

Making Numbers Work

HATING MATHS

Most people either hate Maths, or mistrust Maths, but without numbers our ability to manage and improve performance is significantly reduced. For many people, Maths was badly taught at school. Add to that **“lies, damned lies and statistics”**, particularly in the hands of the media or politicians and it’s hardly surprising that “Making Numbers Work” is not a widespread skill in many organisations.

This article is based on some of our experiences in helping people get real insight into performance improvement opportunities by making better use of numbers.

WHAT IS 6 SIGMA?

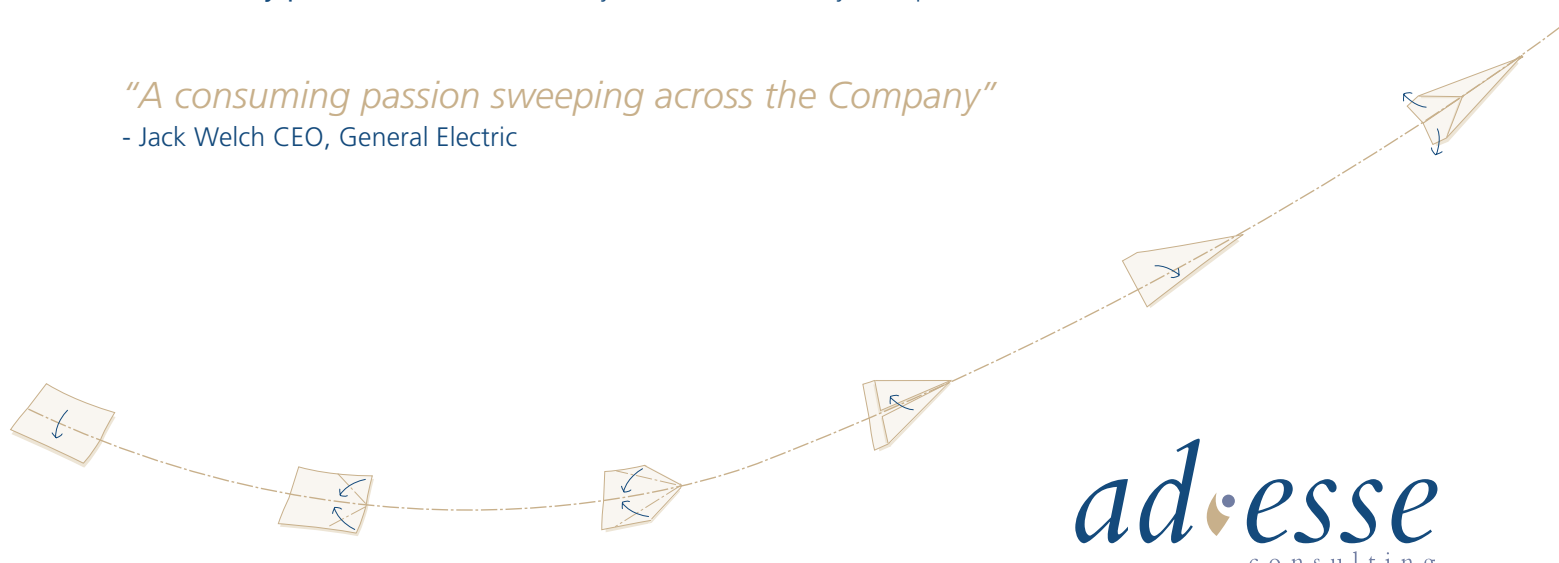
Depending on who you talk to, you’ll find a range of definitions and descriptions of the scope of 6 Sigma...

- A) It’s a highly technical and statistically-based way of managing and improving processes (often used by manufacturing organisations)
- B) It’s an evolution of the concept of “Zero Defects” leading to the aim of near perfection by reducing defect levels to below 3.4 parts per million opportunities (the focus is on understanding customers’ requirements, so you can define a “defect opportunity”)
- C) It’s the development of a culture of sustainable and continual improvement based on:
 - striving to understand and meet customers’ requirements,
 - by driving out waste and defects
 - through the involvement of people in improvement activities

The good news is, it can be any of these. The bad news is, it’s easy to pick the wrong one for your organisation, or to **“cherry-pick”** the bits of each that you think will be easy to implement.

“A consuming passion sweeping across the Company”

- Jack Welch CEO, General Electric



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It's also important to say, right at the start that most of the Maths in 6 Sigma is very simple! Before you even start to worry about 6-Sigma and any of its statistics, consider whether you are getting the best out of your existing data.

DATA PRESENTATION

Badly presented data makes it hard to understand performance and difficult to identify what course of action to take to improve things.

Very few people need absolutely accurate numbers (Actuaries, Accountants, Scientists and Engineers are common exceptions). So, for most management information, rounded data will be easier to handle. Which of these is easier to see the biggest percentage increase in crime?

Violent crimes have increased from 47,250 to 63,217 whereas robberies have increased from 30,154 to 46,430	Violent crimes have increased from 47,000 to 63,000 whereas robberies have increased from 30,000 to 46,000
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It's much easier on the eye, and to do a bit of mental arithmetic, on the second (right-hand) example and say that an increase of 16,000 violent crimes is about a third (33%) and an increase of 16,000 robberies is about half (50%).

Applied with common sense, rounding to two effective digits usually makes numbers easier to cope with and to get a quicker understanding of what's going on.

Tables of data also present a great opportunity to make life easy or difficult for the reader. Columns of data are almost always better than rows, because the eye can scan up and down more easily. So...

	Sales (£k)	Profit (£k)
2004	25,000	2,400
2003	22,000	2,000
2002	18,000	1,600
2001	14,000	1,000
2000	10,000	650

Is easier to read than...

	2000	2001	2002	2003	2004
Sales (£k)	10,000	14,000	18,000	22,000	25,000
Profit (£k)	650	1,000	1,600	2,000	2,400

Putting the latest data, or the biggest numbers, at the top of the table, is also usually helpful.

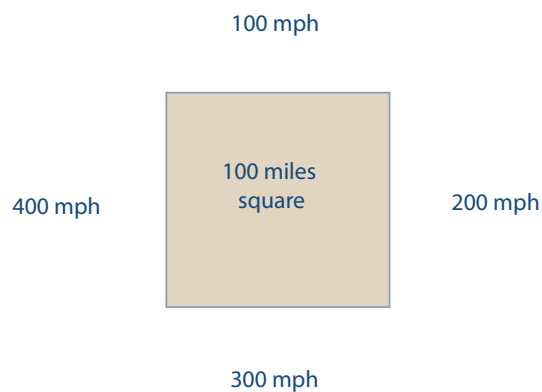
Adding Row or column averages (or totals) can also provide some focus and aid understanding...

# of Complaints	Q1	Q2	Q3	Q4	Average
North	370	350	320	350	348
South	160	150	150	180	160
East	47	51	46	63	52
West	42	40	36	40	40
Average	155	148	138	158	150

The eye should be drawn to the averages first, to aid interpretation of the data. For example, Q4 in the East is well above the average for that region. Whether or not that increase is (statistically) significant can be revealed by use of some of the 6 Sigma techniques.

Averages can be misleading, or even meaningless, so they do need to be used with care. Try this...

An aeroplane flies round the four sides of a 100 mile square. It flies at 100 mph on side 1, 200 mph on side 2, 300 mph on side 3 and 400 mph on side 4. What is its average speed? (Answers at the end of this article)



Averages only tell you part of the story. If I tell you that the average queuing time to get through Security at an airport is 5 minutes, how much wiser are you?

If you also knew that the queue time varied from 30 seconds to 20 minutes, depending on the time of day and day of the week, you'd have a greater insight into what was going on. You'd probably also be able to make more effective plans for how much time to allow when arriving at the airport.

When somebody tells you the average salary in the organisation is £30,000, your first question should be "which average?". Is it the Mean, Mode, or Median? We don't have space to explain these here, but there might well be a big difference between the three answers, depending on the variation in the data.

UNDERSTANDING VARIATION

We're getting closer to being able to talk about 6 Sigma!

All work is a process and every process is subject to variation. Performance is affected by factors such as people, procedures, materials, equipment. The combination of these leads to variation in process outputs.

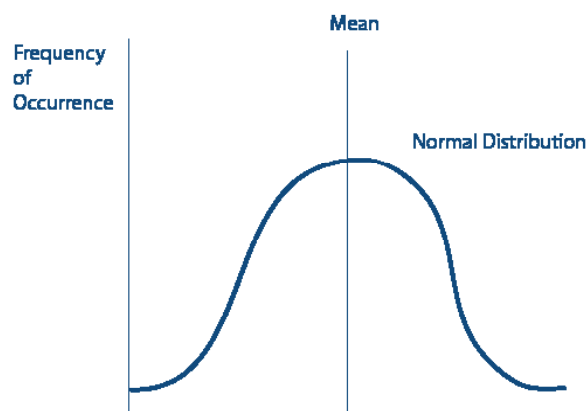
The way things vary depends on what causes them to vary (obviously) and there are two types of cause:

- Common causes which are typically always present, small, predictable and stable (e.g. variations caused by skills, training, or operating procedures)
- Special causes which are irregular, unpredictable and come from a few major sources (e.g. introducing a new, untrained employee, or a day of exceptional, bad weather)

Think about your journey to work. Most days the time it takes will be predictable, within a known range (perhaps +/- 5 minutes). This range is due to Common Causes. Occasionally, there will be an accident causing a hold-up, or major road-works; these might make you 15-30 minutes late and are the result of Special Causes.

In organisations, variation is the enemy and the cause of waste and excess costs. Understanding variation is the key to improving process performance. We usually display the variation in a process by means of a Histogram (see Diagram below). Often the shape of the Histogram will show a “Normal Distribution”, also known as a bell-shaped curve. It shows us where the Mean (average) performance is, but also the spread of performance.

If somebody asks you to improve the performance of this process, you need to know two things; firstly, where do you want the Mean to be (is it currently OK, too high, or too low?) and secondly, how much variation is acceptable?



Back to our Security Queue example: if the Mean is 5 minutes and we have a target of 5 minutes, then that's OK. If we have a range of 30 seconds to 20 minutes, but we have a Service Standard of 10 minutes maximum queuing, then we've got a problem. There will be many customers who have to wait longer than our 10 minute maximum and our challenge is how to reduce the variation in the process so that more of our total range falls within the 0-10 minute band. (Actually, in this case we might not have a Normal distribution, there may be a longer tail to the right of the Mean.)

A 6 Sigma approach simply means reducing the variation in a process so that there are fewer cases of customers requirements not being met, or errors being made. A 6 Sigma process is virtually defect-free: it means no more than 3.4 million defects per million opportunities (DPMO).

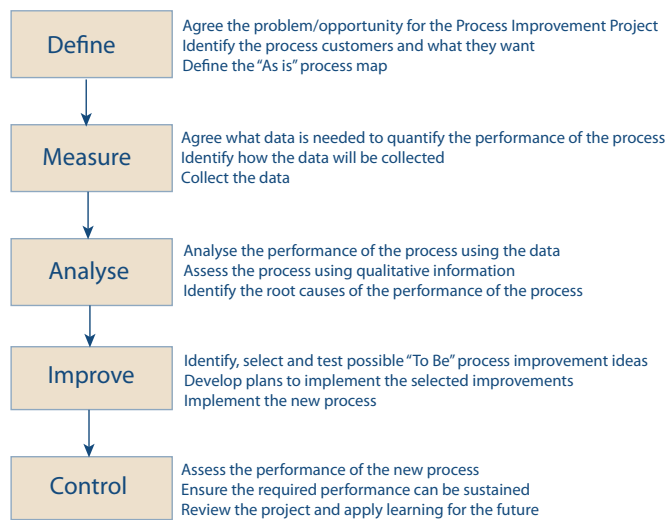
In our queue example, every passenger has an “opportunity” to be delayed by more than our service standard. If 20% of the 1000 passengers passing through security wait more than 10 minutes, that is equivalent to 200,000 DPMO. That's about 2.3 Sigma (not very good). By comparison, the fatality rate for air travel is around 0.4 DPMO (even better than 6 Sigma).

DOING IMPROVEMENT

Crunching the numbers – the “**statistics**” bit of 6 Sigma - is the easy bit. The challenge is how to make improvement actually happen. All the analysis in the world won’t make process improvement happen as if by magic.

That’s where Improvement Projects and the Culture Change aspects of successful 6 Sigma come into play.

Improvement happens through projects. 6 Sigma projects typically follow the Define – Measure – Analyse – Improve – Control approach (DMAIC).



However, as always, it’s the change management “stuff” that will cause this to succeed or fail, not the maths/ statistics.

You also need:

- Educated Leaders (senior managers), to provide the drive, focus and commitment
- Picking the right projects, to deliver a combination of quick wins and substantial, quantifiable benefits
- Trained DMAIC team leaders and members, to have the capability to run successful projects
- Internal Facilitators/Coaches (Black Belts if you want to use the 6 Sigma terminology), to support teams and senior managers
- A communication system to ensure plans and progress (measurements of achievement) can be shared
- A recognition system to reinforce the positive behaviours (and a means of addressing unwanted behaviours)

The importance and breadth of these change management aspects will depend on whether you want to use 6 Sigma at a tactical level to address very specific problems, with a need for statistical techniques, or at a more strategic level to improve organisational performance. Ignore them at your peril!

HAVE WE IMPROVED AND ARE WE CONTINUING TO IMPROVE?

These final questions are about demonstrating benefits and being confident that improvement is sustainable. There are, in our experience, all too many examples of the “spotlight effect” where processes improve while a team is working on them, but drift back to previous levels of performance once the team has disbanded and moved on.

This is part of the "Control" stage of the DMAIC approach and is where the use of charts to demonstrate trends is invaluable. Most managers will be familiar with Line Graphs, showing performance on the vertical (y) axis and time (e.g. day, week, month) on the horizontal (x) axis.

Unfortunately, it is all too easy to over-react, or under-react, to data presented on a Line Graph. Worse still, is to look at too narrow a span of data. Every year there are numerous examples in the media of reports such as "this Christmas arrests for drink-driving are down from 9.5% to 9.3%; we're really pleased to see the results of our campaigns are making a difference".

Firstly, two data points do not constitute a trend and secondly, without knowing the amount of normal variation we can't possibly tell if a drop of 0.2% is of any significance.

The use of other statistical tools such as Control Charts (SPC Charts), Cusum Charts, or simple Moving Averages are much more likely to reveal the significance of any change, over time. They aren't difficult to produce, even with a spreadsheet, but if people don't understand why they might want to look at trend data, they are hardly likely to fire up Excel are they?

One of the key points for ensuring sustainable performance improvement is to make the people operating the process responsible for tracking its performance. To do that, they need the skills to gather the data, produce the charts and interpret them for themselves. What they don't need is a 6 Sigma Black Belt doing it for them (or to them).

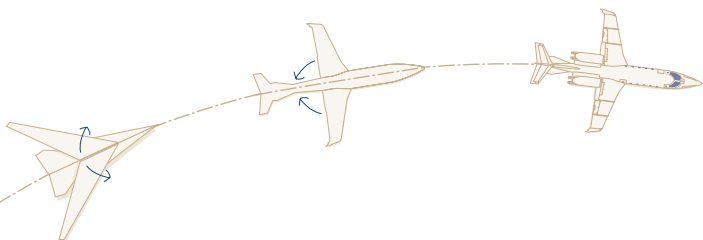
SUMMARY

You don't need to be a mathematician, or statistician, to succeed with 6 Sigma. It can be as complicated, or as simple as you (or your consultants!) choose to make it! Making 6 Sigma some mystical technique that is only understood and used by a few "insiders" is hardly likely to be a recipe for success.

You do need to be clear about what you are trying to achieve, be it a series of tactical improvements, or an organisation-wide approach to develop sustainable performance improvement, with a high degree of staff involvement.

You also need to open people's eyes to how numbers can help them improve their processes, reduce errors and waste, and ultimately deliver benefits for customers and the organisation. Making numbers work is everybody's business if you are serious about improvement.

Answer to the aeroplane question: The average speed is 192 mph. (Not 250 mph).



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