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THE DUODECIMAL BULLETIN

8 Dozen 5

"The most famous bunch of bananas in legal history"
- Judge Bruce Morgan

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THE DOZENAL SOCIETY OF AMERICA
℅Math Department
Nassau Community College
Garden City LI NY 11530-6793

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THE DOZENAL SOCIETY OF AMERICA

(Formerly: The Duodecimal Society of America)

is a voluntary, non profit, educational corporation, organized for the conduct of research and education of the public in the use of base twelve in numeration, mathematics, weights & measures, & other branches of pure & applied science.

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'METRIC MARTYR' LOSES HISTORIC CASE

by Jean Kelly

[ADAPTED IN PART FROM *THE YARDSTICK*, THE JOURNAL OF THE BRITISH WEIGHTS & MEASURES ASSOCIATION (BWMA), NUMBER 15. AUGUST 2001.]

On April 9, 2001 Steven Thoburn, a market trader of SUNDERLAND, England was convicted of breaking European weights and measures legislation by selling his fruit in pounds and ounces in the first prosecution of its kind in Britain.

He now faces a fine of about £1,000(about $1450) on each of the two offences and court costs estimated to run up to £60,000(over $86,000). He was also put on six months' conditional discharge, which is similar to probation in the United States

He was convicted of breaching the Weights and Measures Act of 1985 in a hearing which district judge Bruce Morgan said centered around the "most famous bunch of bananas in legal history." The greengrocer's woes began when trading-standards officers from Sunderland City Council raided his market stall on July 4 last year, seizing two sets of scales.

Greengrocer Convicted of Selling His Fruit in Pounds and Ounces

He was prosecuted for selling his produce in pounds and ounces. Judge Morgan said he was aware that regardless of the verdict the case would be going to appeal. "It has been made clear to me that despite the decision of this court the matter will be taken elsewhere."

The case was the first brought under European Union legislation governing weights and measures. Thoburn — who was dubbed the 'Metric Martyr' — broke the 1985 act, which made it illegal to sell loose products such as vegetables, fruit, cheese and meat by non-metric measures.

The hearing has been seen as a test case which will shape the future of Britain's weights and measures system and prove whether European legislation takes precedence over British statute.

Thoburn's Actions Pitted UK Law Against Eu Regulations

There is much opposition to the imposition

of an awkward decimal metric system. In addition, a recent opinion poll showed pro-Europe sentiment was lower in Britain than anywhere else in the 15-nation group, with only 28 percent of Britons believing EU membership was a good thing and ?? percent saying it was bad.

Most of the world has evolved *a counting system based on ten*, but *a system of weights and measures based on twelve*. Why this difference?

For the most part, our ancestors counted on their fingers. In a world where communication was limited, most societies independently developed a ten-based counting system. Of course there were exceptions. A few barefoot tribes counted in twenties, the Babylonians used sixty, and one tribe in South America counted in threes.

At the same time, practical people measured in dozens. Once again, people throughout the world independently arrived at the same conclusion. Thus:

- the baker sold donuts in collections of twelve
- the carpenter divided the ruler into twelve subdivisions
- the *grocer* dealt in dozens and in dozens of dozens or *grosses*
- the pharmacist and the jeweler still use the twelve ounce pound
- the minters divided the shilling into twelve pence, etc.

Counting in tens is a biological accident. If only we had been born with twelve fingers how much simpler all this would be. But measuring was not accidental. It was devised by practical people who used the fractions: ½, ⅓, and ¼. That is why merchants and tradespeople chose to divide their units of weights and measures into twelve parts. Simply put, by choosing twelve subdivisions, they could have their cake and eat it too. They could use the three most common fractions without having to actually employ fractional notation. For ½, ⅓, and ¼ of a foot are 6, 4, and 3 inches respectively — whole numbers, not fractions!

Biological Accident vs the Practical

Solutions

Over the course of time, many suggested that we try to align our counting and our measurements. Proposals were made advocating various bases. For example base eight was offered as a solution to this dilemma, since in base eight halves, quarters and eighths are simplified. Computer scientists use a similar idea

when they switch between bases two and sixteen.

The desirability of aligning our counting — which is based on a biological accident — with our measuring — which was devised by pragmatic people — was well understood in the 18th century at the time of the French Revolution. It was evident that either counting should be changed to base twelve or that measuring should be changed to base ten so as to be in agreement with one another. The French blundered into changing the wrong one. Maladroitly, they decided to keep the accidental and to change the practical. It is analogous to cutting off one's toes instead of obtaining a larger shoe. (Or as G K Chesterton said, "Cutting heads to fit hats".)

Human Progress

Good ideas are often resisted when they are first presented. For example, some localities passed laws that a person holding a lantern was required to walk in front of an automobile lest these new-fangled, frivolous toys frighten horses that were needed for commerce and industry. Of course, eventually good ideas do win out.

Thoburn Convicted for Metric Law Breach

But not once — never — in the course of history has any society, anywhere, ever voluntarily adopted the unfortunate decimal metric system. Why is it that in every country where it is required today, it had to be *forced* upon an unwilling populace by law with the threat of fines and/or imprisonment? Are all of us everywhere so ignorant of what is good for us that a few *Big Brothers* in government must tell us how we must sell bananas, fish or rugs to one another? I don't think so. I think that common people have resisted and rejected this accident in favor of simple ordinary fractions because they know which is really more convenient.

Big Brother vs Common People

The U.S. is now the last industrialized country in the world that allows its citizens the freedom to measure in any way that they deem practical, profitable or convenient.

In the United States, every pupil in science class is taught the so-called advantages of the abominable decimal metric system. Metric measuring devices are available. Yet when given a chance to measure something for their own use,

a chance to use whatever measure they prefer, they use dozenal measures because fractional parts of units are easier to handle.

A Misconception

Some people wrongly believe that the ability to multiply and divide by powers of the base by simply moving the fraction point is an advantage special to base ten. But such is not the case. It is not "*ten*-ness" that gives this property (after all it wouldn't work with ten-based Roman Numerals). No, this advantage exists in every base, for it is a property of the *place value notation* we use for expressing numbers along with *a symbol for zero*. Thus we see that

$$110.11 \div 10^2 = 1.1011$$

is always true, no matter what base one is using.

The above are some of the reasons why thinking people advocate a gradual change to dozenal counting. Because of the prevalence of computers, many students at present are being taught about base two and base sixteen counting. It would be simple to teach children both a dozenal metric system and the ill-advised decimal metric system, and then allow them to freely use the one they prefer. In one generation awkward systems would go the same way ancient Roman Numerals have gone — relegated to clocks, cornerstones and other curiosities. Remember, until the Crusaders brought what are called the Hindu-Arabic numerals to the West, all of European commerce was dependent upon Roman Numerals, and many people were convinced that this could never be changed.

Hindu-arabic Numerals Will Never Replace Roman Numerals

Thoburn, who runs a fruit and vegetable market stall in north-east England, quickly became a cause celebre among British opponents of greater integration with Europe and vocal critics of European Union bureaucracy.

Opposition Conservative Party leader William Hague, campaigning on a pledge to "keep the pound," has backed Thoburn and the many other traders who face prosecution if the verdict goes against him.

"I wake up at night in a panic and try and work out how my mates and I could find ourselves persecuted for doing nothing but selling fruit and veg," says Thoburn,

who denies two counts of having imperial-only weighing scales. He added: "If the Europhile political parties win the day, then we will be able to speak any obscenity that we like, but the use of words 'pound' and 'ounce' will be deemed liable to deprave and corrupt."

Mr Thoburn attracted huge support for his fight against the weights and measures legislation. His case was taken up by the UK Independence Party (UKIP) which believes the outcome could decide the future of the nation's weights and measures system.

Mr Thoburn and his fellow trader Neil Herron, a fishmonger who has also been ordered to change his scales, were described by some as 'metric martyrs' and a legal expenses fund was set up.

UKIP solicitor Tony Bennett said at the time: "This is not about one trader taking on his local council, the implications are huge. The eyes of Europe will be on Sunderland while this case is in progress because it will decide the future of our traditional weights and measures."

Mr Thoburn, who is now using dual measure scales, gathered support from shoppers to hand over a 5,000-signature petition to Downing Street. His campaign was also backed by a number of celebrities from the entertainment world.

5,000 Signatures

But Mr Thoburn's legal team believes British traders have a legal right to use imperial measures under the provisions of the 1985 Weights and Measures Act. They have argued that the government gave assurances that stallholders could continue to use imperial measures.

Well-wishers flocked to Sunderland, a small city 275 miles from London, to show their support. Even the judge was sympathetic. "I accept he is a decent hardworking man and he did what he did because he believed he was right, "Judge Bruce Morgan told the court.

From the beginning, the case was about much more than pounds and kilograms. It has pointed up Britain's ambivalence about its increasingly close relationship with Europe and all that will eventually entail, affecting everything from monetary policy to military matters.

Thoburn's attorney had cited a British law allowing shopkeepers to use either

metric or imperial units should take precedence over a European Union directive — later adopted by Parliament — which requires loose goods to be sold in metric measures.

Prosecutors say the law, which took effect a year ago, states clearly that vendors must use the metric system when selling produce. ✹

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As we go to press we just learned that the case is being appealed and that written judgement of the court included the following defect:

> [It] "was the judge's insistence, on the one hand, that in consequence of the European Communities Act 1972 the UK ceased to exist as a legal entity and therefore EU regulations take precedence even over UK primary legislation, yet on the other hand that Parliament could restore legitimacy to imperial measures simply by repealing that Act. But that is self-contradictory: for if Parliament is free to repeal the Act then it must still be sovereign, in which case repealing the Act is unnecessary! Conversely, if the UK legislature is subordinate, then it has no power to free itself from the superior legislature! Either way he's talking nonsense."
>
> -taken from "Attacking from Four Quarters", page 2
> *The Yardstick*, Journal of the BWMA

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British Weights & Measures Association is a wonderful organization opposing the forced imposition of the awkward decimal metric system. *The Yardstick*, Their Journal, is a terrific source of interesting information. They can be reached at

45 Montgomery Street, Edinburgh EH7 5JX
Internet sites: www.footrule.org
www.bwmaOnline.com

Membership costs only £10 a year. Send a check or money order (payable to BWMA) to the Hon. Treasurer: Fabian Olins, 22 Foscote Road, Hendon, London NW4 35D

HOW METRIC IS EUROPE?

John Gardner

The following article appeared in The Yardstick, Journal of the British Weights and Measures Association, Number 3, November 1996 on Pages 2-3 and is reprinted with permission.

It was published in this Bulletin *Whole Number 7*, Volume 3#, Number 1, Pages 9-11; in 11*6 and is reprinted here at the request of several members of our society.*

Although most of Europe has been metric officially for over a century, British visitors to the Continent are often surprised to discover an ongoing use of non-metric measures, much as in the same way Americans visiting Britain are surprised to learn that the UK uses miles for road signs instead of kilometres. So, while the Department of Trade and Industry (DTI) has convinced itself that adopting various metric units is necessary to bring Britain into line with Europe, its programme of compulsory metrication is effectively pushing Britain *out* of line with Europe.

The metric system was invented in the aftermath of the French Revolution and was intended to be as unlike previous weights and measures as possible. When the French government imposed metrication in 1837, the outlawing of customary units such as the *livre* (pound) was widely resented. Instead of abandoning the livre, French people adjusted it from its pre-revolution weight of (what was to become) 490 grams (17.3 ounces) to its modern weight of 500 grams (17.6 ounces). This adjustment made the livre compatible with the metric system by providing an easy conversion between kilograms and livres: two livres to the kilo. Modern French shoppers do not say *"1.5* kilos" or "1,500 grams" but ask for "three livres." The standard traditional French loaf of bread, whilst weighing one kilogram, is referred to as "pain de deux livres." For smaller quantities of food such as butter, French traders and shoppers divide the livre into a *demilivre* and a *quart de livre,* traditional divisions based on a half and a quarter that cut across the livre's internal metric division of 500 grams. Thus, a French quarter pound *(0.125* kilo) is 4.4 ounces and close to the UK/US quarter pound.

The survival of avoirdupois is seen in numerous other European countries: the Danes buy using the pund, the Swiss the *livre* and *pfund,* the Germans the *pfund* and so on. As in France, it is acceptable in Holland and Switzerland to

refer to quarter and half pounds. The reason for the pound's ongoing use in Europe is not merely tradition but that the pound is a more appropriate weight for food markets than the kilogram. A pound is only half the weight of a kilo and so allows a wider choice of weights to be dealt with as whole numbers and simple fractions. For items such as fruit, vegetables, meat, cheese and butter, the pound is the right *measure.*

Pounds are not restricted to use in food markets. In France, the livre is used by wholesalers. In Germany, people may give their own weight in pfunds, or use pfunds to describe the weight of a new- born baby. The use of pounds on the Continent reveals the lack of knowledge by Britain's metric lobby on how metrication is actually applied in Europe. Historically, pound weights varied across Europe: the German pfund was the equivalent to 16.5oz/468 grams, the Dutch *pond* 17.4oz/494 grams, the Danish pund 16.6oz1471 grams and so on. France had several versions of the livre in different cities and regions. The effect of metrication has not been to abolish the pound but to standardise it across frontiers.

The use of pounds across Europe has ensured the survival of the hundredweight. In Germany and Switzerland, the *zentner,* in like manner to the British cwt, is one-twentieth of a tonne and is used by industry, commerce and agriculture for weighing machinery, wood, farm produce and coal. The zentner is equal to 100 pfunds or 50 kilos, weights within 2% of the British hundredweight and has been adopted instead of the two nearest metric alternatives,the myriagram (a hundredth of a tonne) and the quintal (a tenth of a tonne). In Germany, the metric tonne has thus been cut up to recreate customary measures and illustrates a departure from the metric principle of units building up in multiples of 10, 100, 1000: thus. 500 grams = i pfund; 2 pfunds = i kilogram; 50 kilograms — i zentner; 20 zentners = i tonne. No German unit of weight is ten times the previous unit. Those metric units needed to complete the decimal structure - the dekagram, hectogram, myriagram and quintal are not used in Germany.

The practice of reducing metric weights to customary sizes extends to volumes of liquid. In Italy, for instance, it is common to refer to "quarter-litres." In the Flemish-speaking part of Belgium, a quarter- litre makes a *pintje* (small pint), again defying the metric rule that units are divided throughout only by ten. Having converted to the metric system, Europe is returning to the very use of fractions which the metric system was supposed to eliminate, and giving these fractions new identities based on traditional human-scale systems.

The inch is another customary unit that is retained in Europe. In Belgium, DIY shops describe tools in inches; thus, the teeth of a saw is described as the "number of points to the inch." In Swedish tool shops, equipment is described in terms of *turns,* and in Norway, *tommes,* alongside metric. Swedes also describe the sizes of electronic wafer boards in tums. Inches are often used on the continent for plumbing. Whereas British plumbers converted to metric some years ago, necessitating the use of adaptors where metric pipes do not f~t existing installations, in Belgium all plumbing equipment, whether fittings or pipes, continues to be supplied in customary measures. Inches are used in Italy to describe plumbing pipe threads, in Iceland for radiator circuits, and in Germany the inch (zol!) is used to describe diameters of pipes, taps and washers (for instance, *114"* or 3/4"). Germans also use inches for producing firearms, as illustrated by .202 and .303 rifles. Most, if not all, European publishers use the inch for measuring type size and ink density because global computer and printer technology is now inch-based.

Customary units sometimes exist in name but not in practice, as in the Netherlands where the "ounce" referred to by shoppers is in fact a hectogram (100 grams). Conversely, customary units exist in practice but not in name, as with the 300-millimetre "unit" used on the Continent for design work (the foot in disguise).

Shipping and aviation are two areas where customary units are used frequently. In aviation, feet are used by European aircraft for measuring altitude. In shipping, the nautical mile and the knot *(mule mann* and *noeud* in French) are used for distance and speed. France and Spain also use nautical leagues. Sweden uses feet *(fots)* for the construction and description of boats. For land distance, road signs in Sweden are specified in kilometres but, when speaking, Swedes prefer *mils,* a traditional measure some ten times the length of a kilometre. A Swede glancing at a metric road sign stating "150 kilometres" will say *"15* mis."

Non-metric units for measuring land are common. Sweden uses the *:unnland* which is the equivalent of 1.2 British acres and Austria has the *joch* (1.4 acres). Denmark and Belgium use their own variations on the acre and France uses the *perche.* For fields and farmland, Italy uses the *acro* (equal to 4046 square metres), and Germany the morgen (0.6 acre). These units are alongside the metric hectare.

Human-based measures exist in Europe for approximations. In parts of Spain,

people use the *palmo* as a rough measure of distances that can be covered by the span of a hand, such as the gap between two cars when parking, or the length of a small table. In Italy, the *spanna* is used in the same way. Italians also use the *dito* (finger-width; plural: *dita)* to give an impression of the length of nails and screws, or the depth of a hole in a wall when drilling. In France, horses are measured in standardised hands or *paumes.*

In Britain's quest to imitate Europe, metric measures have been adopted for uses which do not apply in Europe. Spirits, for example, are now served in Britain using optics of 25 and 35 mililitres, yet no Continental country uses optics. Spirit measures in Europe are necessarily approximate because they are poured freehand from the bottle. In Italy. a customer requesting a spirit might ask for two *dita.* Nor do most European countries use metric units for the serving of draft beer. Beer, unless bottled, is sold simply by the glass, and the size of the glass can vary from outlet to outlet. Drink servings on the Continent are seldom standardised as in Britain and Ireland. It is therefore a paradox of European "standardisation" that Europe's only standardised spirit measure, the gill, has been banned outright, and one of the very few routinely used standard measures of draft alcohol, the pint, has been restricted in its use.

Having enforced metric measures where they do not apply in Europe, the British government has failed to implement metrication in several areas where it does apply. The government has exempted two areas where the same set of metric units applies consistently throughout the Continent: kilometres and metres for road- signs and centimetres for clothing sizes. In some cases, the British government has adopted different metric units to those in use on the Continent. In the year 2000, Britain will use the gram for food markets whereas other countries such as Italy, Sweden and the Netherlands use the hectogram (100 grams). The millimetre has been accepted for a vast range of uses in Britain that would be unheard of in other countries due to its tiny size. Centimetres are much more common in Germany.

While the DTI has decreed compulsory metrication in Britain on the grounds that metric units are adopted all over the world for comparison and compatibility, a vast range of manufactured goods in Europe are based on non-metric specifications for the same reason. Computer disks are produced in Europe based on the 3 ½-inch standard and are sold as such, and the number of tracks on a computer disc are expressed as 48 or 96 tracks per inch (tpi). Video tape is universally half an inch wide; tape used within a sound cassette is an eighth of an inch wide. Car tyre diameters are specified in inches throughout

Europe as are most sizes of bicycle tyre and wheel diameters. Shops in Europe frequently express the width of television screens and electric fans in inches *(pollici* in Italy, *pulgadas* in Spain, *pouces* in France). European manufacturers willingly produce goods designed to imperial specifications specifically for export to non-metric markets. Examples of this are Belgian carpets and rugs, and French glasses in pint and half-pint sizes.

Although Britain's supporters of metrication regard Europe as a decimal role-model, there is a wide range of other systems on the Continent which are based on customary divisions of twelve and sixteen. Clocks and calendars, with twelve hours on a clock face and twelve months in a year, have yet to adopt a recommendation of 1875 that they be decimalised. There are still (except to some extent in France) 360 degrees in an angle and each degree is divided into 60 minutes and 60 seconds. The dozen *(dui~zend* in German, *douzaine* in French) is widely used by European industry as a quantity for packaging. Pure gold is specified as 24-carat. Compasses all round the world are marked off with sixteen points and music remains binary; one semi-breve consists of two minims, four crotchets, eight quavers and sixteen semi-quavers (not to mention twelve notes in an octave). Similarly, European paper sizes adopt non-decimal divisions whereby one sheet of Al equals two sheets of A2, four of A3, eight of A4 and sixteen of AS. It is contradictory that metricators regard sixteen ounces in a pound as random and archaic while accepting the self evidence of sixteen sheets of AS in a sheet of Al. Even the Euro '96 football finals started with sixteen teams, divided into four groups of four to enable the progression of semi-finals and quarter-finals.

The metric system is firmly established and widely used in Europe, but not in the form imagined by its supporters in Britain. Many metric units have long since been obsolete. Other metric units have been cut up to reproduce measures based on customary sizes and some trades never converted to metric in the first place. Customary units exist in general conversation and for convenient approximations. Many products made in Europe are based on pound/foot specifications. Europe uses the metric system but is not obsessed by it; only in Britain has metrication become a measure of whether one is "European."

Thanks to: *J Ödemark, Natacha Tual, Justin Brooke, Monica Mann, Joan Pontius, Maria Tsatazoni, Jonathan Rogers.*

See page *1 Dozen 5* for additional information

ALPHANUMERIC CROSSWORD PUZZLE

Lewis Frances

A hint 4 U — B aware of to items:
Won. Homophones
Too. Number bases

■	■	1	■	■	2	3	■	4	■
■	5		6	7		■	8		9
*			■	#		10		■	11
■	12		■	13			■	14	
15			■	■	■	16	■	■	17
18	■	■	■	■	■	19	1*	1#	
20	21	22	23	■	■	■	■	■	24
25			■	■	26	27	28	29	
2*	■	■	2#	■	30	■	31		
■	■	32		33		■	34		■
■	35		■	36	■	■	37	■	38
39			3*		3#	■	40	■	41
42	■	43	■	■	44	■	45	■	■
■	46		47	48	■	49		4*	4#
50		■	51	■	■	52			■
53		54	■	55	56				57
58	■	59	5*	■	5#	■	60	■	61
62	■	63		64		65		■	■
■	66	■	■	67			■	68	69
6*		6#	70		■	71	■	72	
73				■	74		75		

□ □ □

Remember — your gift to the DSA is tax deductible

ACROSS:

1 Plural suffix
2 Tardy
4 Exist, singular
5 Prince.
8 ABCs
* Mother
# Relating to King of beasts
11 Possessive suffix
12 French article
13 Sob
14 Zero
15 Person
16 Hexadecimal 12;
17 Nada
18 Eye
19 0
20 Great literature
24 Golf peg
25 Long time
26 Trio
2* Exist plural
2# Had eaten
30 Romeo, decoded
31 Auto
32 Decimal fractions.
34 FDRs cousin
35 Game similar to handball
36 Aye
37 Goose egg
38 Baker, decoded
39 Pardons
40 Beverage popular in all seasons
41 Golfer's cry
42 Ocean
43 Oxygen
44 Roman dek
45 Hydrogen
46 Rare
49 Babies
50 Ordinal suffix
51 #
52 Spanish gold
53 Feverish
55 _ _ Tyrannis, VA motto
58 2.71828...
59 Gold
5# Musical note
60 $e^{\ln e}$
61 Famous transcendental number
62 Dozen.
63 Weekdays
66 Ewe
67 8
68 53. in dozenals
6* Twice 2-ply
71 Alpha, decoded
72 Electric appliance manufacturer
73 Mood
74 Speaker

DOWN:

1 Person
2 More tardy
3 $\sqrt{54}$;
4 Undergraduate Lib. Arts degree
5 Warsaw inhabitant
6 Awkward base.
7 Devoted a-10.-tion
8 Kind
9 Gun
* Roman 6#4
10 Court cry
14 Nil
15 More agreeable
1* Napier's base
1# 16;th letter
21 Behold

22 Article
23 ½ dozen
26 Readin', 'ritin', & 'rithmetic
27 Curve
28 #s
29 Harm
2# First 2 words of the *Gettysburg Address*.
32 Stress.
33 Hurry
35 $5,000.
38 Ere
39 Envision
3* Roman ½ X
3# English county
46 Exclamation
47 #
48 ½ railroad
49 Jefferson to his friends
4* Digit
4# 17;th letter
50 Apostles.
54 Skin art
55 ½ 10;
56 French state
57 Musical note
5* Pronoun, plural
64 Spouse of * Across
65 10; months
66 Alien space craft?
68 Do without
69 ½ a 10. spot
6* 2 score.
6# Atop
70 FORTRAN's ≤
74 11. - #
75 $^2/_3$ of a dozen

⬡ ⬡

More on How metric is Europe?

"In France, precious stones are today bought and sold in carats; firewood in cordes; milk in pintes [*sic*]; gravel in toises; grain, potatoes and charcoal in boisseaux; wine in barriques, feulllettes, demi-setiers and chopines; wood for construction in pieds, pouces and lignes; beer in canettes and pots; sugar and coffee, among the poor people, in livres, demis-livres, etc. Cattle dealing is in pistoles and écus, and not in francs. Finally, the French government has just issued a twenty-five centime piece, doubtless because it represents a quarter of a franc."

-From *The Yardstick*, Number 15. August 2001, p16.

AN EXTENSION OF A FAMILIAR PROBLEM

by Jean Kelly

A popular problem is:

Question A.

Can you find a 9-digit number consisting of the 9 non-zero (decimal) digits used once each such that:

the first digit is divisible by 1,
the first 2 digits form a 2-digit number that is divisible by 2
the first 3 digits form a 3-digit number that is divisible by 3
the first 4 digits form a 4-digit number that is divisible by 4
...
the first 8 digits form an 8-digit number that is divisible by 8
and all 9 digits form a 9-digit number that is divisible by 9?

That is, the first *d* digits form a *d*-digit number that is divisible by *d* as *d* takes on the values 1, 2, 3, ..., 9.

The comparable problem in dozenals would be

Question B.

Can you find an el-digit number consisting of the el non-zero (duodecimal) digits used once each such that the first *d* digits form a *d*-digit number that is divisible by *d* as *d* takes on the values 1, 2, 3, ..., #.

Solution to B

In decimals we have patterns for divisibility by 2 and 5, the factors of ten. We know that numbers divisible by 2 must end in an even digit. Numbers divisible by 5 must end in 5 (or 0, which is not being used in this question). Hence the fifth digit must be a 5 in a decimal solution and the digits must alternate: odd, even, odd, etc.

Fortunately, due to the factorablity of twelve, we have patterns for 2, 3, 4, 6, 8. 9 and *. Numbers divisible by 6 must end in 6 (or 0) . Numbers divisible by 4

or 8 must terminate in 4, 8 (or 0). Numbers divisible by 3 or 9 must end in 3, 9 (6, which must be the sixth digit, or 0). Numbers divisible by 2 or * must end in 2, * (4, 6 or 8, which have already been accounted for).

Letting d_1, d_2, d_3, ... , $d_\#$, represent the digits we have:

d_6 is 6
one of d_3 and d_9, is 3 and the other is 9
one of d_4 and d_8, is 4 and the other is 8
one of d_2 and d_*, is 2 and the other is *
d_1, d_5, d_7 and $d_\#$, must equal 1, 5, 7 and # in some order

Thus the pattern for any possible solution is

[1,5,7 or #][2 or *][3 or 9][4 or 8][1,5,7 or #]6[1,5,7,#][8,4][9,3][* ,2][1,5,7,#]

Further, 12 d_7 + d_8 must be a multiple of 8 and
12 d_8 + d_9 must be a multiple of 9.

From this it can easily be shown that since d_7 is odd d_8 must be 4 and d_9 must be 6. But this is impossible since d_6 is 6. Thus we have no solution in dozenals. ■

Question C.

Solution B shows that we are unable to find one number satisfying all el of our criteria. We now extend the original idea by investigating the following el cases which ask for el different numbers each satisfying one of the criteria.

Can you find:

1. a 1-digit number consisting of the first non-zero (duodecimal) digit such that it is divisible by 1.
2. a 2-digit number consisting of the first 2 non-zero (duodecimal) digits such that it is divisible by 2.
3. a 3-digit number consisting of the first 3 non-zero (duodecimal) digits such that it is divisible by 3.
...
#. an #-digit number consisting of the all the non-zero (duodecimal) digits such that it is divisible by #.

Solution C

The first 4 problems have simple obvious answers, namely:

1 = 1 x 1
12 = 2 x 7
123 = 3 x 49
1234 = 4 x 36*

These numbers are divisible by 1, 2 3 and 4 respectively. (The first 3 are also solutions in base dek.)

Other solutions are:

21345 = 5 x 5081
123456 = 6 x 2468#
1234576 = 7 x 205946
12385674 = 8 x 195683#
129456783 = 9 x 1785#4*3
12345679*8 = * x 151790948
123456789*# = # x 136#4#7421 [a]

■

Question D.

Once more, we extend the question. Can you find — not merely el *d*-digit numbers consisting of the first *d* non-zero digits such that each one is divisible by *d* — but in addition numbers such that the first *k* digits form a *k*-digit number that is divisible by *k* as *d* takes on the values 1, 2, 3, ..., *d* and *d*, in turn, takes on the values from 1 to #?

Solution D

From the solution to C above we have the first 4 such numbers

[a]Note that every number composed of all el different digits is divisible by #. In general, if the sum of the digits of a number in base *b* is divisible by *b*-1 then the number itself is also divisible by *b*-1. This is the basis of "casting out nines" in base dek.

1 since 1 = 1 x 1
12 since 1 = 1 x 1 and 12 = 2 x 7
123 since 1 = 1 x 1, 12 = 2 x 7 and 123 = 3 x 49
1234 since 1 = 1 x 1, 12 = 2 x 7, 123 = 3 x 49 and 1234 = 4 x 36*

For a 5-digit solution, the only possible candidates would be 12345 and 52341. Both of these satisfy the divisibility for k = 1, 2, 3 and 4 but neither one is divisible by 5.

6. 123456 and 523416 are the only candidates for a 6-digit solution and they fail since 12345 and 52341 are not divisible by 5.

7. The possible candidates for a 7-digit solution are *o*234*o*6*o*, where *o* must be and odd digit 1, 5 or 7. From our work with the 5-digit solution it is clear that either d_1 or d_5 must be 7. None of these four possibilities work.

8. The possible candidates for an 8-digit solution are *o*23*eo*6*oe*, where *o* must be and odd digit 1, 5 or 7 and *e* must be an even digit 4 or 8, and the last two digits must form a two digit number which is a multiple of 8. There are only 3 possible pairs of 7th and 8th digits to consider: 14, 54 and 74. These 3 pairs produce six possible solutions: *o*238*o*6*o*4 where *o* = [1,5 or 7]. Of these only two satisfy the divisibility tests for division by d = 1 thru 6 and neither of these satisfies divisibility by 7.

9 to #. The case for 9-, *- and #-digits reduce to the fact that
12 d_7 + d_8 must be a multiple of 8 and
12 d_8 + d_9 must be a multiple of 9.
As shown above, these cannot be satisfied.

In conclusion we see that we found solutions to our original question for 1, 2, 3 and 4 digits only.

■

Question E.

What if we relax the condition that we must use the first *d* digits and allow any *d* different digits? Would there then be solutions for *d* > 4?

Solution E

The number 1298#674 provides solutions for d =1 thru 8 digits.

And we have already shown that there is no solution for the #-digit case in the solution to Question B above.

For the 9- and *-digit questions we see that the 7^{th} and 8^{th} digits must be 14, 54, 74 or #4. But $d_8 = 4$ leads to $d_9 = 6$ which, once again, is impossible.

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Problem Corner

For our Problem Corner we offer-

1. Referring to questions B, C, D and E in the article above:

Investigate the analogous questions for bases 2 thru #.

2. In base dek the cryptarithm $E^2 = DE$ has 2 solutions: $5^2 = 25$ or $6^2 = 36$. Hence E = 5 or 6 and D = 2 or 3 respectively.

In base do, $E^2 = DE$ has a unique solution for D and E. Furthermore if

$L^2 = ED$
EA - OE = DZ
O x Z = A
O + Z = N
Z - O = D

find the values of all the digits represented by letters and place them in numerical order.

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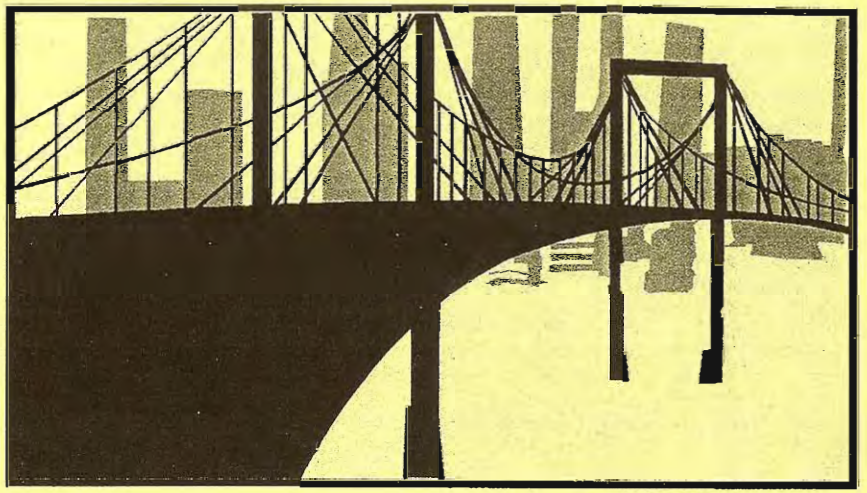
Remember — your gift to the DSA is tax deductible

ANNUAL MEETING RETURNS TO MANHATTAN

After three dozen years the DSA will once again hold an Annual meeting in Manhattan, the scene of its birth. Our Secretary, Christina Scalise has arranged for us to convene at her place of employment, Bank Street College , 610 West 112th Street between Broadway and Riverside Drive.



You can take the number 1/9 train to 110th street, walk 2 blocks north to 112th street and you will see the Bank Street Bookstore. Turn down that block and the next building is us.

We gather on Friday 5 October 11*9. The time is (tentatively) set for 1 pm. Please try to attend.

For details contact either:
Christina at 212 875 4789 or at cscalise@bnkst.edu or
Gene at 631 669 0273 or at genezirk@mindspring.com

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NOTE: The dozenal number base is an excellent topic for math reports and projects for students of all ages.

Dear Gene,

I sometimes think we live in a dictatorship.

Imperial measures are legal; but a European Directive (issued not by our elected Parliament but by Eurocrats) apparently overrides the laws of the land. How long now before trial by jury and being presumed innocent till proved guilty give way to European practice... the suspect/accused has to prove himself innocent in Europe... And Parliament is not really bothered about what we want.

I don't like it at all, and even if I did like the metric system, I would rather vote for it than have it stuffed down my throat. And if I publish anything, just let them try to force me to remove references to Imperial Measures!

This is not the Britain I was brought up in; there's a few nasty things lurking in the cellars...

So watch the sneaky arguments and the fellow travelers.

Best wishes,

Shaun Ferguson

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Bad News/Good News

First, the bad news:

Some years ago I went to the college library to look up F Emerson Andrews' original article in the October 1934 issue of the *Atlantic Monthly*. Much to my dismay I learned that the magazine had been discarded. It seems that libraries all over the world are discarding original periodicals and replacing them with microfilm copies or digital copies.

Now, the good news:

Recently, thru the offices of a rare book dealer, I was able to locate a good copy of that issue of the magazine. Of course it cost a bit more than the cover price of 40 cents. I am very happy that we now posses this relic of our heritage, an original copy of "An Excursion In Numbers." If you haven't read it lately, maybe now would be a good time to reread this gem. -GZ

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We received this in a feeble list sent via e-mail:

> If we had been intended to use the metric system, Jesus would have chosen only ten apostles.

To which we might add:

> If we had been intended to use the awkward metric system, God would have only ten tribes of chosen people.
>
> Since Jesus gave us 8 Beatitudes, he wanted us to count octally.
>
> If we had been intended to use the awkward metric system, the apostles would have gathered only ten baskets of left overs and not one dozen.
>
> If we had been intended to use the awkward metric system, the new Jerusalem would have only ten gates, 2½ on each side.

⬡ ⬡

MEMBERS ...

Your 11**;(2002.) dues are due as of 1 January. Please forward your check for one dozen dollars to Treasurer Alice Berridge. Student dues are $3 and LIFE Memberships are a gross of dollars. As you know, our continued work depends very much upon the tax deductible dues and gifts of our members.

WHY CHANGE?

This same question was probably rife in Europe between the years 1000 and 1500, when the new Hindu-Arabic numerals were slowly making their inching progress in displacing the comfortable and familiar Roman numerals then universally used.

Yet, although it took D years, and despite much opposition–("Who needs a symbol for nothing?")–the new notation did come into popular use. Released from the drag of Roman notation, people's thinking leapt forward dramatically, and mathematicians discovered a new dimension in mathematical symbolism. Working with Hindu-Arabic numeration, they found that the new system better accommodated mathematical statements and facilitated the working out of ideas. Re-examining their fundamental concepts of numbers, they made advances in arithmetic, algebra, logarithms, analytic geometry and calculus, and thus contributed to the explosion of human thought which later became known as the Renaissance. Then, in a related development, people awoke to the fact that different number bases could be used.

A parallel to today seems tenable. The notation of the dozen base better accommodates mathematical statement and facilitates ideation. It, too, is a step forward in numerical symbolism. The factorable base is preferred for the very same advantages which led the carpenter to divide the foot into twelve inches, the baker and the grocer (one who deals in *grosses*) to sell in dozens, the chemist and the jeweler to subdivide the Troy pound into twelve ounces. And yet, this is accomplished by such simple means that students in the primary grades can tell why they are better. Literally, the decimal base is unsatis**FACTOR**y because it has **NOT ENOUGH FACTORS**.

Then should we change? Yes, but no change should be forced, and we urge no mandated change. All the world counts in tens. But people of understanding should learn to use duodecimals to facilitate their thinking, their computations and their measurings. Base twelve should be man's second mathematical language. It should be taught in all the schools. In any operation, the most advantageous base should be used, the one best suited to the task at hand. (Similar to computer scientists use of binary, hexadecimal or octal - whichever is most convenient.) If this were done, duodecimals would progressively earn their way into general popularity because they simplify the all-important problem of the correlation of weights and measures, the expansion of fractions (1/3 = 0;4) and give an advantage in calculations involving time and our twelve-month calendar. Perhaps by the year 2000, (or maybe by 1200; which is 14; years later!) duodecimals may be the more popular base. But then no change need be made, because people will already be using the more convenient base.

If "playing with numbers" has sometimes fascinated you, if the idea of experimenting with a new number base seems intriguing, if you think you might like to be one of the adventurers along new trails in a science which some have erroneously thought staid and established and without new trails, then whether you are a professor of mathematics of international reputation, or merely an interested pedestrian who can add and subtract, multiply and divide, your membership in the Society may prove mutually profitable, and is most cordially invited. ✹

YOU ARE INVITED TO JOIN THE DOZENAL SOCIETY OF AMERICA

The only requirement is a constructive interest in duodecimals

Name _____ / __ / __
Last First Middle Date

Mailing Address (including full 9 digit ZIP code)

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Annual Dues ..... Twelve Dollars (US)
Life ..... One Gross Dollars (US)
Student (Enter data below) ..... Three Dollars (US)
(A limited number of free memberships are available to students)

School _____

Address _____

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Instructor _____ Dept. _____

College Degrees _____

Other Society Memberships _____

To facilitate communication do you grant permission for your name, address & phones to be furnished to other members of our Society?
Yes: No:

Please include on a separate sheet your particular duodecimal interests, comments, and other suggestions.

Mail to: Dozenal Society of America
c/o Math Department
Nassau Community College
Garden City LI NY 11530-6793

DETACH--HERE--OR--PHOTOCOPY