

THE DOZENAL REVIEW

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(incorporating the Duodecimal Association)

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E D I T O R I A L

It is still, unfortunately, fashionable to denigrate Britain and its achievements, and a large section of the public appears to have been brainwashed into thinking that traditional ideas, customs and units that have stood the test of time are somehow - and rather abruptly - no longer valid today. That which is imported, whether it be cars or ideas, is often hailed as better than the native product; and we are in danger of believing that we have become a second class nation in potential and ideas as well as in military strength.

Britain is still great, and the British are still important; though there are times when the wages scramble makes me wonder if our famous common-sense has disappeared, there is much that we have that should not be abandoned.

Many of our traditional units of measure are products of our common-sense, and more suited to our needs than are those of the imported (and to be imposed) metric system. We of the DSGB believe that base ten is intrinsically inferior to base twelve; we believe that the decimal metric system is not the best metric system possible (though that may sound like heresy to the priests of the Metrication Board...); and we certainly do not agree that the metric system is the most suitable for Man, or the most suited to him. We believe that base twelve will eventually replace base ten, to the improvement of arithmetic and the benefit of all.

In this REVIEW, as in the last, we present some more arguments in favour of base twelve, some more rumblings against the decimal metric system, and a mixture of other matters; we hope that this mixture will contain material suitable for those new to the topic of dozenals as well for those well-versed in it.

The views contained in articles appearing in this REVIEW are those of their authors, and should not be taken as representing the official policy of the DSGB on a given topic.

DESIGNING THOSE DIGITS

Donald Hammond.

Most Dozenal Society members will have experienced (perhaps I should say endured!) many attempts to produce dozenal digits, particularly those for ten and elf, and will be rightly wary of further flights of fancy; especially since most of these result in symbols which are inferior to Isaac Pitman's 2 and 3.

However, the idea here presented is the result of a real effort to avoid the bizarre and instead to concentrate on practicality and simplicity; while yet observing the essential arabic style. Thus, there is nothing spectacular here: there may, I hope, be something workable and acceptable.

TYPEWRITER

1 2 3 4

5 6 7 8

9 2 3 0

There is no real confusion with this set. Typewritten figures are accurately formed and, until alternative types become available, I am content with the above.

BROAD PEN SCRIPT

1 2 3 4

5 6 7 8

9 2 3 0

The broad-pen set contains the two innovations I want to suggest. Compare ten with two, and elf with three: ten now has a sloping bar; elf has a full-width base bar, but an abbreviated crescent.

SCRIBBLE (PENCIL OR BALLPOINT)

1	2	3	4
5	6	7	8
9	2	2	0

It should be noted that a good many children write 2 when they mean 2! The modified form of ten given here is far less likely to cause confusion of a disastrous kind in these cases: the slope is the key!

CALCULATOR DISPLAY

This now becomes quite easy:

1234567892t0'

The sloping bar of ten will happily stylize into vertical for the seven-bit display. After all, if they can get away with that 4....!

The foregoing covers most requirements except those of typefaces for formal or printed work. I have drafted formal designs for the two digits (see next page), which are now submitted for comment.

FORMAL DESIGNS FOR TEN & ELF.



DONALD HAMMOND 1978

TEN (dek)

By tilting the top bar steeply, the vertex is brought down and the serpentine curve eliminated. This effectively removes undue resemblance to an inverted '2', yet retains the essential arabic character of Isaac Pitman's numeral. (I should be interested to get the DSA's opinion of this design: the figure is vaguely akin to the letter 'd', and has at least one-quarter of an 'X'!)

ELF (el)

I have taken the top of the crescent back to the centre-line and lowered the middle vertex, but have made sure that the base bar extends the full width of the containing rectangle. This base is strongly reminiscent of the roman 'E', yet does not detract from the arabic form of the digit as a whole. Again, this numeral is rather less like an inverted '3'.

GENERAL

The ratio of width to height in each case is 3 : 4, which is an excellent arabic proportion.....And dozenal ratio!

NOTE BOOK

In a patty political broadcast on 25. 1. '78, Barbara Castle MP referred to the profiteering that took place under decimalisation of the currency. Perhaps statistics for the effect of metrication are not yet to hand.

*

The Sunday Times (8.1.'78) carried a Brain Teaser of dozenal interest. Briefly two new numerals (@ and &) are introduced into the common number scale, but in unknown positions; we know that & rates less than @ and that the existing numerals retain their present relative order. Test calculations 35×64 and 54×66 have answers comprising either only the new numerals or none of them. What are the two answers? (Answers will be found p.46)

*

ARITHMETIC A LA DOZEN: with this Review we are sending out to each member a copy of a special workbook issued for the brighter children in the first two (comprehensive) years. This booklet was prepared by DSGB member Tom Pendlebury. Your comments are invited. An errata list for the booklet will be found on p.43 of this REVIEW. The Editor apologises for these errata; he did not check the booklet before sending it to be printed.

*

MEMBERS WRITE...

One of the mysteries of the Industrial Revolution is why it should have occurred that Britain, closely followed by America, shot ahead of the rest of the world in Engineering, in spite of certain disadvantages, e.g. when it was all starting, engineering education was well-established in France and virtually non-existent in Britain. France ought to have been the engineering leader, but was not. I believe it was the use of feet and inches that gave us the small advantage that got us away to a good start. They are suitable sized units for doing engineering, and the 12" relation is of tremendous advantage in making scale drawings, an indispensable part of mechanical engineering. So here in Britain (and in the USA as soon as it was sufficiently industrialised) there was a slightly easier channel for ideas to pass from brain to reality. And now some fools are trying to close that channel.

Members write (continued)

The present units have a great advantage in their distinctive names. The use of a single name for the unit of mass, or length, or whatever, with prefixes to denote multiples and fractions, is a source of confusion, and we ought to be aware of this in making up names for dozenal units.

(J·D·RICHARD)

*

Mr. Hammond mentions that he has found that modular patterns whereby numbers reveal their shapes has considerable impact on pupils with a low interest in the subject. The Dozen Scale, forming as it does the natural divisions of the circle, is admirably suited to this purpose.

*

Inflation has made a sorry mess of our currency. Whether you blame large wage-increases or the ever-increasing price of oil and imports, or just the floating pound, the value of our currency-unit has fallen tremendously. One friend of mine says he thinks of £1 as one shilling; then the 10p coin approximates to the old 1d in value, and prices seem to slide back into a more familiar perspective.

In any case the coins are far too large. The choice of £1 as the larger unit made the smaller unit (1p) too large, and this has tended to contribute to inflation, and even though the half-pee is still around fewer and fewer people are taking it seriously. The present bronze coins could be replaced by versions in aluminium, enabling us to scale down the 5p and 10p to (perhaps) nickel-brass coins with a 50p a copper-nickel coin of shilling size. This would pave the way for coins of face-value greater than 50p; and if inflation is not calmed soon I for one foresee the appearance of the aluminium pound...

By the time inflation is halted I expect that we will have bronze 5p and 10p pieces, with copper-nickel 50p, £1 and £5 coins; taking 5p as a new penny (1d) and the 10p as 2d, the 50p as 2d, all we would need would be the 3d, 6d, 1s, 2s and 6s to replace banknotes and restore the currency to a (familiar) dozenal pattern. The shilling, with its divisions into 3d, 6d, 9d and 4d, 8d, provided more stopping-points against price-rises than does the decimal p and £ system we at present suffer.

(S·FERGUSON)

Scandinavian Measures.

A correspondant in Norway has kindly sent in a sample of a folding foot with Norsk tommer that is still in use by joiners and forestry workers. Mechanics in industry however now use UK Imperial units and have scales with feet and inches on one side, decimal metric on the other. Enquiries in Copenhagen recently showed that British feet and inches are in common use throughout Denmark. The old to-fod rule of 24 tommen was known but no sample of it has yet been obtained.

Details quoted from Aschehrug's Dictionary gave the minor variations that have occurred during the last century.

In Norway (1824) the Fot was defined as the length of a one second pendulum $\times 12/38$ at latitude 45° and equalled 12.352 of our inches. Before 1824 the Norwegian Fot and Danish Fod were equal at 12.362 inches each, but the Danish Fod is now 12.356 inches.

In Sweden, before 1863, their Fod was a little shorter than our foot at 11.685 inches. Afterwards it was made longer, 13.239", - which looks like an adoption of the Northern Foot, but on the large side. No reasons have been given for the above changes; enquiries will continue.

The Northern Foot (or Belgic foot) identified by Petrie from a study of buildings along our eastern seaboard was later identified as originating from the Indus Valley, having "inches" of five wheat grains. It eventually became the Pied-du-Roi of Paris at 12.797 inches.

and from Egypt...S.Ferguson

(Quoted from "The Civilisation of Ancient Egypt" by Paul Johnson, Weidenfeld & Nicholson):

The Egyptians made a bigger contribution to general knowledge in devising systems of measurement, which appealed to their empirical spirit. They were very observent people. They were the first to note the fact that all the parts of the body are (on

average) constant in any individual in terms of their mutual relationships, irrespective of the individual's size relative to others. It was this observation of an invariable canon which lay at the heart of their extraordinary grasp of physical form in their painting and sculpture. But it also led them, very likely at an earlier stage in predynastic times, to an anthropometric system of measurement. The basic unit was the armlength from elbow to thumb-tip, the cubit. This was divided into 6 palms or handbreadths (measured on the back across the knuckles), each made up of 4 fingers. The thumb was $1\frac{1}{2}$ fingers, which later became standardised as the Roman uncia or inch. A hand of 4 fingers plus thumb was $5\frac{1}{2}$ fingers or $1\frac{1}{2}$ basic handbreadths. The distance from elbow to wrist was 4 handbreadths or as it was termed in Egypt the "two-thirds" (of a cubit); in other Mediterranean systems it was called the pous, or foot. The ordinary or "short" cubit (6 palms or 24 fingers) was supplemented by the "royal cubit", equal to 7 palms or 28 fingers - and, in our terms, nearly 21 ins. For longer distances there was the "River Measure" of 20,000 cubits (6.8 miles or 10.5 Km). The basic land measure was the setjat or 100 cubits square, approximately $\frac{2}{3}$ of an acre.

Footnote: Berriman, in his "Historical Metrology" suggests that the Royal Cubit was the diagonal of a square of side 1 remen; this would make it $\sqrt{2}$ remen, the remen being 20 digits.

A PRE-METRIC METRE

S.Ferguson

In his "The Tragic Dynasty", the history of the Romanovs, Bergamini refers to a cannon which took a most unusual size of cannon-ball: "One incongruous monument of Fedor III is the 40 ton Tsar Pushka, the largest cannon in the world at that time. Cast in 1586, it was designed to take a ball 1 meter in diameter, but it was never operative, and it never left the Kremlin grounds."

Obviously designed by a prophet with a crystal ball, the metre being invented after the French Revolution of 1789...

Zoological Note: It has been stated that the leopard cannot change its spots. At any rate one species of leopard - the Ounce, peculiar to some small shops in South London, is of a very variable nature, and may be spotted in different places by Inspectors of Weights and Measures. (From "FUN", 1887).

Dauids Bookshop of Letchworth, Herts, held their 2nd annual event at the Broadway Adult Education Centre last November and the Society was invited to take a place alongside the Yoga, Esperanto and Organic Farming Advocates for appraisal by an estimated attendance of some 5,000 open minds. The various papers and booklets we have produced were displayed on our stall for hand-out or sale, together with our collection of national measures to illustrate the fact that a distance of about one foot has been recognised world-wide as an efficient unit of measurement.

Your Information Secretary patiently explained the principles of calculation and measurement throughout the day and Mr Pendlebury was on hand to describe the TGM system and demonstrate his slide-rule (a print of which accompanies this issue of the REVIEW). His was elegantly mounted on plastic sliders.

The stall was backed with large-print posters describing the dozenal system (copies may be had from the Information Secretary, 15p postage, please). A working dozenal clock surmounted all and attracted considerable attention and effectively made the point, although some customers went away with a puzzled look. Every home should have one of these: cut the figures from an old calendar!

The Duodecimal Society of America supplied copies of their publications for the occasion, including the Manual of the Dozen System and their circular slide-rules for sale. Space was also allotted for the Anti-Metrication Board's posters and papers, and also for Mr. Kala's alphanumeric proposals as described elsewhere in this issue.

Reactions were interesting, ranging from the incredulous to the enthusiastic "at last someone has some sense". Leaflets were readily taken but sales were negligible. It was, however, a very useful exposure and many more are now aware of the possibilities.

*

No more metrication

QUOTATIONS

The Danish words for 20, 30 and 40 denote, as ours do, 2, 3 and 4 tens. But 'tres' and 'firs' for 60 and 80 are shortened forms of 'tresindstyve' and 'firsindstyve' which mean 'three times twenty' and 'four times twenty'. "Halvtreds" for 50 is a shortened form of 'halvtredsindstyve' meaning 'half three times twenty'. Here "half three" means $2\frac{1}{2}$, its significance perhaps being 'half way to three'. Similarly 'halvfjerds' and 'halvfems' denote $3\frac{1}{2}$ and $4\frac{1}{2}$ twenties. (Man & Number, p.23)

There are, however, examples of the use of 12 as a base. We still count eggs in dozens(*), we have twelve inches in the foot and 12 pence in the shilling, there were 12 ounces in the old pound. It may be that the words 'eleven' and 'twelve' - irregularities in our present system of number words - are due to an earlier duodecimal system (i.e. a system with base twelve). They and the equivalent words in some other Indo-European languages appear originally to have meant 'one left' and 'two left' - left, that is, to be counted after all the fingers had been used. ... There are obvious advantages in the use of 12 as a collective unit as it can be divided into halves, thirds, quarters and sixths without the use of fractions ...

(Man & Number, p.24)

It is unlikely that anyone deliberately planning a number system would decide to use the base ten; a duodecimal system (i.e. base 12) would be a more probable choice. For such a system two more symbols would be needed, i.e. there would be eleven single code symbols, e.g. 1, 2, 3, 4, 5, 6, 7, 8, 9, $\triangleright$, $\perp$. In writing numbers greater than eleven the second place would be used to denote the number of twelves, the third place the number of twelve twelves, and so on. Thus twelve would be written 10 and the number of this page (112) $\overline{94}$ (nine twelves and four). As twelve is an exact multiple of 3, 4 and 6 as well as of 2, division by these numbers would be simplified; there would be less carrying and fewer fractional results, e.g. $10 \div 3$ would equal 4 and $100 \div 6$ would equal 20. Further, the fractions $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ and $\frac{1}{6}$ would be expressed in the form 0.6, 0.4, 0.3, 0.2, but $\frac{1}{5}$ and $\frac{1}{10}$ (sic) would be expressed in recurring form. The advantages of such a system would be the greater if all the systems of weights and measures were also duodecimal.

(Ibid., page 112)

*The Secretary has received a German egg-box which holds TEN eggs!

QUOTATIONS

It would be an enormous boon to international commerce if the hundreds of money systems used by different countries could be simplified. At present, though the standard units of the various coinages (pound, dollar, rupee etc) are of the utmost variety in their values, there is a large amount of uniformity in the method of dividing these units into smaller ones, by using ten or 100. Of course, this is the result of the whole civilised world being in agreement about basing its method of counting and calculating on the number ten. If human beings had twelve fingers and toes instead of ten the nations of the world would probably all be using twelve instead of ten. and many sums would be simpler than they are now, for twelve has twice as many factors as ten (not counting one). A few enthusiasts have advocated the scrapping of our system of counting entirely and suggested that the whole world should re-learn to count in dozens, gross (144), and great gross (1,728) instead of tens, hundreds, and thousands. (Romance in Arithmetic)

(The metric system to be introduced in Britain)...there is little doubt that it will eventually happen. Such a development would be welcomed by the business community who claim that they can increase trade with foreign countries when those countries are able to understand our quotations and prices more easily. However many people - and not least mathematicians - are strongly opposed to the change and regard it as a retrograde step believing the decimal system to be only superficially simpler or more useful than our present one. (Man Learns to Measure

MAN AND NUMBER: Donald Smeltzer, Black, 1958

ROMANCE IN ARITHMETIC: Margaret Bowman, Univ. London Press 1061

MAN LEARNS TO MEASURE: Keith Irwin, Dobson 1960

UNHELPFUL PATTERNSDozenist

I note from various "Word Books" that five is an important grouping; on studying my son's Disney "Wordbook" I found all the numbers above five illustrated with groups of five: for example 6 as ***** *, 16 as ***** ***** *. Surely they could have used more instructive patterns, or is there a move to make 5 more important than the other numbers? Richard Scarry's Wordbook does the same, so I wonder who pinched the idea from whom; and why...

NOTE BOOK

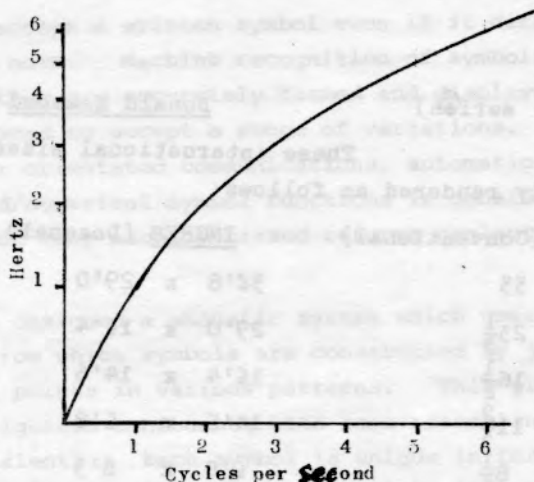
Replying to letters in "The Times" regarding the dichotomy between methods of measurement taught in schools and those that children encounter in the real world outside - Mrs. Saunders (June 6) and Mr. Manton (July 1) - the Metrication Board sheltered behind "advice" given by various Governments since 1960. On Mrs. Wiggins' query regarding the metrication of circular measures, time and angles, the Board denied that this was intended (14 Aug). The grade still lurks in the background, however, and there are those "more royal than the King" as the Canadian Metric Association's fact sheet no. 5 shows. Progress in metricating terrestrial maps and charts was proudly cited but without a decimal time scale the arithmetic of navigation becomes more complicated. Space navigation was metric from the outset, being beyond human comprehension, but maps of the Moon and planets to an Earth commensurate unit will surely overlap somewhere.

An attempt was made to slip through an Order in Council on the Easter Recess last year (not usually well attended) that would outlaw Imperial units for use in the retail trade on pain of a fine or imprisonment (shades of 1984). However Lord Munson managed to rally the troops and it was quietly withdrawn; New Zealanders, erstwhile sturdy individualists, were not so lucky: an announcement in "The Press", Christchurch, stated that a retailer can now be fined \$500 for not working in metric.

The New Zealand Physicist, which should know, has its own views: "There are still some pockets of resistance against the move to metrication. Until these are overcome we must continue giving clear descriptions of the new units to the populace:

- LITRE A wine measure based on the size of the French bladder.
- METRE The unit of distance which all Europeans use to measure their height. This brings most happiness to men who are 5'11½" tall.
- CC The French measure of volume. Will eventually eclipse the old standards of pinch, handful, cup and a half, half G and Giant Family Size.
- CHEVAL One Horsepower = enough meat for about 2 weeks.

They also published a chart as an aid when converting frequencies from the old British units to the more scientific units:



The Metrication controversy seems to be starting at the top in the USA. During an AAAS session the President Elect Kenneth Boulding (an English economist) considered units should be related to human experience (New Scientist 11.1.'79). For energy we should use a 100 watt bulb hour, easily visualised, rather than the tiny metric erg or unwieldy BThU. SI does not seem to have made much of an impression either!

QUOTES:

If we had twelve fingers instead of ten we should probably have acquired the habit of counting by twelves and of considering all large numbers as composed of so many twelves.

Of all the possible methods of considering the number, that which breaks it up into tens is the most convenient merely because we are accustomed to it. Scientific Arithmetic, 1896.

ANTI-METRIC ACTION

We would draw your attention to the letters section in the last two editions of "THIS ENGLAND" and to the petition organised by the Editor of that magazine - a petition which expresses the views of the public; views that have been ignored so far by our representatives.

PAPER SIZES ('A' series)Donald Hammond

These international sizes
may be accurately rendered as follows:

	<u>INCHES</u> (Conventional)	<u>INCHES</u> (Dozenal)
A0	$46\frac{2}{3}$ x 33	32'8 x 29'0
A1	33 x $23\frac{1}{3}$	29'0 x 18'4
A2	$23\frac{1}{3}$ x $16\frac{1}{2}$	18'4 x 14'6
A3	$16\frac{1}{2}$ x $11\frac{2}{3}$	14'6 x 8'8
A4	$11\frac{2}{3}$ x $8\frac{1}{4}$	8'8 x 8'3

- of course, one needs a ruler with twelfths of inches! The sizes given are in ratio 2 : 1 with an error of only 0'015/g (0.007%)

These proportions are of at least equal accuracy with millimetric sizes, but do not depend on such tiny units. If we use lines, which are twelfths of inches (more than twice as large as millimetres), the sizes are:

A0	328 x 290
A1	290 x 184
A2	184 x 146
A3	146 x 88
A4	88 x 83

line²

The rotational symmetry of the typewritten numbers for A4 is remarkable, and makes it easy to remember! It is very satisfying to find these sizes, now in very widespread use, coming-out more simply in dozenal inches than in decimal metric...

FACE TO FACE WITH METRICATIONB.A.M.Moon

Norman Stoke Chief Information Officer, Metrication Board,
London:

"Some traditional weights and measures are funny enough in themselves. I cannot say "Two fardels equal one nooke" to myself without smiling; I am delighted that the fathom originally meant the distance a Viking encompassed in a hug; the Statute of Henry I which defined the foot in terms of thirty-six barleycorns taken from the width of the ear has a charm of its own; there is something laughable in the fact that the gauge of railways in Britain is the same as the distance between the wheels of a Roman chariot; and who would not be amused at the recollection that the basis of much modern town planning is the acre, an area ploughable in one day by a team of two oxen. It is one furrow long (furlong) by one chain;" (1)

Well, well, well! And has the droll Mr. Stone heard of similarly bizarre, but obsolete, units like the decigramme and dekalitre, quaintly related to other well-known units such as the hectogramme and megalitre by certain powers of the number of his fingers? So compelling is the mystique of this number that some simple fish-mongers believe they are now required to sell oysters in multiples of it, not in heretical dozens, while many of the more sophisticated amongst us feel that Cambridge and Oxford should each increase the number in their boats so that they both contain a nice round number. What matter if the number of Symphonies Beethoven wrote equalled the number of Muses? He was clearly remiss in failing to write another. After all, the number of Commandments was hiked by two to satisfy this most fundamental of criteria. (2)

Let us also remember to do proper homage to that most profound of all touchstones of scientific virtuosity - the metre. Mearly, but not quite, the length of a second pendulum at the poles at sea level; nearly again, but not quite, a certain mystical fraction of the length of the meridional quadrant of the Earth, it is actually, wonder of wonders (!), equal to 1,650,763.73 vacuum wavelengths of the orange radiation of krypton 86. The commonsense and harmony with nature encapsulated in the choice of this unit will be obvious to philosophers and practical men alike.

By contrast, the naivety of good King Henry in applying sound statistical methods in the definition of the foot as the length of thirty-six barleycorns placed end to end, or the alternative of the year 1514, when the average of the lengths of the feet of sixteen men (measured as they happened to pass out of church when the Sunday service was finished) gave a right and lawful standard, very properly permits us to smile indulgently, secure in the knowledge of our own superior erudition and wisdom. Good for you, Mr. Stone!

All right-thinking men will quickly abjure today the old admonition "by their deeds shall ye know them" - will disregard the wrongheaded choice of the foot instead of the metre for the first moon landings - will properly condemn as wilful a comparison of the relative amounts of the oceans of the Earth charted using the metre and that ridiculous alternative, the distance encompassed by a Viking in a hug. With a splendid opportunity to adopt with open arms the beautiful, pure and rational metric system that the kind bureaucrats wish to bestow upon them, how perverse and ungrateful indeed are the Anglo-Saxon yeomen in continuing to prefer their own rude ways and customs.

- (1) R.L.Weber & E. Mendoza (eds): 'A Random Walk in Science', p.123
- (2) R. Graves: "The White Goddess", p 471.

A NEW NATURAL & PRACTICAL SYSTEM OF UNITS I.V.C.Valevski (DSA)

(What follows is a summary of the physical units proposed:)

- 1) TIME: 1 second (TIM) = 386,587,173;76 vibrations of CS atom
1 Mean Solar Day = *20 hours = *2000 Min = *200000 tim
- 2) ANGLE: 1 circle = 2π radians = 4 rt. angles = " "
- 3) VELOCITY: $\sqrt{6} \times 10^{-8}$ "c" = 2;54887522x10⁻⁸ "c" (velocity of light)
c² = velocity of light squared = 2×10^{13}
- 4) ACCELERATION: of force of gravity = "g" (afg) = 1;0
more exactly $g = 0;882067 + 0;009066 \sin^2 \phi + ;000059 \sin^4 \phi$
- 5) PRESSURE: Atmospheric = 1;0: water boils at 352⁰ (100.4775⁰C)
- 6) ELECTRIC CHARGE: 10¹⁶ charge of an electron (or proton)
- 7) ELECTROMAGNETIC PERMEABILITY: : μ
of vacuum = $\mu_0 = 3 \times 10^{-7}$ units

8) ELECTROSTATIC PERMEABILITY: ϵ of vacuum: ϵ_0

$$= 2 \times 10^{-9} \text{ units}$$

9) BRILLIANCY : of a totally black body = 3×10^4 units.

3 7. 8:-

$$\frac{1}{4\pi\epsilon_0} = c^2$$

THERMOMETRIC SCALE: $267^\circ + 32^\circ = 35^\circ$ Ice melts at (267°) (0° to 32° F)water boils at 257° .

$$\text{Normal Standard Temperature} = 289^\circ / (2)89^\circ / 19.351^\circ\text{C} = 66.832^\circ\text{F}$$

DERIVED UNITS:

Length: 1 (novo)foot (nufut, podi) = 10 ins

$$= 1\text{E}72\text{E}6;56 \text{ Kr}_{72(86)}$$

$$= 29.6500 \text{ cm } (29.649940)$$

$$1 \text{ metre} = 3;45800(88) \text{ n.feet}$$

Mass: 1 (new)ton = 1000n.lbs = 921.06Kg = 2030.59 lb

$$1 \text{ new lb (catty)} = 1 \text{ emiton} = 18.80 \text{ oz.}$$

Canine Sums

A suggestion from one member: useful names for base 4 sums,
following an idea in Land's "Language of Maths" on base 8
and the octopus;

1 one 2 two 3 three 10 doggie

11 doggie-one 12 doggie-two 13 doggie-three 20 twoggie

30 throggie and 100 houndred...

Legal Tender

Sterling: Notes - any amount

"Silver" - up to 40/-

"Copper" - up to 1/-

Decimal: Gold (!) - any amount

Coins of greater value than
10p - up to £10

Small "silver" - up to £5

"Copper" - up to 20p

Mr. Max Wood is chairman of the Metrication Board, but on the evidence he is woefully, shockingly, shamefully, ill-informed about what is happening to metrication in the U.S.A.

So is Lord Orr-Ewing, his predecessor, who at a private Conservative party meeting last week, came close to calling the magnificent Mrs. Sally Oppenheim a liar because she, like me, denies that the U.S.A. is going his way.

Last week Mr. Wood wrote to this newspaper, claiming that I had been misinformed and that metrication in America was well under way.

It is interesting that, of all the grenades I had fired in his direction, this was the only one which he chose to try to lob back.

I think I see why this is the point at which the metricators in retreat are trying to stand and fight. If America does not take the plunge then they have sold the British public a pup.

Right: what are the facts? For the sake of impartial witness I call in aid the columns of the *Wall Street Journal*.

If Mr. Wood were to read it regularly he would be perhaps no wiser but certainly considerably better informed.

The *Wall Street Journal* of March 20 tells us the following:

1 The U.S. Metric Board (to which, as Mr. Wood proudly says, the Senate has just confirmed the nominations) has to decide in the months ahead whether the Government will actively promote a switch to metric or just be neutral about it.

2 Thomas Hannigan, an official of the International Brotherhood of Electrical Workers nominated to represent organised labour on the Board, told the Senate committee: "I feel it's important to avoid a national commitment to the metric system." In its 1975 law, he said, Congress remained neutral between the metre and the yard.

3 Congress did not give the Board any enforcement powers.

4 Delays by President Carter and Ford in establishing the Board were taken as a sign that metric conversion has had a low priority at the top of the Government.

On to the *Wall Street Journal* of April 5. This adds the following information:

5 When the Metric Board held its first meeting "there was wide disagreement on whether metric conversion in America will amount to much."

6 The lawmakers had shrunk from setting a deadline for conversion or even declaring a forthright national commitment.

7 The Metric Board still hasn't any money or staff.

8 A member of the Australian Metric Board who attended as an observer predicted that conversion might take 50 years in America.

"I think you are going to have to strengthen that legislation," he said. The *Wall Street Journal* added: "Even the metric system's strongest advocate in Congress admitted that the 1975 law was the strongest that could have been passed and there isn't any move afoot in Washington to strengthen it."

To this I will only add that, of course, some U.S. industries are metricating voluntarily but the \$30 million voted in 1975 is a derisory amount. President Carter has told the Board that the rate of metrication is to be governed by the market place, and the U.S. voter has got tremendous power to block what he doesn't like. So don't be fooled by Mr. Wood.

In the meantime I am happy to announce the second Huther Award for Metrication Madness. It goes to the city fathers of Wolverhampton who, as my photograph shows, have put up a "Maximum Headroom 1950 mm" outside their spanking new Civic Centre.

Drivers have two choices: (a) divide 1950 by ten to get centimetres, divide by 2.5 to get inches, then divide by 12 to produce feet and inches or (b), take a risk on crashing into the sign, in which case the barrier to the car park shuts automatically.

No more metrication

HUTBER, "Sunday Telegraph", 7.5.78

WHAT about a national referendum on that awful last gift of the Menzies era — metrication?

19

We can guess that there'd be a loud "Yes" from the Australian people in favor of calling a halt to replacement of our good old pints, inches, pounds, Fahrenheit and the rest by unfamiliar metric measures.

Decimalisation of our currency WAS overdue, although marred by a poverty of imagination among Our Betters who could think of nothing better than the imitative and confusing "dollar" as our main monetary unit.

But whom do they think they're benefiting by a rush into metrics in areas where the Americans won't have a bar of them, and where even European housewives, artisans and merchants stick to pints, inches and dozens?

The argument that metrication would simplify our overseas trade is exposed as a furphy. Ninety-five per cent of our exports aren't affected. Of the remaining five per cent some are advantaged, some handicapped.

Soon it will be too late to stop the next squander — a Board of Works plan to replace all its metres to measure our water consumption in kilolitres instead of gallons, at vast cost to taxpayers and profit to scrap-metal merchants.

So it's time for the Prime Minister, Mr Whitlam, to step in and hold that referendum.

A WARNING

The outcome wouldn't be binding on the states. But an almighty national "yes" in favor of reverting to century heat waves, inches of rain, and recognisable vital statistics for beauty queens would be a warning to the metric mad-hatters to go slow.

The Sun, Tues. Mar. 18, 1975

METRICS ON THE SOFA: LOGIC IS IN THE EYE OF THE BEHOLDER.

I have a great many books on the metric system in our home. I was sitting on the sofa reading one of them. My wife, Ruth, was also sitting on the sofa—also reading a book.

Suddenly Ruth closed her book and announced: "This system is really designed to be easy!" I closed my book too and listened respectfully. "This system is logically designed for people who cannot count over 20," Ruth continued.

That made me uneasy. I protested: "You are 165 cm tall; you weigh 60 kg; and when we visited in Europe we bought 200 grams of lunch meat for our sandwiches. How can you say that this system is designed for people who cannot count over 20?"

With considerably greater calm Ruth answered: "I'm not reading a book about the metric system. I'm reading an English detective novel. They just found a rather heavy corpse—it weighed 17 stone and 13 pounds. This was long before England had gone metric. When they got up to 14 pounds they called it a stone and most people weighed under 20 stones. For human height: when they got up to 12 inches they called it a foot and most people (in those days at least) were under 20 feet tall. As to their money: It took 12 pence to make a shilling and 20 shilling to make a pound and in the days of this novel the pound was worth so much that most people had 20 or fewer pounds around the house. So—for human height and weight and for everyday money transactions they could usually get along without ever counting over 20. This system was logically designed to keep numbers low. Without such a logical system the English could not have put together such a large empire and dealt successfully with the many uneducated people in their colonies."

OGONTZ METRIC NEWS, Jan. 22, 1977

(pro-metric...)

MERCURY, Tas. 29/1/76.

The metric rip-off

A few days ago an article appeared in The Mercury telling the public that it is cheaper to buy butter by the 500gm standard as against the pound (454gm). The 454gm (pound) is selling at 74c, while the 500gm is 86c. I wonder if people like to be hoodwinked or do they not care?

On the basis of 74c for 454gm, the 500 gm should be 81.5c. Who reaps the extra 4c on each packet of butter?

H. CRAWFORD.
Sandy Bay.

US THUMBS DOWN TO GOING METRIC

MOST of the Government timetables for converting the United States to the metric system have 1980 as the deadline for schools, agencies and official functions to be conducted in metres, litres and kilos. But with just two years remaining, pro-metric forces are faced with a public resistance that is growing by leaps and bounds.

As in Britain, the true test of metric's acceptability in America will be in the schools. But for the first time, Washington officials in charge of the conversion are fretting that the test may be postponed, if not cancelled, by a rising tide of consumer protests.

Just how angry Americans really are about metrication was underscored by a recent Government survey that covered both large and small business and individual citizens as well.

The survey discovered that only half of the 500 largest U.S. companies have even begun conversion to metrication and less than 12 per cent of a 1,400 small business sampling have followed suit. More to the point, the survey revealed that U.S. citizens oppose the metric system's use by two to one.

What has the pro-metrication forces in an uproar is that the Government survey (conducted by a Congressional accountability office) accuses the Government of supporting metrication even though there is no convincing proof for either business or consumer of benefits to be

derived. The report cites what it calls "the inevitability syndrome" or metrication—that is, the belief that it is inevitable so one might as well join in and convert even though there are no benefits involved.

The report backs up the accusation by citing survey results that a mere 5 per cent of the 500 largest companies in the US believe that metrication will significantly help their sales overseas.

Given the consumer revolt, and business indifference, the accountability agency recommended—to howls from the pro-metricationists elsewhere—that its timetable until a review is the Government should delay taken of whether the estimated billions of dollars involved in conversion are being wasted.

More to the point, a small band of anti-metrication Congressmen have announced that will reintroduce previously unsuccessful legislation to abolish the U.S. metric board (USMB) the agency in charge of pushing through conversion. The legislation would permit metrication where and when marketplace conditions warrant.

The first real public outcry came when the American wine, distilled spirits and soft-drink industries began the conversion to litre and millilitre bottles. The reduction in amount from pints and gallons was not accompanied by a reduction in price which brought allegations of cheating.

Similar attempts at packaging groceries, home appliance and paper products have met with similar resistance and

suspicion to the point that most manufacturer of consumer good have also included non-metric measurement on packages.

Earlier this year the Government's Highway authorities asked for public comment the planned conversion of speed and distance signs and 98 per cent of the comments received were hostile. Public opposition to the weather service's Celsius conversion was "almost unanimously against."

More to the point, America's multi-national corporations, which should be in the vanguard of conversion, have with the exception of car manufacturers and pharmaceutical companies, ignored metrication and aviation, petroleum, maritime, railway and construction industries have almost totally retained traditional measurements.

Even in Detroit, most of the conversion progress is being carried out by General Motors with Ford not planning to convert until the late 1980s, and Chrysler and American Motors looking at the early 1990s.

As for the schools of America which are to produce a generation of children unable to calculate in quarts and feet, there is a problem as well. Despite pressure to convert, only 13 State governments have joined the national Government in the 1980 conversion date and parental opposition in the remaining 37 states remains firm.

However one looks at it, the 1980 deadline for America's conversion to metrication does not appear reachable, perhaps never.

Many books explain the use of slide rules. The principle of adding and subtracting logarithms to achieve multiplication and division is applicable to any base.

The $\mathbb{N}$ slide rule is divided logarithmically in base twelve which thus carries the advantages of dozenal division into all applications, logarithmic, log-log, trigonometric, and thus into every science and technique in addition to the common matters of everyday affairs.

Simple scales are also included to span that sometimes awkward manoeuvre, conversion between decimal and dozenal. On the reverse of the slider a Multibase set of scales enables the real enquirer to convert, compare and calculate also in other bases.

The following notes describe the various scales and give worked examples. The nomenclature is as used in the paper on the T G M Dozenal Metric System issued with the Duodecimal Review No 26.

The scales are divided on the halves to quarters to twelfths pattern, i.e. the major marks read as 3, 6 or 9. Scale references are at the left-hand end, interpretations on the right. To describe operations we use a shorthand, so: (DF)8;6 to (CF)13 means set the rule slider so that 8;6 on the scale (DF) lines up with 13 on (CF).

Linear Calculations

Multiplication and Division are performed as usual on the lower main scales (C) and (D), or—on the upper scales (CF) and (DF). These form a useful extension of (C) and (D) to avoid "end-switching", but their primary purpose is multiplication and division by π . Cursor set to any value x on (D) gives πx on (DF), and similarly (C) to (CF).

Reciprocals to (C) (D) and (CF) are found respectively on (CI) (DI) and (CIF). These can also be used in the ordinary way to reduce the number of settings:—

$23\pi \div 9 \div 8 = 1;216$. Set (CF)9 to (D)2;3, cursor to (CI)8 gives 1;216 on (D). Three operations by one setting of slider.

Squares, Cubes and Roots. Scale (A) gives the square, and (K), the cube, of (D) by cursor line. In reverse the square or cube root.

Circles and Angles

The factor π , as explained, is handled by scales (CF) and (DF). π and 2π are also marked ready for use on most scales.

Area, πr^2 , is most accurately handled thus:— e.g. $r = 1;5$ (CI)1;5 to (D)1;5, cursor to (CI)1 gives (DF) 2π or 6;36.

Trigonometric Functions are found in the usual way by scales (S) and (T) to (C) on the slider. The ST-scale found on decimal rules is redundant in dozenal.

Angles are given in dozenal divisions of π . π radians is 180° . 1 zenipi = 15° . 1 duniPi (see numbered divisions) = $1\frac{1}{4}^\circ$. Twelve triniPis = 1 duniPi. Degree equivalents are shown at intervals of 5° (4 duniPi). In script a vee-sign is placed over the zenis figure: $\overset{\vee}{20} = 30^\circ$. Examples:-

Sin $\overset{\vee}{20}$: (S)20 gives (C)6, i.e. 0;6.

Cos $\overset{\vee}{20} = \sin(60 - 20)$, so (S)40 gives (C)7;4 ϵ , i.e. 0;74 ϵ .

Cosec and Sec, the reciprocals of Sin and Cos, are read on scale (CI). E.g. Cosec $\overset{\vee}{17}$ (S) gives (CI) 2;596.

The Tangent scale (T) runs left to right up to $\overset{\vee}{30}$ (45°) and then right to left for greater angles. The tangents are found on (C) then (CI) respectively:- Tan $\overset{\vee}{20}$ (forward T-scale) gives (C)6; ϵ 2 i.e. 0;6 ϵ 2. Tan $\overset{\vee}{40}$ (retro scale) gives (CI)1;895.

For Cotangents the scales must be in contradirection:-

Cot $\overset{\vee}{20}$ (forward) is (CI)1;895. Cot $\overset{\vee}{40}$ (retro) is 0;6 ϵ 2(C).

Conversion to Radians from Pis (or duniRadians from duniPis, etc.) is achieved quite simply by multiplying out the Pi:- (C)3 gives (CF)9;52, so Arc 3 duniPi = 9;52 duniRadians. This is used also for Sin ∇ Tan ∇ Arc of angles less than $\overset{\vee}{4}$.

For Sines and Cosines close to unity the (S) scale is too compressed for direct reading. The mark $\overset{\vee}{1}$ on (S) is then used with the formula:- $\cos \theta \nabla 1 - \frac{\theta^2 \pi^2}{2}$ (θ in Pis). Example: Find

Cos $\overset{\vee}{23}$ or Sin $\overset{\vee}{99}$:- (C)1 to (D)2;3. Cursor to (S) $\overset{\vee}{1}$. Read on (A) 20; ϵ 9. So: $\cos 2;3 \text{ duniPi} = 1 - 0;0020\epsilon 9 = 0; ϵ ϵ 9 ϵ 03.$

$\cos 2;3 \text{ triniPi} = 1 - 0;000020\epsilon 9 = 0; ϵ ϵ ϵ 9 ϵ 03.$

(The dozenal point in 21;06 is moved to left twice, the number of places shown by the prefix, for (duni)² = quedri, (trini)² = hesi).

Logarithms, Powers, Roots, etc.

The LL-Scales cover numbers from $*10^{-5}$ (LL03) up to $*10^5$ (LL3). Cursor to scale (D) gives their Natural Logarithms. If the calculation physically crosses the slider, the logarithm is negative.

Logarithms to other bases are on Scale (C) when the slider is set to (C)1 or 10 to Base(LL..).

Logs to base *10. Set (C)1 to 10(LL3). Cursor to 10^3 (LL3) lines up with (C)3, so also does 0;001 (twelve to the minus 3) on (LL03). Cursor to 2(LL2) gives 3;43(C) which means 0;343, for LL2 is one scale down from the base scale LL3. With the cursor in this same place we find also: Log*2460(LL3) = 3;43, Log 0;00051(LL03) = -3;43, and Log 0; ϵ 3 ϵ (LL01) = -0;0343.

Powers and Roots are on LL-scales, their indices, on (C) or (CI). E.g. for $1;6^5$ set (C)10 to (LL2)1;6. (C)5 gives $7;71$ on (LL3). This same position also gives: $1;6^{0;5} = 1;226(LL2)$, $1;6^{0;05} = 1;0206(LL1)$, $1;6^{-5} = 0;17(LL03)$, $1;6^{-0;5} = 0;7176(LL02)$, and $1;6^{-0;05} = 0;8987(LL01)$.

~~4~~*900:- Set (CI)1 to 900(LL3). Cursor to $4(CI) = 6(LL3)$.
 $e^{3;3}$:-Cursor to (D)3;3 gives (LL3)21;7. $e^{-3;3} = 0;057(LL03)$
 whence Sinh 3;3 and Cosh 3;3 by the usual formula.

The frequency ratio of the musical octave is 2:1. This is divided into twelve equal logarithmic steps called semitones. The Perfect 5th is seven semitones. What is its ratio? Set (C)10 to (LL2)2. Cursor to (C)7 gives (LL2)1;589.

Precision Reciprocals. The LLO-scales are reciprocals of the LL-scales and are more precise for numbers less than 2;6.

Reciprocal $1;0184(LL1) = (LLO1)0;871$.

Conversion Dec/Doz and Vice Versa

Scales (CZ) and (CFZ) are equivalents of (C) and (CF) but with decimal subdivisions, e.g. $1;9(C) = 1.75(CZ)$. $25(CFZ) = 21(CF)$. $8;4(C) = 11.33(CZ)$.

For higher and lower orders set index arrow(CF) to required order on scale (OF). Then work with (DF)/(CFZ) or (D)/(CZ). E.g. Set $\uparrow$ to (OF)100. (D)3 gives (CZ)4.32 meaning $*300 = \uparrow 432$. $\uparrow$ to (OF)1/100. (DF)9 gives (CFZ)6;25 meaning $0;09 = 0.0625$.

Remote Orders, beyond 10^7 or 10^{-6} can only be set by the (O) scale. Slider should normally move to left for ascending, and right for descending, orders. If setting by "wrong" end is necessary, the decimal has crept one order ahead of dozenal. Reduce the indicated indices by 1 for dozenal, e.g. " 10^9 " means 10^9 decimal but 10^8 dozenal, " 10^{-7} " is $\uparrow 10^{-7}$ and $*10^{-6}$. Don't forget to convert when index is in two figures. " 10^{-12} " is $*10^{-10}$ for "right" end setting, $*10^{-8}$ for "wrong" end, e.g.: Convert $*8 \times 10^8$ to dec. (CZ)12 to (O)10¹¹ won't give it, so (CZ)1 to (O)10¹² ($=*10^8$). (D)8 gives (CZ)5.95 ($\times 10^{12}$).

Degrees to duniPis: Set (OF)1 to (CFZ)15.

Tens of degrees to zenipis: (OF)10 to (CFZ)15.

Minutes to quediPis: (OF)1 to 6.25.

Seconds to queniPis: (OF)1 to (CFZ)31.25

Seconds to hesiPis: more easily set by (C)2;73 to (D)10, but read seconds on (CZ) of course.

Multibase Scales on Reverse of Slider

These are too involved to be fully dealt with here. They handle bases two to nine inclusive and "onezen four" which is given the non-dozenal non-decimal name "Libral". Gradations on the libral scale serve also bases 2, 4 and 8. Base nine

gradations serve also base three.

Upward arrows manipulate the ascending orders and downward arrows the descending orders. All indices are in dozenal. The righthand numbers are the base orders, the lefthand indicates the order of dozen for scale (C).

Full explanatory leaflet, price 30p, from T. Pendlebury, 19 Edinburgh Road, HOLT, Norfolk NR25 6SL.

The Full Cursor

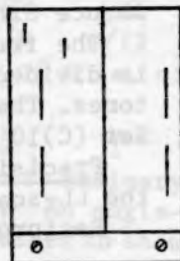
Apart from the single fiducial line, extra lines as shown can greatly increase the versatility.

The top mark rides over scale (K) and gives the Volume of a Sphere whose diameter is set by main line on (D). Position: the mark 1; $4\pi(K)$ when main line on (K)8.

The next mark, over scale (A), gives Area of Circle for dia on (D). Position: $(A)\pi - (A)4$.

The other four marks ride over scales DF, CF, CFZ, CIF, and CI, CZ, C, D. They display the Dec/Doz conversions of the next orders up and down, and give percentage to pergrossage at a glance, etc. Positions from main line = 5 to 6 on the scales concerned, or consecutive marks on the 0-scales.

A Full Scientific Cursor has additional marks riding over scale (O) for orders 14, 28, 40, 54, 68, 82 and 96, positive and negative, extending the scope from 10^{-109} to 10^{109} .



Full Cursor

An International Symbol for ORDINALITY.

Numerals are:— 1, 2, 3, 4, 5, 6, and so on. These characters are international (somewhat); but their names differ in language.

Ordinals are:— 1st, 2nd, 3rd, 4th, 5th, and so on. But, in every language, these declensions or suffixes have to be expressed in various forms; in French, Danish, German, Greek, Spanish, Latin. What is needed is a Symbol to cover them all in certain circumstances. It can be written in all cases, but read-out in the vernacular.

It is needed in cramped-space charting (pedigrees) and for computers.

The Symbol offered here, is a small raised reclining comma. $1^{\sim} 2^{\sim} 3^{\sim} 4^{\sim} 5^{\sim}$.

Printers' name for the metal type-piece, can be "yem" (after French ième).

$2^{\sim}$ earl; $3^{\sim}$ baron; $4^{\sim}$ child; $1^{\sim}$ time; $10^{\sim}$ week. The yem must never be used to express Fractions. (Confusion of Ordinals with Fractions occurs in English.)

L. Loynes

The rule was started many years ago for my own private research before I had ever heard of a dozenal society. Pocket calculators were not even dreamt of, and computers were heat-generating monstrosities that filled very large rooms.

It lay on top of the wardrobe for several years in a very crude state, practically no subdivisions, and not very accurate primary ones. Then on a college library shelf I found a copy of Halcro Johnson's "Reverse Notation". The knowledge that there were at least two of us in the world reawakened my interest. The rule developed a little further with new hieroglyphic numerals, uppers and downers, for the revised system.

Yet a few more years, and via Esperanto I discovered the D S A in America, and so the D S G B.

When they and I had more or less learned to tolerate each other I turned to the rule again. A clean sweep and fresh start was indicated, so the three-foot long rule was covered with white Fablon. Meanwhile I had gained much experience at the drawing board and obtained accurate instruments.

Each mark now had its distance from the common datum calculated to the nearest hundredth of a millimetre,—reams of them! An accurate draughtsman's scale was strapped in position by masking tape, and with two pairs of spectacles for high magnification, the divisions were carefully and unhurriedly marked out.

After a very long time the stage was reached when the slider (hitherto nailed in situ) could be released for a trial run. It worked! And pretty damned accurate at that! I was flabbergasted and delighted.

Then Arthur Whillock saw it and wanted to have it reproduced photographically. I doubted whether the result could be sufficiently accurate. But he's done it, and here it is! ⁶

The finished prototype is now covered in transparent Fablon to protect the scales, which otherwise would be easily effaced. Do that to yours the moment it is satisfactorily mounted.

Hints on Making the Rule

1. If you don't feel competent to make a pukka slide rule, you can still use the scales for Reciprocals, Square and Cube Roots and Powers, Sines, Cosines, Tangents, and Natural Logarithms, by simply pasting on a board fairly parallel to a straight edge. Make a simple cursor to run along the edge like a tee-square.
2. The stator scales printed beside the front face slider may

(~~as~~ Enclosed with this REVIEW)

be rather faint, especially the O-scales. Use those printed beside the Reverse. They are identical.

3. When scales are stuck down, cover them immediately with transparent Fablon as a protection. The back of a junior hack-saw is a good tool for ironing it down firmly.

4. Accurate positioning of the two halves of the stator is extremely important. First, fix lower stator in its final position. Second, place slider against this and align. Use a magnifying glass. Strap in position by masking tape. Third, align upper stator to undisturbed slider. Check with magnifying glass, and fix.

5. Watch the levels. Stators will need extra packing to accommodate the thickness of Reverse slider scale and its protective Fablon.

6. A liberal clearance hole for one of the cursor screws makes it adjustable for accuracy.

HISTORICAL METROLOGY

Roman Measures of Length: Smaller Measures

<u>Measures:</u>				<u>Feet</u>	<u>Inches</u>
Digitus					0.7281✓
1½	Uncia	("inch")			0.9708✓
4	3	Palmus			2.9124✓
12	9	3	Palmus maior	(of late times)	8.7372
16	12	4	1½	PES	11.6496
20	15	5	1½	1½ Palmipes	1 2.562✓
24	18	6	2	1½ 1½ CUBITUS	1 5.4744✓

GET WITH IT! (Part zen) For Students & Beginners. T. Pendlebury

When we make the wheels go round we apply Force, Acceleration, Power, etc., not in a straight line, but round the circle.

Torque, Turning Moment, Moment of Force

Open the room door. Then try to close it by pushing very close to the hinge side. It needs more force than if you close it normally by the handle side. $\frac{1}{2}$ lb at 2 ft = 1 lb at 1 ft = 2 lb at 6 ins = 4 lb at 3 ins, and so on.

Torque or Turning Moment = Force x Radius

and is expressed in pound-feet, pound-inches or newton-metres. These must not be confused with foot-pounds, inch-pounds and metre-newtons (or joules), which are units of energy, i.e. 1 lb applied through a forward distance of 1 foot, etc.

TGM makes the radial factor in a unit clear by the following prefixes:-

Abbrev.

Abb.

radi- divided by radius r- rada- multiplied by radius R-

quari- ,, by sq of ,, q- quara- ,, by sq of ,, Q-

cubri- ,, ,, cube of ,, c- cubra- ,, ,, cube of ,, C-

So the TGM unit of Torque, 1 Mag of Force x 1 Gf of Radius, is the radaMag (RMg), i.e. the Mag (Force) in rotation. The word means: unit radius x unit mass x G.

Angular Displacement.

In rotation all points do not move the same distance. A point at 1 ft from centre moves twice as far as a point only 6 inches from centre, and only half as far as another point 2 ft from centre.

$$\text{Angular Displacement} = \frac{\text{Arc}}{\text{Radius}}$$

and is measured in Radians.

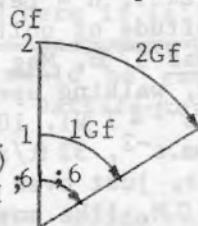
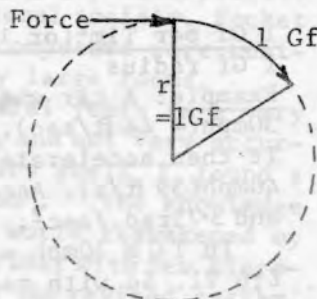
$$1 \text{ Radian} = \frac{1 \text{ ft(arc)}}{1 \text{ ft(rad.)}} = \frac{1 \text{ m(arc)}}{1 \text{ m(rad.)}} = \frac{1 \text{ Gf(arc)}}{1 \text{ Gf(rad.)}}$$

"Rad." is the usual abbreviation, but TGM contains also the useful form "rGf".

Angular Velocity is similarly its linear brother divided by radius.

$$\frac{1 \text{ ft/sec}}{1 \text{ ft radius}} = \frac{1 \text{ m/sec}}{1 \text{ m radius}} = \frac{1 \text{ Gf/sec}}{1 \text{ Gf radius}} = 1 \text{ radian per second.}$$

$$\frac{1 \text{ GfTm}^{-1}}{1 \text{ Gf radius}} = \frac{1 \text{ Vlos}}{1 \text{ Gf radius}} = 1 \text{ Rad. per Tim, or radiVlos (rVl)}$$



$$\frac{1 \text{ ft/sec}^2}{1 \text{ ft radius}} = \frac{1 \text{ m.s}^{-2}}{1 \text{ m radius}} = 1 \text{ radian per second per second.}$$

$$\frac{1 \text{ Gf per Tim}^2 (\text{or } 1 \text{ G})}{1 \text{ Gf radius}} = 1 \text{ rad./Tim/Tim, or } 1 \text{ radiGee (rG).}$$

Example: A car wheel is 1 ft radius and the car travelling at 30mph (= 44 ft/sec). So the wheels are turning at 44 rad./sec. It then accelerates during four seconds to reach a speed of 40mph (59 ft/s). Acceleration is 2.5mph per sec = 3.75ft/sec², and 3.75rad./sec².

In TGM 30mph = 8 ⁴Gf/Hr = 8 Gf/Tm i.e. 8 Vlos. 40 mph = 7;6 Vl. So with radius = 1 Gf we have: 8 radiVlos increasing to 7;6 rVl in *20 Tm (4 sec), i.e. 0;13 rG for the wheel, and 0;13 G for the car, about 1/9 the acceleration of falling.

Work, Energy in rotation.

Force x Distance becomes Torque x Ang. Displacement. Traditionally you multiply pound-feet or newton-metres by radians and get foot-pounds or metre-newtons (joules). In TGM we multiply the radaMag by the radiGrafut, rada- and radi- cancel out, leaving, Mag x Grafut = Werg. This proves mathematically that energy is independent of radius.

Power = Energy/time = Force x Velocity = Torque x Ang.Vel.
 Pound-feet or newton-metres multiplied by radians per second give foot-pounds or metre-newtons per second. 1 mNs⁻¹ = 1 watt.
 550 ft.lb/sec = 1 Horse Power.

In TGM: radaMag x radiVlos = Mag x Vlos = Pov.

A common formula for the horse-power of rotary machines is
 $\text{power(HP)} = \frac{2\pi NT}{33000}$ where T = Torque in lb. ft
 N = RPM. Note how the 2π turns these into radians per minute. In TGM the formula becomes:-
 $P = 2\pi nT$, n = revs. per Tim (Cims), T in radaMags.

Magnitude of units.

Maz 57 lb, Mag 57 lbf, rMg 55 lb.ft or 75 newton-metres.
Vlos, walking speed, 3.8 mph, 5 Vl = 30 km.h⁻¹, 8 Vl = 30 mph.
 $1 \text{ m.s}^{-1} = 7 \text{ Vl}$, 100 ft/s = *16 Vl. Gee, acceleration of falling 9.8 m.s⁻², 32 ft/s². Werg, 75 joules, 55 ft.lb. Pov, 3 gross watts, just over half h.p. Just to put you in the picture. In TGM, like any other system, you don't go converting to something else.

Example. The drum of a windlass is 0;6 Gf radius (6 in or 0.15 m). A 0;6 Mz weight (28 lb, 12 kg) is hung on the rope and wound up. The handle is let slip so that the weight descends. The mass of the drum causes a drag of 0;1 radaMaz (4.5 lbm ft or

0.6 m.kg). a) What is the acceleration of the weight? b) What is the angular acceleration of the drum? c) What is the speed of descent after *20 Tim (4 sec.)? d) What is the angular velocity of the drum at that time? e) What is the power at that time? f) What is the torque on the drum? g) What is the torque multiplied by the angular velocity?

a) Drag of 0;1RMz = 0;2Mz at 0;6Gfradius, which must be added to mass of weight to be moved. The force is gravity acting on the weight:-

$$\text{Force } F = 0;6 \text{ Mz} \times 1 \text{ G} \quad 28 \text{ lb} \times 32.2 \text{ ft/s}^2 \quad 12 \text{ kg} \times 9.81 \text{ m.s}^{-2} = \\ = 0;6 \text{ Mg.} \quad = 901.6 \text{ poundal.} \quad 117.7 \text{ newtons.}$$

$$\text{Drag} = \frac{0;1 \text{ RMz}}{0;6 \text{ Gf}} = 0;2 \text{ Mz} \quad \frac{4.5 \text{ ft lb}}{0.5 \text{ ft}} = 9 \text{ lb} \quad \frac{0.6 \text{ m kg}}{0.15 \text{ m}} = 4 \text{ kg}$$

$$\text{Total mass} = 0;8 \text{ Mz.} \quad 28 + 9 = 37 \text{ lb.} \quad 12 + 4 = 16 \text{ kg.}$$

$$\text{Accel.} = \frac{0;6 \text{ Mg}}{0;8 \text{ Mz}} = 0;9 \text{ G.} \quad \frac{901.6}{37} = 24.4 \text{ ft/s}^2 \quad \frac{117.7 \text{ N}}{16 \text{ kg}} = 7.36 \text{ m.s}^{-2}.$$

$$\text{b) } \frac{0;9 \text{ G}}{0;6 \text{ Gf}} = 1;6 \text{ rG.} \quad \frac{24.4}{0.5} = 48.4 \text{ rad/s.} \quad \frac{7.36}{0.15} = 49.1 \text{ rad.s}^{-1}.$$

$$\text{c) } 0;9 \text{ G} \times 20 \text{ Tm} = 16 \text{ Vl.} \quad 24.4 \text{ ft/s}^2 \times 4 \text{ s} = 97.6 \text{ ft/s.} \quad 7.36 \text{ m.s}^{-2} \times 4 \text{ s} = 29.4 \text{ m.s}^{-1}.$$

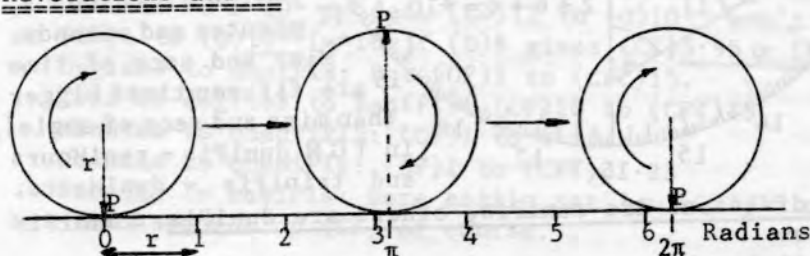
$$\text{d) } \frac{16 \text{ Vl}}{0;6 \text{ Gf}} = 30 \text{ rVl.} \quad \frac{97.6}{0.5} = 195 \text{ rad/s.} \quad \frac{29.4 \text{ m.s}^{-1}}{0.15 \text{ m}} = 196 \text{ rad/s}$$

$$\text{e) } 0;6 \text{ Mg} \times 16 \text{ Vl} = 9 \text{ Pov.} \quad 28 \text{ lb} \times 97.6 \text{ ft/s} = 2733 \text{ ft lb/s} = 4.97 \text{ h.p.} \quad 117.7 \text{ N} \times 29.4 \text{ m.s}^{-1} = 3460 \text{ watts} = 4.7 \text{ chev.vap.}$$

$$\text{f) } 0;6 \text{ Mg} \times 0;6 \text{ Gf} = 0;3 \text{ RMg.} \quad 28 \text{ lb} \times 0.5 \text{ ft} = 14 \text{ lb ft.} \quad 117.7 \text{ N} \times 0.15 \text{ m} = 17.65 \text{ Nm.}$$

$$\text{g) } 0;3 \text{ RMg} \times 30 \text{ rVl} = 9 \text{ MgVl or } 9 \text{ Pv.} \quad 14 \text{ lb ft} \times 195 \text{ rad/s} = 2730 \text{ ft lb/s.} \quad 17.65 \text{ Nm} \times 196 \text{ rad/s} = 3460 \text{ watts.}$$

Revolutions and Pi



One complete revolution = $6;3494\dots$ radians. In case you don't recognise it, it is twice Pi, written 2π .

π , the ratio of a circumference to its diameter, is in every counting base an unending never repeating fractional! Decimal: $3.141592654\dots$ Dozenal: $3;1848 \ 0949 \ 40\dots$ Even in Septal, the best for rounding off, it is $3;066365143\dots$

In practice we say "Pie", write " π " and only multiply out the numerical value when absolutely necessary.

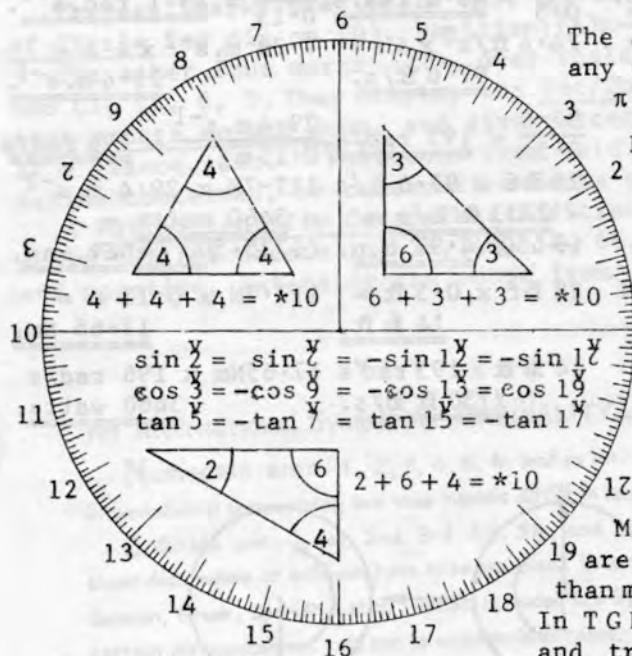
It is the practice in engineering and scientific works to express angles in radians unless otherwise indicated. So when you see " $\cos \pi/2$ " it means cosine 90° , and " $\sin \pi/3$ " means sine of 60° , etc. π is a sort of counting base for radians. Common expressions are:-

for 360°	180°	120°	90°	60°	45°	30°	15°
2π	π	$2\pi/3$	$\pi/2$	$\pi/3$	$\pi/4$	$\pi/6$	$\pi/12$

which neatly fit the dozenal system. A twelfth of π is, of course, a zenipis (1π):-

2π 1π π $\pi/2$ $\pi/3$ $\pi/4$ $\pi/6$ $\pi/12$

This, extended into duniPis, triniPis, etc., just ordinary dozenal numbers, is the system of angles in TGM. An angle-sign π is placed over the zenis figure when required to show that the number refers to angle.



The sum of the angles of any triangle is 180° i.e. 3π (radians) or 10 .

Diametrically opposite angles differ by + or - $*10$.

1 zenipis rotation of Earth takes 1 Hour.

Astronomers measure some angles in $^\circ$ "

but Right Ascension in hours, minutes and seconds.

Mins and secs of time are fifteen times bigger than mins and secs of angle!

In TGM duniPis = zenisHours and triniPis = duniHours.

Numbered divisions are zenipis, others are duniPis. 4 duniPis = 5 degrees.

In traditional measure to convert degrees to radians one has to multiply by $\frac{\pi}{180}$. ($\frac{\pi}{n}$ for any other system, where n = number of divisions per semicircle). Minutes and seconds are usually first converted to decimals of degrees:-

$10^\circ 45' 30'' = 10.7583 = 0.0597685\pi$ radians = 0.187768 radians. In TGM just multiply out the Pi: $3 = 3\pi$ Rad = 0.952 Rad.

In TGM, Longitude and Earth Time both start at 180° E of Greenwich, and run continuously westward like the sunrise and sunset. This makes Greenwich longitude 10° , and at 10 Hours Earth Time (written 10Hr) GMT is at 0 i.e. midnight (it is already noon of the same date in the Pacific). Earth Time minus Longitude (to nearest zenPi) generally gives the basic local Standard Time (excluding any political deviations).

To convert longitudes W of Greenwich, $\div 15^\circ$ and add 10° .

“ “ “ “ E “ “ “ $\div 15^\circ$ and subtract from 10° .

Examples:-

			Time Zone	Zero local =
Tokyo at 140° E =	$10^\circ - \frac{140}{15} = \frac{10}{15}$	$\frac{10}{15}$	9	3 Hr = GMT + 9 hr
Peking 117° E =	$10^\circ - \frac{117}{15} = \frac{10}{15}$	$\frac{10}{15}$	2	4 Hr = GMT + 8 hr
Baghdad 45° E =	$10^\circ - \frac{45}{15} = \frac{10}{15}$	$\frac{10}{15}$	9	9 Hr = GMT + 3 hr
Greenwich 0° =	10°	10°	10	10 Hr = GMT
Montreal 74° W =	$10^\circ + \frac{74}{15} = \frac{149}{15}$	$\frac{149}{15}$	15	15 Hr = GMT - 5 hr
Los Angeles 118° W =	$10^\circ + \frac{118}{15} = \frac{178}{15}$	$\frac{178}{15}$	18	18 Hr = GMT - 8 hr
Anchorage 150° W =	$10^\circ + \frac{150}{15} = \frac{160}{15}$	$\frac{160}{15}$	12	17 Hr = GMT - 10 hr

TGM

PROBLEMS: (1) A force of 2 Mag (110 lbf, 500N) is applied to a rotary system at a radius of 4 Grafut (4 ft, 1m). What is the torque in radaMag, lb ft, and N.m?

(2) When this torque has turned the system through 2 radians how much work has been done in Wergs(MgGf), ft lb and joules?

(3) If the work was done in 8 Tim (1.4 sec.) what was the average power (work/time) in Povs, ft lb/sec and watts?

(4) What was the average angular velocity in rVl and rad/s?

(5) If the acceleration was uniform from standstill to a maximum at the end of the 8 Tm, a) what was the final angular velocity? b) what was the acceleration?

(6) Just as Force = Mass x Acceleration, so Torque = Moment of Inertia x Angular Acceleration. So what is the Moment of Inertia of this system in quaraMaz, slug ft² and kg.m² (Torque divided by angular accel.)

(7) Write the following angles in zenPi: 45° , $22\frac{1}{2}^\circ$, 75° , $37\frac{1}{2}^\circ$, 105° , 240° , 270° , 330° , $7\frac{1}{2}^\circ$, 5° .

(8) What are the angles of an equilateral triangle in zenPi?

(9) A triangle has angles $\frac{1}{8}$ and $\frac{1}{4}$. What is the third angle?

(7) What is the difference in clock time between Baghdad and Montreal? Which appears earlier in the day?

(8) What are the TGM longitudes for: 60° W, 60° E, 75° W, 5° W, 40° W, 100° E, 150° E, 45° W, 50° W, 55° W, $62\frac{1}{2}^\circ$ W, $77\frac{1}{2}^\circ$ E?

In the next article: Trigonometry, etc.

Answers to Get With It!

- (1) 8 RMg, 440 lb ft, 500Nm. (2) 8 RMg x 2 rGf = *14 MgGf or Wergs, 880 ft lb, 1000 metre-newtons or joules.
 (3) *14/8 = 2 Pv, 629 ft lb/sec, 714 m.N.s⁻¹ or watts.
 (4) 2 rGf/8 Tm = 0;3 rVl, 1.43 rad.s⁻¹.
 (5) a) Initial velocity = 0, so final = twice the average. 0;6 rVl, 2.86 rad.s⁻¹. b) 0;6 rVl/8 Tm = 0;09 rG, 2.04 rad/s²
 (6) 8 RMg/0;09 rG = 78 QMz [R/r = R² = Q. Mg/G = Mz], 245 kg.m², 215.7 Slug ft² [1 slug = 32 1741 lb mass].
 (7) 3, 16, 5, 26, 7, 14, 16, 12, 06, 04.
 (8) 10 ÷ 3 = 3
 (9) 68 + 24 = 90, so third angle = 10 - 9 = 1.
 (Z) Subtract longitudes: 14^Y - 9 = 5^Y, so 8 hours difference. Montreal, farther west, has greater longitude to subtract from Earth Time, and will appear to be earlier in the day.
 (E) 60°W, 60°E, 75°W, 5°W, 40°W, 100°E, 150°E, 45°W, 50°W, 14^Y 8^Y 15^Y 104^Y 128^Y 54^Y 2^Y 13^Y 134^Y
 55°W, 62 1/2°W, 77 1/2°E.
 138 142 6Z (Read: one three zeni eight, one four zeni two, six zeni ten, etc.)

Going metric

Sir — As one who has made "a detailed study of the uses of measurement systems in technical and scientific fields" may I reply to Mr. Charles W. Harvey ("EDP," April 5th)?

I know the metric system thoroughly including most of the more abstruse units. Yes, it is a full system, as compared with the fragmentary bits and pieces we call Imperial, and it is mainly coherent (different kinds of units being related. Amps are related to kg., etc.). Most of its units, but not all, run in one common system of magnitudes, tens, like our numbering system. It is at this point that metric parts company with common or garden arithmetic, two twos are four, and all that, for ten is a bad denominator, and always will be.

The lowest common multiple of .1, .2, .3, .4 (and .6) is 1.2, a dozen tenths, and if .5 is included the answer is 6.0, the half-dozen. Fives and tens are not very good at counting their own decimals! The most common multiplications run up the series 2, 4, 8, 16, 32... which has nothing to do with fives and tens. One out of every three numbers

is a multiple of three, but 5 and 10 and all their powers manage to steer clear. This elusiveness of ten causes even the simplest fractions to break out in a rash of 5s and recurring decimals: .125, .375, .0625, .333..., etc., and gives the grotesquery 33 1/3 per cent. for the simple notion of 1 in 3. The bug-eyed monsters must find all this a bigger laugh than mashed potatoes!

So, even though metric is used for every science, it of itself is very unscientific. In truth, it is arithmetically impossible — I repeat, impossible — to have an ideally straightforward system of measures, unless humanity will abandon the stupidity of counting by tens. A thorough and detailed system which combines the advantages of both Imperial and metric and many more simplicities does in fact already exist for forward-looking people to explore. But, it corrects the counting error: *10 means twelve.

To go metric, political? Yes, to pander to the way of the world, right or wrong. Scientific? Enlightened? No. — Yours truly,

TOM PENDLEBURY.

19, Edinburgh Road,
Holt.

EASTERN DAILY PRESS: 11.4.1978

Imperial measures and metric propaganda

PATRICK HUTBER, referred last Sunday, to "the conspiracy of silence" in schools about our Imperial weights and measures.

As a maths teacher I am required to teach metric units to my classes, their examinations being set exclusively in metric units; at the same time I am concerned that my pupils should know about Imperial units. I find, however, that many pupils on reaching the secondary school do not know what an inch is, let alone an ounce.

It is in the primary schools that the 'revolution' has taken place, and it is here that the inch-rulers have given way to the centimetre ones. I could give many examples why the standard inch ruler is superior to the centimetre one; yet such is the "brainwashing" that the children have received that they reject any mention of non-metric units.

In one case, I noticed a child's essay in which the word "feet" had been replaced by the teacher with the word "metres"

—incidentally making nonsense of the sentence it was in.

If this area is typical of the country as a whole then it will not be long before we have a generation leaving school as ignorant of Imperial measures as today's school-leavers are of fad units.

I am glad the "mass choirs of the Press" have now joined in the metrication argument; but I very much doubt whether the Government will take any notice; all it has to do is wait, and after a while the Press will get bored with the topic and leave the powers that be to get on with the eradication of the British element from Britain.

—SHAUN FERGUSON, Secretary, The Dozenal Society of Great Britain, Carlisle.

SUNDAY TELEGRAPH
28.5.78.

Without claiming duodecimal dexterity, we can acquaint you at least with some of the basic concepts. The fundamental time unit is 1 *tim*, the $(12)^{-1}$ fraction of the familiar hour, or 0.17361 sec. The unit of length is the *grafut* ("gravity foot", abbreviated *gf*): the distance through which an object drops in an earth-normal gravity field during the first *tim* of free fall. It works out to be almost exactly one British foot (well, about three-eighths of an inch shy). The mass unit is defined as the amount of H_2O mass occupying one cubic *grafut* under standard conditions, and so forth. There is a complete set of basic unit definitions and base-12 prefixes to take the place of base-10 multipliers like "kilo-."

Trying to put all this into some sort of perspective, we are reminded of a story we've heard from one of our anthropologically learned friends. It seems there are primitive tribesmen so algebraically unsophisticated that they only count "one—two—many". There are times when, quite frankly, we envy them.

Easier By The Dozen?

Last year we reported on the ever-changing status of engineering urfits* and were moved to observe that some of these still have a rather parochial basis. Now we are obliged to confess to a certain extent of parochialism on our own part: the earlier discussion had been limited to what's happening in the *decimal* metric system.

We have now before us a hand-somely mimeographed brochure from the Duodecimal Society of Great Britain (Scotby, Carlisle CA4 8BG, England). A cover note points out that this new metric system (base 12) is superior to the "French" system (base 10).

*"Measurement Units: Why They Won't Stay Put", DESIGN NEWS, Aug. 23, '71, pp. 36-37.

* * *

IT is a poor heart which never rejoices and we are all of us entitled to be

delighted at the Government's major climbdown on metrication.

The Government has abandoned compulsory metrication for one simple reason. In spite of its threats, in spite of its blandishments, in spite of all the efforts of Mr. John Fraser (whom I find so disconcerting to meet because he looks so like a middle-aged punk rocker) it could not assemble a Parliamentary majority to get its orders through.

The reason it could not get a Parliamentary majority is that steadily, bravely, unobtrusively Mrs. Sally Oppenheim had rallied the Conservative ranks till they were very close to unanimous on the issue.

And the reason she was able to do that is because, without immodesty, this column, over a period of years argued, cajoled, pleaded and mocked the metricators.

When I started, mine was virtually the only voice raised in the British press against this thing; in the last few weeks it has been like listening to the Hallelujah Chorus, as the mass choirs of the popular Press joined in.

It was a piece of uncovenanted luck that the crunch came in an election year but my consistent forecast that, when it did come, compulsory metrication would be wildly unpopular, has proved to be correct.

In a sense it is a minimum victory. Metrication will still go ahead and I have no doubt that the assiduous bureaucrats of the Metrication Board will attempt to achieve by stealth what they have failed to do by force.

But we have established the principle that shoppers should not be prevented from purchasing the goods they want in the dimensions they desire.

I must thank all the many, many people who have written to me, particularly over the past week. I am particularly happy for people like Mr R. Berry, a Kent fuel merchant who for months has been fighting against a particularly idiotic form of metrication about to be prescribed for the coal trade, and who yet found time actually to ask his customers what they wanted. The result: 238 replied wanted to buy fuel in metric quantities, 4,589 were against it, though interestingly 4,131 were in favour, as is sensible, of showing dual weights. For him victory has come in the nick of time.

We have now two important things to do. The first is to insist that the conspiracy of silence in so many of our children's schools about our traditional weights and measures is ended. The social engineers have no right to rob our children of part of their heritage — and disadvantage

them in a world which still has imperial measures.

Second we have to persuade the big bone-heads of British industry that it is sensible — and can pay — to give the consumer a choice and, in President Carter's phrase, let the systems compete in the market place.

Let me give an example. A colleague recently had a new thermostat fitted to his central heating. It had a centigrade scale, which meant nothing to him. I spoke to the manufacturers, Satchwell Controls, on his behalf. Speedily and efficiently they sought out the last fahrenheit thermostat cover in their entire works and des-

patched it to him. But why on earth not keep it in production and meet demand?

In the end though, I have always believed that the metrication issue was not just about the merits of rival systems, or whether it made sense to change all our road signs.

It was about the imposition upon a reluctant public of what the bureaucrats thought was good for it: it was about moves to alienate us from yet another area of the familiar, about dishonest propaganda and the debasement of the truth.

What a commentary upon the times that in this day and age it ranks as a major victory to have forced Big Brother back half a step.

HUTBER: Sunday
Telegraph 15.5.78

Give an inch, take a nation

31

DAILY EXPRESS

9.3.76

AFTER WHAT will be a perfunctory debate in the Commons, an Order will become law making it an offence to sell skirt lengths, chair covers, hard-board or carpets in measurements of feet and inches.

It will, quite unbelievably, be possible to fine a draper £250 and send him to prison for three months for selling four feet of curtain material!

Surely the Metrication Board has reached a stage in its development where somebody should design a uniform for its members.

Where metrication is genuinely wanted, as in heavy engineering, there is no need to enforce it; conversely where it has to be enforced it is not wanted. There is no irresistible pressure from the EEC to excuse this nonsense. Metrication is the pet fad of people who rather like diminishing the identity of this country.

When George Orwell wrote "1984," some 30 years ago, he took it for granted that a tyrannical State would measure things in metres, kilos, litres, and hectares.

Today they don't support tyranny but they are part of the new flavourless and homogenised quality of modern life. They give a plastic taste to the goods they measure and they make the citizen feel abroad in his own country.

To the Metrication Board and to the International Union, the sight of a postcard (essentially) of the 18th-century British landscape "among the hills, doubtless brings back thoughts of his holidays in the Loire Valley "among truly civilised people."

To most of us they are an insolent imposition upon people who have never been consulted.

Any political party which has a feeling for what people want, would know the wisdom of resolutely opposing all such measures for metrication, of reminding the present order, of allowing a free market in measurements, and of kicking the Metrication Board back into oblivion.

Not a fine instrument

Sir.—In reply to Mr. Thurston's letter (March 28) regarding suitable units: if one "thou." is too large a unit in the Imperial system, why not choose a smaller unit, say one "mil." (0.001 thou.). After all, if we want to avoid using decimal places and at the same time keep the numbers we are using within reasonable bounds, we can choose any subdivision of an existing unit (and give it a name if we wish).

The fact that the decimal metric system has a set of units with special names does not imply that it is therefore superior to any other system. Unfortunately, the decimal metric system is rapidly becoming a religion.

The decimal metric system is neither as fine an instrument nor as natural a one as one that could be derived from our present units. In fact, should we decide to use the foot as our standard, the range Mr. Thurston mentions (say 0.1 micron to 1mm) could be accommodated by a range of about 600 units in a dozenal system where this

unit is a simple dozenal division of 1 foot.

And as for the Teslas and Newtons—well, we can provide a much better system that embraces, with simple relationships, all the electrical and magnetic units that are so difficult to manage in metric.

Shaun Ferguson,
Secretary,
The Duodecimal Society
of Great Britain.

(Financial Times: 17.4.74)

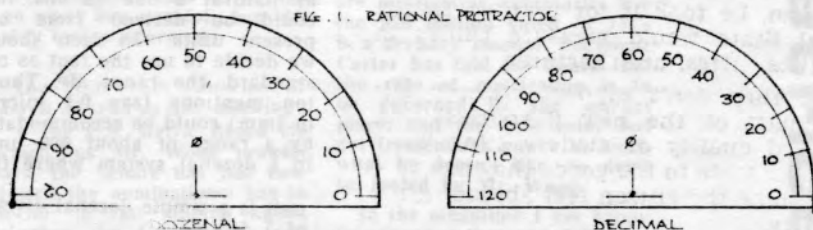
THE RATIONAL PROTRACTOR: A SIGNIFICANT PROPERTY.

Donald Hammond

Readers of the Review will recall, from the article in no.*30, that the Rational protractor is based, not on the circle or semicircle, but on the quadrant; and that it divides this important right-angle into *50 (460) Rational degrees so that:

1 quadrant	=	50°
1 semicircle	=	20°
1 circle	=	180°

- which provides an angular measure with numerous advantages, including acceptance of prime factors 2, 3 and 5 and the property of being constructible in the plane by ordinary compass-and-straight-edge methods. It can be numbered roundly in both dozenal and decimal, and gives adequate angular division with exceptional clarity (Fig.1).



Now, the Rational protractor fits the existing twelve-hour clock face, of course. In fact, each minute-interval on the clock face equals four Rational degrees (see Fig.2) precisely.

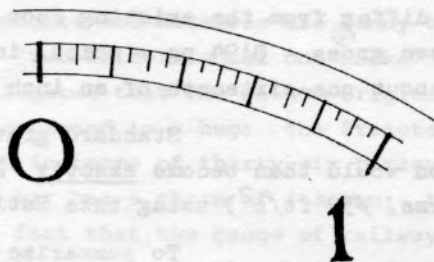


Fig.2. Rational degrees added to a clock face.
1 clock minute = 4°

Let us now consider a clock, marked with Rational degrees in addition to the ordinary hour and minute divisions, and equipped with a sweep seconds hand. The sweep seconds hand rotates once per minute, as usual, so that the 'minute' markings become 'seconds' markings as far as the sweep hand is concerned.

The time taken by a sweep seconds hand to traverse one Rational degree is thus one-quarter of a second.

A falling body, in vacuo, starting from rest in standard gravity at sea-level will fall, in one-quarter of a second, a distance of:

1'0094 ft (dozenal), or 1.0054 ft (decimal)

This distance follows from taking gravitational acceleration as 432.1740 ft/s, and is very close indeed to the British-American foot. If we adopted a modified foot which gave a value of unity for the above distance, such a Rational gravity-based

foot would differ from the existing foot by less than ten per dozen gross - 0.94 pg - which, in conventional terms, is about one-sixteenth of an inch longer!

Standard gravitational acceleration would then become exactly $*28 \text{ ft/s}^2$ (or, in decimal terms, $*32 \text{ ft/s}^2$) using this Rational foot.

To summarize: the Rational protractor offers the following benefits.

- (a) Constructibility in the plane.
- (b) A perfect compatibility with the clock face.
- (c) Acceptance of prime factors 2, 3 and 5, which are mathematically necessary for angular scales.
- (d) Acceptance of dozenal or decimal calibration.
- (e) The possibility of a gravitational foot which is very nearly the same as the present one.

It's worth thinking about, is it not?

DO YOU REMEMBER ?

"Dozen ft"

Find what change I should receive from a £1 note after paying for :

- | | |
|---|---|
| (a) $2\frac{1}{2}$ lb. at 3s. 4d. per lb. | (b) 15 pt. at $6\frac{1}{2}$ d. per pt. |
| (a) $3\frac{1}{2}$ lb. at 2s. 8d. per lb. | (b) 12 articles at $10\frac{1}{2}$ d. each |
| (a) $1\frac{1}{2}$ doz. at 6s. 9d. per doz. | (b) 5 packets at 2s. $3\frac{1}{2}$ d. each |
| (a) $2\frac{1}{2}$ doz. at $1\frac{1}{2}$ d. each | (b) 3 tins at 1s. $5\frac{1}{2}$ d. each |

What volume of air in cubic feet will a greenhouse hold if it has a shape and dimensions as given in Fig. M (i) ?

How many cubic feet of air will be contained in a lean-to veranda as illustrated in Fig. M (ii) ?

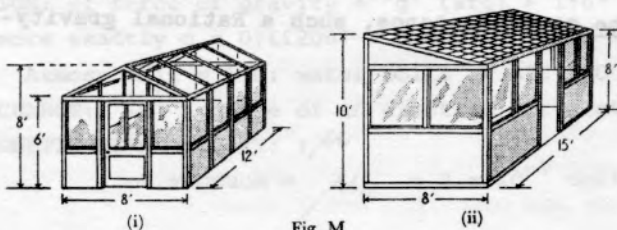


Fig. M

The brain can accept a written symbol even if it differs greatly from the accepted norm. Machine recognition of symbols is possible only if they are accurately formed and displayed, or the machine is programmed to accept a range of variations. With the advent of computer orientated communications, automatic compatibility with sound/numerical symbol functions is considered a desirable goal, but many machine biased reforms neglect human requirements.

Mohan Kala has designed a phonetic system which uses a three by three matrix from which symbols are constructed by joining the nine junction points in various patterns. This gives six vowel forms and eighteen consonants with some resemblance to their Latin equivalents. Each symbol is unique in form and can readily be scanned by ordinary mechanical, optical or electronic means.

Mr Kala has also recognised that for calculation base twelve is superior to base ten and therefore he includes twelve numerals in his set of three dozen characters. They are capable of extensive extension to minus 1 and fifteen for ternary and base sixteen computer work.

Mr Kala's system has received acclaim in the international press and he has been granted a Visual Arts Award by the Greater London Arts Association to support his work, this work being exhibited at the Polytechnic of Greater London Regent Street Gallery last November.

The matrix derived characters have a somewhat angular appearance, but can readily take a cursive form for handwriting:



For efficient use new units of time and length suitable for a base twelve counting system have been devised by Mr Kala. He proposes a day of *20 hours, each hour being divided into *100 new minutes and each of these minutes being *100 new seconds; (the new second thus proposed is also known as the TIM in the TGM system). For a unit of length the Fondijyal system selects one related to the speed of light (this velocity can now be measured with sufficient accuracy for it to be used as a means of standardising units of length: see NATURE vol 239 (8.9.72) and NEW SCIENTIST p 181 (27.7.72)). The present value of c is decimally $2.997\,928 \times 10^{10}$ cm/s. In new seconds it becomes $5.204\,736 \times 10^9$, which is close to the ninth power of twelve. The proposed new unit (which is larger than 1cm, this being recognised as not being large enough) is of a sensible size and is related to a universal constant by an integral multiple of a power of twelve. Its value is 2.017cm. Mr Kala remarks that with this length for a basis the speed of light becomes 6×10^8 new units per new second. The 'foot' of the system with 12 new units will be 24.2cm or 9.6 inches, which is approximately the original Greek Pythic foot of twelve digits (about $9\frac{3}{4}$ ").

Full details of the Fondijyal System can be obtained from: Mohan S. Kala, 14 Kenilworth Rd., Ealing, London, W5 3UH. The two pages which follow represent the symbols invented by Mr Kala; note that he uses X for ten and # for eleven.

The use of a nine-dot matrix is very neat; some years ago we received a similar suggestion (but not as fully worked out) based on a twelve-dot matrix. To provide the full range of vowels in English, however, would require far more vowels than are provided for in Mr Kala's system, and in this respect it is not fully phonetic. Members are invited to write to Mr Kala for more details; they will then be able to weigh up the merits and demerits of the system for themselves.

Recent Publicity and articles

Mathematics Teaching, December 1978, no. 85

Short article on the Reverse Notation by S.Ferguson

Mallorn, no. 12 (Magazine of the Tolkien Society):

Short article on weights and measures as used in Professor Tolkien's "Lord of The Rings": S.Ferguson



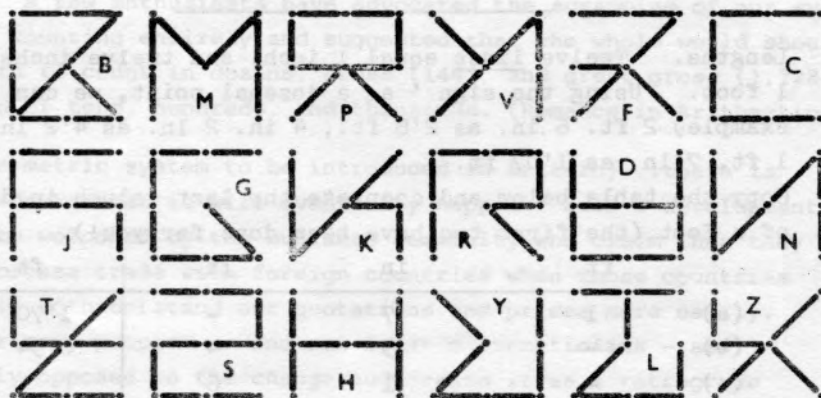
FONDIJYAL SYMBOLS FOR THE FUTURE



VOWELS



CONSONANTS



NUMERALS



Note * for 'ten'
for 'eleven'

Modern Shms - a typical worksheet on "BASES"DOZENALS (Cont'd)

The following calculations are in dozenal. Give your answers in dozenal, too.

1. $57 + 28$ 2. $39 + 28$ 3. $36 + 46$ 4. $67 + 55$
5. $79 + 12$ 6. $20 + 12$ 7. $202 + 11$ 8. $147 + 307$
9. $36 - 19$ 2. $65 - 28$ 2. $77 - 39$ 10. $81 - 22$
11. 46×2 12. 12×3 13. 12×2 14. 22×10
15. $212 + 202$ 16. 202×202 17. 270×82
18. 22^2 19. 6^3 12. $350 \div 6$
12. $713 \div 2$ 20. $128 \div 14$

21. Lengths. Twelve lines equal 1 inch, and twelve inches equal 1 foot. Using the sign ' as a dozenal point, we can write (for example) 2 ft. 6 in. as 2'6 ft., 4 in. 2 ln. as 4'2 in., and 1 ft. 7 ln. as 1'07 ft.

Copy the table below and complete the last column in dozenals of a foot (the first two have been done for you!).

	ft.	in.	ln.	ft.
(a)	1	7	-	1'70
(b)	-	3	4	0'34
(c)	-	1	6	
(d)	3	-	3	
(e)	2	7	6	
(f)	2	4	2	
(g)	9	2	5	
(h)	-	-	6	

22. Continue the sequence, 0, 1, 4, 9, 6, ..., which is a sequence of the units digits only of square numbers in the ordinary base ten system. Write the entire sequence across the page, going as far as 144. Underneath, write the same sequence for dozenal square numbers (use your multiplication table). Compare the two sequences and comment upon them.

NEXT February, we shall be plunged willy-nilly into decimal coinage. We shall lose the shilling which divides conveniently into two, three, four, and six. Instead we shall have 5p. which does not divide at all.

All sixpenny and ninepenny charges will go up to a shilling, as the fares of London's Underground have already done. The rise in the cost of living will be fantastic. We shall have no unit between the new penny and the pound, an intolerable arrangement.

And all for what? All to please a few faddists who packed a committee and persuaded the late Government that decimal coinage was somehow more modern. Now, we are told, there can be no going back.

But there is still time to fight against a far cruder change. We are threatened with metrication of everything. The Labour Government accepted this. The Tory Government has not repudiated it. Our only hope is a promised parliamentary debate in the autumn.

Now is the time to protest and to ensure that the debate throws out metrication before it starts. For consider what is involved.

All our linear measure will be changed. The centimetre will take the place of the inch. The metre will take the place of the yard. The kilometre will take the place of the mile. The foot, a most useful measure, will simply disappear.

New maps

EVERY map showing miles will be out of date. Eight million motorists will have to buy new maps. The Ordnance Survey will have to start afresh. Every road sign and every milestone will have to be changed. Speedometers which show only miles an hour will be useless.

Every furnishing shop and every tailor's establishment will have to be re-equipped. The carpenter and the plumber will have to change his tools.

The cost will be beyond all reckoning, and all for the whim of a few unknown cranks. We are told that foreign tourists are used to kilometres. But the Americans are our most profitable visitors, and they use miles. Instead of feeling at home, they will be bewildered.

This is only the beginning. Our liquid measures are to be changed also. The pint, the quart, and the gallon will be replaced by a single unit, the litre.

Now the litre is a useless

measure for any practical purpose. A nineteenth-century duke said of the goose: "A willy bird. Too much for one, and not enough for two." We can say exactly the same about the litre.

Take our two commonest liquids on sale, milk and beer. The pint bottle of milk meets all domestic needs. Everywhere on the Continent milk has to be sold in two alternative bottles—half-litre and litre. So it will be here.

Again, the pint and half-pint are perfect measures of beer. No one except the Germans wants to drink a litre of beer (which is nearly a quart) at a go. Yet a half-litre is too little. As to a quarter-litre, it is too small for the most modest thirst.

In Continental countries they replace it by the third of a litre glass, which makes nonsense of the metric system. And the French bottle of wine does not relate to the metric system at all.

So here we are, abandoning a measure which has satisfied generations of beer drinkers for one which is largely disregarded even in metric countries.

Think once more of the cost. Every milk bottle in the country withdrawn, and two manufactured for each one in use now. Every glass, mug, and tankard of beer scrapped and replaced by three, all unsatisfactory, for the two used now.

Most beer drinkers and milk users will switch from the pint to the half-litre. But the half-litre is not a pint. It is only four-fifths of a pint. But you

by A. J. P. TAYLOR

THIS METRIC MADNESS

—SUNDAY EXPRESS, 1970—still valid!

can be certain that we shall pay the pint price. In other words the cost of beer and milk will go up by a quarter, and in order to pay for the new measures probably more.

Think of another liquid: petrol. Every pump in the country will have to be changed. Many of them will have to be scrapped. Once more this will not please the Americans. They use gallons just as we do, even if theirs are not quite the same as ours.

Turn finally to weights. Here too we have an admirable and most flexible system—ounces, pounds, hundredweights, tons. The metric system offers us nothing except the gram and the kilogram. The gram is minute—a thousand to a kilogram. The kilogram, which is something over two pounds, is too large for ordinary use and ridiculously small to take the place of the hundredweight or the ton.

As a result the kilogram is disregarded even on the Continent. Go into any grocer's shop in France. And what do you hear? Housewives buying butter or cheese by the pound or half-pound, even though these are now treated as 500 and 250 grams.

No escape

THE metric system has been in use in France for nearly 200 years. Yet the common sense of ordinary people still rejects it, and they go on using weights which were supposedly abolished two centuries ago.

Yet there is to be no escape for us. The scales will have to be changed in every food shop. All existing weighing machines will have to go.

Now here is a gigantic change of habits and equipment imposed on the entire nation without either warning or discussion. No one wants it except the obscure members of a forgotten committee.

Scientists and engineers do

not want it. They can use the metric system in their technical work without disturbing the lives of ordinary people—and their own. I have certainly never met the most abstruse scientist or the most aloof mathematician who refused a pint of beer.

The only argument in favour of the decimal system is that we have ten fingers. But we do not count on our fingers after we leave primary school.

For any other purpose ten is a very bad number, dividing only into five and two. Twelve is a good number. Sixteen is a good number. We have them both and should stick to them.

Voice

OF course if we want to be really scientific we should go over to two as the top number. Scientists do this in their most advanced work. But it is an impossible system for ordinary purposes.

We are now being driven into a system of weights and measures which has no advantages except perhaps for printers who will have to set lots of naughts. It has innumerable disadvantages and will cost hundreds of millions of pounds.

Democracy has a last chance to work in this matter. Our M.P.s are as much in the dark as we are. Few of them are enthusiasts for metrication, but they will all vote as the Whips tell them, unless a more powerful voice is raised on the other side.

There is such a voice. It is the voice of the people. We want to keep our pints and our miles. Write to your M.P. and tell him to vote against metrication when it comes up for debate. If you fail to write, then don't complain when you get less beer and pay more for it.

No more metrication

New egg grading system

From 1 February, egg packers will have to conform to Common Market rules about egg quality classification. This will give us new and helpful information about the eggs sold in shops.

First, the box will have to be labelled with a **quality** classification — **A, B or C**. Most eggs in the shops will be **Class A**: broadly speaking, eggs as they come from the chicken. Seven in 100 can have faults (including no more than four in 100 with cracks, or one in 100 with blood spots). This is much the same as the 'first quality' classification which covers most present egg production.

Class B eggs may be less fresh than **A**, or preserved or refrigerated: unlike **A**, they may have been washed or dry-cleaned, and anyway may have less clean shells. **Class C** eggs are fit for food manufacture only. Eggs from both these classes must have their class stamped on them, as well as having it on the box (unless they are too cracked).

Class A boxes could have a red label sealing them, marked **EXTRA**. This means that the eggs have been packed less than seven days ago, and have passed more stringent quality requirements.

Egg boxes will now also have to carry a **date mark**. For **Extras**, this must be the actual date of packing. For others, it can be the number of the week (week 1 = week in which 1 January occurs). This will give a useful indication of freshness.

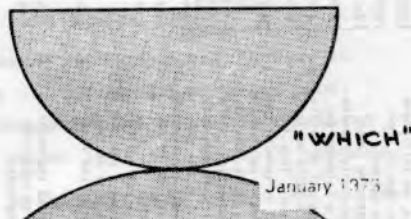
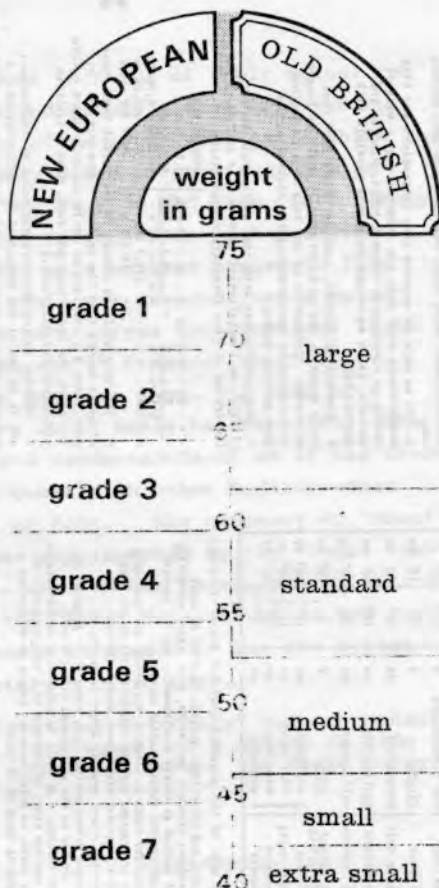
The box must also carry the name and address of the packer or the firm for which the eggs were packed.

We have five egg **sizes** at present, based on the weight of the egg: **large, standard, medium, small and extra small**. These must be marked on the box.

The Common Market has seven egg sizes, also based on weight. Grade 1 is the largest (70 grams and over) and Grade 7 is the smallest (under 45 grams). Packers will now be allowed to use these, if they wish, instead of the British sizes. And although few may do so at first, they will all eventually have to use Common Market sizes. See Diagram.

Grades 1 and 2 will both be large eggs, but Grade 1 is bigger than most eggs now sold here. Grade 3 may include some **large** eggs, but will probably be mainly **standard**. Grade 5 may include some **standard**, but will probably be mainly **medium**.

Under the present system, over a third of the eggs sold in shops are called **large**. This covers eggs of the new Grades 1, 2 and some from 3. So the new size grades should eventually give you a wider choice of more evenly graded eggs.



The metric system violates the natural human requirement of subdivision into 3, 4, 6, 8, ... parts. It is also inadequate for the subdivision of the circle, for the 24 hours in the day, the 12 months in the year, and the 32 points of the compass. All these requirements are met by changing the number base from 10 to 12, as has been pointed out repeatedly. The advantages of the present metric system are retained and the disadvantages are overcome, merely by a change of base. Details are worked out in a book by Jean Essig.¹⁷

The metric system was introduced into this chapter merely as an example of the difficulties that the human race encounters when it slavishly adheres to the Base-10 system. Undoubtedly a better base could be found for *general use*. Of course, the practical obstacles in the way of changing the thinking of mankind from one base to another are formidable.

Extract from "The Abacus" (D.A.M. Moon)

We're half way to lunacy

By RON SAW

THE NATION, says the Metric Conversion Board, is now more than half metric in thought, word and deed. We are past the point of no return. And a pig's wishbone to that, sir.

The nation is blundering wretchedly with the metric system. We are not even an eighth — I beg your pardon: 0.125 — of the way there. And it would be a great saving and a relief if we stopped at this point and forgot, or tried to forget, all about it. The metric system, in Australia, is a bloody disaster.

Who do you know — take your time about it — who actually uses metrics? Who speaks comfortably, or even uncomfortably, of metres and litres and hectares? Sports broadcasters, yes. The horse-fanciers are probably closer to the point of no return than any other section of the community. True, a mile and a quarter still sounds unreal as 2000 m. A jockey riding at 51.5 kg seems nothing short of adipose. And the 200 m mark will never replace the furlong pole. But racing is a world of busy and objective businessmen who'd weight jockeys in Cypriot oaks and punt in tials and akkers rather than waste time by arguing the toss.

On the other hand, cricket will never be a metric sport. It is simply embarrassing to hear Alan McGilvray and Lindsay Hassett wretchedly describe, say, Tony Greig, crouching "about three metres from the edge of the wicket" or a ball zipping by "hardly a centimetre from the off stump."

And where conversion depends on the public en masse nothing good is happening at all. Just about everybody in industry is trying to use the metric system and just about everybody is hating it. Flourmillers and stockfeed packers, who converted as early as December 1972, still say that metrics are "a bloody nuisance" and a "hindrance" to business. The chain stores' descriptions range from "an expensive waste of time" to "you wouldn't believe it." It'd suit retailers and

it'd suit the public if we went back to Imperial measures right now.

It seems only fair to keep the metre-fanciers on their toes, to let them know that they're getting away with nothing.

Who, for instance, started all this rot? We may never know. The Metric Conversion Board certainly doesn't know who started it. "There was," says a spokesman, "a Senate Select Committee and it recommended metrics to the Gorton Government . . ." Yes, yes, yes. But who or what got the Senate Select Committee going in the first place?

Well, the Weights and Measures Act established a National Standards Commission to "advise the Minister with respect to weights and measures." That was in 1948, but it wasn't until 1967 that the Senate Select Committee got busy with its inquiry into "the practicability of the early adoption by Australia of the metric system of weights and measures." It brooded for 18 months, then gave metrics a unanimous okay in a report upon which the government, in its turn, brooded for two years before adopting.

But we're still no nearer to an answer. WHO wanted metrics? WHOSE idea was this "early adoption?" Who stood to gain so much that he could put the nation to the staggering expense — ah expense too great for the United States — of changing a yard to a metre? The MCB claims that "exporters and importers stand to gain." Which exporters? Which importers?

The fact that Europe is big in metrics is neither here nor there. Uniformity in international trade might be nice but it's by no means essential. Were it so we'd all be speaking Esperanto, because the problems of weights and measures are simply picayune in comparison with problems of language.

The more one looks at the situation the more likely it seems that the original damage was done by some bureaucrat; for the bureaucrat is probably the only man who stands to win with metrics all the way. As long as there is a three-foot building alignment to be changed to a one-metre alignment; as long as there is some ordinance to be re-written, using litres instead of gallons, there will have to be a pants-polisher to rewrite it. And — angels and ministers of grace defend us! — we haven't yet started trying with pascals, joules and newtons.

And what, after all, are we adopting? We are adopting a system created in the late 18th century for no better reason than the discovery, by some nameless Frenchman, that he had five fingers on each hand and could thus count up to 10.

It's worth noting that his forbear, an ancient Gaul, used a system of measurement based on the figure 20 — almost certainly because he wore no boots and could thus count higher.

I for one am ready to say, firmly, that things would have been a lot better for us all had the Gauls stayed barefoot.

Parliament has passed the Weights and Measures &c Act, 1976. Now Government, manufacturers, retailers, consumer organizations and the Metrication Board are getting together to plan the final stages of the metric changeover.

This new Act paves the way for Government through Parliament to see that imperial weights and measures are not used in trade side by side with metric for too long.

Given that the change is inevitable, organizations representing shoppers and shop keepers believe that the period of overlap should be as short as practicable.

New Law

THE Weights and Measures &c Act, 1976 removes the last major legal impediment to the orderly completion of metrication in the United Kingdom. The proviso in the Weights and Measures Act, 1963, preventing the removal of imperial weights and measures from the schedule of the units lawful for use for trade in favour of metric units, has been repealed.

The Government can now:

- set dates, which can be effective from 21 April 1978, from which only metric packs of prescribed quantity goods will be allowed;

- set dates ending the use of imperial units for other prepacked goods or goods measured or weighed out in front of the customers. The Minister of State for Prices and Consumer Protection has given an undertaking that, in the case of weighed-out meat, fish, fruit and vegetables sold retail, these dates will not be before 1 January 1980;

- generally prohibit the use in trade of all imperial units except for the mile, foot, inch, gallon and pint;

- restrict the use in trade of any imperial unit sector by sector.

Fuller details are in Metric Memo M37.

"GOING METRIC" Feb. '77

From January 1 1978, joules should be used instead of the kilocalorie (usually called Calorie) in all statutory food energy declarations, recommend Food Standards Committee in a Report published in November 1976. For food labels and diet sheets the practical unit will be the kilojoule (kJ). The optional use of the Calorie should be allowed for only two years from that date.

A PLEA FOR SIMPLICITY

I find it very hard to get used to that semi-colon! To me, the semi-colon instantly registers as the punctuation mark it is, and I pause automatically. This effect persists even with numbers, since one uses semi-colons to separate numbers which have to be dealt with successively, such as:

- Q. Give the first number in each pair as a fraction of the second:

$4\frac{1}{4}$, $7\frac{1}{2}$; $5\frac{1}{5}$, $6\frac{1}{6}$; 18, 26 .

This is a notation that most people understand, and it will be difficult for those we try to interest in dozenals to make the necessary mental adjustment to seeing " ; " as a fraction point. Furthermore, of course, it takes longer to write a semicolon by hand than to write a dot. It is nearly impossible to persuade people to do anything which appears to be more trouble, and since we are dedicated to showing that dozenal arithmetic is simpler than is decimal, our case is not helped by having this rather tedious fraction point, is it?

We have an alternative. It has always been staring us in the face, and is already used as a dozenal fraction point! I refer, of course, to the single inverted comma, ' . It is in use to denote feet, and was used to denote shillings, as in:

length 5' 6" or price 2'6d.

I know the objections and will deal with them as follows below.

- (i) This sign means minutes. So it does, but only in conjunction with the $^{\circ}$ sign for degrees.
- (ii) This sign is used to denote complementation of sets. True, but then it is used on letters, e.g. AB'C .
- (iii) If followed by other digits, it will be mistaken for feet and inches. With single figures, this will not matter much, anyway! With two or more figures, the absence of the " sign will make clear the difference, e.g. 64'76 will not be confused with 64' $7\frac{1}{2}$ ".

I use the sign myself when writing dozenals, and find it far superior to the semi-colon. Compare:

$$\frac{1}{8} = 0;16 \text{ or } 0'16 ; \quad 31\frac{5}{8} = 31;76 \text{ or } 31'76 .$$

Easier to write and easier to understand, is it not? What do other members think?

DH

ARITHMETIC à la DOZEN

Errata

Section	Page	Line	Underlining indicates the corrected characters.
*40	7	4	digit
Pract*	19	*11	(1) *Z9473 by Z
*45	*11	*28	Answer *285E and *22 over.
Practice			
*24 (f)	*15		3;49 ÷ 1;6 negative bars were omitted.
*65	*15		$1 \div *11 = 0;0E0E..... = 0;1111111111$
	*20		Table 6:- 5^7 should be 3 9265
			8^8 " " 575 1054
			E^6 " " 71 5261
			E^8 " " 5E95 6341
			$1E^3$ " " 705E
			$1E^8$ " " ,132 1623 5281
	*21		Table 8:- *10 ⁸ in Base 4 should be 121 220 100 000 000
	*22	4	8(p7): (c)*91279
		7	E(p8): (a).....or 194Z (b).....or 1752
	*15		*16(pll)(h)1, *3Z
	*20		*17(pll) (t)*3224, 5 over
	*23		next to
			bottom.*2Z(pl6): (a).....= 15E;76
			Bottom (c).....=159;4439.
	*21		Table 8:-*10 ⁷ in Base 4 should be 2 020 230 000 000
			(was one nought too many at RH)
*48	*12	4	1Z£

BRING OUT YOUR DEAD

Have you any old Arithmetic or Algebra Text-Books you don't want? The Secretary is making a collection of as many different types as he can find before they all disappear. Many books have vanished from schools since the £ was decimalised; many more are fast vanishing as the schools replace them with metricated editions. And if any Members of the DSGB would like to advertise wants in the Review, please let me have them; so far, apart from books as mentioned above, foreign coins have been mentioned, and stamps for Charities. Your views, and your wants, welcome.

SHOE SIZES & BARLEYCORNS.Ferguson.

"It is ordained that three grains of barley, dry and round, do make an inch."

There is a relic of this in shoe sizes; a number 8, for instance, is 11" long, a number 9 is $11\frac{1}{3}$ ", a number 10 is $11\frac{2}{3}$ ", the sizes increasing by $\frac{1}{3}$ of an inch, i.e. a barleycorn. Some old books, by the way, go even lower than the barleycorn, and give twelve hairs-breadths = 1 poppy-seed; four poppy-seeds = 1 barleycorn.

PRINTING MEASURES:The Point System

Printers do not measure their types or printing materials in inches or centimetres but in a special typographical "point".

There are roughly 72 points to an inch (more precisely 0.9962") and this unit of $1/72$ in. is used in multiples to measure all typographical materials. Twelve points, still referred to by the old name of "pica", is a unit used for measuring the lengths of lines of type.

A point system was developed in France in the eighteenth century but it was not until 1886 that the American typefounders nominated a committee to consider the point system, and in 1898 the point system was adopted in England. The French point was fixed as $1/144$ ($\ast 1/100$ or 0.01) of two French inches; hence 72 points to 1 French inch.

Until the adoption of a point system types had borne no mathematical relationship to one another, nor did the sizes of one typefounder agree precisely with the sizes of another. The different sizes were given names: Agate, Diamond, Ruby, Brevier, Canon, Great Primer - but since there was variation from one typefounder to another a rational system was needed to standardise the sizes for all.

There is also the "em". This is the square of any body size; it is correct to speak of 6 pt. ems, of a 10 pt. em, and so on - but if no size is referred to then the "em" meant is the 12 pt. or Pica em. Half an "em" is known as an "en"; these words sounding so alike many printers refer to them as "mutton" and "nut" respectively.

There are below the em and en other standard spaces; as fractions of the "em" they are: $\frac{1}{2}$ em or "thick", $\frac{1}{4}$ em or "middle" and $\frac{1}{5}$ em or "thin"; there is also the "hair" space of $1/12$ em. (This latter is made to the nearest $\frac{1}{2}$ point to $1/12$ th; for example in 6pt type the hair space is $\frac{1}{2}$ pt, in 12pt type it is $1\frac{1}{2}$ pt, in 18pt it is 2pts.) Hair spaces can also be obtained in brass 1 pt thick, and in copper $\frac{1}{2}$ pt thick (or $1/144$ in.).

The usual sizes of type stocked by a printer are the following
6, 8, 10, 12, 14, 18, 24, 30, 36, 42, 48, 60, and 72 pt.

(Adapted from "An Approach to Type by J.R. Biggs)

SF

THE DOZENAL SYSTEM

S.Ferguson

Every issue of the REVIEW is supposed to contain material for all from the beginner to the expert in dozenals, and yet - probably because those of us who write the articles have been playing with dozenals for some years - we tend to overlook the needs of the newest member and those of the interested enquirer.

What the beginner often needs is a set of reasons why dozenals are better than decimals; and quite often some beginners need to know simply how one calculates with dozenals. We have dealt with both topics in the past, but since the REVIEW comes out but once a year, and since it is often used as reference material, we ought to repeat the basic message in each REVIEW.

Here, then, are some simple facts.

Any and every type of calculation which can be carried out in base ten can be carried out in base twelve or in any other base one might choose. "Points", "logs", slide-rules and even push-button calculators are not peculiar to base ten, but are employed also by other bases - though, for some functions, not as extensively.

The merits of base twelve are due to the great factorability of the number twelve, the next really useful number being 60, but this latter number is rather too large to be a practical choice for an everyday number-base. Ten is unsatisfactory because its factors 2 and 5 include the prime 5 which in turn is not as useful as the prime 3 (though one professor of mathematics complained that we were not being really fair to the number 5...). The dozen, and the dozen dozen or gross, have shown their usefulness in packing and packaging over many, many years. Eggs may well appear packed in boxes of ten to suit the apostles of metrication and those who prefer arbitrary order to common-sense practicality but they are packed in dozens and half-dozens for sound common-sense reasons.

It is in this latter respect that we see the essential difference between metricists and dozenists: they prescribe and dictate, subordinating all systems to a regimented set of powers of ten, while we prefer to persuade, basing our arguments on the practical commonsense for which the British were ever famous.

We of the DSGB believe that the counting system the world uses should be organised in twelves and powers of twelve, and not in tens and powers of ten; we recognise such a view as revolutionary - and as costly - and yet we maintain that base twelve is so superior to base ten as to justify the costs and problems involved in such a change. We do not necessarily believe, as do the metricists, that every unit required by a rational system must be forced into a prescribed form. To take a simple example, we suggest the hour be kept so that the day is still *20 hours, not *10 "double-hours", "du-hours" or "bi-heures" as such a unit has been named. By insisting on the "pure" *10 units to the day we would lose, and there is no reason why we should not select our units to suit ourselves, and not some arbitrary rule. As an example of metric intransigence, note how the centimetre has been pushed out of the SI metric system so that the length units are arranged in batches of 1,000: mm ... m ... Km. This is neither necessary nor desirable; but the purists of the metric system have insisted on it.

Here is a summary of basic "SUMS", most of which, we hope, you will recognise.

- 1) Addition: we "carry" a unit to the next column on the left whenever our total reaches one dozen:

$$\begin{aligned} 6 + 8 &= *12 \text{ (one dozen \& two; zen-two);} \\ *37 + 49 &= 84 \text{ (eight dozen \& four; eightzen-four);} \\ \text{\text{E}}; \text{\text{E}} + 4; 3 &= 14; 2 \text{ (notice the ";" for the dozenal point)} \end{aligned}$$

- 2) Subtraction: if you "borrow" from a column then it is twelve you borrow, not ten.

$$*34 - 9 = 27; \quad 3; 4 - 0; 9 = 2; 7. \quad 11; 6 - 4; 09 = 9; 53$$

- 3) Multiplication: (and you might make out the "tables" for yourself as practice...)

$$4 \times 8 = *28 \quad *50 \times 4 = 180 \quad *6; 3 \times 2 = 10; 6$$

$$\begin{array}{r} 632 \times \\ 21 \\ \hline 10640 \\ 632 \\ \hline 11072 \end{array}$$

Remember, we are using *10 to mean twelve and we must therefore have two new symbols - one to represent ten and one to represent eleven. In this magazine we use $\text{\text{Z}}$ for ten and $\text{\text{E}}$ for eleven; these are not the only symbols which

have been suggested or used. Here are some examples using the two symbols:

$$2 + 9 = \text{\text{E}} \quad 26 - 8 = 1\text{\text{Z}} \quad 3 \times \text{\text{Z}} = 26 \quad 2\text{\text{E}}5\text{\text{Z}}3 + 3 = \text{\text{E}}5\text{\text{E}}9$$

By the way, the answers to NOTE BOOK are: $35 \times 64 = 2445$ and $54 \times 66 = 600\text{\text{E}}$ (but we didn't do these ourselves....)