the direction of the difference.' So we'll use the absolute value function and now I'm going to take the value for April 1997 which is 28 and take away from that the value from the previous period, March 1997, which is 38. Now really, if we did that calculation in reality we would get a negative sign, a value of -10, but because I'm using the absolute value function it's going to strip the negative away and just give us the absolute value of 10.

We want to calculate the Moving Ranges all the way through the time series for our performance measure so again I'm going to use the copy down feature of Excel and drag the bottom right hand corner of that cell all the way down the length of my time series for my performance measure value. Actually I'm going to stop it where the data stops. So my data stops in row 21 so that's where I'm going to stop those Moving Range calculations. I will explain a little later why I have let the Central Line go a bit further.

Now you can see that I have values for the Moving Ranges for our customer complaints measure. So again, 10 is the difference between 28 and 38, 6 is the difference between 34 and 28, 7 is the difference between 41 and 34 and so on. The



Moving Ranges are going to be used to help us compute the Natural Process Limits. So that is essentially all you are doing in step 3. Calculating your performance measure values Moving Ranges. That means we are now up to step 4.

## STEP 4: Calculate the Average Moving Range

In step 4 we are going to do something very similar to what we did in step 2. In step 2 we calculated a Central Line for our customer complaints for our performance measure. What we are going to do here now is **calculate an Average Moving Range** in much a similar way. We'll call this the Average Moving Range column and it's the same kind of formula using the average function, again, using five or six points.

Because I used six points to calculate the Central Line for my measure in column C and because I don't have any values of my Moving Range in the first row I'm actually only going to give five values for my Moving Range average. In fact I might give that a fill colour so you know that there is a formula in there. That formula referenced the first six values of my customer complaints value but because we don't have the first in those six for the Moving Ranges, simply because logically it doesn't work that way with the way that you calculate a Moving Range, in my Average Moving Range calculation what I've done is just used five values. I'm going to give that a fill to let you know there is a formula in there.

The Average Moving Range is something that also behaves like the Central Line. In other words, we want to copy those values down. So again, I'm going to reference it by putting an '=' sign and clicking the cell above and then copying that function all the way down. Now we've got the Average Moving Range all the way down through the length of our time series.

## Questions?

Okay, so we are close to halfway through these instructions. It might be a good time to pause and check how your understanding is going. We've done step 1 and collated our data, in step 2 we've computed a Central Line for our performance measure which is going to be the blue line on our Smart Chart, in step 3 we've computed some Moving Ranges because they are going to help us calculate the Natural Process Limits and in step 4 we've computed an Average Moving Range which is part of the calculation for Natural Process Limits.

Does anybody have a question at this point in time? Is there anything you would like me to cover over again? If everything is clear just a quick message saying 'All clear' would be great but if you do have a question please feel very welcome to ask it now and you can do that by either raising your hand and I'll un-mute you or you can type the question into the box.

Mala, you have raised your hand so I'll un-mute you.

**Mala:** I just missed the beginning. I just joined the webinar. Will you be able to cover it again from the beginning?

**Stacey:** Absolutely Mala, if you've missed any of this Lesson or any of the other Lessons you'll have the replays that you can go and watch online.

**Mala:** I missed the beginning. I just joined the webinar.

**Stacey:** Yes, so on the website you will be able to watch all of the Lesson replays over and over again as many times as you want to. So if you've missed anything, you won't miss it because it's right there for you.

**Mala:** Okay. So if you could cover again otherwise I will go to the website and do it.

Okay, thanks Mala.

For everybody else, Melinda you are saying its all clear and so is Anita, Gordon, Atchara and John. Excellent, that's wonderful. I will keep moving then.

## STEP 5: Calculate the Upper Range Limit

Step 5 is where we are up to. With step 5 it's one more final thing that we need to do before we can compute our Natural Process Limits. Step 5 is **calculating a thing called the Upper Range Limit**.

Now our Upper Range Limit is based on the Average Moving Range that we just calculated. You might be wondering where does this fit in and what's it got to do with the Smart Chart?

On the Moving Range chart that I showed you before you notice that its anatomy was something similar to a Smart Chart. There were the Moving Range values themselves behaving a little like the customer complaints or performance measure values in the Smart Chart, so they're bubbling along up and down in a grey line. You also noticed that it had a version of a Central Line as well – a horizontal flat line, and also a limit. It only had an upper limit though.

Well columns E & F here in this spreadsheet – the Average Moving Range and the Upper Range Limit – are those extra lines that you see on the Moving Range chart.

Now to calculate the Upper Range Limit we have a very interesting formula to put in here. I'm going to put it in first and then I'll explain it for you.

We're doing a formula so we'll use '=' and then what we are going to do is take our Average Moving Range value and we're going to multiply it by a constant 3.27. Now I did not pluck that number 3.27 out of thin air, that is a statistically derived constant designed for XmR charts or Smart Charts. What it does is aside from producing a value of 23.5 for our particular customer complaints example here, what it does is it

makes the Upper Range Limit in a sense sort of equate to three standard deviations above the Central Line, or the Average Moving Range.

Now when you did high school mathematics or maybe you did something at University or business school or maybe just though your career you have come to learn about these concepts of average and standard deviation. The standard deviation is a measure of how much variability there is in a set of data and the idea is that three standard deviations either side of the average line generally means that most of your data can be expected to fall within that range.

So if any data falls outside of three standard deviations you have a signal. So you could probably relate that back to what we were talking about in Lesson 2 when we were looking at the signals of performance measures in Smart Charts. You remember the special cause signal or the outlier? It was the one where you get a point that falls outside one of the Natural Process Limits. Well that's equivalent to a point falling pretty much outside three standard deviations. In other words, it's very rare that it should do that so it's probably something you should check out. It's not behaving normally. If it was behaving normally it would just be randomly distributed within those three standard deviations.

I guess the bottom line here is **for that constant 3.27 you don't change that**, you just trust that is a constant that you will always use when you are creating a Smart Chart. Now again, we have created a formula here so I'm going to just flag that as a formula by giving it a grey fill. And back to my pedantic behaviour I am going to limit that column to have one decimal place to keep it nice and simple.

Guess what we are going to do next? Yes, we're going to copy this value down just like we did for the others. So down we go to the bottom of our data series. What we have there at the end of step 5 is all the values that we need to calculate our upper and lower Natural Process Limits for our customer complaints measure. That brings us to step 6.

## STEP 6: Calculate your performance measure's Natural Process Limits

In step 6 we are computing two things – we are going to put values in columns G & H. So, we will have our lower Natural Process Limit and we will have our upper Natural Process Limit and they are computed from the values that we just created.

What we are going to do is multiply the Average Moving Range by another constant value, a different one this time but again a constant that is statistically derived specifically for Smart Charts or XmR charts.

Here's how it looks. We've actually got to create a value and then add it and subtract it to the Central Line. Because those Natural Process Limits are equally distant, or the same distance on either side of the Central Line, the Central Line is our centre point

that we are going to use to work out where those Natural Process Limits need to go on the graph. So our first calculation for the lower limit is to take our Central Line value – that 33.2 in column C – and take away from it a value which is the Average Moving Range, our value of 7.2 there, multiplied by this **new constant 2.66**. It's similar to our constant of 3.27 but the 2.66 belongs to the top Smart Chart and the 3.27 only belongs to the Moving Range chart, that bottom chart that you were just introduced to this morning. So I'll hit enter and that will then produce for us our lower limit for the Smart Chart.

The other limit is calculated in a very similar way except this time with our mean line we are going to add that same value. So we are going to add the Average Moving Range times 2.66 and that gives us an upper limit of 52.3. And again, we will get rid of these extra decimal places.

What I generally do is shade these two columns to match what they look like on the Smart Chart. Do you remember that the way I represent Natural Process Limits on a Smart Chart is a shaded pale blue area? Well that's why I'm colouring these two columns the same way because they are a shaded blue area.

So what I might do is make those two there bold because they are calculations. And we are going to do the same thing and copy them down. We're going to do the two together this time, so I've got both of those values copied and I can drag both values down the length of my performance measure time series at the same time, and you can see how it's just accurate copied those Natural Process Limits in there. That's a good time to save.

All the calculating is done.

So while on the face of it, because you probably haven't seen the mechanics of this before, there was a bit to follow along there but you've got the instructions in your workbook so you can read through it all again and you can follow through the example.

The calculations are finished, they are in a template ready for you to use so you don't really have to do all of this yourself. What you can do is simply take the spreadsheet and then add your data in and make a few adjustments. I will also show you how that works as well but first we'll finish creating this particular example from scratch for our Customer Complaints measure.

## STEP 7: Assemble your "Smart Chart"

We haven't done the charts yet. To do the charts I'm going to highlight the data that I want in the charts. I want month, I want my customer complaints value, I want my Central Line and I also want my upper and lower Natural Process Limits. So I want all of that data to go into a line chart. So we will insert a line chart.

It's a really horrible and ugly way that Excel by default puts these charts together for us so we've got a fair bit of formatting to do just to tidy it up and make it look a bit more decent. I'm going to decrease the size a little bit and then we'll work with it over here.

### Tidy it up

The first thing that I do with a Smart Chart, or any kind of chart, is delete the legend – I don't need it. Another thing that I do is delete the grid lines because you really don't need that many grid lines on your chart. It's too messy.

Now I'm going to format the axis just so they are not quite so big and dominant. I like to give them a grey colour and I like to make their text a bit smaller. Something else I like to do with the axis is something I learnt from Stephen Few.

If you are familiar with Stephen Few you will know he's the author of some fantastic books on visual analysis. He has a book called *Show Me The Numbers* and then the next book that came out of his was *Information Dashboard Design* and then the last book that has come out is called *Now You See It*. They are brilliant books and there is so much that I have learnt from him about visually displaying data and this is one of the things.

On the axis you don't really ever need to look at every single point in your time series so you don't really need to look at every single time period or month. So with the axis options what I like is to change the number of months to be every six months. It's just stripped out all of the months not needed and now it's put the alignment horizontal so it's easier to read. It looks far less cluttered.

We'll do a similar thing with the vertical axis. We are going to make the font a lighter grey and a smaller size so it's not as dominant, because we really don't need that data to jump out at us.

### Format the measure values

The next thing I want to do is format my data series and I know it's this blue line because it's the one that's going up and down all over the place. I like to have markers on my data series. That's probably a personal preference more than anything so it's entirely up to you if that's something you want to do or not do. I've certainly seen people do these charts without putting markers on their data series. One thing I do with that data series is give it not such a prominent colour. I make all the colours of that line a pale grey. The line does not need to be that thick – 1pt is just fine.

### Format the Central Line

Let's look at the Central Line and we'll format that next. No markers for the Central Line, it's just a horizontal flat line. The line colour – recall that I like to give it this blue

colour and I like it to match the colour that I've given the data in the spreadsheet itself? So I've chosen that colour for the line. It definitely doesn't need to be that thick either but I like it to be around 1.75pt just so that it stands out a little bit more.

I'm going to talk a bit more in Lesson 5 about formatting suggestions for Smart Charts and why I have chosen certain conventions and really the theory behind why I have chosen those conventions so that if you don't like particularly the way that I have done it you can still follow those same conventions but put your own personality or flair or style into the way that they look.

### Format the Natural Process Limits

Now here's where it gets a bit trickier when you are starting from scratch. Like I said, in the template this is already set up for you but when you are starting from scratch you have to set up the graph from scratch as well.

To get the upper and lower Natural Process Limits to be a shaded area rather than lines there's a little trick that you need to do. We need to change what sort of chart type they are. So if I select the first one and right click on it I've got an option that comes up that says 'Change series chart type' and I'm going to choose that.

At the moment you can see it's a line chart, that's what we started off with and I'm now going to change it to an area chart and I'm going to choose this first option for the area chart options. It's going to look terrible for now but bear with me. I'm going to do the same to the bottom limit as well, change its series type to an area.

What I need to do is change the order that this data is set up in the chart because what I want to have happen is the area chart for the lower Natural Process Limit to be on top. At the moment the area graph for the upper Natural Process Limit is on top and the trick I'm going to fiddle with here doesn't work when they are in that order so I need to change the order around.

What I do is right click on the chart anywhere and I choose the select data option. You can see in the list here how we've got our customer complaints data series there, our Central Line data series and then we have the two data series for our Natural Process Limits. What I'm going to do is just click on one of those and swap the order. So I'll click on the lower Natural Process Limit and I'm going to use this move down arrow here to shift it downwards.

Straight away you can see the chart behind changing. Now the lower Natural Process Limit is on top. It's come out and it's obscured part of the upper Natural Process Limit area graph.

I'll show you why that was important to do. What I'm going to do is format the upper limit and I'm going to do that by giving it a fill colour that matches that pale blue that I like that range to be. You can see that it's starting to look a bit more like the conventional Smart Chart that I have been showing you. We just need to do a trick



with our lower Natural Process Limit. I'll format that line, give it a fill colour of white – the same as the background of the chart.

There you have it. It didn't take too long to do. Of course you probably don't ever have to do it because I've already done it in the template for you but if you were ever in a situation where you wanted to create one from scratch they are the steps to go through to format it and make it look a lot more like a Smart Chart.

Every chart probably should have a title so we will put a chart title on here. We'll call it the name of our performance measure. It doesn't need to be that big. Whether you centre it above is entirely up to you.

### Extending the Central Line and Natural Process Limits as your future baseline

I've forgotten to do something in this chart which I will do now. You can see I've allowed the Central Line to extend past the length of the time series of my performance measure values. I should have done that also with the upper and lower Natural Process Limits so I'm going to do that now simply by going back to my data and copying these values down as far as I copied the mean line down. In the chart you can see that's now extended it out.

While targets are going to be more of a topic that we cover in Lesson 5, the reason why I do this is so that I can have a target on my chart and I can compare the target more easily to the Central Line, if that's what I have set the target for. It also puts into the future my baseline, because that's what your first calculations of your Central Line and Natural Process Limits are – they are your baseline. It lays a pattern down, in a sense, so that as you add more values of your performance measure to the chart... Let's do one now:

Let's go back to the data and say we've now reached March 1999 and we got 17 customer complaints. I'll type that in now and we'll go back to the chart and you'll see that it's added that in. I've added that new point there and it's certainly less than the previous month in terms of the number of complaints but we wouldn't draw a conclusion based on just that to say it's better than last month. We need to look at the patterns, not the points, and adding that extra point there has created an eighth point in a row on one side of the mean line so we would need to do a recalculation for that.

### Adding a recalculation

I'll show you how to put in a recalculation. It's a long run, and you'll recognise this from a signal you learnt in Lesson 2. A long run is a series of points on one side of the Central Line. So it starts there at April 1998 and that's where we need to start our recalculation. The way we do that is copy the cell that has the formula for our Central Line and we're going to paste that into April 1998 which is where that long run started. See what happens? All the values for our Central Line after that point where I copied

that new formula have all been updated. So that's a nice convenient way to lay that out so that you don't need to constantly do copying and pasting.

I'm going to do the same now with the calculations we needed for the Natural Process Limits. I need those four cells – the Average Moving Range, the Upper Range Limit and the two calculations for the Natural Process Limits. I'll copy those and I'm going to paste them down on the same row for April 1998. The same thing has happened, now we've got a new calculation for our upper and lower limits. That's how it looks on the chart. You can see it's automatically updated in the graph. It's a nice and easy way to have that template to use for all sorts of KPIs. Now that is set up there I don't have to create one from scratch for each KPI, in fact I could just copy this sheet and make multiple copies of the sheet within the whole spreadsheet file and each sheet could focus on a particular KPI.

We have been talking about this Moving Range chart. I won't take you through how to calculate that specifically but we'll have a look at it when we go to the full template, because it's already set up in there.

That is the 8 steps for creating a Smart Chart from scratch. It's probably a good point now to see if you have any questions or just to confirm whether everything is still all clear and you are going okay. Then after we handle any questions that you might have now we will go and take a look at the actual template itself and I'll show you how you can just paste in a different set of data and make a few modifications to get it humming for your performance measure.

Anita says,

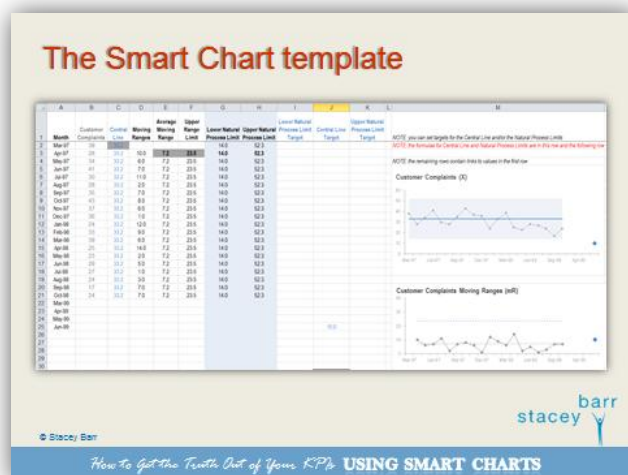
“Okay so far.”

I will open up the template to give you guys a bit of time to ask any other questions or just to confirm whether you are still going okay as well.

## The Smart Chart template

Here is the template that we are going to use. This is what you will be able to download from the website if you haven't already.

The measure that we are going to look at is one that's come from Cheryl. It's a measure that relates to that fluoride example that we looked at in Lesson 1 and it is a Chlorine Hours Below Minimum. I think we looked at the Fluoride Hours Above



Maximum and this is hours below minimum. We'll see if we can take that very different data and use it with the spreadsheet.

## Questions?

Elke has a question,

*"Will you be walking us through the long/short run identifiers again?"*

Actually, we can absolutely do that. Of course you have it all written down in your workbook as well as the examples in the replays for each of the Lessons.

John says,

*"In the template I noticed that you have used an IF statement when calculating the value for the lower Natural Process Limit."*

That was very astute of you to notice that John! The reason that I have done that is that with some performance measures they have a logical minimum value of zero. Customer complaints is a good example of that. You can't have negative complaints. You can't say 'We got minus three complaints this month.' It doesn't make any logical sense.

But sometimes when you compute your lower Natural Process Limit just the mathematics turns out that it can end up having a negative value and that doesn't make any sense so what I've got in the spreadsheet formula is a little caveat that if that process limit goes negative it gets reset to zero. That's for a lot of performance measures where a negative value doesn't make any sense, but there may very well be some performance measures where a negative value is fine. I guess profit can technically go negative in any given month when your expenses exceed your revenue. So in that case you would get rid of that IF statement and make sure that you did allow the lower Natural Process Limit for profit to have a negative value if it so turned out to be the case. So that was a really good question John.

## ...back to using the Smart Chart template

Here is our data for Chlorine Hours Below Minimum. I am going to now open up the template itself. The template has the Customer Complaints data in it so you are going to have to over-write it with whatever data you have.

### Adding in your measure data

Let's grab our Chlorine Hours Below Minimum data. We need both of these columns and we're going to copy them and I'm going to go across to our template and paste

those performance measure values into the first two columns. You can see now that data is in there, it's over-written the Customer Complaints data.

### Adjust the calculations and charts to match the length of your measure values range

We have to make some the first obvious difference is there is a lot more of it so our calculations up here don't go down long enough to cover the range of data. So I am going to copy down our calculations to match the length of that data.

Often when that happens, when you have more data in your performance measure than is in the template or a previous measure that you might be copying over, you also need to make sure that your charts are reflecting that range of data as well.

We have now taken our range of data down to row 42 so I want to make sure that the chart does that. So I right click anywhere in the chart and then I choose 'Select data'. That brings up the little screen we saw before when we were swapping around the order of the Natural Process Limits. We don't need to do that now but what we do need to do is for each of our data series we need to make sure that the data range goes down at least as far as row 42.

I'm going to edit each one and make it go to 42. It's a bit laborious but it's just something that you do need to be quite specific to remember to do otherwise you will be looking at a chart saying 'What's going on? That doesn't look current. That doesn't look like it's matching what I expected to see over the last few months.' You can see now that our data is all in the chart.

### Change the chart title

We also need to change the title of our chart as well. It's not Customer Complaints any more, it's Chlorine Hours Below Minimum.

### Adding targets

Can you see this blue point that is on the chart? It has come from column J in the spreadsheet which I did not set up when we just did that demonstration from scratch with the blank spreadsheet.

There are three columns in fact - I, J & K – that are in the template and they are for you to include targets in your Smart Charts. Like I said before, I will elaborate on targets more in Lesson 5 but just so that you are not totally confused about what is going on here, one of the things in a Smart Chart that you might want to set a target for is your Central Line.

You are no longer setting targets for the individual monthly values of your performance value and going each month: 'Are we above target? Are we below target?' Because

you know now that's just erratic behaviour and not the way to really interpret what's going on with a performance measure.

The Central Line is, in a sense, a measure of the current level of performance that you have and so it seems natural to set a target for that Central Line. If the current level of performance is at 40 but you want it to be at 20 then it's not just going to be that way, you've obviously got to make some kind of process improvement to get there but at least on a chart you can tell that story that the Central Line says 'This is where our level of performance is' but that blue dot is telling us where we want it to be.

The thing I like about targets this way is that I can put that target at the time that I want to achieve it by. If I had wanted to achieve 10 by the 11<sup>th</sup> April there is not a lot of signal there suggesting that I have achieved it. That Central Line is still quite high so that might have been way too an aggressive a target to set, there. I will move it so you can see how it can move around in the chart. I'll delete that one and let's say we've set a target that's a little more realistic for this set of data of 20.

We need to increase the range of data on this chart for that target line. Select the data, find the Central Line target data series, edit it and you will see straight away it's still only referencing up to row 25 but we'll make it go to row 42 like all the others. Now you can see that the target has appeared on the chart.

We've got a bit of interpreting to do on this chart and a bit of readjusting of the limits, so let's pause for a moment first and I want to see if any of you have any questions about what I have done there, about how I've extended the range of the data and extended the range of the chart to encompass all of the data, or about targets. If you have got a question you can either raise your hand or type it in, but if you have no questions just type a quick 'OK' or something like that to let me know where you are standing right now. John is okay. Melinda is okay. So is Anita and Thomas. Thanks Elke and Gordon. Thanks Janet, you are okay too. We'll keep trucking on then.

Let's take a look at this chart and maybe I'll zoom in and increase it in size a little so hopefully it makes it a bit easier for you to see. Let's see what sort of signals we are getting.

### Interpreting historical performance your Smart Chart

We are looking at this retrospectively. We are not starting out with five or six points and setting up our baseline of a Central Line and Natural Process Limits and then just waiting to see what happens as more points get added to the chart. We are not doing it that way.

We have got a set of data where we have probably about four years' worth of data that we have had historically that we have decided to look at thorough the lens of a Smart Chart. So really we are doing retrospective signal searching and the way to do that is to start at the beginning and see how we can tell the story that is unfolding as we move from left to right in the chart.

If you can see the first signal that happens in this chart from left to right feel very welcome to type in what you think it is and I'll remind you of what the signals are just to help you a little bit.

One of the signals is an outlier where a single point has fallen outside the Natural Process Limits.

A second signal is the long run – that's where you have seven or eight or more points in a row on the same side of the Central Line.

The third signal is where you have three out of four points that are closer to one of the Natural Process Limits than they are to the Central Line.

Another signal is not so much a signal but more an observation of chaotic behaviour.

There are at least two of those signals that have popped up first and I'll tell you what they are and get your assessment about which one you think is the most appropriate. I think the two possible signals that have come up first in this time series is either the outlier or the short run. Which do you think of those two best describes the first signal in this chart?

Anita agrees with me, everyone else has a different thought. Anita I am going to go with your response here, you are saying that the short run seems stronger than one point outlier and I would agree with that. I think these three points here are a stronger signal that there actually has been a shift as opposed to just a single point going haywire because that's really what an outlier is: it's just one weird off-the-cuff strange event that caused it.

But from this it looks like there actually has been a short run here. So we are going to go with that and treat the Smart Chart as though that was the signal that we got.

### Recalculating the baseline

With the short run you will remember that we use five points from the start of that short run to do the recalculations and I'm going to do that now. Copy the Central Line formula, and put it at the start of where that short run began which is January 10 and it's recalculated a new Central Line for me. I'm going to do the same with the Natural Process Limits. So taking another look at our chart you can see where the recalculations happened.

Now what we do is we've got that new baseline and we use that new baseline to look for the next signal. So what do you think the next signal is here?

It's quite a dramatic one and it kind of doesn't fit precisely what I have described as that short run rule, where you have three out of four points in a row closer to a Natural Process Limit than to the mean line. We have some very huge dramatic shifts here. In this case I think those of you who had said outlier before would probably be kind of closer to the money here but we don't have a single outlier, we've got a dramatically



big shift there. Five points absolutely above the upper Natural Process Limit as Anita suggests. So something that we could do is recalculate for those five points. That started at July 2010. There we have our new baseline.

You know what? The more we look at this data and we see the wild swings every time we do a recalculation the more that gets me thinking that probably what we have is not so much a set of data that has clear distinct signals in it but more a set of data that has a lot of chaos in it; a lot of wild variability.

### When chaos seems to be the best explanation

That's something to really pay attention to. Not every performance measure is going to behave in a really clean, consistent way. You are going to have cases where you do have a lot of wild swings all over the place.

In this case what I would tend to do is not stick with the rules of looking for a short run and recalculating etc. In hindsight probably what I would do is back where we did our first recalculation I would probably base that first recalculation on more points and try and get a sense of how wide the variability is through this whole area here. I'll show you what that would look like if we were to do it.

I'm going to undo this last recalculation that we did just by pasting over the top of it. Now, instead of using five points here, I'm going to use more. I'm going to take in about 10 points and see how that looks.

Now look at it. Those Natural Process Limits are probably now in hindsight a better descriptor of what's really been happening over this whole period here in the middle for the Chlorine Hours Below Minimum. It is a really variable process, it would seem.

Who knows what would cause that? Why would there be such large swings in the number of hours that chlorine levels go below the minimum required? It's something you would want to explain and be able to have a reason for.

Now that we have done that we have got a baseline that we can still look for signals from, so we can see a signal and I'm sure you can see the same signal that I am seeing here at the end of this KPI. Does anyone remember what that signal is called? It's where we've got these 10 in a row on one side of the Central Line. Do you recall what that signal is? I'll give you a few moments to type that in while I go and do a recalculation starting back here.

You all get gold stars because you all said it's a long run, and that absolutely is a long run and we've done a recalculation so now we have a new baseline for working how what this Chlorine Hours Below Minimum is going to continue to do in the future.

Something that I learned from Donald Wheeler - who I would call my guru in the space of Smart Charts and XmR charts and this more statistical analysis of performance measure data or management data - is that you can't take a pure approach to looking for signals in your performance measures. You really have to get to know your

performance measure. You really have to understand that when you are looking at a performance measure you can be seeing several signals going on at once or you could be seeing complete chaos. You could be seeing a system that really doesn't have a lot of control around it and therefore you probably need to figure out how to get it under control and get some consistency into it before you start relying on the signals that are popping up in the Smart Chart.

It can feel a bit messy but it's still far superior to what we have done in the past where we've looked at this month compared to last month and tried to draw a conclusion, or this month compared to the same month last year. There are just endless examples of where those sorts of comparisons cause conflicting conclusions to be drawn for the same set of data and causes us to spin our wheels. We just don't take action because we don't know whether things are really getting better or worse, or obviously to waste resources by fixing things that just aren't broken.

### The Moving Range (mR) chart

Now I have not spent too much time talking about this Moving Range chart at the bottom here. I've got to change its title because it's not the Moving Range chart for Customer Complaints anymore. It's the Moving Range chart for our measure of Chlorine Hours Below Minimum. I'd like you to be able to see both charts at the same time. We haven't added the extra data into here so I'll do that really quick. All I'm doing here is what I was doing before when I was extending the range of data that the chart referred to for the Smart Chart. We don't need these targets on the bottom chart.

The Moving Range chart tells a story of how the variability is changing in our performance measure and you can see that straight away. If you look at our performance measure Smart Chart at the top, you can see that the variability that we start off with is quite narrow. In fact, it only ranges from about 24 up to 50-odd. That's the range of routine variation. But after we saw that chaos start to emerge, those multiple signals that are flying at us, we recalculated and discovered that the routine variation is actually a lot bigger and it's ranging now from about 9 up to 63. So what we are seeing there is a step increase in the size of variability in our performance measure.

Now let's look at the Moving Range chart and at about the same time you will notice that it did a step change as well. The values were quite low averaging at around 5 and then we would have seen a signal showing that we needed to recalculate and now the new Average Moving Range line is about 10 and also the Upper Range Limit went from 16 up to almost 33.

That is reflecting that yes, there really was a shift in the amount of variability in our performance measure. So the Moving Range chart tells us about changes in the amount of variability in our measure. Not the average level but the amount of variability. It is confirming that there really is an increase in the level of variability.

Sometimes you will see no signals at all in your Moving Range chart because the amount of variability is staying pretty consistent. You might see a little blip here and there, like an outlier, in your Moving Range chart where you've just got a single point outside the Upper Range Limit. That would show you that you had a shift in your performance measure level but not necessarily a change in the overall amount of variability.

So the two charts work together. I call the Smart Chart the first one because (even though I don't have confirmation on whether this is absolutely okay to do, I can't see any reason why it's not) I prefer in my reporting only to use the top chart – what I'm calling the Smart Chart.

The bottom chart gives you some useful information but I think for managing performance you get everything you need out of the top one.

Anita is asking a very wise question,

*“Do you ever see a signal in the Moving Range chart and not in the Smart Chart?”*

Generally no, because that Moving Range chart is telling you about a significant change that has happened in the chart above. So if you get a signal in the Moving Range chart then it means something did actually change in the Smart Chart. So the direct answer to your question is no. Good question Anita, thanks.

That is going to be enough for demonstration on how the Smart Chart works in the spreadsheet and that ought to be enough, coupled with the instructions that are in your workbook, for you to start playing with your own KPI data and sticking it in the template and creating your first Smart Charts.

Now, we will be getting together for Lesson 4 on our third webinar and we'll be doing Lesson 5 as well in fact and getting into how Smart Charts apply for different types of performance measures or KPIs. We are going to look at measures that have seasonality, measures that have a long term consistent trend in them, measures that are infrequent or rare events. We are going to look at percentages and averages and ratios and counts and all sorts of types of performance measures and I'll show you just how versatile Smart Charts are in helping us manage performance for all those different types of measures.

## Questions

If you've got any questions right now please feel free to fire them through and we'll answer them before we wrap up. Otherwise you could let me know if you are okay and how ready you feel to start creating your Smart Charts.

Anita has another question,

*“What statistic package do you use beyond Excel?”*

I don't. When I was a research statistician I used to use SAS but I didn't use it for these sorts of charts. I was doing different sorts of analysis back then. I do know that Minitab does these sorts of charts and analysis and there probably a few others like SPlus. There are a few stats packages. I don't think you need them.

The idea with performance measurement is to keep it as simple as possible because you are dealing with people who don't have a statistical background and people who will be reporting and using the charts, so keeping it really simple is the go and everything that I am going to be showing you through this course, even dealing with seasonality in your data, is all very simple to do in a spreadsheet and quite simple to explain to people as well.

So I don't use any statistical package beyond Excel.

Melinda says she's,

*“...ready to go.”*

That's good. Janet says,

*“Can't wait to start when I get a chance.”*

Good Janet, I hope you get the chance soon.

Gordon is asking,

*“Could you please recap the formatting of the Natural Process Limits.”*

Okay, I will do that briefly. I will go back to the spreadsheet and briefly explain what I did but I won't redemonstrate it Gordon because you'll be able to get that from watching the replay again.

Let me flip back through to the template. So the first thing I did to reformat the Natural Process Limits was I turned both the upper and lower Natural Process Limits into a different chart type. I turned them into an area chart instead of a line chart which is what they started out being. After I did that I had to make sure that my lower Natural Process Limit was in front of my upper Natural Process Limit so that when I changed the area to white it would mask the bottom of the area for the upper limit. So I had to go into 'Select data' and change the order that the upper and lower limits were by default in that list. Then I formatted the colours and made the lower Natural Process Limit white in fill colour and the upper limit pale blue. In general that is what you are doing, you are changing the chart type, changing the order to make sure that the lower limit will mask the bottom part of the upper limit and then you are just making the colours nice. But again, just watch the replay again and you can follow through on the steps for doing that. I hope that's okay Gordon.

Elke says,

*“Really good session again. Have been following with my own KPI and managed reasonably well.”*

Great feedback Elke. I was curious about how many of you would actually try and do it live and the fact that you did and it worked out quite well is brilliant.

Okay everybody, you have done a tremendous job following through with this. I will look forward to catching up with you when we get together for Lesson 4 when we start exploring the broad ranging applications of Smart Charts and some of the things that you need to do to make some of your performance measure data appropriate for a Smart Chart.

Okay everybody, I'll catch you then.

Sorry Elke, I just saw your question there,

*“Does the Central Line and the moving average range need to be based on the same number of values?”*

Not the same number of values but I like to line up the range of values as much as possible. The first time I calculate my Central Line it will use the first six values, and the first time I calculate the moving average range it will have less values because you don't have a Moving Range value for your very first performance measure value. But after that I generally try to line them up and have them focus on the same five or six values if I'm doing a recalculation somewhere. I hope that helps.

Okay great that will do for today. You have more opportunity to ask questions during Lessons 4 and 5. I look forward to that. Everybody have a great day or evening ahead and I will catch you in our next webinar.

**End of transcript.**