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RBC Letter

Bring me a ruler please

The concept of a system of measurement is woven into the cultures of every commercial nation on earth. While a universally consistent system seems a straightforward desire, deciding on one is anything but straightforward. 'Bring Me A Ruler Please' posits why the decision is such a complex one, and what role human nature might play in making it that way.

"Man is the measure of all things". So said Protagoras more than 2400 years ago. Exactly what he meant has been debated ever since. Perhaps it was no more than the incomparability of sense impressions; is the green I see the same as the green you see? Or perhaps he meant that what cannot be measured by human beings does not exist, is not a thing at all. If the latter interpretation is correct many modern thinkers would agree with him. What can safely be said is that today, in the full tide of an ever more science- and technology-based society, human beings are measuring all things, and ourselves not least among them.

Measurement is the use of standard units to compare objects or concepts of the same class: first of all time, weight, and length or distance. Its earliest beginnings can perhaps be traced to the manufacture of the first tools. Hunters used spears to kill their prey at a relatively safe distance. Too short or too light would not do the job; too heavy, or too long could not be thrown a useful distance or accurately.There was a "correct" length and weight for spears, passed on from generation to generation. We cannot know when weights and lengths were first conceived abstractly in standard units. For measuring time, of course, the units came ready-made: the alternation of day and night through the rotation of the earth, the phases of the moon and the annual course of the sun are still the basis of time measurement today. But for weight and length units certainly came no later than the building of the first cities, since we find standard weights for scales (shaped, no one knows why, like ducks) in the ruins of Sumer.

Even without the Mesopotamian ducks we could have assumed that standard units arrived with the first complex societies, since the one cannot function without the other. Architecture, land surveying, trading, taxation, organized warfare – none of them could have progressed very far without recognized systems for measuring time, distance and weights.The enforcement of such systems is one of the oldest functions of the state. Perhaps the most remarkable thing about the pyramids of Egypt is not their enormous size but their geometrical perfection.The base of the Great Pyramid, 751 feet square, is less than 0.1% out of true, an achievement so remarkable that some have ascribed it to visitors from space. It was in fact done with infinite care and repeated measurements, using ropes and an official standard unit, the famous Egyptian royal cubit of 52.35 centimetres.The cubit, originally the distance from the elbow to the fingertips, had a long and distinguished career before it. Noah, the Bible tells us, used it to design the ark and King Solomon used it for his temple. Slightly different versions were used all over the Middle East and the Islamic world (including the once-Islamic Iberian countries) until recent times.

The origins of standard units for measuring an abstract concept, economic value, also lie somewhere before the arrival of written records. Since it was important that the units not merely measure value but also store it

and serve as a medium of exchange, they themselves were not abstract at all but usually lightweight, easily comparable items of some intrinsic worth. Africans used cowrie shells and the Aztecs and Maya used cocoa beans.The Greeks of the Archaic period, roughly 800 to 500 BC, used small metal spits – souvlaki skewers.The drachma, still the name of the Greek monetary unit today, literally means "fistful" – a fist full of metal spits, *obols*. Cattle, widely used for important payments from East Africa today to ancient Ireland, might seem to be an exception to the lightweight rule but they have the advantage that they transport themselves – and produce value as well as store it. The state was curiously late arriving in this potentially profitable field. The first coins were metal slugs whose standard weight was guaranteed by the stamped name and image of the issuing authority – a system still with us in form, though not in substance.Once governments realized that fiscal crises could be overcome by devaluing their own coins, the currency became an ever more useful tool of statesmanship.

Measurement was soon too successful for its own good. Measurement implies comparison, but different systems of measurement soon became deeply embedded in individual cultures. Merely to list all the units humans have devised would require a far longer letter than this one. An organization called English Weights and Measures lists acres, bushels, chains, chalders, chaldrons, crowns, customary measures, drachms, drams, farthings, fathoms, feet, florins, foolscap, furlongs, gallons, gills, grains, groats, guineas, hundredweights, lasts, leagues, miles, minims, nails, ounces, pecks, pennyweights, pints, poles, perchs, pounds, quarts, quarters, rods, roods, sacks, scruples, stones, tods, tons, troy ounces, wire gauges, weys and yards – and this is an incomplete list from a single country. For most of recorded history all attempts to facilitate comparisons by using a single system were at best partial successes, usually brought about by overwhelming military power. A Roman milepost indicates the same distance in Wales or in Lebanon, but such uniformity was not to be seen again until modern times.

Modern times for measurement arrived when the leadership of revolutionary France considered the existence of several different systems within the borders of their country. Instead of trying to harmonize them, or to impose one at the expense of the others, they – guided by the great chemist Lavoisier – decided to adopt an entirely new system that would be easy to learn, easy to use and – because it would be based on universal natural standards with no cultural baggage – would be universally acceptable.Thus the unit of distance would be a metre, which would be one-thousandth of a kilometre, which would be one ten-thousandth of the distance from the Equator to the Poles. This was the metric system, today called the SI after the French initials of its current official name, the *Système International d'Unités.*

A truly great achievement, the metric system has in part lived up to its creators' expectations. It is one of the foundations of the modern world. But the revolutionaries were decidedly optimistic, or perhaps naïve, in thinking that its simplicity and rationality would make it universally welcome. On the contrary, it has been often seen as an instrument of French, European or Western cultural aggression, the adjective depending on the critic's standpoint. The organization English Weight and Measures, mentioned above, exists to protect the country's traditional units against the alien forces of metrication, and wherever possible to restore them to use.

More than two hundred years after its invention, the supremely rational metric system is in partial use everywhere but in complete use only in a handful of countries. Brazilians continue to weigh meat by the ancient Arabic *arroba*. The English continue to express their body weight in stones, to the bemusement of foreigners and colonials. Tin is measured in Malay *piculs*, originally the load one man could carry, and a *picul* is one hundred *catties,* a measure in daily use today in the markets of Hong Kong.The Japanese still measure the area of their homes by tatamis, the traditional floor mats.

Again, the list could be extended indefinitely. But the great holdout against metrication is of course the United States.That country is a party to the various international metric agreements (the first, the so-called Convention of the Metre, was as long ago as 1875).The system is widely used for scientific, medical and commercial purposes.Metric weights or volumes appear on packaged foods. In 1988 the federal government required federal departments to achieve metrication by 1992 and set up a program to encourage companies and institutions to make the change. Nonetheless, as any short visit to the USA will confirm, "US customary measures" – a variant on the British Imperial system, of all things – are the only system familiar to the vast majority of Americans. The official reason is the cost of making the change. This

would certainly be great, but given Americans' impressive record of achieving whatever they collectively decide to achieve, it is hard not to think that the main reason is political. There are no votes in metrication, and experience in other countries suggests that there would be plenty of votes against it. Thus the first country to rebel against British rule is now the last country to use what is essentially the British system. And it does so in majestic isolation. Liberia and Myanmar, long cited as fellow holdouts, have now adopted the metric system.

Metrication has been an immense boon to the precise measurement of the world around us. Here the last three hundred years have seen great gains. Parallax – the apparent shift in the position of an object due to the movement of the observer – was first used to calculate the distance of the stars in 1838. A related method, triangulation, made it possible to calculate the height of the highest mountains. (In 1807 the early British surveyors in India tentatively calculated the height of the Himalayas as over 26,000 feet – a result that was ridiculed as a gross exaggeration. In fact there are eight peaks over 28,000.) The invention of the microscope led in due course to the creation of systems for measuring things that are far too small for the human eye to see. The need for ever greater precision in engineering (badly measured steam engines tend to blow up) made it necessary to measure ever smaller distances in materials, especially metals – "tolerances" in technical language.

Today computers handle that task and many others, since the human senses have been left far behind. Measurement has been extended to the unimaginably large and the unimaginably small alike. Not by any means inconceivable – scientists after all conceive these things every day – but unimaginable because they are so utterly removed from our daily experience.Most of us have heard of nano-seconds (one billionth of a second), but how many know that nano-anythings are far longer or larger than their minute cousins, the yocto or one-septillionth family? The achievement is magnificent but like much of science, bad for the human ego. Our familiar world of feet and metres is simply one whistle-stop on a very long line from the infinitesimally small to the infinitely large.

The triumphs of the physical sciences have spawned attempts to extend its techniques to other fields. Especially in the social sciences – a significant name in itself – measurement has been increasingly extended to abstract concepts. School and university grades are given by performance in competitive examinations – at least in the humane disciplines a highly subjective process, as anyone who has done it knows, but one essential to the working of the academic and bureaucratic machinery. Even more ambitious is the measurement of human intelligence.This has become a major industry in itself, despite the absence of an accepted definition of intelligence, of agreement on whether it is a single or multiple attribute, or even on how far intelligence is inborn and unchanging through life.This fuzziness is a little disturbing, since it is easy to imagine intelligence testing being abused to create a society of alphas and betas like that of Huxley's *Brave New World.* Professionals in the fields of education and psychology tend to resent these doubts of the laity, and may well be right to do so, but there is an undeniable difference between the measurement of intelligence and the measurement of, say, the distance to the moon.The shelves groan under works about the nature and methods of intelligence testing, but no one writes books to prove that lasers are an accurate way to measure distance.This does not prove that intelligence testing is meaningless, simply that the results are likely to vary significantly with the mix of methods used on any one individual.In the physical sciences, in contrast, the ability to replicate results exactly (when physically possible) is universally accepted as the ideal test of the validity of a theory or method.

Intelligence testing is also an example of another widespread trend in measurement; obtaining a single overall number as a function of other numbers. An individual is tested for mathematical, linguistic and spatial skills, among others, and the results are combined to produce a figure for intelligence in general. Such overall numbers are widespread in our society.We live in a world where the apparently "hard" information expressed by numbers and measurements is highly valued, often for its own sake. Surprising numbers of people know the batting averages of long-dead baseball players. Consequently the apparent objectivity of overall numbers can give them great influence. Universities are rated by deriving a single score from twenty or more relatively "hard" numbers such as class size and library holdings. Dog shows score pedigreed dogs in much the same way.The Dow Jones Index is derived from the share price of leading publicly traded firms. Much more ambitiously, the United Nations has taken to ranking its members by their "quality of life", based on various levels of social

well-being which themselves may often be overall figures.

Overall numbers are another list that could be extended indefinitely.The objectivity of such scores and ratings is only apparent, however, because they are at best derivative and at worst a sophisticated form of propaganda, one that illustrates Disraeli's comment about "lies, dammed lies, and statistics". The overall figure is the result of human decisions on selecting and weighting the underlying figures, decisions that may be far from objective.This is obviously the case in "quality of life" measurements, since there is no consensus on what constitutes the good life. All the same such ratings are a godsend to the media, being the stuff of headlines on a slow news day, and can be used effectively by the academic administrators, corporate executives and politicians who have been blessed with top scores.They also appeal to something deep in human nature: we may accept equality (however defined) as a social goal, but it is much more fun to read about hierarchies.Overall figures will certainly be with us for some time to come, but while they can be useful tools they should never be confused with the measurable realities that in principle at least should underlie them. In more ways than one, they are a long way from those long-ago Egyptians with their ropes and cubits.

Early in the twentieth century the American psychologist Edward Lee Thorndike, a faculty member at Harvard, wrote, "Whatever exists at all exists in some amount". Clearly, any thing that exists in some amount can be measured. It follows that anything that cannot be measured does not exist at all. We are back to one possible interpretation of Protagoras: only what human beings can measure is real.

Thorndike practiced what he preached.One of the founders of what became the behaviourist school of psychology, he made his name by observing how fast cats learned to escape from the "puzzle boxes" he had designed.Today his dictum is the guiding assumption of many, perhaps most scientists.For some it assumes the proportions of a creed.This is not surprising. Measurement works.Without it we could not have built the modern world, by all historical standards so immensely productive of goods, services and ideas.With its aid, we understand the workings of the physical universe better than we ever have before – and we can dimly grasp how much we have yet to learn. And if we have increasing doubts about the consequences of our way of life for this earth and the species with which we share it, measurement helps to give us an idea of the damage we are doing and of what we might do to remedy it. By any measure – so to speak! – measurement is here to stay.

Still, we have doubts. In the 1989 movie *The Dead Poets Society,* a teacher of English literature, played by Robin Williams, ridicules the idea that poems can be graded on a scale of merit. Poetry can be good or bad, but it cannot be measured as if it were so much salami.This belief is part of a wider attitude to life on the teacher's part, which the film portrays as profoundly disruptive of established structures of authority. Measurement, it is suggested, is one more instrument of power in a repressive society. This is clearly an exaggeration, even a caricature, yet most of us can find some sympathy for Williams' standpoint. Poetry is not measurable and neither, we like to think, are the human beings who write and read it.Thorndike's puzzle boxes may have told him something about cats but it makes us uncomfortable to think they might work on us. It is noticeable that in our measurement-based society we are still intensely conscious of the ethical and aesthetic values that exist outside the measurable world. We may even be more aware of these intangibles than ever before, precisely because the physical and social scientists have built around us a world that is essentially a gigantic machine, its parts known with ever greater exactness. Measurement, we feel, may enable us to know the world, often to exploit it, sometimes even to control it, but in the last analysis it continues to be the immeasurable that gives meaning to human life.

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