Capitalism and the Triumph of Quantity over Quality.

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Introduction

An earlier paper in *Radical Statistics,* Scott (2018), discussed the way in which quantification in general and statistics in particular have become key components in the *spectacle* that dominates contemporary capitalist social relations. The most recent example of this spectacle is the way in which numbers are central to both government policy and mass media commentary regarding the coronavirus epidemic. The number of people testing positive, the numbers dying, the R (reproduction) value, to name but three quantities, are pounded into our heads on a daily basis. There is, by comparison, very little public discussion of the qualitative dimensions of the epidemic. How is a corona death defined? What pressures are doctors under when signing death certificates? Are questions that are rarely asked. Similarly, what is the meaning of a positive test result given by a large multi-product/service private company, such as Serco, with little or no track record in this specialist area? The R value is a perfect example of reification, see again the above mentioned paper. How are the weights allocated to the range of variables used by the ten or so organisations publishing R values in the UK? More generally, it is clear that the qualitative focus of the UK government is to use the pandemic to reinforce its socio-economic agenda, i.e. attempting to cut what is left of the welfare state, privatising the National Health Service, promoting the interests of tech companies, pharmaceuticals and certain other businesses. As a result, it is no oversimplification to say those dying from the virus are overwhelmingly elderly and ill working class people, typically in private nursing homes looked after by staff on the minimum wage.

The purpose of this paper is therefore, given the above mentioned state of affairs, to investigate the way in which quality has by and large been vanquished by quantity. To this end, the paper will take a historical perspective in order to demonstrate that the diminishing of quality is not a random development, but rather that each stage in human history is marked by its own relationship between quantity and quality. For the most part, quantification, how many, is reductive: the whole is merely the sum of its parts; whereas quality refers to identity, what an entity is, which suggests process, the becoming of the natural and social world. Since statistics is the most common form of quantification, i.e. applied mathematics, it is surely important for us to to acquire a deeper understanding of the genesis of the rise of the quantitative and the corresponding decline of the qualitative.

Quantity in prehistory

We can begin in prehistory, see Kelly (2007), when early nomadic hunter-gatherers interacted with each each other and the natural world around them. With a few exceptions, such as tribes in Western Canada which practised slavery, hunter-gatherer societies were classless and egalitarian. Counting would have been rudimentary and democratic, pretty much restricted to male hunting of animals, fish and birds and female gathering of fruit, edible plants and the like. Whilst limited by what items could be carried, it would seem that qualitative cultural activities were central to the lives of hunter-gatherers. Bellos (2011) discusses his time with one surviving Amazonian tribe, the Munduruku: “there was never any need to count…Counting people…is a way of singling people out, which makes them more vulnerable to malign influences” (p15-16). This can be compared to the racist view of Dantzig (2007) who, writing in the 1920s, discusses “the most primitive tribes of Africa and Australia…These savages have not yet reached finger counting” (p14).

As settled agriculture developed, quantification seems to have become more widespread; with farmers measuring field sizes, weighing grain, counting building materials and so on. Similarly, artisans would would count, weigh and measure in order to practice their craft. However, as Graeber (2012) points out, it is important to note that neither barter nor the use of money were a regular feature of village or communal life. Rather, the distribution of goods and services seems to have been predicated upon an egalitarian ethic similar to that of their hunter-gatherer ancestors.

The development of number systems in the ancient world

With the rise of the ancient city states, the relatively democratic and practical approach to quantification changed dramatically. The key feature of the city states which arose around 6,000 years ago was the existence of social class divisions. The ruling elite would systematically dispossess the subordinate classes, employing scribes to record numerical information in order to measure their wealth and power; a proto-accountancy as Brooks (2019) explains. Early evidence of quantification in ancient cities can be found on surviving clay tablets, found in the Tigris Euphrates basin, along with notches on tallies and other markings used to record “taxes, tithes, census data, dates, land” and so on, writes Levy (2013,p14). Needless to say, members of subordinate classes were excluded from the more abstract forms of quantification. Complex number systems developed as the ruling elites of these city states employed bureaucrats, astronomers, priests, proto-accountants and others to record “weights and measures, squares and cubes…reciprocals…(and) compound interest”, Levy (p35). As compared with these developments, the later Imperial Roman number system, including I, II and III, seems rudimentary, with subtraction implicit in the symbols for four and nine, i.e. IV and IX. However, this quantification system appears to have been sufficient to maintain the exploitation that marked the ancient Roman economy. In contrast, judging by the contents of surviving fragments, the ancient Egyptians’ number system was highly sophisticated. The intellectual elite developed tables for multiplication and division, anticipated Zeno’s paradoxes concerning motion, generated summation series and geometrical progressions, with ever larger denominators and powers. As we shall see, these developments were to be integrated into later capitalist quantification methods, which in turn formed the backdrop to Victorian statistics.

Number as abstract symbol

The creation of number systems by priests, astronomers and other elite groups in the employ of the ruling classes of the ancient city states was underpinned by the belief that numbers contained the secrets of the universe and these should not be made known to the uninitiated. As explained in most histories of mathematics, see for example Parker et al (2019), the political fortunes of the ruling elites in the ancient world waxed and waned, dynasties came and went, and there developed a number of initiate mystery groups. The best known of these being the Pythagoreans, who were strongly influenced by ancient Egyptian and Babylonian mathematics. Rather like today’s professional mathematicians and statisticians, these mystery castes sought to monopolise specialist areas of calculation, charging for their services in largely innumerate societies. Their esoteric approach to number was made possible by the process whereby numbers metamorphosed from *adjectives*, such as two books, into abstract *nouns*, denoting simply two. Thus abstract number symbols became reified and, according to these mystics, each number became *qualitatively* different from the others. For example, the number 7 was given great significance in terms of the planets, the diatonic music scale, the days of the week, alchemic experiments and more.

The number 13's Satanic associations, along with other remnants of qualitative notions of number, are today dismissed as superstition and 13 has become just another abstract number; although in some cultures its demonic heritage survives to this day. As a reading of Shesso (2007) suggests, in capitalist society religion and mysticism have for the most part been displaced by secularism, astrology has become astronomy, and alchemy has been transformed into chemistry. Correspondingly, each number symbol has been purged of its mystical significance and become a mere abstract symbol. However, remnants of older number systems remain, such the use of Roman numerals and bases of 60 and 12 in measuring time.

Raju and the history of mathematics

...the Babylonians had numerical and algebraic expertise that went far beyond anything the Greeks ever achieved; Clegg (2017a, p46).

The Greeks Thales and Pythagoras *travelled to Egypt specifically to study mathematics. Presumably there must have been more for them to learn than is revealed in the Ahmes and Moscow papyri*; Levy (2013, p22-3).

Building on the contributions made by Indians over thousands of years to logic, mathematics and probability, Raju (2013) challenges the view that mathematics was invented by the ancient Greeks. As the epigraphs above suggest, some British writers are following Raju's lead, noting that the Greeks confined themselves to geometry and used letters of the alphabet rather than numbers. Written long before paper entered Europe from China, surviving Greek texts are, Raju points out, for the most part, translations from a number of languages, notably Arabic. He notes that contemporary classicists play fast and loose with regard to the progeny of the texts attributed to Plato, Aristotle, Euclid and other Greeks. Similarly, Raju refers to the scant evidence for the existence of Pythagoras and the members of his cult, noting that geometric theory was established long before in ancient Egypt and India. He challenges the classicists' high estimates for the number of free citizens, mostly slave- and land-owners, who would have had the leisure time and resources to write books on geometry.

Crucially, Raju questions the very existence of the key figure in the history of mathematics: Euclid. Speculating on who might be the real author of the *Elements,* he notes that the famed library in Alexandria had copies of mathematical texts from Egypt, Babylonia and elsewhere. Raju points out that this and other ancient libraries were destroyed under orders from the priest caste of the Roman Catholic church. Having purged itself of liberal tendencies, Catholicism became the official ideology of the Roman empire and its priests encouraged a mob to murder the mathematician Hypatia in the 5th century AD. In what he refers to as the Christianisation of mathematics, Raju traces the later struggle of the priests against Muslim people, who had colonised much of southern Europe bringing with them material wealth and advanced quantitative techniques. As part of this struggle, the priests encouraged landowners and their serfs, in a materially and intellectually backward feudal northern Europe, to volunteer for a series of Crusades to 'liberate' Jerusalem from Muslim control. These military adventures failed, as a result of which the priests accepted material and intellectual reality, adopting some of the more advanced thinking of the Muslims. Military force having failed, the priests sought to bolster Christian doctrine as a means for converting Muslims, Jews and "pagans" by means of rational argument. Central to this endeavour was setting up universities, modelled on Muslim institutions in Spain and elsewhere, in order to train priests in doctrinal apologetics. The *Elements,* attributed to Euclid despite scant evidence, became a key text in training the priests at Paris, Cambridge, Oxford and other universities. This text became a model for proof by means of deductive logic, a method that remains a paradigm amongst mathematicians and statisticians to this day.

However, Raju argues that some of the 'proofs' contained in the *Elements* are not deductive at all, but rather are empirical, i.e. based on evidence gained from practical experience. For example, 'proofs' relating to triangles in the text rely on the areas of squares, knowledge of which had been systematised by ancient Egyptians for purposes of land division and architecture. Even the doyen of the Cambridge deductive proof paradigm, Bertrand Russell, admitted as much in his writings on mathematics. The orthodox approach to deduction as the basis for timeless and universal truth is taken, in large part, from the range of texts attributed to Aristotle. However, Raju doubts the authorship of these texts, demonstrating that alternatives to deductive logic were developed in India, China and elsewhere, as discussed at length in Scott (1999).

Finally in this section, Raju points out that mathematics and logic were highly developed in ancient and mediaeval India; including discussions of infinity, the number zero, square roots, linear and non-linear equations, all of which were vital to the development of statistics. Long before the Italian accountants, Raju argues, Indians used negative numbers to signify debts and percentages to measure interest rates. Given their invention of a form of calculus and the use of graphs, long before Newton, increasingly historians are claiming that European maths is more or less plagiarised from Indian sources, via Arab traders. Yet, in the European medieval period, users of the abacist culture and Roman numbers, supported by the church, resisted the Indian/Arabic number system, described by one monk as "dangerous Saracen magic" Shesso (p8). Eventually, north European merchants began using the "Saracen" system in secret.

The quantification and domination of nature

In the later medieval period and beyond, the major European powers began a dual process of exploiting nature at home and, by colonial expansion, abroad. Isaac Newton, supported by his secular successors, provided the quantitative underpinning to this dual process. These pioneers of the scientific revolution side stepped the Aristotelian deductive method, with its hard distinction between the true and the false, and adopted an inductive approach to nature in which repeated observation and experimentation became the norm. Gradually, the 'laws' of nature were modelled in the form of mathematical equations which underpinned its domination. Here nature included human beings which, as we have noted above, were racially stereotyped in order to justify the institution of slavery, in which the value of human beings was reduced to quantities of currency. Thus began the colonial, and later industrial revolution, the effects of which are, in the form of climate change, threatening human survival in the early 21st century.

Despite intellectual stagnation in the Muslim world, the Arabic/Indian number system gradually replaced Roman numerals for the accountants, bankers and others facilitating trade, colonial expansion and slavery with the formation of joint stock companies. With the weakening of Papal influence, use of the number zero, or nothing, became a commonplace. The qualitative associations of nothing, such as poverty, death and absence, were discarded as Arabic numbers became the reified quantitative lubricant of the emerging capitalist wage labour system which came to dominate social relations in Europe, North America and elsewhere. Abstract symbols were used to measure the prices and quantities of goods, services and wage workers in the relentless pursuit of profits expressed in purely quantitative terms. For the factory owner, quality was merely a minimum standard of the use-value of a product, as required by the state. As the state supported colonial expansion, developments in warfare methods brought with them the need for data collection and storage; whilst mass production required such accounting paraphernalia as double entry book-keeping, invoices and ledgers. Commenting on the resulting diminution of quality, Boyle (2000, p7) writes: "the more the words give way to figures, the more counting simplifies things that are not simple". Topical examples of the contradictions between quantity and quality include the cutting down of a tree that is sawn into pieces and sold. This process is both quantifiable and profitable, whereas if the tree remains in the ground, reducing climate change, it is not. Similarly, weed killer may cause cancer but adds quantifiable value to crops and the drugs to cure the resulting health problem add even more.

The gentlemen mathematicians of Cambridge

As the industrial revolution was transforming the world, aided by the various applied mathematical disciplines, the notion of pure mathematics developed in some of Europe's elite universities. Commenting on pure mathematics, Heaton (2015) writes: "until the late eighteenth century, no mathematician would have known what you were talking about" (p41). Central to the development of pure quantification, untainted by any consideration of quality, was Cambridge University, a "finishing school for gentlemen" Agar (2001, p13), which was set up by the Roman Catholic church in the 14th century following a breakaway from Oxford University. A Christian rival to earlier Muslim universities, like hundreds of other church institutions, Cambridge university was intended to propagate Catholic teachings. Across Christian Europe, the Latin quadrivium, consisting of arithmetic, geometry, music and astronomy, became the core of an elite young man's education; women being largely excluded from universities. Following Henry VIII's break with Catholicism, the universities, including Cambridge, became more secular, offering a wider range of degrees. By the 19th century some academics at Cambridge openly declared themselves to be atheists. Cambridge's colleges, particularly Trinity, established a reputation for educating gentlemen in *pure* mathematics. Rouse Ball (1960), a leading academic at Trinity, expressed the prevailing orthodoxy on the origins and methodology of mathematics. Like the overtly racist statistician Francis Galton, Rouse Ball praised Greek mathematics, calling that of the ancient Egyptians, Indians and others "prehistoric". These "early races", he argued, "knew something of numeration and mechanics…were also acquainted with the elements of land surveying". However, he claimed, the mathematics of these "races" were "founded only on the results of observation and experiment" rather than the deductive proofs of Euclid and the other Greek mathematicians. Their results, he added, "were neither deduced from nor did they form part of any science" (p1 and 2).

Hardy's *Apology*

Whilst pure maths departments are today closing down in universities around the world, with the relevant maths taught in applied departments, Cambridge is one of the elite institutions continuing to offer the subject and features an alumni that includes Russell, Hardy, Wittgenstein and Turing, along with a smattering of scholarship boys and later girls from "low income" families. Russell and Hardy took the view that pure mathematics, as opposed to its applications in engineering, architecture and the like, was an intellectual exercise in deductive logic. Hardy (2019) followed the lead of Rouse Ball, advocating a Platonic approach: "mathematical reality lies outside us...our function is to discover or *observe* it" (p123; emphasis in original). Snow's foreword to Hardy's book is typical of his social class's thinking, describing Hardy, who only merits a footnote in most histories of maths, as having a mind that is "brilliant and concentrated" with "a formidably high I.Q. as soon as, or before, he learned to talk" (p11 and 14). Members of this intellectual elite normally earned only a modest salary by the standards of their class, but were offered board and comfortable lodgings, for life, in an atmosphere of quiet contemplation. This was interrupted only by the occasional lecture or tutorial, so as not to interrupt their discovery of new mathematical proofs. Comparing maths to composing chess problems, according to Hardy, the "function of a mathematician is to do something" and that something is "to prove new theorems"; other aspects of maths, he argued, "is work for second-rate minds" (p61). "Oriental mathematics", Hardy continued, "may be an interesting curiosity, but Greek mathematics is the real thing" (p81). Hardy was committed to what he regarded as the Greek method of proof, frequently citing Euclid and Pythagoras, claiming that it is "clear cut" and "unanimously accepted" (p82). Regarding the application of maths to calculation, he argues that "very little of mathematics is useful practically, and that that (sic) little is comparatively dull...I am interested in mathematics only as a creative art...I have never done anything 'useful'" (p89,115 and 150). In other words, maths should have nothing to do with the real world of qualitative processes. Maths therefore becomes, Raju claims, religious metaphysics or aesthetics.

A more recent academic who ought to have offered an apology is Badiou (2016). A product of the French equivalent of Cambridge, and supporter of Leninism, he argues in much the same way as Hardy that *real* mathematics was born in Greece. An advocate of the Platonist view of mathematical objects as bearers of universal truths waiting to be discovered in some mystical timeless world beyond, Badiou writes of “the ultimate beauty of mathematics” (p4). Due to his exposure to Leninism, Badiou accepts the existence of multi-valued logic, but cannot square this with his commitment to the two-valued logic of Greek mathematics. He admits that pure maths is an elite activity involving “only those who are able to understand the most difficult proofs…mathematics, particularly in France, really *is* used as a method of selection of elites via the entrance exams…The vast majority of people, once they’ve taken a number of relatively easy exams in school, no longer have any real connection with mathematics” (8 and 9, emphasis in original). As a Platonist, Badiou believes mathematics “bypasses the particularity of language” (p34), apparently having its own universal language. Yet, he admits that the specialisations that make up contemporary mathematics mean that often only a “dozen people” around the world are capable of understanding them: “it’s the most exclusive of all possible elitisms” (p15). As a result of his timeless approach, for Badiou quantification has no history and no connection with its qualitative socio-economic environment. Therefore he can offer neither an explanation for, nor a solution to, the widely acknowledged parlous state of contemporary mathematical education for those outside of the “elite”.

Cambridge’s dissidents

A number of Cambridge gentlemen broke away from pure mathematical orthodoxy. The best known of these is Wittgenstein who, like Hardy, compared pure maths to a game, such as chess, but unlike the latter did not accept the Platonic approach. Wittgenstein accepted that maths generated contradictions, but argued this did not mean there had been an *error*, as Russell and Hardy believed. His method, in effect, was to ignore these contradictions and continue as if they did not exist; which was at odds with the proof by contradiction method that remains an axiom in contemporary mathematics. Another dissident, Imre Lakatos, began his pure mathematics career at Cambridge but, after exposure to the orthodox paradigm, moved on both literally and figuratively. His much discussed text, Lakatos (1976), shows his eventual distance from his Cambridge tutors, describing their paradigm of “theorem and proof” as a “Euclidean ritual” a “conjuring act” involving “sleight of hand”. “Mathematics”, he writes, “is presented as an ever-increasing set of eternal, immutable truths” with an “authoritarian air” (p142).

The Cambridge scholarship boys to the rescue

The calm of the Cambridge gentlemen was shattered when, in the 1930s, Hitler began to invade much of Europe. The British military elite successfully argued that resources should be put into breaking the codes in which Nazi military communications were formulated. To this end, the government recruited the services of a number of mathematicians, mostly from Cambridge university. Alan Turing is by far the best known of these mathematicians, thanks to the motion picture *The Imitation Game* and a substantial literature claiming that he more or less invented the computer. In these times of social inclusion, as corporately defined, the life of Turing has been used as a smokescreen, to deflect attention away from some important aspects of British code-breaking activities during WWII. Rather than discussing the social class aspects of events at Bletchley Park, the focus of the film and much of the writing about Turing concerns his homosexuality at a time when it was illegal in Britain. Turing came from a modest background relative to, for example, Wittgenstein whose father was one of the richest men in Europe. Turing had to sit an entrance exam/interview at Cambridge, which he failed first time around, whereas Wittgenstein just turned up and, under the wing of Russell, attended lectures and later became a tutor.

Setting the record straight, as Timewatch (2011) documents, an early, perhaps the first, electronic computer was developed by Tommy Flowers, son of a bricklayer who won a scholarship to Cambridge, in order to decode the Nazi Lorenz machine. Another key figure at Bletchley Park was Gordon Welchman, solid middle class and Cambridge educated. As Greenberg (2014) explains, Welchman was written out of history because, whilst working in the United States after the war, he revealed some of the secrets of Bletchley, arguably long after they had any relevance to modern code-breaking. Bill Tutte was the son of a gardener who obtained a scholarship and, although sidelined by his upper class officers, broke the Lorenz code, the latter being a greater achievement than breaking the Enigma machine code.

Pure quantification: the computer and AI

The discussion of the computer in the previous section is important because it is the epitome of quantification, predicated on 0 and 1, so it is in order to reflect on its genesis. 20th century monopoly capitalism, with its corporate giants and large government departments, functioned by means of hierarchies in large part consisting of skilled mathematicians and statisticians making decisions supported by clerical workers performing routine operations. Superseding the adding machine, Agar (2001) argues, computers were designed to operate in precisely this hierarchical environment. Punch-cards, developed for textile machinery, with a hole for *on* and no hole for *off*, were to play a major role in the development of the adding machine and later the computer. Agar refers to the use of simultaneous equations, which were time-consuming to solve prior to the advent of the computer. Comparing decimal and binary numbers, Agar points out that the former is more user friendly, or anthropocentric, than the latter; but 0 and 1 lend themselves more readily to rapid calculations. Notwithstanding the contradictions that arise when zero and infinity are used in programs, most mathematicians have continued to insist that deductive reasoning, remains the best approach to computing, AI and robotics. However, the AI specialist Wilks (2019) begs to differ, arguing that despite rapid growth in some areas, other AI areas show little progress using deductive logic. Much of the progress, he explains, has been made by the use of statistical methods rather than programming languages based on formal logic. Referring to the arguments of the mathematician Gödel, who cast major doubt on the process of mathematical proofs, Wilks takes a more qualitative approach. He argues that the most successful AI researchers are tending to use modes of reasoning more akin to lay human thinking, in which we tend to use past experiences and a range of factors in decision making. We must remind ourselves, however, that computing, AI and related technologies are mediated by their corporate capitalist context in terms of cost cutting, job elimination, data gathering, social control and spying: "counting promotes the counter and demotes the counted"; Boyle (2000, p41) quoting Chambers.

Quantification, race and gender

Readers may have noted that the text has made almost no mention, apart from Hypatia, of women. Largely excluded from higher education until the mid 20th century, women began to do work associated with calculation in the growing bureaucracies of large companies and government departments. Yet, as at Bletchley Park, women were by and large doing more routine work overseen by middle class, middle aged, white men. The African American women working at NASA in the 1960s did perform high level calculations, notably Katherine Johnson, but were routinely discriminated against, as depicted in the film *Hidden Figures.* It is to the credit of Su (2020), a former president of the Mathematical Association of America, that he has mentored Christopher Jackson, an African American young man incarcerated for armed robbery, encouraging him to study mathematics in prison. This endeavour is linked to Su's view that mathematics can promote human flourishing, love, justice, truth and more. Alas, this is not what Su's book delivers. Rather, it offers either only geometry, algebra and calculus with no mention of the qualitative basis of American capitalism. Su could have perhaps encouraged his readers and Christopher Jackson to produce descriptive statistics as one side of an investigation into the qualitative relationships between race, ethnicity, religion and social class, on the one hand, and drug addiction, types and definitions of crime, unemployment, income differentials and more, on the other.

On the widely acknowledged crisis in mathematical education, students could be invited to investigate the claim that the ancient Greeks, as white Europeans, were the source of mathematics, philosophy, democracy and more. Students could be encouraged to investigate the qualitative nature of ancient Athenian society; they could, in terms of quantification, be asked to enquire into estimates of its population size, the numbers of slaves and slave-owners, the number of citizens or women able to vote and related issues. Again, numbers of important archaeological sites remaining in Egypt and Greece could be compared and the implications of this for mathematics could be investigated. Similarly, American students could be asked to investigate how many of their presidents have been women and use this to introduce the number zero and the qualitative meanings of the word nothing. The Indian origins of zero could be investigated along with the reasons why the Catholic church was so hostile to its use. Further investigations could include why, given this hostility, zero was eventually brought into use; young people could investigate what ongoing problems use of the number zero creates for a) mathematicians and b) software coders.

The late Reuben Hersh

...the inner world of human life - can never be mathematized...the inner life of society...falls outside the computer, outside any equation or inequalities; Davis and Hersh (1990, p13 and 14).

Describing the daily life of the billion or so workers who stare at screens and tap keyboards for a living as "slavery", the various texts of self styled *humanist* mathematician Hersh are a breath of fresh air. He is one of the few highly qualified mathematicians who readily acknowledges the socio-economic genesis of his subject. Hersh is highly dubious of the notion of proof, the foundation of pure mathematics, noting that Wiles' 'proof' of Fermat's last theorem is around 150 pages long. He describes proof as a matter of debate amongst members of a specialist group in a particular field of maths. Arguing maths will never be free of contradictions and uncertainties, Hersh shows that addition, along with the other mathematical operations, is no routine procedure that can be successfully applied at will. Rather than a universal truth,1+1=2 is a cultural artefact predicated on the need to facilitate the trillions of daily transactions that are the life blood of the capitalist mode of production. He challenges the assumption that an income of £40,000 p.a. is twice one of £20,000 p.a. in terms of a range of qualitative factors. As with all professions, the overuse of symbols is a means of excluding the vast majority of the population, he argues, and is critical of mathematics in the classroom as a paradigm for the promotion of competition, and a lesson for students in the ethics of the wage labour system. With regard to who is the cleverest at maths, the middle class kid wins most of the time, facilitating a life of the mind at an elite university, studying four dimensional figures, to cite Hersh's example, which have no basis in the real world.

A note on arithmetical operations

Schoolchildren around the globe are more or less forced to learn arithmetical operations in order to function in their allotted role in capitalist society. In schools and colleges, arithmetical skills are typically applied to profit and loss calculations, taxes, insurance and a range of related business skills. Along with their times tables, children are taught what came to be known as BODMAS (PEMDAS in America), i.e. in arithmetic first address brackets, then of, next division, multiplication, addition and finally subtraction. Most commentators tend to promote an uncritical and unquestioning approach to this aspect of quantification, ignoring the fact that different calculators and programming languages offer different operational orders with regard to this rule. A more informed approach is offered by Haelle (2013), who acknowledges that: "Math has syntax just as language does - with the same potential for ambiguities". she writes: "It's knowing what operations the author of the problem wants you to do, and in what order". Haelle points out that PEMDAS is "not a rule at all. It's a convention, a customary way of doing things we've developed only recently". Symbols refer to operations that were practical but, like numbers metamorphosing from adjective to noun, now refer to the abstractions of pure mathematics. Whilst most mathematicians take the order of these operations for granted, they have a history and some early examples are provided by Haelle. When the operations are applied in different orders, this will often produce different, rather than 'wrong' answers. Thus the issue of right and wrong answers, argues Haelle, raises the issue of global power in a corporately dominated system predicated on quantification and *standardisation.*

Measurement and variables

Perfect squares, triangles, cubes and the like only exist in the Platonic world of Hardy's pure mathematics, whereas in the real world, as Parker (2019) mentions, over 90% of spreadsheets contain errors. Bearing in mind that when dealing with non-linear variables, i.e. those that rise or fall at increasing rather than constant rates, small arbitrary errors lead to gross errors, as statisticians know well; which draws attention to issues of measurement and accuracy. Measurement is only ever as accurate as the technology being used to facilitate it and is subject to varying degree of arbitrariness; i.e. no person is *exactly* five feet tall or weighs *exactly* ten stones; all *populations*, a key term in statistics, change both quantitatively and qualitatively. As developments in fractal geometry indicate, if, for example, you want to measure a coastline, the smaller or more flexible your measuring device, the more accurate you are likely to be. The statistician Taleb (2007) offers the example of using a ruler to measure a table's dimensions: "The less you trust the ruler's reliability…the more information you are getting about the ruler and the less about the table" (p224). How accurate a measurement needs to be will be determined by practical considerations which will always be mediated by social relations. Symbols can never be *identical* with the real world, particularly with regard to motion; and in this context calculus simply reduces movement to states of rest. Whilst real world phenomena exist irrespective of our units, symbols and models, they can only be known to us via our experiences of them and our subsequent perceptual articulation of them in the form of observation statements expressed in a given language and accompanying culture. The much neglected concept of desire, in its widest sense, is mediated by capitalist social relations, but plays a central role in all of human activity, including quantification.

To the extent that researchers identify a variable and seek to measure it, this process will often involve a *unit* of measurement. Such units are not arbitrary, but rather relate to specific historical circumstances, related to agriculture in medieval times or imperial conquest, to name but two examples. Today these units are mediated by global capitalism in the form of the EU, the UN and other bureaucracies. Students of statistics are routinely coached in the ways of positivism with its distinction between continuous variables, such as height or weight, and discreet variables, such as number of computers or helicopters. Often used as examples in statistics textbooks, weight and height are constantly changing in all beings, animate and inanimate, so measurement of these variables always involves a degree of arbitrariness. As Hegel (1977) indicates, mathematicians are obsessed with obtaining the 'correct' value rather than acknowledging that all phenomena are part of an ever-developing process. Textbook writers express continuous variables with no acknowledgement that such apparently indifferent quantities have a whole range of qualitative associations. Given their conservative “do well at school and you will get a good job” ideology, statistics teachers frequently use exam grades as raw data. Despite the apparent indifference between equal quantitative subdivisions, certain values are associated with profound qualitative implications, such as the distinction between 39 and 40, or 69 and 70, as is well known to academics. The reduction from quality to quantity is well demonstrated in Likert scales that are typically used in questionnaires giving the respondent the opportunity to, for example, rate their level of job satisfaction on a scale of 1 to 5. Thus, the qualitative richness of human being is reduced to the indifference of number. In the real world of government spending cuts, health care has been subject to the spectacle of quantitative benchmarks and yardsticks as applied to selected variables, which drive management actions with the motto “data driven decision making”. Thus quantity, rather than quality, determines the health of nations. Cradle to grave, from exams forced upon children to means-tested benefits for the unemployed and elderly, the measurement of variables has become an alien reified force controlling the lives of wage workers around the world. It is no exaggeration to say that modes of measurement have in large part created the contemporary world, with pound, dollar or other currency symbols dangling in front of those struggling to pay their mortgage, rent, food bills and more.

With regard to pharmaceutical companies, quality is mediated by profitability; thus drugs are designed to suppress symptoms, rather than killing the goose that lays the golden eggs by developing cures. With regard to the behavioural sciences, measuring ‘intelligence’ by means of I.Q. and other tests, so as to identify “gifted children” or “geniuses”, is used to justify unequal treatment of young people. As middle class parents know, by paying private tutors to facilitate practice, test scores can be improved. Resources are typically allocated in terms of league tables, such as those based on exam results, with variable scores aggregated; however, these tables are mediated by social class, manipulation of results and more. To the extent that corporate taxation is deducted from profits, the world’s most adept lawyers and accountants are well paid to seek to redefine the ways in which profit is measured. If, for the likes of Amazon, UK tax were to be based on turnover then the same battle of wits over measurement will no doubt ensue and ‘creative’ accounting, as the art of measurement, will continue to be the basis of a lucrative career.

The reification of time
Before moving to a conclusion, let us turn our attention to the quantification and unitisation of time. Given this quantification, as Einstein pointed out, time varies at every location on our planet. So, in the real world, as opposed to the world portrayed by equations, the longer the time span the more objects become qualitative processes and are less able to be modelled with quantitative constants. Time is an important variable in statistics, but is typically treated in a way that neglects its socio-economic genesis: “Time, once passive, is now aggressive…Time is Money”; Garfield (2016, p4 and 191). To unitise time is to engage in a process that is never far removed from the internal contradictions, such as the fact that low wages create high profits but reduce demand, that mark capitalist social relations. Few statisticians refer to the ways in which clock time is a key component in the multiplicity of ways in which global capitalism imposes its discipline on the lives of wage workers. Again, Garfield (p4, my italics) writes: “We place a clock by our bed but what we really want is to smash it up…We work all hours so that we may eventually work less. We have invented *quality* time to distinguish it from that other time”. An ‘objective’ approach to time, typically used by statisticians, was derived from the movement of the sun and moon which, Muslims and others know, are not synchronised. Poets, philosophers, lovers and others can confirm ‘subjective’ time is a more elusive concept. As football fans know only too well, “how slow it seems when you’re winning and waiting for the final whistle, and how quickly it goes when you’re behind”; Garfield (p10). There are a range of competing ways of measuring ‘objective’ time and, like other units of measurement, historically these were subject to power struggles with regard to how these were imposed. With regard to hours, minutes and seconds, prior to the industrial revolution these had little significance; the working day began when the sun rose and ended when it went down, scant attention was given to the local church clock.

As industrial capitalism rose to dominance, factory owners imposed their discipline on wage workers using the medium of time as measured by the factory clock. Each factory or mill would have its own unique time, which was forced on the workforce, members of which were often not allowed to bring timepieces into the factory. The police and courts were used in the case of repeated absenteeism, extended work breaks, failure to work longer hours, or when there were labour shortages. It was only with the advent of the railways that it was felt necessary to coordinate differing times; a London-based timetable was introduced across the country in the 1840s. Differing local times would potentially increase the risk of accidents, especially on single track lines; so by 1880 all clocks around the country were legally required to adopt London time. Similar events occurred in other developing capitalist nations, which emphasised the dwindling power of the church vis-à-vis the capitalist class. In France, following events in 1789, the secular Jacobins had changed time by changing the calendar; they wanted to increase productivity in both agriculture and the production of weapons of war. British military power was used to impose clock time throughout its empire so as to measure labour productivity and the coordination of shipping.

The way in which clock time is divided was reinforced by Taylorist time and motion regimes in the workplace, currently imposed by computer technology. Reminding us of slave plantations, these regimes establish a recommended time in which each part of a process should be performed, so as to extract every unit of productivity from a given group of wage workers. Garfield discusses his own experience of working on the production line of a car factory, which is geared to making a car roll off the line every 68 seconds. One manager told Garfield that he "wished people could be more like machines; the problem with staff was that they introduced variability into the process. Absenteeism put a big spanner in the works" (183). Garfield quotes Taylor himself in a classic example of reification: "In the past the man had been first; in the future the system must be first" (p192).

Concluding remarks

In capitalist and state capitalist societies the dominant approach to quantity and quality is at odds with our ability to develop a rationality that really does promote human flourishing. We are perhaps reminded of Hegel's (1977), alas underdeveloped, claim that quantity and quality should be unified as *measure*. Devlin (1997) calls for a "soft mathematics" of the future, one which takes into account motivation and belief. Logical and mathematical rigour, he argues, should give way to alternative modes of reasoning. How his "soft mathematics", or a soft statistics, of the future will look remains an open question. However, in my view, only when the destructive social relations of capitalism are transformed into a world of authentic democracy, with the abolition of money and wage labour, can the relationship between quantity and quality be humanised.

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