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FULCRUM is a newsletter for collectors of antique weighing and measuring equipment and enthusiasts of historic metrology. It is published in February, May, August and November. Contributions should be sent to the Editor, John Knights.

Special K

There was a time when scientific definitions were fun, even though it sometimes sounded like the author was not really trying hard enough.

The ampere, for example, which is now one of the seven base units of the SI system used to be defined as '*a constant current which, if maintained in two straight parallel conductors of infinite length, of negligible circular cross-section, and placed one metre apart in vacuum, would produce between these conductors a force equal to* 2×10^{-7} *Newtons per metre of length'*.

This sounds really convincing and 'sciency' but in fact is pretty much meaningless. Infinite length? Negligible cross section? In a vacuum? Do me a favour! The conditional tense should be a clue.

It's pretty obvious that nobody ever actually did that or anything like that to calculate the magnitude of the ampere but there it was supporting the whole panoply of electrical science.

In pre SI days we British had our own system of units based on the pound, foot and second. Throughout the UK this was long inflicted on hapless school children in addition, of course, to the CGS version of metric, which turned out to be, very much, the 'Betamax' of the system.

The Pound, Foot, Second unit of luminous intensity was the 'Candle Power', ie.
'The light produced by a pure spermaceti candle weighing one sixth of a pound and burning at a rate of 120 grains per hour'.

Apart from the total 'wrongness' of a candle made from bits of a whale, the prospect of some white coated guys gazing at a 2 and a bit ounce candle to calibrate a light bulb is not altogether convincing. In the modern SI system the unit of luminous intensity, now expressed in terms of the efficacy of monochromatic radiation of a particular frequency, is still based on the illumination emitted by a candle. It's even called the 'Candela'!

All units, in current use, have long been redefined in non material terms which no longer require the possession of infinite lengths of wire or a dead whale, except of course the kilogram.

Up until 2019, the kilogram was still defined, and I paraphrase, as 'that lump of metal in a building just outside Paris, of such eminence that not even the rampaging Nazis in 1940 dared to interfere with it' (otherwise known as Le grand K!).

Le Grand K was made in 1879 from the most stable metallic alloy available, with a view to its being infinitely invincible. Copies were distributed around the world which could be inter-compared periodically and it was thus hoped that this expensive lump would do the job forever.

It was probably realised that the standard would not stand up to scrutiny in the very long run but in the short term it seemed to do alright so nobody bothered to look any further. Even when the metre was redefined a few times, so as to separate it from its erstwhile physical forms it was still agreed that the unit of mass fell into the 'too hard to do anything about' department. They thus, carried on occasionally dusting off Grand K and declaiming its supremacy.

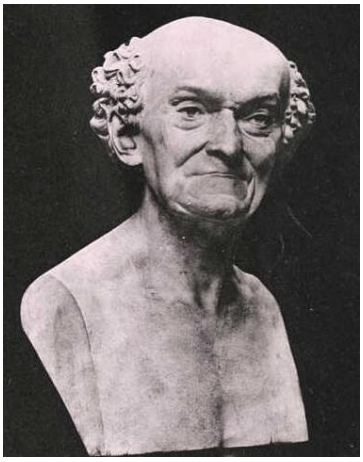
Eventually, of course, it dawned on the standards police that K was in fact mortal when it was actually found to be a losing a tiny bit of mass. The formerly ungraspable nettle finally had to be seized.

In reality the problem of a replacement had been considered and two possible methods of dematerialising the kilogram had been identified, both of which relied on theoretical 'constants'. At this point in the proceedings the whole thing enters stratospheric levels of incomprehensibility to idiots like me, who begin to long for the return of the dead whale. The first constant being touted was that of Amedeo Avogadro, a 19th century Italian scientist. I remember when Avogadro only had a 'hypothesis' to his name which dealt with the numbers of molecules contained in volumes of gas (we quite like your work Avogadro but we're not entirely convinced). His hypothesis has now been upgraded to an actual law and Avogadro also seems to have acquired a constant which has somehow become very significant in calculating the amount of 'stuff' contained in 'stuff'.

With regards to the kilogram this somehow transmogrified into a rather beautiful shiny sphere of silicon. Apparently because it is the most 'spherey' sphere ever made and thanks to Avogadro's constant, the makers could then calculate how much 'stuff' there was in the said sphere and thus the kilogram could be accurately defined.

This whole approach is totally incomprehensible to me but it is so aesthetically pleasing that I really hoped that this method would be adopted, if only on the principle that beautiful solutions are invariably the best. When Crick and Watson cobbled together their first model of the DNA molecule, they knew immediately that it was not right as it was a gangly mess. Only when the graceful double helix emerged did they know they had actually found the correct solution.

In reality the super shiny sphere was not to be! In another part of the Galaxy, people were playing about with a device called the Watt Balance and yet another constant attributed to one Max Planck. Planck was a contemporary of Einstein and was a fellow physicist who came up with the Quantum Theory of matter, out of which emerged the eponymous constant represented by the letter 'h'. We all know that mass can be expressed in terms of energy, thanks to Mr Einstein and we also know that energy can be calculated from the frequency of a fundamental particle such as the photon, using Planck's constant. I use the term 'we all know' incorrectly of course! By means of this concept and the wondrous Watt Balance (which has now been renamed the 'Kibble Balance', in honour of its inventor), an extremely accurate value of 'h' has been calculated and from this a theoretical definition of the Kilogram has emerged. The equation was formally adopted by all concerned on 20th May (aka World Metrology Day. *Yes really!*) 2019. I do note however that the practical application of the theory does still involve an enormous piece of kit that looks not entirely dissimilar to an electronic force balance, which has some kind of weighty thing sitting on it. This does, perhaps says something about the difficulty encountered in moving away entirely from reliance on the 'Grand K'.



Pirates in an Adventure with a Scientist

As mentioned in Edition 42, it is generally thought that the rejection by the USA of the metric system is attributable to Homer Simpson and that secretive organisation known as The Stone Cutters (who also control the British Crown and keep the lost continent of Atlantis off the maps).

In fact it is not as simple as that. In the 1790s one Thomas Jefferson, (second from the left on Mount Rushmore) who was then, Secretary of State in the newly created republic was actually a potential early adopter of the new system, then being created in Revolutionary France. The new American nation had many problems to resolve which included having a hodgepodge of foreign metrologies kicking around in various parts of the country. Jefferson had connections with France and the two nations, of course, shared recent experiences of removing oppressive rulers. Jefferson thought that this new rational system of metrology might be ideal for the new nation and sent out a request to the French.

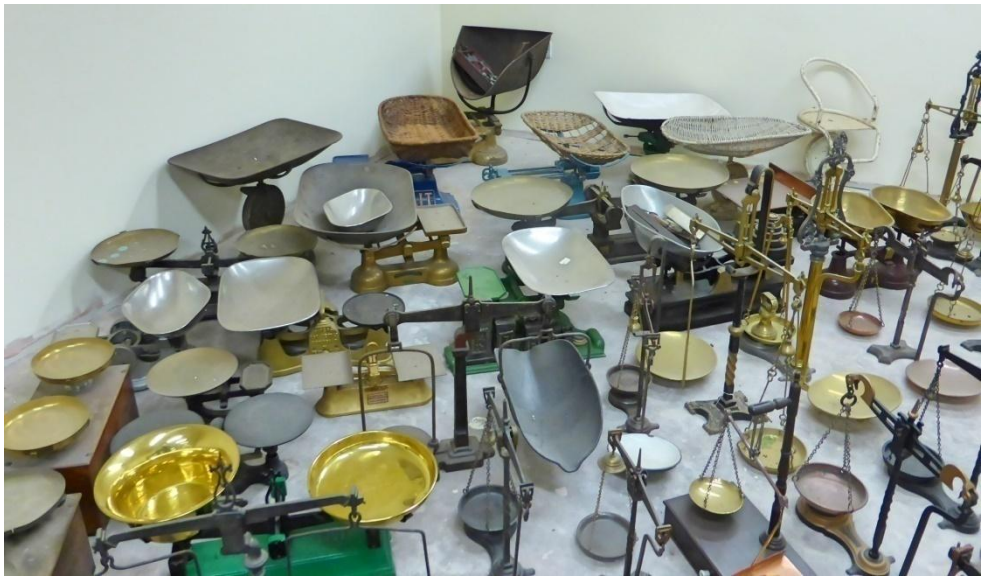
The system was still a work in progress at this time and indeed, Messrs Delambre and Méchain were still trudging around France, triangulating church steeples. Based on existing information however, preliminary models of the yet to be metric standards had been mocked up.

Thus, in 1793 examples of the new Metre and Grave (not even a Kilogram at this time) were dispatched to America in the charge of one Joseph Dombey. Dombey was a notable botanist and man of science who was, unfortunately, somewhat unlucky in the course of his career. Like many Europeans in the 18th century he spent time visiting the new world to collect specimens of exotic flora. Unfortunately his ships did keep getting attacked by pirates or impounded by local governments so not many of his specimens actually made it back to France. Quite what pirates wanted with exotic flora is a bit of a mystery! He was nonetheless chosen to be the bearer of the pre- metric standards to Thomas Jefferson in America.

Sadly his misfortunes followed him even into this enterprise! After his ship was blown off course by an Atlantic storm he was once again set upon by English privateers, basically government sponsored pirates, who yet again ransacked his cargo. Among the stuff taken by the pirates were the copies of the metre bar and the Grave which was in the form of a copper cylinder. You can imagine their delight! Dombey ended up as a captive on the Caribbean island of Montserrat where he unfortunately died, having never delivered his cargo.

Ironically the standards did end up in America, in the hands of a private collector who bought them from the pirates. They were eventually donated to the body that later became known as the National Institute of Standards and Technology where (presumably) they are kept incarcerated to this day by Homer Simpson.

Quite a collection!



Some collectors are much more skilled than I am at acquiring examples. My good friend John, for instance, has a plethora of types of all classes of weighing machine.

This nucleus of pleasing artefacts is, to my amazement, complemented by other equipment from throughout the metrological spectrum.

My failings as a collector also extend to organising and displaying what I've got – another skill John has, with help from his friends, developed into a fine art. As can be seen from these few photos, I hope.

Our September visit brought gasps of amazement and admiration from all attendees at the range and quality of exhibits John has achieved. As an Inspector of Weights & Measures in my younger days, I saw quite a few such items in the field.

What I was able to focus on this time was a wonderful display of <u>CAPACITYMEASURES</u>. These have nostalgia value for me, but they're also objects of great aesthetic beauty, especially when they come in sets, like weights. The form of the measure is reproduced in exactly proportional dimensions, as can be seen above. Each design is practical, and pretty rigorous in a scientific sense.

There's also the excellent provenance which a good collector will insist upon. Local Standards like the one above carry a date (here '1954'), the owner 'Ashton-under-Lyne Corporation' (succeeded in 1974 by Greater Manchester County Council, then by' Tameside'), and the correct working temperature of 62 degrees Fahrenheit (remember them?). A 3 Gallon measure with its carrying handles is the *acme* of the brass-founder's art, in my view. It should also be on someone's Red List of disappearing species…

A standout example of provenance is given by this pair of copper and brass petrol measures, in original bespoke wooden carrying chest. It still has the typewritten memo from Durham County Council's Darlington Divisional Officer attached, with yellowing sellotape, giving a few important safety precautions.

I'm very glad John has taken the time and made the effort to save such artefacts from the wreck of 'Time's winged chariot'. They don't just embody engineering principles. Such objects carry a human story woven around the people who used them, the places they were employed, the checks and balances on human activities which they provided.

For some unknowledgeable people, our collections may just be obscure objects of desire. For the true collectors, each piece is a joy in itself and a piece in a much larger and more fascinating jigsaw. Mike Sharpe.