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Lay metrology and metroscoping: Towards the study of lay units

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Abstract

This exploratory article provides groundwork towards a tentative framework for exploring how lay measures and units – what is here called 'lay metrology' – intersect with formal metrology, and its various mediations. This article concerns itself with the role that everyday 'units' – grounded in part in the material culture of bodies and experience – play in relation to a metrological landscape, or 'metroscape' that is also inhabited by standardised units routinely popularised through various media. After a brief overview of the relevant literature on metrology, examples of lay metrology are provided that examine the relation of everyday units of, for example, length and area, to particular forms of bodily experience, social identity and sensorial capacities. This article draws on elements from science communication and affect theory to develop the notion of 'metroscoping' and to articulate a series of orienting questions for engaging with lay metrological processes.

Keywords

affect, body, identity, lay metrology, mertroscoping, science communication, units

1. Introduction

Let us consider the 'Vague Ruler'.[1] This artefact, produced by designer Matty Benedetto, is one of '30 New Inventions That Solve Nonexistent Problems In Your Life', as the webpage puts it. The Vague Ruler is made up of a flat wooden 'paddle' (that incorporates a handle); onto this is inscribed a regularised scale that, rather than numbers, is marked by such seemingly arbitrary objects as forearm, beer bottle, remote, soda can and chapstick. In a humorous twist, it also includes 'ruler' and '2 feet or so'. In one photo, the Vague Ruler is held alongside a tape measure. On one reading, it is an ironic enactment of the idea of metrology – the institutionally sanctioned standardisation of the measures that undergird the infrastructures of late capitalist societies.

This irony can be unpicked in three initial ways. First, the Vague Ruler is not attached to any recognisable institutions but is the product of a single designer. In this respect, it carries neither the sociomaterial heft of the usual, familiar scales nor signals the expertise on which such scales

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depend. Indeed, by contrasting itself against such accredited scales, the Vague Ruler hints that such institutions can be questioned: how are they composed? What is their politics? Second, the Vague Ruler singularly fails to convey the sense of a standardised and abstracted scale against which different entities can be measured, quantified with particular, common units and compared. Insofar as it involves the direct contrasting of everyday objects in a seemingly 'slapdash' way in which each object is itself an approximation (after all, the sizes of soda cans, remotes, beer bottles are themselves variable), it conveys a sense of 'making do' – of practical estimation – in everyday life. Accuracy is not always a pre-requisite in the context of mundane exigency: a workable slapdashness is good enough. The third irony concerns 'scalability', that is, the work that is done in rendering entities comparable through an abstracted measure. The use of named objects on the Vague Ruler has the effect of evoking a multidimensionality. Rather than assessed against a predesignated scale (say length in centimetres), naming reintroduces additional specificities, complexifying the matter of comparison. The seeming arbitrariness of the named items printed on the Vague Ruler implies other relational modes, not just that of comparison against an abstracted scale. For instance, one can imagine narrative or corporeal or practical linkages and disparities between the various objects.

The point of this extended opening example is to raise a number of issues about the way in which metrology features in everyday life; that is, to explore how a mundane or lay metrology interlaces with the more formal processes of metrology exercised by various expert bodies. As such, this article concerns itself with the role that everyday 'units' – grounded in part in popular (material) culture – play in relation to a metrological landscape, or 'metroscape' (Crease, 2011), that is also inhabited by standardised units that are increasingly divorced from the mundane, and aspirationally attached to universal, physical constants.

But what does such a focus on 'lay metrology' afford? At a popular level, there seems to be a lay audience for accounts of the rise of contemporary metrology. Noteworthy here are James Vincent's (2020). *Beyond Measure: The Hidden History of Measurement* and Simon Winchester's (2018) *Exactly: How Precision Engineers Created the Modern World*. In these cases, the focus is primarily on the practices of professionals: other sorts of physical units as mobilised by publics are relegated within the narrative of increasing technical accuracy.

In terms of one core tradition of Science and Technology Studies, controversy has played a pivotal part as an entrée for symmetrically investigating the assumptions, practices, interests, networks and assemblages behind opposing or divergent epistemic claims (e.g. Bloor, 1976; Latour, 1987). While such controversies can revolve around the appropriate units of measurement (e.g. imperial vs metric; toxicological vs epidemiological), more usually, common – foundational – units (such as metre, gramme and volt) are pre-supposed. These latter are the 'collateral realities' that allow for the sides of a controversy actually to engage in debate, and that enable their respective ontologies to be managed (e.g. Law, 2011). In the examples I discuss below, derived as they are from popular culture and everyday life, units are deployed which reference concrete objects, locally resonant artefacts, stereotyped places, bodily commonalities and sensorial capacities. These are often – explicitly or tacitly – juxtaposed against more formal (or expert) standardised units in ways that might be variously oppositional, parallel, tangential or synergistic. This article thus aims to ask: how might we think these 'juxtapositions' of a 'lay metrology' with standardised formal units in the unfolding of particular putative phenomena (such as infrastructural problems, medical crises, or environmental disasters)?

Before we proceed, a line of demarcation needs to be drawn. This article concerns those modes of measurement oriented towards physical attributes – length, size, electricity, density and so on. It does not engage with matters of social and psychological measurement that are captured by such terms as 'audit society' (Power, 1999; Strathern, 2000). This is not because such measures (and

their politics) are irrelevant to the present argument, but because the aim here is to explore how specifically physical measurement and metrology is entangled within popular cultures (and their politics).

In sum, in light of the questions posed above, this exploratory article aims to do some initial groundwork towards a tentative framework for exploring how lay measures and units intersect with formal metrology, and its various mediations. I begin with a brief overview of the relevant literature on metrology in order subsequently to situate the emergence of mundane units which can serve particular social functions and/or reflect particular forms of experience. The point of this section is to explore how lay units are bound up with issues of identity, affect and corporeal experience, that can be juxtaposed to formalised units (and their institutional sources). This article then sketches a tentative framework for engaging with lay metrological processes.

2. Metrology, metrosophy, metroscape

In discussing metrology, we can begin with Robert Crease's (2011) *World in the Balance* and his broad characterisation of measurement. He draws a useful distinction between metrology and metrosophy. Metrology refers to the technical derivation, establishment and standardisation of units of measurement: that is, the ways in which units are instituted and refined over time. Accordingly, the function of metrology is to replace more or less local measurements with abstracted units that render the world measurable through universal or global systems of standardisation. Thus, instead of an inch defined by three dried barleycorns, or a yard by the distance between the nose and the furthest finger (e.g. Klein, 1974), a standard can be materialised in a particular object such as the 'seconds pendulum' which, in order to take one second to swing, had to be a yard in length (Crease, 2011). The advantage of such standards is that they could be reproduced, though they did vary depending on conditions: the seconds pendulum varied according to such things as latitude. The upshot is that such standards required an on-going calibration against particular exemplars, in what, as O'Connell (1993) framed classically framed it, universality is realised through the circulation of particulars. As Crease (2011) traces, metrologists have aimed to get away from embodied or materialised standards to focus on 'numbers, units, a scale and a beginning point. (Metrology) establishes that one property is greater than another, or it assigns a number to how much of a given property something possesses' (p. 269). The aspiration is that measurement transcends improvised measures – drawing on the human body, or natural phenomena, or physical standards such as the seconds pendulum or the standard metre that used to be held just outside Paris. Rather, units are embedded within 'a single, universal network that relates many different kinds of measurement and tied them all ultimately to absolute standards – physical constants' (Crease, 2011: 269) such as the Plank constant h, elementary charge e, speed of light c. The metre is now defined 'by taking the fixed numerical value of the speed of light in vacuum *c* to be 299 792 458 when expressed in the unit m s^{-1}, where the second is defined in terms of $\Delta\nu_{Cs}$'.[2]

Against metrology, Crease contrasts metrosophy[3] by which he means the concern for 'shared cultural understanding of why we measure and what we get from measuring, and (how that) understanding evolves over time' (p. 227). To engage in metrosophy is thus to explore how metrology is situated within, and inflects with, changing social, cultural and political conditions. Accordingly, it requires a consideration of the ways in which the advocacy of particular metrological systems and forms of standardisation map onto, for example, the development of the state and its modes of taxation (Ashworth, 2004), different national political systems (Crease, 2011), and even divergent cosmologies (Schaffer, 1997). Further, metrology, long the prerogative of expert institutions, intersects with metrosophy, which is the academic – but also popular – reflection on what it means to measure, in what Crease calls the 'metroscape' which is the broader 'landscape' of measurement as it

were. Within the horizon of the metroscape, 'Measurement is not merely one tool among others, belonging only to separate elements such as rulers, scales and other instruments; measurement is a fluid and correlated network that is smoothly and intimately integrated into the world and its shape' (p. 231). However, as Crease indicates, this fluidity can yield dissonance and conflict, whether through the deliberate mis-use of measurement in certain legal settings, or through the systemic over-application and over-precision of measurement (e.g. Bowker and Star, 1999; Vincent, 2020). As Crease puts it, 'In some regions of the modern metroscape, we demand exacting precision, while in others we are content with loose measurements and even prefer them' (p. 247).

Now, useful though the notion of the metroscape undoubtedly is, it leaves under-developed particular aspects of the social dynamics of measurement, not least when divergent modes or genres of enacting measurement (expert, popular, lay) intersect in ways that can be dissonant, parallel, tangential, or consonant. Moreover, under-explored are how popular, or what is here called 'lay metrologies', emerge, resonate and function in relation to publics for whom measurement *per se* is but one goal out of several. For example, while the human body has been an initial source of measures, and while in formal metrology it has been excised from this role, in lay metrology it still plays a part, not least as a seat of experience. As we shall see below, lay metrological units typically evoke an affect or sensation – an experience of length attached to disgust, discomfort or pride, or a sense of density or hardness associated with risk, damage and pain. In light of this, we might ask: what are the implications of these affective dimensions of lay metrology? In the next three sections I consider lay metrology in relation to, respectively, bodily experience, identity, and practices and the senses.

Lay metrology and the return of the body?

As noted above, metrology can be understood historically as a continuing process of divestment of the material, and especially of the corporeal.[4] As metrologists aspire to units grounded in physical constants, they technically remove reference to the body. Except, of course, the body is a major resource when comes to practices of science communication and popularisation.

Let us consider the example of nanotechnology. Nanobots and nanotubes can be represented for popular consumption either more technically (imagery produced through scanning tunnelling electron microscopy) or more imaginatively (by graphic designers or artists where links are drawn to applications). For De Ridder-Vignone and Lynch (2012) and Ruivenkamp and Rip (2014), technical depictions serve to 'authenticate' the reality of the nanotechnology and its underpinning, whereas imaginative representations serve to establish the practical promise of nanotechnology. However, we can also note that nanotechnology is not untypically compared to (a fraction of) the width of a human hair: as the inventor of the original Vantablack (new forms of Vantablack are now available) put it:

> Each nanotube in the vantablack forest has a diameter of around 20 nanometres (that's about 3,500 times smaller than the diameter of the average human hair), and are typically from around 14 microns to 50 microns long. A surface area of 1 cm^2 would contain around 1,000 million nanotubes.[5]

On the surface, this might appear a simple exercise in scientific popularisation that helps non-specialists visualise a particular phenomenon. But such informal units are not innocent. What human? What hair? What imaginary is assumed when such a comparison is rendered? At the very least we might suggest this comparison is suffused with affectivity – a micro-scale version of the technological sublime (Nye, 1994) in which wonder and awe are experienced at the smallness of technology and intricacy of human endeavour.

In the above illustration, the comparison to the body is, arguably, a way of mobilising sensory experience as a means of rendering the un-experience-able graspable. In contrast, everyday comparisons such as 'hailstones the size of golf balls' and 'the tumour was the size of a grapefruit' serve effectively as lay units that emphasise not simply size (as measured technically), but also, respectively hardness and potential harm, and invasiveness and bodily discomfort. In these cases, there appears to be an imaginary in operation that focuses on the damage-ability of the body: the affect is a visceral one (unlike affects attached to units of length based on measures of the body, where affect might be more concerned with commerce and parity, fairness and cheating – see Vincent, 2020). In these specific instances, the standard units of length and volume are folded into an imaginary of corporeal capacities to feel various forms of pain. In this mundane contrast between formal measures and informal comparators, there is a parallel – classical – contrast between the processes of medical objectification and patient subjectification (cf. Cussins, 1996).

Another example of the 'return of the body' can be found in the ways in which the UK government's injunction to maintain 2-metre social distancing for COVID-19 was popularised at the height of the pandemic. Two metres distance effectively operated as a sort of 'unit of safety', although the evidence supporting this distance was never straightforward (see Qureshi et al., 2020). In any case, once the 2-metre distance rule was pronounced, various efforts were made to popularise it, not least through particular visualisations. Thus, the BBC presented a number of ways of visually grasping 2 metres. Included in their clip were such 2-metre visual equivalents as: the length of two shopping trolleys; the length of a bed; the horizontally laid out height of three tall sportsmen and an enormous Bond villain.[6] Of course, there are many things that can be said about this array of visualisations. For example, the imagery divides along stereotypical gender lines – feminised domesticity that safeguards domestic space versus masculinised strength that 'fights the war' against the virus.[7] For present purposes, the focus will be on what these popularly re-visualised units might mean and do in relation to expertise and standardisation.

To the extent that these popular images of 'two metres' evoke a cohabitation between formal measures and informal analogies of everyday units, they are at once a mediation or translation and a tacit critique. On one hand, they convey – humorously – what two metres look and feel like: the invocation of bodily and affectively resonant imagery serves to potently convey '2 metres'. On the other hand, the official pronouncement of a standardised '2 metre distancing' evokes an abstract or alienated space (e.g. Viderman, 2020) that belies the ways bodies move in relation to one another, as a series of negotiated approximations shaped by the contingencies of everyday life. If safe spacing is concerned with how people practically operationalise '2 metres', the imagery presented serves as an ironic commentary on how the mundane estimations of '2 metres' are managed (e.g. Grimwood, 2021). Here, 'expertise' comes to lie with laypeople whose practical knowledge (of micro-sociomaterial processes) enables them to realise '2 metres' distancing in the flow of everyday life.

Measurement and lay identity

In addition to the body, lay metrology also deploys units that can derive from other sorts of entities such as particularly meaningful geographical spaces, technologies and structures. Two examples are provided.

Popularising depictions of environmental devastation are routinely compared in units of area which seem familiar, but which might be less than tangible. An example that is common in the UK is the unit of 'the size of Wales', also rendered as 'X number of Waleses'.[8] Even a cursory on-line survey reveals that 'the size of Wales' has been used to measure the area of destruction visited by an asteroid or a nuclear explosion, and to convey areas lost from the Antarctic ice shelf or the Amazon rainforest.

While another such popular unit of area – 'the size of football pitch' – can be more or less readily comprehended not least visually, this does not apply so obviously to 'the size of Wales'.[9] What makes 'the size of Wales' intriguing is that, while it is cartographically graspable, it cannot be experienced in a 'direct' sense. In this respect, there is something ridiculous about this measure: it has, in other words, become a cypher or an analogy for 'a very big area' that can nevertheless be collectively shared (at least in the United Kingdom). This aspect of sharing becomes clearer when we consider the environmental charity 'Size of Wales'. This organisation has been

> turning that negative use (to measure the rate of forest destruction) of the country's size on its head . . . Size of Wales successfully reached the target of helping to protect 2 million hectares of forest (the size of Wales!) in 2013.[10]

Here, given the charity is based in Wales and is oriented to the people of Wales (as well as communities indigenous to sites of deforestation), the 'unit of the size of Wales' has been attached to national identity. As it says on their website: 'Size of Wales encourages the people of Wales to help tackle climate change by taking simple positive actions'.[11] There is an entanglement of the huge scale (mediated through official statistical accounts) of deforestation, a popular measure of deforestation, national identity, and climate concern and action.

This last example again crystallises another affective dimension of lay metrology. This is the feature of irony that seems so often to attach to such popular units. If irony is, at base, a linguistic form in which a 'surface' meaning overlays a 'deeper' or 'counter' meaning (e.g. Muecke, 1969), in the case of 'the size of Wales' this irony plays out because the humour of the unit 'the size of Wales' is underlain by the seriousness of environmental concern and intent mobilised through national identity. In other words, in enmeshing identity, Wales, environmentalism, formal and popular units, there is an affective enactment of ironic humour that at once encompasses the arbitrariness of a unit and the necessity of environmental action. This can also be understood as a tacit critique of the passivity of governments or the indifference of corporations in relation to deforestation.

A second example of this irony can be found in the case of the many representations of London fatberg (Michael, 2020). The then largest London fatberg – found in September 2017 in Whitechapel – was estimated to weigh about 130 tonnes and have a length of over 250 metres and to be composed of a hardened conglomeration of fat, human excreta and effluvia, and various objects and substances (wet wipes, needles, drugs). Ironically, the fatberg prompted not only feelings of disgust but also pride. In part this was mediated by the translation of the length and weight into units that were recognisably Londonesque: as relayed in the UK liberal broadsheet, The Guardian:

> The units in which it (the fatberg) was routinely measured gave away its birthplace. This being a London phenomenon it was invariably described in local currency: at 820 feet, the fatberg was 'longer than Tower Bridge' or 'twice as long as Wembley Stadium' and 'the weight of 11 double-decker buses'.[12]

The London-ness of the fatberg is ironic insofar as the deployment of indigenous units to chart London's own seeming infrastructural decline (the problematic state of London's sewerage infrastructure) is simultaneously a celebration of 'London's' stoicism and sense of humour. Here, the units convey the disgusting enormity of the fatberg (and the extent of London's infrastructural problems) but also serve in an enactment of London as able to laugh at itself in the face of a profound disgust, predictable decline and possible disaster. Within the complex enactments of the fatberg, Londonesque units combine with formal units to convey a labyrinthine pattern of affects, minimally: irony, resignation, disgust, and pride (see Michael, 2020). However, there is

arguably another affective dimension at play here. While the various popularising (science communicating) accounts, especially those that appeared in a high profile TV programme and a major exhibition, emphasised a panoply of risks (to health, to domestic plumbing and to the sewerage infrastructure) none of these came to pass. In actuality, the fatberg did not disastrously impinge on London. In effect, the problems the fatberg potentially posed were successfully removed. In this context, the ironic deployment of mundane Londonesque units amounts to a tacit criticism of the official portrayal of the (size of the) fatberg and the (size of the) risk. Indeed, connoted through these mundane measures are the sense that the fatberg was a routine problem managed by mundane maintenance as opposed to an unprecedented monster that was spectacularly defeated (Michael, 2020).

Lay metrology: Practices and senses

The UK government has long promoted energy smart metres as a means of reducing energy (and carbon) consumption (e.g. DECC 2009). Underlying this policy are models of energy consumption that assume that consumers can use the information provided by smart metres – not untypically couched as technical units (such as Kilowatt hours) – to modulate their energy use. The underlying model of the consumer is one of a rational, calculative individual who can draw on this information to increase domestic energy efficiency (for instance, by reducing the use of energy-hungry appliances, or switching off standby-enabled devices). Putting aside such difficulties as installation in a multi-apartment building or technical issues in information processing (see Boucher et al., 2018), evidence has gradually accumulated that such smart monitors do not seem to facilitate the presumed energy savings (e.g. Buchanan et al., 2015; Hargreaves et al., 2010). Indeed, in many cases there was a recursive process through which apparent energy efficiency increased consumption (for instance, residents left on for longer low energy lighting). In addition, people struggled to integrate the monitors into their domestic routines. It seemed that consistent use of the monitors needed a particular sort of set of skills and interests (echoing what Strengers, 2013, called 'resource man'), otherwise they were often consigned to out-of-the-way places.

Drawing on Rex Martin's (2020) ethnography-based case study of a microgrid on the Isle of Eigg in Scotland and reading it through the lens of lay metrology, it would appear that monitor-based formal units were routinely overtaken by 'lay data', or experiences. These are rooted in attuned senses and everyday practices, in particular sensibilities towards, and responses to, energy hungry appliances and environmental conditions. Such sensorial data provided ready clues as to what counts as efficient or reduced energy use, and informed how the use of appliances should be managed. Here, there is a local 'imaginary' grounded in specific practices and senses that develop in response to specific circumstances (the microgrid and the limits to consumption that this imposes). In Martin's case study, while these formal units and corporeal measures intermesh, analytically they comprise different epistemic and affective registers, as it were. As Martin (2020) summarises:

> Technical knowledge, such as an ability to use and understand units of energy and power, is indeed relevant to islanders' understandings of energy consumption. However, rather than forming the basis of most householders' understandings, this technical knowledge was instead used to both formalise and supplement practical forms of knowledge developed through bodily engagement with the environment, and lived experience (such as a sense of which appliances were most energy hungry, or the presence or absence of wind). Although not necessarily as accurate or detailed as the technical knowledge communicated by energy monitors householders draw on intuitive forms of heat-based sensory feedback in order to understand their energy use. (p. 7)

In Martin's example, we have a more or less consonant entanglement through which a particular public encompasses senses of energy availability, practices of energy consumption, and information about formal units of energy consumption in order to ensure a regular supply of electricity. What this implies is that the formal units of energy mediated by energy monitors are in themselves insufficient for the management of energy usage. Further, that these are enmeshed in lay metrologies suggests that to privilege energy monitors (as UK energy policy does) and their standardised readouts is to de-privilege the sensibilities which enables energy use management, and to risk the eventual disuse of the monitors (as various studies have shown). A metrological vocabulary that can incorporate the different registers of formal and informal, measure and practice, observation and sensibility might usefully serve in better enabling energy management more broadly.

3. Some limitations and complexities

The preceding sections have set out three broad ways in which lay measurements function – in relation to bodies, to identity, and to practices and the senses. As is evident, it is not always easy to differentiate bodies, identities, senses and practices. Other limitations are that these illustrations are primarily UK-based, and they are confined to measures of length, area, density and electricity. It is taken as a given that a lay metrology that drew on different physical units or analysed the enactment of units in different cultural settings might play out in different ways. Nevertheless, the present examples do serve the broad purpose of pointing to how everyday publics can draw on a range of lay measures in grasping their sociomaterial world that stand in contrast to more expert measures. However, to juxtapose lay and expert metrologies solely in terms of 'contrast' is misleading: there are many ways in which these are entangled, not least, through the efforts of practitioners of science communication and popularisation, as we see above. Indeed, technoscientists themselves can enter into this process of rendering metrology 'lay'. Take the Chronophage.[13] As a mechanical clock, it conveys the phenomenological relativity of time as it speeds up and slows down, while also keeping to metrological standards (evidenced in the fact that it incorporates six new patents). A visit to the Wikipedia page 'List of humorous units of measurement'[14] reinforces the view that the border between expert and lay metrologies is porous, even 'rhizomic' insofar as lay and expert metrologies 'inform' one another (see Martin, 1998). Perhaps most famous is the unit of the Smoot.[15] The Smoot is the unit of length of 5 feet 7 inches equivalent to the height in 1958 of then student Oliver R. Smoot who was used to measure the span of the Harvard Bridge (364.4 Smoots). Ironically, Smoots subsequently became the American National Standards Institute's Chairman, and then the International Organisation for Standardisation's (ISO) president. The Smoot, among other units, is (ironically) used by both Google Earth and Google Calculator.

The point of this seeming excursion is that it emphasises the complexity entailed in the 'circulation' of units 'across' expert and lay domains. This circulation can be contrastive but also ironic, synergistic, tangential and co-habitational. The examples presented above have merely scratched the uppermost surface of these unitary 'circulations'. In the next section, drawing on the preceding examples, a framework is sketched for thinking about, and empirically engaging with, lay metrology and its entanglements with accredited metrological actors and popularising practitioners.

4. From metroscape to metroscope

When Crease (2011) writes 'In some regions of the modern metroscape, we demand exacting precision, while in others we are content with loose measurements and even prefer them' (p. 247), there is an evocation of separate domains over which can be cast a god's eye view (Haraway, 1997). However, as we have seen, such domains emerge in relation to one another: precision and

imprecision play off each other, not least because practices, bodies and identity are mobilised in various ways in everyday life. Indeed, rather than the notion of metro*scape* with its optical connotation of a received landscape, we can propose the idea of a metro*scope*, understood as a proactive process of *scoping* the range, circulation and interlacing of expert and lay metrologies. In what follows, there is an attempted operationalisation of this concept of metroscope, one that begins to 'track' units across popularising, everyday and expert metrological domains.

5. Towards a framework for the analysis of lay metrology

In metroscoping lay units, one good place to start seems to be publicisation of particular lay units in the media: as we have seen, enactments of Covid-safe distance, the London fatberg, the unit of ecological devastation all find expression in the media. Here, we can draw on the literature in science communication and popularisation. Science communication and science popularisation can be distinguished (though in some places, such as China, these are by and large interchangeable – see Li and Ma, 2021) as follows: the latter has overtones of diffusionism, though more recently it has been used to demarcate science-public communications in which, for instance, the science is less subject to controversy; the former is more concerned with controversial science and increasingly with communicative forms in which publics are engaged in one way or another (e.g. Bucchi and Trench, 2016). Clearly, there is much overlap between these fields especially when one takes into account the mediation (or even mediatisation, Väliverronen, 2014) of scientific knowledge and debate through a panoply of news media outlets and fora (not least digital), museums, installations and galleries, popular science publications and TV programmes, fictional genres such as soap operas, science fiction and police procedurals, government and corporate sponsored public consultations, and university-led participatory and dissemination events. In any case, both science communication and science popularisation can be said to be involved in a process of translation, adapting scientific knowledge into representations that are more accessible to various publics.

However, to some extent 'translation' is a misnomer. As studies of science communication and popularisation have long noted, popular culture can inform the ways in which scientific knowledge and debate comes to be formulated (e.g. Martin, 1998; Clemens, 1986). Even so, the element of translation remains a central part of science communication and popularisation. Indeed, for Cloître and Shinn (1985) the pattern of translation can be said to follow an 'expository continuum' structured along three parameters from scientific to popular: decreasing reference to scientific phenomena and increasing indications of historical context and practical application; from pervasive use of graphs, tables, and so on to deployment of schemas, cutaways, icons, metaphors, and so on; and a shift from highly specific and quantitative arguments to broader, qualitative ones.

The impression that this focus on translation conveys is of a unilinear movement from the 'citadels' of science (Martin, 1998) into the public arena. However, as critiques of actor-network theory have insisted, things are rather more complicated when 'translation' is understood in relation to actors who resist, or to settings marked by divergent practices (see Michael, 2017). For Davies and Horst (2016), grasping the processes of 'science communication' entails paying attention to the complex circuit of culture (and materiality) that encompasses not only representation, but also production, consumption, regulation and identity. Crucial for present purposes are the ways in which the representations of science communication are consumed, but also the ways such communications are performative in the sense of promoting particular expectations about science and technology, of enacting particular versions of scientific citizens, and of facilitating the circulation of particular emotions and affects.

There are three main points to raise about this 'extended' version of science communication. First, as Davies and Horst note, we cannot assume that the public towards whom these science

communications are directed are passive. Drawing on Hall's (2003) cultural studies model of representation, they argue that the representations entailed in science communication need to be decoded by audiences. The second point, that echoes classic work in critical Public Understanding of Science (e.g. Wynne, 1992) is that these audiences bring to bear their own cultural and practical resources in the process of decoding – resources that reflect their particular sociomaterial circumstances and identities as, for example, HIV activists (Epstein, 1996) or advocates for repetitive strain injury (Arksey, 1998). Third, a parallel point applies to expert communities: they too can be confronted with the folk understandings of publics, and draw on their professional resources variously to dismiss or accommodate public understandings. To access such resources, the concept of imaginary seems particularly helpful, especially if qualified with the prefix 'metrological' (despite warnings against the use of such prefixes – see McNeil et al., 2016). While other frameworks – say those associated with discourse analysis or social representations (see, respectively, Gilbert and Mulkay, 1984; Moscovici, 1984) – can be also used to engage with these resources, the notion of imaginary lends itself particularly well to tracing the role of affect in metrology. In this regard, in what follows we discuss what a concept of 'metrological imaginary' might offer.

In Science and Technology Studies, it is the pioneering work of Jasanoff and Kim (2009) that has most influentially articulated and developed the notion of imaginaries. Their concept of 'technoscientific imaginary' is particularly attuned to the ways in which the operations of the state link to and 'lock in' particular innovations and programmes of innovation with visions of the future. As McNeil et al. (2016) usefully trace, this version of 'imaginary' has been extended to encompass, for instance, how discrete technoscientific institutions enact images and discourses of the public, and how, rather than placing the emphasis on the emergence and privileging of particular imaginaries (by states), other imaginaries can also be studied not least in terms of how they resist or counteract predominant imaginaries. Charles Taylor's classic definition of social imaginaries particularly captures the depth of imaginaries. Accordingly they entail: 'the ways people imagine their social existence, how they fit together with others, how things go on between them and their fellows, the expectations that are normally met, and the deeper normative notions and images that underlie these expectations' (Taylor, 2003: 23). In the present case, this involves the shared units through which technoscientific issues, matters of concern, controversies and so on are tacitly structured. As noted in the introduction, these are the background assumptions that 'normalise' debate in the sense of allowing it to proceed on commonly accepted grounds. If imaginaries operate normatively, as Taylor argues, then they are deeply affective not least in the sense that to undermine them can lead to disorientation and even moral outrage.

To articulate the affectivity of the 'imaginary' of units we can draw on the work of Anderson (2014) who argues that affect is patterned by sociomaterial conditions that can take various forms including apparatuses (whereby affects are targeted as 'objects' of knowledge and intervention by governmental means), and atmospheres (which are a more diffuse ensemble of not always easily identifiable elements). In relation to imaginaries, Jasanoff and Kim's original formulation of technoscientific imaginaries might be aligned with affective apparatuses as implemented by nation states that aim to instil in their populations a commitment to preferred versions of innovation and progress. Affective atmospheres are perhaps best related to the work of Haraway (1997) whose analytic approach, as McNeil et al. note, ranges over multiple genres (including science fiction, advertisements and cartoons as well as technical and popularising texts) and captures the complexity of imaginaries and their multiple affects such as hope, anxiety and pleasure.

In sum, we can envisage lay metrology in terms of – to put it crudely – a 'movement' of technical units that are complexly translated through popularising and communicative media that can entail decoding through atmospheric metrological imaginaries. As an initial way into empirically

and analytically engaging with this movement, a process of 'metroscoping' can be proposed. This can be formalised through a series of broad, orienting questions:

1. Scope representations of lay units: what sort of media enact lay units (e.g. news, specialist, popular, activist and advertising) and what are their typical audiences (e.g. local, general and special interest)?
2. Scope lay units: what units are being enacted and how do they map onto formal metrological units (e.g. distance, mass, density and time)? Do these lay units have an overt or stated function, for example, are they concerned with making things more comprehensible or practicable?
3. Scope how these lay units implicate a broader lay metrology: what are the atmospheric imaginaries which inform or shape these lay units and their affectivity, for example, does a lay unit reflect a commonly held identity or shared sense of practical contingency?
4. Scope how these lay units function performatively. Do these lay units reproduce a hierarchy in which formal metrology remains the source of 'proper units'? Do they affectively reinforce particular lay cultures that directly challenge, gently ironise or tacitly critique the applicability or appropriateness of formal units?
5. Scope the reactions to lay units. How do expert practitioners respond to lay metrologies and their relation to formal metrological units? When are these regarded as practical 'rules of thumb', dangerous deviations or outright opposition to expert metrological knowledge and procedure?

In this section, albeit all too briefly, there has been a survey of several literatures with the aim of developing a sketch of the intertwining elements that compose what has tentatively been called 'lay metrology' and 'metroscoping'. In a nutshell, it has been suggested that metrology comes to inform – undergird – the enactments of science communication and popularisation which publics decode with the aid of atmospheric, affect-laden, imaginaries. In some ways, this amounts to a characterisation of (aspects of) the metroscape wherein measures are supplied and contested, assumed and challenged, and are variously presented as precise or vague. In any case, this involves a doing of politics in which the circulation of units from different sources (expert, popularising, lay) come together at various points in differing degrees of consonance and dissonance.

6. Concluding remarks

This article has attempted to lay out some of the ways in which we might articulate and exemplify a 'lay metrology': these have been initial steps towards establishing this as a bona fide substantive field of research. The rest of this article sketches the outlines of a research programme, or at least formalises some of the issues that a research programme could address.

Now, the present analysis is not meant to imply that lay metrology is somehow 'superior' to the standardisations wrought by formal metrology. In addition to dangers of valorising lay metrology in the context of arguments over the dangers of 'post-truth' cultures (e.g. Kelly and McGoey, 2018), there is a parallel risk of neglecting the complex work that formal metrology does in enabling the processes of infrastructuring, including co-ordinations across infrastructures. However, given that contemporary understandings of infrastructures take note of the multiplicity of their functions (e.g. Karasti and Blomberg, 2018), this throws into relief the point that metrology does many things. The upshot is that to study lay metrology is to be attuned to the multiple elements of lay and formal metrologies and their various operations, functions and intersections.

To end, we can return to the Vague Ruler as an initial model for thinking more speculatively about lay metrology (e.g. Wilkie et al., 2017). As noted at the outset, the specificity of the objects named on the Vague Ruler, implies that there are emergent modes of comparison and connection other than that of length, such as narrative and affective. For instance, the unit of the London bus and Wales can be compared in terms of the sorts of pride or identity that each evokes. How might, say, participatory engagement with specific groups allow for the 'invention of scales' (that might combine the formally metrological with lay metrologies of affective, narrative, economic, and so on qualities) in ways that both illuminate the tacit functioning of the formal metrologies and allow for more novel questions to be articulated?

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Notes

1. https://www.boredpanda.com/product-design-unnecessary-inventions-solve-problems-no-one-has-matty-new-benedetto/?utm_source=facebook&utm_medium=social&utm_campaign=BPFacebook&fbclid=IwAR1FC7x_sxGT6qiwrFdgCdGZz3IKfJkma-WZC3O5xQ9jbr9H5iCFSMV76DU (accessed 10 May 2022).
2. See US National Institute of Standards and Technology. https://physics.nist.gov/cuu/Units/current.html
3. Metrosophy has another irrelevant-for-present-purposes meaning, namely, that of urban-based philosophy (Kishik, 2015).
4. To reiterate, the examples presented here are primarily UK-based. While these are no doubt found in other regions given the globalisation of science, no claims are made about the generalisability of these examples.
5. http://www.surreynanosystems.com/vantablack/faqs (accessed 29 January 2017).
6. BBC (2020). How to keep 2 m social distancing. https://www.bbc.co.uk/news/av/health-52054844/coronavirus-social-distancing-advice-what-two-metres-looks-like
7. Thanks go to Laura Salisbury for this insight.
8. This is evidenced in a BBC article which asks in its heading 'Why is Wales used as a unit of measurement?' then goes on to give several examples. https://www.bbc.co.uk/news/uk-wales-46737277 (accessed 3 May 2022).
9. It is worth noting that the size of a football pitch varies considerably across age groups, and even for 'adult sized pitches' it ranges between a length of 100 yards and 130 yards and a width of 50 yards and 100 yards, with the Football Association recommendation being 110 × 70 yards. See http://news.bbc.co.uk/sport1/hi/football/rules_and_equipment/4200666.stm; https://www.thefa.com/cfa/facilities-and-funding (accessed 27 September 2022).
10. https://sizeofwales.org.uk/about-us/ (accessed 3 May 2022).
11. https://sizeofwales.org.uk/about-us/ (accessed 3 May 2022).
12. London's fatberg on show: 'We thought of pickling it'. *The Guardian*. https://www.theguardian.com/culture/2018/feb/04/fatberg-museum-london-display-pickling-age-waste (accessed 28 November 2022).
13. See Beware the time-eater: Cambridge University's monstrous new clock. *The Guardian*, 18 September 2008. https://www.theguardian.com/artanddesign/2008/sep/18/corpus.clock (accessed 3 October 2022); *The Chronophage*, https://www.johnctaylor.com/the-chronophage/ (accessed 3 October 2022).
14. https://en.wikipedia.org/wiki/List_of_humorous_units_of_measurement#FFF_units (accessed 4 May 2022).
15. http://web.archive.org/web/19970806205154/%68ttp://web.mit.edu/museum/fun/smoots.html (accessed 4 May 2022).

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