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Disparate Measures

95.5:58.42:91.44 may not suggest to all of you the desirability of a meaningful relationship.

$42\frac{1}{2}$:26:40 3/4 lignes probably reminded the Bishop of Autun of the young nuns he had overseen but not overlooked. On that fateful day in 1790 when he arose in the States General of France to propose the creation of a new system of weights and measures could the young Bishop have foreseen that the canonical dimensions of beauty must be translated from $37\frac{1}{2}$:23:36 inches to 95.5:58.42:91.44 centimetres? No! That was before the Bishop of Autun became the Prince de Talleyrand and long before these dimensions became the girth, at noticeable latitudes, of Marilyn Monroe.

From earliest times the human body or its functions has provided convenient units of measurements:

A cubit equals the length of a fore-arm - anywhere from seventeen to twenty inches depending, no doubt, on how much it has been twisted.

The Egyptians knew that four digits make a palm, three palms make a span or ten palms make a pace.

The Romans called a thousand paces a mile but the infantry must have had another name for it - probably unprintable - because, even with their shorter mile, that would mean a 58" pace.

A hand is unrelated to a palm. It probably has the closest affinity to a nose - either as an ill-defined but vitally important dimension or as the repository of the egg-money.

The foot of Hercules was adopted as the standard of measure at the first Olympic Game but, whether through vain glory, carelessness, or chicanery, the standard foot had, by the Mid-eighteenth century, proliferated to two hundred and eight different sizes. After Hercules, the Romans reduced the foot to 11.6 of our inches, the English brought it back to 12, and the French, by degrees, increased it to 12.8. This at a time when Napoleon's conscripts averaged 5'-4" in height. Perhaps travelling on their stomachs did it.

Every woman knows that a yard is the distance from nose to thumb. This is pure coincidence because in the year 958 it was decreed to be equal to the waist-line of the saxon king, Edgar - a perfect 36 in the ready-to-wear department of the local sheet metal shop. By 1324 the urge for scientific accuracy had become so compulsive that a yard was equated to "108 barley corns, round and dry laid side by side". Henry VIII, finding barleycorns more effective in their distilled than in their dry state, and being reluctant to immortalize his waistline, had a metal bar cast to represent the legal yard. This was later presented by his daughter Elizabeth to the Board of Trade for safe-keeping.

A tittle, 'though diminutive like a jot, is neither well-defined nor anatomically based.

In liquid measure two mouthfuls make a gill, although the home-economists say two tablespoons, and twenty-five and a half mouthfuls make a fifth.

Less precise but equally physical are the pinch, the hair's breadth and the snort.

Such carefree concepts of measurement have vastly complicated what might be called numerical iconography. The Good Book says that there were 153 fish in the "Miraculous draft". So the linear dimension of 153 roman feet was used six times in the Old Basilica of St. Peter's. Were the modern archaeologist to use an american tape measure in reconstructing this shrine he would read 148 feet - a number to which it is difficult to assign a mystic significance. The great Abbey of Cluny was laid out in 909 in Carolingian feet of 340 mm, expanded in 950 using the Pied de Lyon of 341 mm, remodelled in 1049 using the classic Roman foot of 295 mm, and when ecclesiastical expropriation brought the building program to a halt in 1750 they were working on the pied du roi of 325 mm. Remarkably, all these different units resulted in dimensions divisible by seven and accorded with the Fibonacci series of mean and extreme ratios as well as fitting a modular grid of twenty-five feet. This mystic arithmetic was, however, only a warm-up for the main event: In 1090 Alphonso VI of Castille and Aragon underwrote the construction budget of the Abbey so it was no more than courteous of the monks to reciprocate by relating all its dimensions to The "perfect numbers" of St. Isadore whose relics Alphonso had recently removed from Seville to his own church in Leon. As everyone knows, perfect numbers are those which equal the sum of their sub-multiples which are integers. The fact that Greek and Hebrew numerals are letters of the alphabet made all sorts of dimensional symbolism possible which probably forms as logical a basis for design as the Chicago Building Code. The quaintness of these concepts does not derive from an era more intellectually barren than others for in 1879 the International Institute for Preserving and Perfecting Weights and Measures was founded in Boston to promote "pyramidology". The adherents of pyramidology believed that the Great Pyramid at Giza was the work of the hand of God and contained all His scientific gifts to mankind. Since it was believed that the Anglo-Saxon race is one of the ten lost tribes of Israel and since even today we are aware of the close ties uniting Israel and Egypt, it was obvious that the customary Anglo-Saxon weights and measures were of divine origin and needed only purification.

Perfect numbers, golden proportions, and symbolic dimensions continue to exert a fascination for professionals of the cloth as well as of the overall -

not long ago a church in Connecticut was built in the shape of a fish. However, minds that could cope with such complexities could be stimulated by the challenges and discoveries which gave the renaissance its impetus and its excitement.

In 1202 Leonardo of Pisa (alias Fibonacci - he of the mean and extreme ratios) made decimal calculation possible in Europe by introducing and advocating the adoption of arabic numerals. The ten fingers and ten toes which had long served the shopper well in making an informed choice between the jumbo and the large-economy-family size increased in usefulness as the basis of this simplified system. In 1585 the dutch mathematician, Simon Stevinus declared the universal adoption of a decimal system of coinage, weights, and measures to be only a matter of time. So it continues to be.

In 1670 Gabriel Mouton of Lyons went further to suggest the necessity of a decimal system of measurements based on an immutable and readily available standard such as the size of the earth. The following year Jean Picard made the first accurate measurement of a degree of the earth's meridian which was refined in 1736 by the French Academy's expedition to Lapland.

1742 marked the invention by Anders Celsius, professor of Astronomy at the University of Uppsala, of the first precise decimal scale of temperature measurement, the centigrade thermometer which still bears his name. Only ten years earlier Gabriel Fahrenheit had invented his scale so, since there had not been time for wide acceptance of it, one wonders whether its use of mercury or its British manufacture is responsible for it persistance in the english-speaking world - even after Lord Kelvin added 459.4 degrees to the bottom of it.

Within half a century the pursuit of simplicity and universality in systems of computation and measurement had become what can only be described as headlong. The closing years of the eighteenth century were, as Dickens noted "the best of times, . . . the worst of times, . . . the age of wisdom, . . . the age of foolishness." They were also stimulating years of feverish activity - intellectual as well as political. While Clive consolidated the British grip on India the novel concept of a government dependent on the consent of the governed evolved in America - While the Ch'ing dynasty brought China to the peak of its power, Voltaire and his circle brought the enlightenment to Europe. It was in this ferment of ideas that Talleyrand, as already noted, proposed drastic revisions to the accepted system of weights and measures. Even more novel, not to say iconoclastic, was his proposal of cooperation with England to achieve a uniform system. Not only did he ask a king already up to his neck in politics to urge this officially, but he wrote to Sir John Riggs Miller who was working on the problem independently in England, and made sure that his proposal was forwarded to Jefferson who, at the request of the senate, was devising his own system at the time. Apparently the world was not yet ready for full-scale cooperation. In spite of voluminous and cordial correspondence among the interested scientists, affecting protestations of politicians, the appointment of committees and the authorization of international commissions, the only point of agreement was that the basis be immutable and available. In 1798 Talleyrand did manage to convene an international scientific meeting but its greatest successes were in its broad spectrum of participation, the educational momentum it stimulated and the precedent of multinational collaboration it established.

Almost immediately the French Academy appointed committees and disseminated their reports which urged that the system be decimal with precisely interrelated units of length, mass, and capacity based on an infinitely reproducible natural measurement. The obvious unit that leapt to all minds was one ten-millionth of the length of a quadrant of the earth's meridian or, in the vernacular, the distance from equator to pole. And where is there a more attractive meridian than that which passes through Paris? Within eight years Messieurs Mechain and Delambre had measured an arc of the meridian between Barcelona and Dunkirk and by June of 1799 a proto-typical metre and kilogram had been constructed in spite of the temporary dissolution of the Academy and the arrest of the surveyors during the Terror. On 4 Messidor, Year 7 (known to us as June 22, 1799) the metric system became official in France.

Though mandatory, the new system found little ready acceptance in France and less elsewhere. New measuring cups, scales, and tape-measures had not been provided for the housewife nor had rulers, gauges, calipers, or conversion tables been prepared for the artisan. Then in 1812 Napoleon, who had the power to establish the metre firmly and finally, pulled the rug from under it by reverting to the old units re-defined in metric terms - the first attempt at "soft" conversion. This confused everyone - especi-ally those countries which were on the verge of adopting the new system. In 1840 Louis Philippe, a more practical if less romantic dictator, with one stroke of the pen achieved "hard" conversion simply by making it a criminal offense to possess any weights or measures or devices calibrated in any units other than metric. The Volstead Act prohibited props to which we were equally habituated but with how much less success! Was enforcement more effective or is the intellect more easily controlled than the palate?

Meanwhile in England the Industrial Revolution and the expansion of trade had underscored the necessity of bringing order to the picturesque con-fusion of British weights and measures. Henry's iron standard yard had, indeed, been replaced in 1758 by one cast in bronze but this was lost when the Houses of Parliament burned in 1834. After a decade of consideration and discussion by royal commissions another bronze bar was cast which Parliament, proceeding as Goethe advised "without haste, without rest" declared official after another thirty-four years. Thirteen years after that, in 1891, Henry's iron yard mysteriously re-appeared and since then it has been kept in the Lobby of the residence of the Clerk of the House - probably on the hall table with the car keys, gloves, and laundry lists. However, it is now only a curio as the yard has, since 1893, been based on a certified copy of the metre even 'though one faction sought to define it as three feet, forgetting that a foot is legally defined as one third of a yard.

English surveyors commonly measure in chains of sixty-six or rods of sixteen decimal feet but land titles are frequently expressed in perches of five and one half yards, except in the Province of Quebec and the Channel Islands where a perch equals eighteen french feet which, of course, has nothing to do with a french perche of twenty-two square pieds de roi.

These trade-oriented measurements are to surveyors as gobbledygook is to lawyers, music critics or theorizing architects. A printer's M, a scotch ell of 37 inches (as expected, based on the ancient Rhineland foot), a nautical mile or fathom, board feet, penny nails, double elephant paper size, minims or drams - all could be expressed more simply without detracting from the specialized knowledge they imply.

These little exercises in linear units, even when expanded into units of area, hardly prepare us for the finest flowering of British whimsy which is to be found in measures of weight and capacity. The basic unit of weight and of money in England has been the pound since Saxon times — The Tower pound supplanted in 1527 by the Troy pound for money but not for weight. In 1853, however, the Troy ounce with its decimal parts and multiples, but not the Troy pound were rescued from oblivion for measuring precious metals and stones. Meanwhile in 1270 the Merchant's pound superseded the lighter Tower pound and, within a generation, was itself superseded by the avoirdupois pound which we still use but which never took hold on the continent. In England, but not Scotland, fourteen pounds make a stone eight of which make a hundred-weight of 112 pounds which is only natural since one hundred pounds make a cental.

Starting from so lucid a base, one doesn't even need Ezekiel's visions to relate weight to capacity, both liquid and dry. In 1266 it was decreed that eight pounds make a gallon of wine, though not of ale, and nine gallons of wine make a firkin while eight make a bushel and anywhere from sixty-three to one hundred forty make a hogshead, but by that time who cares? When the bushel is converted to a dry measure of 2,150.42 cubic inches its shape is important as a bushel of corn is sold level with the rim but a bushel of wheat is heaped or rounded. These quantities were all adjusted to the Imperial gallon in 1824, half a century before Disraeli promoted his employer to Empress. It remained for the tradition-bound Americans to preserve a relic of the glorious past, so we still use Queen Anne's gallon of 1707.

Tradition, however, was not the major concern of our founding fathers in their urgent consideration of a logical system of weights and measures and coinage. On January 5th, 1782 Robert Morris wrote to Congress urging creation of a U. S. legal tender which, he said, should be decimal for simplicity and accuracy and for "calculation more within the power of the great mass of people." This idea was amplified by Gouverneur Morris (no relation to Robert) in a letter to Thomas Jefferson in which he said "Every man is called by our constitution to share in the government. A knowledge of statistics is, therefore, in some measure necessary to every American citizen, and the obtaining of this knowledge will be greatly facilitated by the establishment of a currency which gives the means of conceiving immediately the value of any sum of foreign money; of a measure which gives the same means as to distance and the surfaces of countries; and, lastly, of a weight which (combined with the currency) gives at the same time an easy mode for conversion of foreigh weights." Jefferson echoed this thought in his pitch for decimal coinage: "The bulk of mankind are school-boys through life . . . and feel the relief of an easier, substituted for a more difficult, process of mathematics." In 1786, the Continental Congress replaced the great diversity of foreign coins circulating in the United States with our present decimal currency, to be followed in 1799 by France, in the 1870's by the rest of continental Europe and Russia and Japan, and in 1974 by England.

In his first "State of the Nation" address on January 8th, 1790 President Washington asked Congress to prepare a plan for uniform weights and measures. Jefferson, then Secretary of State, plunged right in to so congenial a task noting that "The divisions (of the currency) into dimes, cents, and mills is now so well understood that it would be easy of introduction into the kindred branches of weights and measures." In spite of the fact that his government job kept him in New York, where he complained, there were no books, he quickly developed a decimal system of weights and measures based on a foot of 10 inches and its multiples or sub-multiples of ten. This was shelved by the Senate while waiting for international cooperation which it neither initiated nor immediately supported.

Before he even had time to check his arithmetic - he later confessed to an error of one millionth of a foot in defining a pottle - the news came of Talleyrand's proposal. This he studied at once and by the end of June, 1790 had written extensive and carefully reasoned comments on it. He considered the French choice of a unit based on measurements to be taken within their own country to be far too nationalistic but he sincerely admired their courage in proposing to go all the way in their reformation - what is now referred to as "hard" conversion. Five years then elapsed before the House voted $1,000 to fund the work of a Committee on Weights and Measures but the Senate never got around to voting on it. Perhaps no travel allowances were included.

In 1811 Jefferson suggested that scientists all over the world express their findings in decimals which, no matter what the basic unit, would be easier to translate and would encourage eventual agreement on a universal system. When the Senate, in 1817, authorized a committee headed by John Quincy Adams to prepare recommendations on a system of weights and measures, Jefferson strongly urged him to make it decimal and to go all the way for hard conversion. (Not having the time-consuming problem of private papers or memorial libraries, ex-presidents apparently stayed in harness in those days.) The recommendations, presented after a four year study, suggested in the most elegant prose that, while the french system was really by far the best, it was not yet universal and France itself was not enjoying its period of greatest stability or prosperity. Furthermore England and Germany were our best customers so their lead should be followed and, finally, the constitutional rights of the States in these matters were being examined by the Supreme Court and imposition of the metric system might be disturbing. So nothing was done and the debate went on over a basis for a universal unit of measurement, Jefferson favoring the swing of a pendulum at the 45th parallel, Sir John Herschell recommending one ten millionth of the earth's polar axis or a fraction of its equatorial circumference. In the year in which he came to the University of Chicago, Prof. Michelson proved that it all didn't matter anyway as he had measured the standard meter in terms of the wavelength of cadmium light which, as an absolute unit, makes a man-made prototype replacable.

Abraham Lincoln, who had many things on his mind in 1863, founded the National Academy of Sciences to advise the government on technical matters, and its committee soon urged the adoption of the metric system. This Congress promptly legalized, equipped every post office with scales and every state with metric standards, and established equivalents and conversion tables. The loop-hole was education. Instead of being compulsory, the system was permitted in the hope of stimulating interest in reform. What it stimulated was controversy among the educators.

Then, one hundred years ago, in May of 1875, the United States and seventeen other countries signed the Treaty of the Meter in Paris and became a founding member of the International Bureau of Weights and Measures at Sèvres. In 1893 the yard was redefined as a fraction - 3600 over 3937 - of the prototypical meter in Sevres and the pound as 0.454 of the kilogram. In the haze of translation from French to English to American, the Imperial yard turned out to be three millionths of an inch longer than ours but the meter is short of its original definition by one two hundred and eighth of an inch. De minimus non curat lex.

In 1960 the BIPM, as the International Bureau is known, redefined the meter in terms of the wave-length of orange radiation in the spectrum of Krypton 86. This is accurate to one part in ten million, just as the scratches in the platinum-iridium bar made in 1798 are but cheer up, the boys who say "Get me a grant instead of a Grant's" are knuckling down to achieve greater precision within the decade by relating the meter more closely to the speed of light.

Now that the last vestige of nationalism has been stripped from the metric system, it has been almost universally adopted, it was endorsed by the Founding Fathers and blessed by their first miracle, our decimal currency, it remains for us to ponder whether we will accept this change passively or take the lead in amplifying it. A Swede devised decimal measurement of temperature, the Americans devised decimal coinage, and the French devised decimal weights and measures. Who will divide the circle into one hundred degrees without making the equilateral triangle decimally impossible? We are used to thinking in decades and centuries and our politicians are used to re-establishing holidays so why should a decimal calendar be beyond our reach? Why not a decimal day of 100,000 seconds instead of 86,400? The hue, value and intensity of color submit to decimal measurement and spatial analysis by computer graphics may be expressed in decimals. The possibilities are limitless.

The approach to metrication is paved with good intentions. From high hopes and a euphoric solicitude for future generations one progresses to so-called "soft conversion". This stage consists simply in expressing old quantities in new units: a quart of milk is re-labelled 0.946 liter; the foot-long hot-dog becomes 30.48 centimeters; all the secret family recipes must be annotated in grams or crepes may rise and popovers sink; the U-factor by which desirable amounts of insulation are calculated, is equal to the number of British Thermal units lost per hour per square foot of enclosure per degree difference between indoor and outdoor temperature. Soft conversion makes it easy: B.T.U.s expressed in pounds avoirdupois and degrees Fahrenheit are multiplied by 1.055,056 times 10^3 to produce joules; square feet times 9.290,304 divided by 10^2 produce square meters; degrees F. less 32, divided by 1.8 produce degrees C. From here on it's clear sailing. At this level we can communicate with the whole world but can we set it on fire?

Now the way becomes rougher and more tortuous becoming known as "hard conversion". A milk carton is enlarged to contain an even liter; the Coney Island hot-dog shrinks to 25 centimeters or an even quarter meter; a board foot of $11\frac{1}{2}$x12x3/4 inches might become a lumber unit of 30x30x2 cm. From here on the excitement and rewards are to be found in the necessity implied of re-thinking many of our standards, even restoring the human factor to design.

Since the human race is growing taller year-by-year (one need only sit in a true antique to verify that), "hard conversion" provides an opportunity to raise the kitchen counter and all the equipment associated with it from 36" to one meter. The eight foot ceiling, so dear to the heart of the project builder, might change in relation to new aesthetics and dimension standards as well as new materials. Although American families are decreasing in size, their noise-level is increasing which adds acoustics to the criteria for new modules. As exposure to the natural environment becomes limited to vacations, our man-made surroundings assume an increased importance, requiring careful study, not as much of the classical "golden section" (rectangles in the proportion of 1 to 1.618), as of the inter-relation of everything we see or touch. Indeed, Draconian must be substituted for Disparate Measures.

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