# Measuring sticks

David Hand explains to the *British Academy Review* how measurement touches on almost every aspect of the modern world

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**Tell us about your own interest in measurement and statistics. Have you always been a numbers man?**
I had a conventional introduction to statistics for professional statisticians. I started with a Maths degree, but then I did a Masters in Statistics, so my interest really stemmed from that period. I have to say that before I did the Masters I did not really know what statistics was. I think this is quite common for people with Maths degrees, because they get a very cursory introduction to it. Since then, I have obviously become an enthusiast for statistics and data.

**Where for you is the fascination? Is it the intellectual ingenuity of manipulating numbers or is it about how numbers can help explain our world?**
My interest and enthusiasm lie not so much in the intellectual challenge of manipulating these things, as in the fact that statistics is all about squeezing illumination and understanding from data. I sometimes say that statisticians see things that nobody else has seen before. They analyse the data and out pops something new. It is a very exciting discipline.

**You start your book *Measurement: A Very Short Introduction* by talking about the historical origins of measurement, about the very early need to measure the physical world, and how – over time – this required agreement on consistent measurement standards of increasing precision.**
If you go back a few hundred years, you find that every village had its own way of measuring length or weight. That, of course, caused all sorts of problems with trade and communication. Gradually over the course of time, things became more consistent. We now have the metric system, which is not quite worldwide but is fairly universal.

The need for precision advances as civilisation advances. Maybe a sixteenth of an inch was sufficient precision for a width measurement when you were building carts to be drawn by horses. But if you are building a motorcar or an aircraft or rocket engine, a sixteenth of an inch is not sufficiently accurate; you need it to be thousandths of an inch.

**How have those improvements been reached?**
I think of it as a leapfrog act. Advances in technical prowess enable you to develop new ways of measuring things, which then complement the demands of new things to be made. Once you have developed new ways of measuring things, new possibilities are opened up.

**You explain that a major motivation between developments in quantification was the need to control society. And you have an intriguing account of how the gathering and summarising of social and economic phenomena revealed patterns and regularities, and how this led to an interplay of statistical ideas between 19th-century social scientists and physicists.**
This is a fascinating story. At the moment, we are in a period where people are exploring something called

econophysics, and saying that the ideas of statistical mechanics can be applied to the social world.

But if you look back in history, there is a much more subtle and alternating relationship. People such as Adolphe Quetelet came up with the notion that you can describe regularities in society. Individual people behave in all sorts of different ways, but if you look at them *en masse* you find extraordinary regularities. You find that the number of suicides from particular methods are fairly constant over time. This is quite remarkable, because someone thinking of killing themselves doesn't look at the figures and think, 'I'd better hang myself to make sure that the numbers come out right.'

People working in statistical thermodynamics, like Ludwig Boltzmann and James Clerk Maxwell, saw what had been going on in this area of the social sciences, and realised that you could apply the same ideas to understand how large numbers of atoms and molecules behaved. This leapfrog has continued, with social sciences looking back at the physical sciences, and then the physical sciences looking back to the social sciences.

The way that the social sciences can have huge benefits for the physical sciences, perhaps over centuries, is something that cannot be picked up as 'impact' factors in research assessment exercises.

**You quote the idea that measurement actually creates society. As we devise new things to be measured – gross domestic product, consumer price index – we call into existence new social concepts.**

This is Ken Alder's idea: that measurements create society. I think it's a very nice idea and there is a lot of truth to it.

The point about measurement of economic and social phenomena is that they are higher-level entities. For example, the unemployment rate is something that refers to a society as a whole, not to a particular individual. And as we begin to describe this higher-level entity – inflation or unemployment – in some sense we are creating the thing we are talking about.

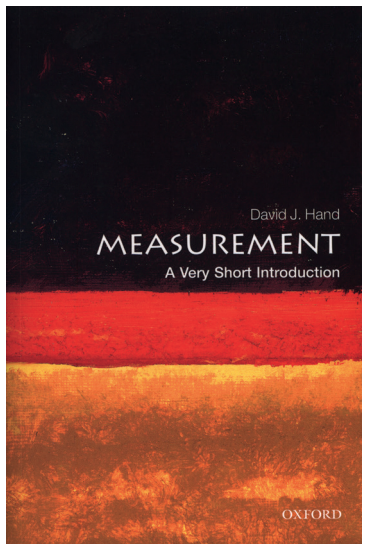
Perhaps here I could contrast measuring economic or psychological things, with measuring physical things like length and weight, because the procedures are rather different.

When we measure length or weight, we try to establish a formal mapping of the objects we are measuring to numbers, so that the relationship between the objects is matched by the relationship between numbers. For example, *this* object forces the scale pan down, so we will assign to it a number representing its weight that is bigger than that for the other object. That is 'representational' measurement. We are trying to represent the relationships in the real world by the relationships in our numbers.

In contrast, you have what is called 'pragmatic' measurement. Things like inflation or well-being are heavily pragmatic measurement concepts, where you are defining the concept through the way you describe how to measure it. You are simultaneously measuring and defining the concept. That is very different from measuring something like weight.

**Things become more complicated as we strive to go beyond the easily countable. How *do* we measure well-being?**

I have written another book on measuring well-being.[1] And it *is* quite complicated. I have been particularly interested in measuring national well-being. National well-being has individual components, such as the happiness of individuals, but higher-level things like sustainability also need to be taken into account: if a society or nation appears to be doing very well but is consuming non-sustainable resources at a very rapid rate so that it is going to burn out within 20 years, it will not in fact be doing very well.




David J. Hand, *Measurement: A Very Short Introduction*, was published by Oxford University Press in October 2016.

**You hint at some risks in measuring higher-level entities. You use the term 'reification': if something has a name, if some measure has been devised, then it must exist in the real world even if it's just an artificial construct.**

Reification is an interesting and rather controversial topic. If you can apparently measure something and use it in a helpful way – predict things with it, make decisions and take actions based on it – it's very easy to forget the fact it might not actually be something real. It might just be a construct you have created, which is useful. The topic has a controversial history.

**And there is the idea that 'what gets measured gets done'.**

That's the last in an increasingly dramatic series of statements: 'you measure what matters'; 'what you measure begins to matter'; 'what gets measured gets done'.

The saying 'what gets measured gets done' represents the fact that in an ideal world perhaps what we would like to measure is something quite elaborate and complicated, but because it's elaborate and complicated we simplify and measure something related to it that we can actually measure. That then becomes the focus of any actions and decisions we may take.

In the Wells Fargo scandal, which was revealed in September 2016, staff performance was measured by how much their customers opened other accounts. This led

1. Paul Allin P. and David J. Hand, *The Wellbeing of Nations: Meaning, Motive, and Measurement* (Wiley, 2014).

to staff opening accounts without customers knowing anything about it.

**The public has a rather schizophrenic attitude to measurement and statistics. We all feel the desire not to be considered as just a statistic – 'I am not a number, I am a free man' (to quote Number 6 in *The Prisoner*). And we fear that measurement robs us of intuitive insights and nuances. You argue that the analysis of mass data really can be turned to the benefit of the individual.**

Measurement is all about accumulating evidence and gaining understanding. The fact that you can measure something cannot detract from the nuances and understanding you do have. It can only give you something more, something additional.

We may not want to be considered as just a statistic – 'I am not a number, I am a human being' – but we are never just a statistic.

Statistics is typically seen as about mass phenomena: you are aggregating, you are summarising, you are calculating a mean, a variance, etc. You are looking at the whole bundle of people together, and the individual seems to play a part in that. In fact, statistics also works in the other direction. Think about what many of these statistical methods are used for. For example, in a clinical trial you will be trying to find out whether treatment A is better than treatment B for some illness. You will do that by looking at a mass of people. You will give half of them treatment A and half of them treatment B and see how things, on average, pan out. But what you are then going to do is apply whichever treatment you decide is the better one to the next individual with a disease who comes through the door. You will match the data on that individual, diagnose them based on data and measurements, decide they have a particular illness, and then from the mass of data and information that you have obtained using your statistic model, decide what treatment to give to them.

So statistics is not just about mass phenomena; it's also about the individual.

**The flipside of our schizophrenic attitude is that we all love a statistic. We are all hooked on numbers emblazoned on newspaper pages. Here there is the risk of the media obsessing about a particular measurement score, which may itself be a summarising of other scores or a statistic that is just a provisional estimate, or about fluctuations in numbers that have no statistical significance.**

'Ninety per cent of statistics are made up, including this one.' We need a better understanding of statistics and data – of what they mean and the critical eye with which you have to approach statistics. Just become somebody says 90 per cent of statistics are made up, you should never accept that at face value. You should think: could this be right? Is this realistic? Does it conform to what else I know? That is a kind of skill and understanding, which is increasingly important for the community at large to acquire.

**Is there also need for more understanding of how incomplete and provisional statistics are, and how much what is being shown by statistics is still going to be subject to change because it's a work in progress? Is that a failure to understand the scientific process that might be behind the statistic that is the headline figure?**

If you read the papers or watch the television, you will see that one day coffee is good for you and the next it's bad for you. You find different reports arising from different studies. The statistics get updated. You get a report that the UK sends £350 million a week to Europe, and then you get a comment saying that's wrong because a lot of the money is sent back. People need to understand these things in the context of the scientific process.

The popular image of science is that it's a bundle of facts which have been, in some senses, proven. But science is really about presenting contingent theories that describe the facts you know, but which are always subject to possible change as you gain greater understanding as more facts come along. Science is always subject to change, is always potentially temporary. If you want absolute truths you have to go to either pure mathematics or religion, I am afraid.

**There is that perennial public scepticism that anything can be proved by manipulating the numbers. You mentioned the EU referendum where statistics quoted by experts and others fared badly. How worried are you by this reputational damage?**
This is unfortunate, because the reputational damage should stick to the people who are misreporting the statistics. The £350 million is a good example. Whether deliberately or through ignorance, the facts were distorted. It is unfortunate if statistics is maligned as a consequence of that, when the criticism ought to be put elsewhere.

**You have published two books in the *Very Short Introductions* series: this one on measurement and an earlier one on statistics. Have you written these in order to help improve perceptions of these subjects?**
I think I wrote them for different reasons. I wrote the *Statistics* one[2] because there was this terrible misunderstanding of what statistics is about: there has been a perception that it is a dry, dull, dusty discipline involving arithmetic skills. Nothing could be further from the truth. Modern statistics with powerful computers is all about probing data, looking for interesting structures and relationships. You don't have to be able to add up numbers anymore. It is a good idea if you have some intuitive understanding – so that you can spot that, when the number comes out as 1,000, it actually should be more like 10. But you don't have to be able to invert a matrix by hand or anything like that. At the touch of a button, the computer will do it. So I start that book by saying that statistics is the most exciting of disciplines, and I hope to convince people that that is the case.

Statistics is not just about mass phenomena; it's also about the individual.

In respect of the *Measurement* book, I have been fascinated by measurement for some time. When I did my Maths degree I specialised in my final year in mathematical physics, where people measure things like length, weight and velocity. After my PhD, I moved to the Institute of Psychiatry where I spent 10 years collaborating with psychologists, psychiatrists and pharmacologists and the like, who were measuring things like opinion, depression or pain. It was quite clear that what they meant by measurement was very different from what the physicists meant by measurement. So I became fascinated by the range of approaches and concepts to which the word measurement is applied. I wrote a larger, much more technical book about it a few years ago,[3] and I wanted to reach a wider audience with the issues – hence this new short book.

**Was it easy to condense so much information into an accessible form?**
It was very frustrating to condense it all. I had to leave out so many good stories. One of my favourite anecdotes which I could not get into the *Measurement* book is about the litre, the unit of volume. It had been proposed that an uppercase 'L' should be used for litre rather than a lowercase 'l' – to distinguish it typographically from the number '1'. But the convention is that capital letters are only used as symbols if the unit is named after somebody. So it is capital 'V' for Volt (named after Alessandro Volta), and capital 'A' for Amp (named after André-Marie Ampère), whereas it is lowercase 'm' for metre. To overcome this gap, in 1978 Kenneth Woolner at the University of Waterloo in Canada wrote a spoof article in a chemistry newsletter giving an account of a 'Claude Émile Jean-Baptiste Litre', an 18th-century glass manufacturer, who was good at creating cylinders and very accurate in calibrating them. He created a whole biography for this Litre. Of course, not everyone who read it realised it was a spoof. It even appeared in *Collier's Encyclopaedia*. And Woolner received letters from school teachers saying, 'This is fascinating. Can you give me the references?' The spoof ran and ran. Somebody else wrote an article describing Litre's daughter – Millicent Litre! Unfortunately, I could not get any of that into *Measurement: A Very Short Introduction*.

The British Academy has undertaken extensive work to address the deficit in quantitative skills (QS) and statistical literacy in the UK, arguing that the ability to understand and interpret data and statistics is an essential feature of life in the 21st century: vital for the economy, for our society and for us as individuals.

This activity falls under the Academy's Quantitative Skills Programme (QS), guided by the British Academy's High Level Strategy Group for Quantitative Skills, chaired by Professor Sir Ian Diamond FBA.

To find out more, visit www.britishacademy.ac.uk/count-us-in

2. David J. Hand, *Statistics: A Very Short Introduction* (Oxford University Press, 2008).
3. David J. Hand, *Measurement Theory and Practice: The World Through Quantification* (Edward Arnold, 2004).