COUNTING IN DOZENS

1	2	3	4	5	6	7	8	9	X	E	10
one	two	three	four	five	six	seven	eight	nine	dek	el	do

Our common number system is decimal - based on ten. The dozen system uses twelve as the base, which is written *10*, and is called *do*, for dozen. The quantity *one gross* is written *100*, and is called *gro*, *1000* is called *mo*, representing the meg-gross, or great-gross.

In our customary counting, the places in our numbers represent successive powers of ten; that is, in 365, the 5 applies to units, the 6 applies to tens, and the 3 applies to tens-of-tens, or hundreds. Place value is even more important in dozenal counting. For example, *265* represents 5 units, 6 dozen, and 2 dozen-dozen, or gross. This number would be called *2 gro 6 do 5*, and by a coincidence, represents the same quantity normally expressed as 365.

Place value is the whole key to dozenal arithmetic. Observe the following additions, remembering that we add up to a dozen before carrying one.

94	136	Five ft. nine in.	5;9'
31	694	Three ft. two in.	3;2'
96	3E2	Two ft. eight in.	2;8'
19E	1000	Eleven ft. seven in.	E;7'

You will not have to learn the dozenal multiplication tables since you already know the 12-times table. Mentally convert the quantities into dozens, and set them down. For example, 7 times 9 is 63, *which is* 5 dozen and 3; so set down *53*. Using this *"which is"* step, you will be able to multiply and divide dozenal numbers without referring to the dozenal multiplication table.

Conversion of small quantities is obvious. By simple inspection, if you are 35 years old, dozenally you are only *2E*, which is two dozen and eleven. For larger numbers, keep dividing by 12, and the successive remainders are the desired dozenal numbers.

```
12 ) 365
12 ) 30 + 5
12 ) 2 + 6
     0 + 2    Answer: 265
```

Dozenal numbers may be converted to decimal numbers by setting down the units figure, adding to it 12 times the second figure, plus 12^2 (or 144) times the third figure, plus 12^3 (or 1728) times the fourth figure, and so on as far as needed. Or, to use a method corresponding to the illustration, keep dividing by X, and the successive remainders are the desired decimal number.

Fractions may be similarly converted by using successive multiplications, instead of divisions, by 12 or X.

Numerical Progression

1	One		
10	Do	;1	Edo
100	Gro	;01	Egro
1,000	Mo	;001	Emo
10,000	Do-mo	;000,1	Edo-mo
100,000	Gro-mo	;000,01	Egro-mo
1,000,000	Bi-mo	;000,001	Ebi-mo
1,000,000,000	Tri-mo	and so on.	

Multiplication Table

1	2	3	4	5	6	7	8	9	X	E
2	4	6	8	X	10	12	14	16	18	1X
3	6	9	10	13	16	19	20	23	26	29
4	8	10	14	18	20	24	28	30	34	38
5	X	13	18	21	26	2E	34	39	42	47
6	10	16	20	26	30	36	40	46	50	56
7	12	19	24	2E	36	41	48	53	5X	65
8	14	20	28	34	40	48	54	60	68	74
9	16	23	30	39	46	53	60	69	76	83
X	18	26	34	42	50	5X	68	76	84	92
E	1X	29	38	47	56	65	74	83	92	X1

THE DUODECIMAL SOCIETY OF AMERICA

is a voluntary nonprofit organization for the conduct of re-
search and education of the public in the use of base twelve
in numeration, mathematics, weights and measures, and other
branches of pure and applied science.

The forms of membership include Honorary, Life, Fellow, and
Senior Members, as well as Members and Student Members. Members
and Student Members are not required to pass aptitude tests in
base twelve, but are encouraged to do so.

Senior membership with voting privileges requires passing of
elementary tests in the performance of twelve base arithmetic.
The lessons and examinations are free to those whose entrance
application is accepted. Remittance of $6, dues for one year,
must accompany application. Forms free on request.

The Duodecimal Bulletin is an official publication of the Du-
odecimal Society of America, Inc., 11561 Candy Lane, Garden
Grove, California 92640. Kingsland Camp, Chairman of the Board
of Directors; Charles S. Bagley, President; Jamison Handy, Jr.,
Editor. Permission for reproduction may be granted upon appli-
cation. Separate subscription rate $3 per year, $1 per copy.

TABLE OF CONTENTS

The Duodecimal Bulletin

All figures in italics are duodecimal.

ANNUAL MEETING

The Duodecimal Society of America held its annual meeting of
members and the Board of Directors on April 16, 17 and 18, 1967
in Council Bluffs, Iowa, at the Howard Johnson Motor Lodge.

The following were elected to the Board of Directors by the
membership, to-wit:

Board Members Class of *1182* (1970)

Kingsland Camp
Tom B. Linton
Van Allen Lyman

Chairman of the Board of Directors, Kingsland Camp, Hotel
Shelton Towers, New York, N. Y., was reelected.

The following other officers of the Society were elected:

Charles S. Bagley, President, 1314 Ohio Av., Alamogordo, NM.
Henry C. Churchman, V. Pres., 10 State St., Council Bluffs, IA.
Tom B. Linton, Secretary, 11561 Candy Lane, Garden Grove, CA.
Eugene M. Scifres, Treasurer, 1580 S.Milwaukee St., Denver, CO.

Jamison Handy, Jr., was reappointed by the Board as Editor of
the Duodecimal Bulletin.

The following members of the board of directors answered to
roll call: F. Emerson Andrews, Charles S. Bagley, Ralph Beard,
Kingsland Camp, Henry Churchman, Jamison Handy, Jr., and Tom B.
Linton.

The gathering heard Charles Bagley describe his work in meas-
urements of the earth at Alamogordo, New Mexico.

Andrews, who sparked a mathematical reawakening in 1934 with
his article on duodecimals in The Atlantic Monthly, related the
story of a woman who maintained that counting by dozens was im-
moral since God gave us ten-base in listing the Ten Command-
ments. His soft answer was: "But my dear, in the New Testament
He gave us the Twelve Apostles."

The meeting also heard Tom Linton describe his ideas for im-
proving a circular slide rule based on the dozen. Churchman ex-
hibited a facsimile of a dek-cent stamp issued 120 years ago by
the post office department. Beard is building an internation-
al organization of duodecimal scholars, a working Academy.

In this cow country of the midwest states, a T-bone steak was
enjoyed with all the trimmings by board members, wives, and
their guests at Johnny's Restaurant in the heart of the South
Omaha stockyards area on Monday evening.

The annual meeting adjourned sine die on Tuesday, 18 April
1967 at 1010ʰ *(117𝟤 April 16;510 moments)* and members dispersed
in all directions to spread a greater knowledge of base-twelve.

---Nonpareil Photo

CIRCULAR SLIDE RULES based on the dozen numbering system exhibited and discussed at the Annual Meeting among, left to right, board members Tom B. Linton, F. Emerson Andrews, and Churchman.

1847

In 1847, the United States postal service issued the first dek-cent stamp, exhibited on your right, using the Roman numeral X to indicate its value was equal to ten cents.

JULIAN PERIOD MOMENTS

Gower N. Euston

A Julian Moment is the exact length of one-twentieth of one kilosecond.[1] If the Julian day 2441 684 begins in Greenwich at mean noon on 1 January 1973 (historically the Julian Day begins at noon), this date is described dozenally as J.D. *999018;0*.

If we add just one digit before and three after that number, as for example, *099 9018;126* (which we may announce telephonically as zero nine nine, nine zero one eight, dit one two six), then within DEK places we may denote ANY JULIAN MOMENT WITHIN a total period of time equal to more than THREE COMPLETED PRECESSIONS OF THE EQUINOX, each cycle being equal to about 25,800 tropical solar years---more than 80,000 years from today.

Because the velocity of light is constant, and its relationship in time with distance is invariable, either time or distance may be sensed by direct comparison of one with the other.

If we might select any arbitrary length as a unit of distance and call it one, then the waiting period for a photon to travel that distance might be designated as a unit of time. If we double the time unit, the distance is doubled.

Still it might be feasible, in effecting a gentle transition from the 18th century obsolete to the modern metric system, to select as the unit of time a waiting period which is some minus power of a dozen multiplied by one mean diurnal period here on earth, such as the DOT. A dot is the mean day multiplied by the minus fifth power of twelve.   Roughly it is one-third of a second, or EXACTLY 25/72 part of a scientist's second of time. One kilosecond is EXACTLY twenty Moments or 2880 dots.

It might be equally desirable, in aid of navigation, to select a unit of distance which is some minus power of twelve multiplied by a great circle of the earth, such as the *hectomètre duodécimal* or Edon. Either just happens to equal the length of ONE great circle of the earth times the minus fifth power of a dozen. The dimension of the Edon (*75 000 000;0* kr. 86) actually is derived from the Metron, which length--*75 000* wavelengths of orange-red krypton 86 light---is in no way dependent on the exact measurement of ANY great circle of the earth.

Let the Dot, which equals one mean day times the minus fifth power of twelve then be said to equal the time required for the photon to travel in vacuum *272 234;0* edons.[2] (I would rather be right than be President, but NBS with machines could correct the author's estimate without a by-your-leave.)

Since a dozen Edons equal one Aeromile, or [3]Navinaut, or [4]Duodecimal Kilometre (kmd), or Nante, therefore we could say that in one Dot light might travel in vacuum the equal of two and seven-twelfths times around the earth or *27 223;4* Aeromiles.

[1]Moment is defined as exactly fifty seconds of time in length.
[2]See Bulletin Dec 1966, "Speed of Light", and "Dominante Unit."
[3]See Bulletin Aug 1958, "Redivivus Reckoning", by C. S. Bagley.
[4]"Douze Notre Dix Futur", Dunod, Paris, 1955, by Jean Essig.

REPLACING KNOTS

John Jarndyce

We know that one knot today is that rate of travel equal to one nautical mile per hour. It goes back to the days of Sir Walter Raleigh and sailing vessels. When both nautical mile and hour are dropped, what do you suggest to replace the knot?

In 1958 the astute Charles S. Bagley suggested the pleasant and highly descriptive name of NAVINAUT as the equal of one edomo part (1/10 000) of one great circle of the earth. Without knowledge of this proposed system, the brilliant French duodecimalist M. Jean Essig, author of "Douze Notre Dix Futur" or Twelve Our Modern Ten, made a similar suggestion in 1955, assigning to that dimension the name of *kilomètre duodécimal*. It was suggested by M. Essig that this new dimension might replace and be used by navigators instead of the present nautical mile. A like dimension, called one Nante (or Aeromile) was advanced at the same time by Henry Churchman and published in the same Bulletin (August 1958).

If one Navinaut (like the Aeromile or *kilomètre duodécimal*) be defined as the equal of 750 000 000 wavelengths of orange-red krypton 86 light, and if one Moment be said to be the equal of fifty present seconds of time or 1/1000 (1/1728) part of the mean solar day, the U.S. might decree one Navinaut as that <u>rate of travel</u> equal to one Aeromile per Moment, and wholly substitute this rate in place of the present knot.

If one aeromile per moment were equal to today's 86.4 statute miles per hour, this might equal Essig's proposal and yield the following rates of travel on land, on sea, and in the air:

1/4 Navinaut	= 21.6 m.p.h.		1 Navinaut(s)	=	86.4 m.p.h.
1/3	"	= 28.8	2	"	=	172.8
1/2	"	= 43.2	3	"	=	259.2
3/4	"	= 64.8	4	"	=	345.6
7/8	"	= 75.6	5	"	=	432.0

Travel above five Navinauts may be spaced out in terms of additional quarter-navinauts with no difficulty. One-twelfth navinaut is the equal of 7.2 statute miles per hour, and one egro (0;01) navinaut might be said to equal .6 Canadian mile or one-half aeromile per hour (one aeromile per duor)—a slow boat to China.

From practical experience, another rate of travel might be found more desirable than one Aeromile per Moment. It would be helpful if air travelers, pilots, and jet craft manufacturers might criticize the above suggestions without regard to persons or things, and help to set up a modern Navinaut which airlines might substitute for surface knots of the sailing vessel days.

-o-0-o-

It has been suggested by T. Pendlebury that dozeners might employ the acronym DIT (Dozenal Identification Tag) in conversation to replace the longer "duodecimal point". Splendid! And more comprehensive too.   -- Ed.

A WORLDWIDE ZIP CODE

H. C. Churchman

In America, delivery of letters is speeded up by assigning to each post office a district number, using only 5 digits. This number is called the ZIP code (Zone Identification Postal code) or Zip Number. In American slang, zip means "quick as a flash" or "instantly." Some exaggeration of course may be claimed.

Thus, Council Bluffs, Iowa, was designated 51501 U.S.A. And no other local post office in the U.S. uses that same number.

Turning for a moment from zip codes to dimensions, one Edonante or Edon, each defined as the exact length of 75 000 000 wavelengths of orange-red Kr. 86 light, is within 1/3000th part the dimension of a Canadian statute one-tenth mile.

Now in a dozenal base system of angle measurements any surface on earth the size of one square Edon can be located by use of only ten places or numerals. And it could be spotted from land, air, or water, by a dozenal-trained navigator.

First, let us divide 360° into twelve equal parts which are named Minaires (30° each); each minaire into twelve equal parts called Renaires (2½° each); then each renaire into twelve equal parts called Donaires (12½' each); each donaire into twelve equal parts named Naires (62½" each); and each naire into twelve equal parts called Edonaires (5-5/24" each).

The arc of one edonaire on ONE Great Circle of the Earth may be said to equal roughly one Edon or the Canadian statute one-tenth mile. That is not its definition, but one of the descriptions of an edonaire arc. It is accurate within 1/3000th part.

The arc of one naire measured on the same great circle of the earth might be said to equal one Nante or Aeromile, or roughly 6336 Canadian feet within perhaps 1/3000th leeway.

A dimension of 6336 Canadian feet is none other than a distance equal to 1.2 Canadian miles. If this length be described as one Aeromile, because it so nearly approaches that unit, and if we may describe one square Aeromile simply as one Congressional Field, then let us note that *any congressional field on our globe might be described by use of dozenal digits or symbols requiring only 8 places.*

Before we leave this description of the Congressional Field, it should be stated that one Aeromile is said to be the same dimension as one Nante, or Navinaut, or duodecimal kilometre of Essig, the new nautical mile. Let us define any of these as the EXACT equal of 750 000 000 wavelengths of orange-red krypton 86 light, in any universal duodecimal metric system.

Zip Angles

In a worldwide zip code, the global initial point of this dozenal angle system lies on the equator where the 180th degree of longitude intersects it.

The 180th degree of longitude may be here called Zero meridi-

an. Moving east along the equator from this zero meridian, we might designate each of the twelve minaires (each an arc equal to 30°) by such numerals as *0, 1, 2, 3, 4, 5, 6, 7, 8, 9, ᘔ* and *Ɛ*. Accordingly, the present ninetieth degree of longitude West of Greenwich is described as *3* minaire, Greenwich itself as *6* minaire, and the ninetieth degree of longitude East of Greenwich becomes *9* minaire. (see The World, on page seven.)

East or West of Greenwich becomes obsolete, as the twain are now met and joined in a complete circumference of the earth. Latitudes designated North or South of the equator disappear as do things no longer required. The South Pole is designated zero, the North Pole is *6* minaire latitude, and the Equator itself becomes simply *3* minaire parallel of the equator.

Any place south of the equator owns a latitude between *0* and *3*; and any parallel north of the equator is designated by a numeral between *3* and *6*. As you move south from the North Pole, count down; as you move north from the South Pole, count up.
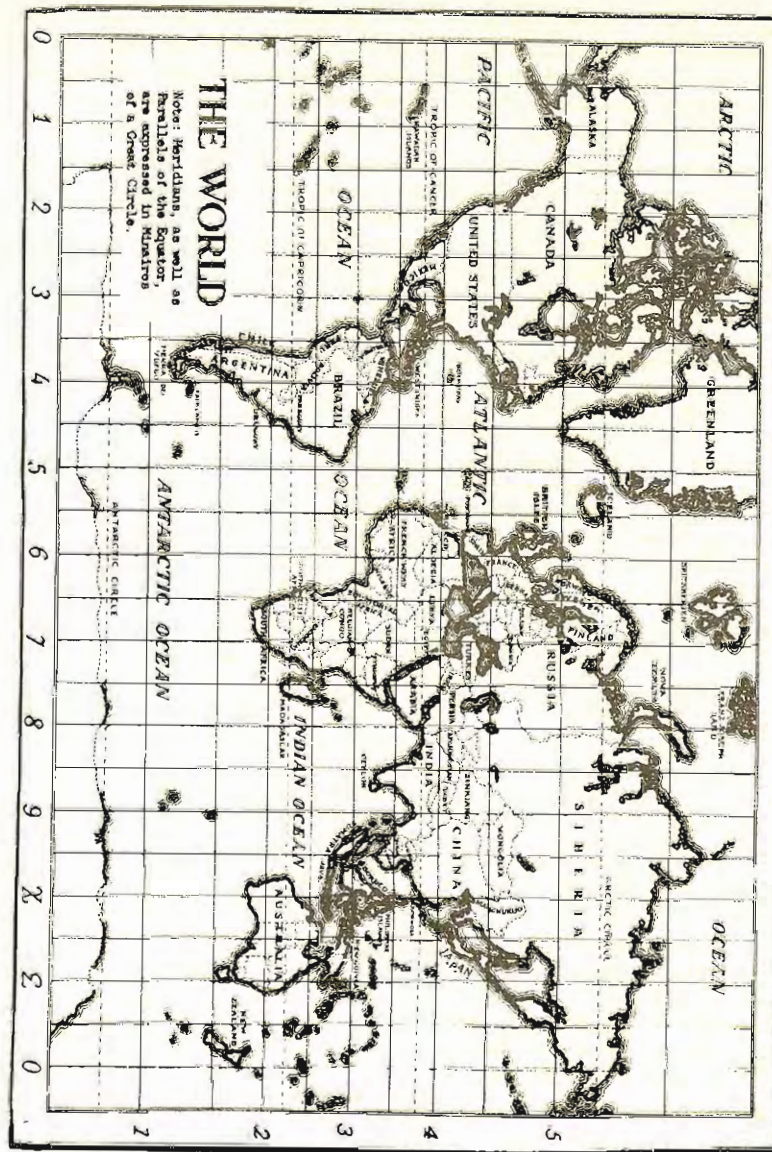
London and Chelmsford Zip Code Symbols

In giving the location of a square Aeromile on the earth, the four digits of a pre-determined longitude are given first, then an equal number of digits for the latitude. Thus, *0000* meridian, called zero, zero, zero, zero (or zero minaire) meridian, will indicate the longitude of 180° reckoning of old. And *3000* latitude, pronounced three, zero, zero, zero (or 3 minaire) latitude, will designate the Equator.   The point on the globe where 180° longitude intersects the equator will appear in communications as Position *0000-3000*. No two points have an identical number, if one is an Aeromile north or east of the other.

A position described as *ƐƐƐᘔ-2ƐƐƐ* (el, el, el, dek, two, el, el, el) is a point two naires (125") West of the 180° of longitude and one naire (62½") South of the Equator.   In other words, it is 179° 57' 55" East longitude, and 0° 01' 02½" South latitude. Dozenally, that position is described by 8 symbols or digits; whereas, presently, we require at least 16 digits or symbols. Not only is there a saving in digits and symbols, but as in any base of a metric system, we may add or subtract the naires of angle dozenally as we would millimetres and centimetres decimally, without first converting degrees to minutes, and minutes to seconds.

Our celestial sphere can be described by the same dozenal method. The twelve signs of the Zodiac are each equal to one minaire on the ecliptic.   Our new Ephemerides might chart the stars not by the present complex, but by naires, or possibly by the smaller angles of eminaire or edominaire. The latter is equal to one naire times the minus fourth power of twelve, the arc of which, on a great circle of the earth, is substantially equal to 3-2/3 inches (or one Metron)---the diameter of a small flagpole on the Capitol building in Washington, D. C.

Many astronomers, and other scientists, frankly ask the public to give up inches and miles entirely---let them enter into

THE WORLD

Note: Meridians, as well as Parallels of the Equator, are expressed in Minaires of a Great Circle.

the spirit of generosity and point the way by giving up the un-
scientific astrologers' habits of describing positions of stars
by degrees, minutes, and seconds; and metric world time mea-
surements by hours, minutes, and seconds. If shillings and
pence are obsolete (nonmetric), equally so and for the very
same reasons are degrees, hours, minutes, and seconds. You can
not burn down one man's house and depend on the fire stopping
there, no matter how good your intentions might be considered.

After our navigators get accustomed to the dozenal system of
angles, they might marvel how they ever managed to live under
the old rules; but during the changeover many of them will wish
they had stayed with the old ship as it sank in the stormy sea.
Change is inevitable. Change is continuous, sometimes in the
oddest places. Who would have thought degrees, hours, minutes,
and seconds would follow shillings?

London, like most large American cities, walks into the coun-
tryside. Somewhere within London's periphery might be found a
square Aeromile (6336 ft by 6336 ft), at the southwest corner
of which is a point described by E-Z Locator number *5££7-4872*
(0° 05' 12½" West Longitude, and 51° 29' 35" North Latitude).
A British Airways navigator might locate its four corners ex-
actly. Any competent surveyor might plat the location perfect-
ly, using present methods until trained in the dozenal system.
Without doubt the new system would be permissive and any old
tar might stick with the system he learned out of the past.

Beautiful Chelmsford, Essex, England, appears roughly to cud-
dle in and about a square Aeromile, at the southwest corner of
which is a point which may be called Position *6023-4880* (0° 28'
07½" East Longitude, 51° 40' 00" North Latitude.

Without any conversion of degrees or minutes to seconds, if
we subtract London's position direct from Chelmsford's, dozen-
ally of course (which should puzzle no Englishman in the '60s,
I'll wager), it might appear as follows:

6023-4880 Chelmsford's position, minus
5££7-4872 London's E-Z Locator number, equals
0028 000£ difference. (Keep lat. and long. separate.)

The above would indicate that Chelmsford lies some 2 (dozen)
and 8 Naires east of the heart of London, and dek Naires north.
By platting this relationship, and knowing the lengths of base
and vertical arcs at that latitude, one might determine the
length of the diagonal (minor arc of earth's great circle) con-
necting these two cities. Tables, of course, eventually will
be developed.

The foregoing calculations are only approximate, of course.
From a small Atlas, the heart of London roughly appears to lie
only 1/11 of 1° West of Greenwich meridian, or 0° 05' 12½" West
Longitude. In dozenal angles, this might equal *6000* minus *5;0*
naires. Chelmsford roughly estimated, appears to lie not quite
½° East of Greenwich meridian, or approximately 0° 28' 7½" East
Longitude. In dozenal angles this might equal *6000;0 + 23;0*

naires, as initially shown above. So much for the **approximate**
longitudes of London and Chelmsford, and relation to naires.

The latitudes of London and Chelmsford were estimated in the
following manner:

		Decimals		Dozenals	
N	30°	=	*4000;0*	naires latitude	
+	20°	=	*800;0*		
+	1° 15'	=	*60;0*		
+	25'	=	*20;0*		
	51° 40' 00"	=	*4880;0*	= Chmfd. lat.	
	-10' 25"	=	*-£;0*		
	51° 29' 35"	=	*4872;0*	= London lat.	

A comparison of a few of the 21st Century angles follows:

	Up to 60° East or West of			Up to 60° North or South of	
	Greenwich			Equator	
Naires	Longitude	Naires	Naires	Latitude	Naires
6000	00° 00' 00"	*6000*	*3000*	00° 00' 00"	*3000*
6020 = E	25' 00"	W = *5££0*	*3020* = N	25' 00"	S = *2££0*
6040	50' 00"	*5£80*	*3040*	50' 00"	*2£80*
6060	1° 15' 00"	*5£60*	*3060*	1° 15' 00"	*2£60*
6080	1° 40' 00"	*5£40*	*3080*	1° 40' 00"	*2£40*
60£0	2° 05' 00"	*5££0*	*30£0*	2° 05' 00"	*2££0*
6100	2° 30' 00"	*5£00*	*3100*	2° 30' 00"	*2£00*
6200	5° 00' 00"	*5£00*	*3200*	5° 00' 00"	*2£00*
6400	10° 00' 00"	*5800*	*3400*	10° 00' 00"	*2800*
6600	15° 00' 00"	*5600*	*3600*	15° 00' 00"	*2600*
6800	20° 00' 00"	*5400*	*3800*	20° 00' 00"	*2400*
6£00	25° 00' 00"	*5200*	*3£00*	25° 00' 00"	*2200*
7000	30° 00' 00"	*5000*	*4000*	30° 00' 00"	*2000*
7020	30° 25' 00"	*4££0*	*4020*	30° 25' 00"	*1££0*
7040	30° 50' 00"	*4£80*	*4040*	30° 50' 00"	*1£80*
7060	31° 15' 00"	*4£60*	*4060*	31° 15' 00"	*1£60*
7080	31° 40' 00"	*4£40*	*4080*	31° 40' 00"	*1£40*
70£0	32° 05' 00"	*4££0*	*40£0*	32° 05' 00"	*1££0*
7100	32° 30' 00"	*4£00*	*4100*	32° 30' 00"	*1£00*
7200	35° 00' 00"	*4£00*	*4200*	35° 00' 00"	*1£00*
7400	40° 00' 00"	*4800*	*4400*	40° 00' 00"	*1800*
7600	45° 00' 00"	*4600*	*4600*	45° 00' 00"	*1600*
7800	50° 00' 00"	*4400*	*4800*	50° 00' 00"	*1400*
7£00	55° 00' 00"	*4200*	*4£00*	55° 00' 00"	*1200*
8000	60° 00' 00"	*4000*	*5000*	60° 00' 00"	*1000*

-o-0-o-0-o-

*Sing metron, jon, and kal, good sirs
(Of a Midsummer morn, all)!
England shall bide till judgment Tide
By [1]metron, [2]jon, and [3]kal!*

[1]Three and two-thirds inches, within 1/3000 allowance.
[2]1 cu. metron, near 1/6 Imp.gal., 800 cc., 4/5 U.S.Quart.
[3]About 1-3/4 lbs. Av., or 4/5 kilogram.

AMERICAN MISTAKES OF THE PAST

Lawrence Boythorn

What about the practicability of the Congress enforcing sole use of the decimetric system of weights and measures? Voluntary use of that metric system is already legal in the U.S.---has been for over one hundred years----it is standard in Europe and Japan, and in most other trading nations.

Now we are being told that unless the U.S. follows "the overwhelming majority of nations", it may find itself ALONE. Much is suggested how this might limit our sales abroad---but the flood of foreign midget cars from Europe and Japan into the U. S. lays that scare tactic to rest. *Performance alone* is what counts in any product. How it was conceived and the language (German, Japanese, millimetres, inches) by which it was together are not overriding at all. And OUR genuine repair parts MUST be used if OUR measurements are different from theirs. Do not overlook for a moment where the profits are made.

There is an interesting suggestion that these United States might set up a DOZENAL METRIC SYSTEM (including metric time, money, and navigation) alongside our customary weights and measures, for VOLUNTARY use by those who prefer a metric system but oppose the 18th Century system. No one should be forced to use any metric system. A permissive dozenal metric system could be the solution to pacify those citizens who prefer a metric system but who also prefer the universal factorability represented in the dozen.

The dozenal measures did not originate in 1795. They are not a recent flash in the pan. Like the Phoenix, as we attempt to kill the dozen we might find it forever injecting itself.

Come, admit it. The people of the United States of America have made a few political mistakes since we left the Old Homestead. But the people can be trusted to correct their past errors, and generously admit they were wrong. That is the real essence of democracy---a willingness to correct our mistakes.

In a whirlwind of reform and prohibition, characterized by one presidential candidate as a "noble experiment", we adopted the 18th Amendment of the U. S. Constitution in 1918. By 1933, it had proved itself so unworkable, so obnoxious, so contrary to what its backers had honestly expected it to be, that the Congress passed the 21st proposed Amendment of the U. S. Constitution, the people approved the repeal of the 18th Amendment and admitted to the world we had created an unfortunate mess.

We made another political mistake about 1785---we set up a base-ten monetary system, one hundred cents to the dollar. All trading nations at that time used a dozen pence to the shilling (or a like system), and we were truly ALONE. By 1795, Frenchmen moved in with us to advance their own political revolution, abandoned their *livre*, and one by one the dominoes tumbled.

That was our mistake alone but France fell for it not so much as "modern" but as "anti-monarchy", both countries having just overthrown their monarchs and established a "republic." Let

us at least admit our mathematical error in limiting the factorability of our coinage. We cannot now divide a half-dollar, a quarter-dollar, or a dime into exact thirds or fourths--- but DOZENAL METRIC MONEY can be so divided and whole-coin exchanges made between seller and buyer.

We could, and should, manfully admit our error (committed in the heat of passion and a popular demand to be rid of all monarchical trappings), confess our sorrow to the whole world, and in effect amend our mistake by adopting the dozen-base METRIC DOLLAR system making each nickel equal the value of six cents.

When you feel you are right, you don't worry about being alone. That is what makes for progress on this earth.

Prior to 1787, we made an administrative mistake, but had the good sense quickly to correct that error. We had actually surveyed land in what is now the state of Ohio, creating Townships containing 25 Sections of land. That is to say, every township measured 5 miles on each side and hence equalled 25 square land miles. Some of these bastard townships exist in Ohio today.

Surveyors however quickly saw the limitations of these base-ten measurements of land, especially their lack of factorability, the difficulty of dividing these townships into halves, quarters, thirds, or sixths; and the Continental Congress was quick to enact the "Northwest Ordinance of 1787" making the legal township (what is today called a Congressional Township) 6 miles on every side and containing three dozen Sections of land ---the present law of the U.S. which has been followed by American surveyors and farmers and tax assessors for 180 years.

Democracies are imperfect because they represent people, none of whom is perfect, and while Americans have made their share of political mistakes we are never afraid to humbly admit our error and correct the abuse, even if it means amending our Constitution---requiring a tremendous popular effort.

Basically, mankind never would advance if we all waited for a worldwide unanimous consent---France set up her base-ten metric system when no other nation was willing to join her. The U.S. set up a base-ten coinage system alone and let the idea percolate slowly. And imagine the Nazarene not acting until the unanimous consent of mankind had been given. Instead a start was made with a DOZEN fearful apostles not at all highly educated or possessing great leadership qualities. On such depended the spread of a worldwide Creed as we find it amongst us today.

Americans might this very day admit to our monetary neighbors our mistake in adopting a base-ten coinage system, initiate the metric-dollar containing one gross pennies, the twelve-cent dime, the six-cent nickel (a sixpence piece, if you will); and once more lead the world financially---but this time into trading habits thousands of years old; metric, yet dozenal--- English money, to be sure, without the double base-ten mixture.

Master, teach us to praise the Continental Congress, Washington, Jefferson, John Quincy Adams, Abraham Lincoln, all of whom stood on principles, not on what "everybody else is doing."

BASE TWELVE MILITARY WEAPONS AND E-Z LOCATOR

Lt. Col. Grosvenor Bond, FA-Res.

Almost always a nation will purposely design its new peace-preserving weapons in a trifle larger bore than the nearest existing piece.

Consider the German 77 as 2 mm. larger than the French 75 mm. When the French capture a German ammunition dump and try to use it guns may jam. But if you capture an ammunition cache 1 or 2 millimetres smaller than what you are using, you might feel the Creator above all, or at least Santa Claus, is on your side.

A few new sizes of current bores appear below, assuming one duodecimal millimetre (mmd) equals seven gross, five dozen (*750* or decimally 1068) wavelengths of orange-red krypton 86 light.

(a) 81 mm = 125 198 mmd, or 126 mmd, dozenally *X6* mortar.

(b) 77 mm = 119.015 mmd, 120 mmd, " *X0* gun.

(c) 75 mm = 115.926 mmd, 116 mmd, " *98* gun.

The new 81 mm might be called the American dek-six mortar; a new 77 mm might be called the German dek-dozen gun; and the new 75 mm, as a matter of course, then would be known as the French nine-eight gun, darling little three inch gun the world around. All of these might use up remaining ammunition on hand.

The foregoing suggests that any set of measurements can be used when the exact length of a unit is defined by law in wavelengths of orange-red krypton 86 light; and comparisons may be made with base-ten metric dimensions. Hence, base-twelve measurements are equally employable in materiel now employing base-ten; and the base-twelve units may be divided by finer subdivisions than is now possible in base-ten.

There can be no valid objection to our defense department employing base-ten-metrically-designed materiel in any territory where it is produced; but we should perhaps encourage the employment of a duodecimal improved metric system at home, so as to enable our nation within the next generation to move up to metric time, metric angles, metric navigation, metric money, and the metric international postal zip code, the E-Z Locator worldwide grid number, none of which is feasible under the SI.

The E-Z zip code, using a six-place number, could designate a certain point on earth within 14.4 Canadian statute miles north or east of any other point. Every capital or metropolitan city in the world might have its own E-Z Locator 6-place number. We might assign *5XX 487*, for instance, as London's E-Z Locator.[1] There is no similar direction or address on this globe. That number pinpoints the southwest corner of a quadrangle 14.4 Canadian statute miles square, enfolding the heart of London.

[1] see page five of this issue.

—o-O-o—

(Abstracted from)

SIMPLER SUMS

J. Halcro Johnston, Orphir House, Orphir, Orkney.

Simple sums are the daily task of everyone; the grocer's bill may have to be checked or the amount required for the shopping worked out. We prefer round numbers; they save time; how annoying to be held up in a queue in the post office when all you want is a book of stamps in exchange for a single coin and someone in front has made a mistake or is waiting for change. Or the same may happen at the railway booking office with only a few minutes left to catch a train. Simple calculations have also to be made by the carpenter if waste of materials is to be avoided or by the bricklayer when setting out a length of walling with frequent openings for doors and windows.

How will a change to decimal units affect these sums and the time we spend in queues?

A Change to Decimals

The advantages of decimals are well known; we count in tens and calculations are simpler if the *same* number is used in the make-up of money and other units. If you buy 12 metres of material costing 12p a metre (12 new pence) you will pay 12 x 12 = 144p and this is the same as £ 1.44. Just shift the decimal point two places to the left. Could anything be simpler? To put it in slightly different language: the *same* number should be used as basis of both arithmetic and measurement.

Why so Unpopular?

Why has Britain taken so long to adopt this system of measures? We find that man has never taken to it of his own free will. The Egyptians divided both the day and the night into twelve hours—not ten; and the Romans divided the foot into twelve inches and the pound into twelve ounces—both inch and ounce coming from the Latin word *Uncia*, meaning a twelfth. The decimal system was introduced into France at the end of the 18th century as one of the changes brought about by the Revolution. But it was far from popular and more than one law had to be passed to enforce its adoption.

The world counts in tens because primitive man found it easiest to count on his fingers. Why is ten so unpopular in other units? Let us look at some of them:

12 inches	= 1 foot	12 months	= 1 year
12 ounces	= 1 lb. troy	60 minutes	= 1 hour
16 ounces	= 1 lb. av.	60 seconds	= 1 minute
24 hours	= 1 day	20 shillings	= £ 1 sterling

Small Factors

We notice at once the popularity of the small factors, 2, 3, and 4; all the leading numbers are divisible by 2 and 4. Six are divisible by 3, and three by 5. Clearly small factors are popular just because they are *small*.

The reason is not far to seek; richness in small factors means overall richness in factors and this is of great practical value because it leads to a wide range of choice. How useful this is in the day of two dozen hours which can be divided into 2, 3, 4, or 8 shifts or into 6 or 12 watches! And how useless would be a day of ten hours each of a hundred minutes!

In the same way the carpenter's rule of three dozen inches gives the draughtsman a wide range of choice in the spacing, for example, of bolts, rivets, reinforcing rods, etc.; and this choice is reflected in the most economical use of materials and the saving of time with the less likelihood of mistakes in setting-out on the site.

In packaging also the value of small factors must be self-evident; the contents of the cartons in which groceries are packed are generally stencilled on the carton. Examine these and you will find they almost always have the factors, 2, 3 and 4. For the same reason a book of postage stamps has 2 x 3 stamps to the page.

In arithmetic also small factors spell simplicity. It is due only to the fact that the number of our fingers is not divisible by 3 that 1/3 = 0.333.., that unwelcome recurring decimal. And not 3 only; every third number gives rise to one. If 2 were not a factor the reciprocal of every even number would recur.

Decimal Shortcomings

Clearly ten is not a very suitable base either for practical units or for arithmetic. Chosen by primitive man only because he counted on his fingers would it not be very strange if it were suitable? If, therefore, we are to enjoy both simple calculations and practical units the present arithmetic should be replaced. But this, alas, is a major operation. Having spent some seven years at school learning decimal arithmetic, not forgetting the multiplication tables, no one would welcome another seven to master another system however good.

A change of arithmetic would have to be a very slow evolutionary change; it would be for the benefit of our great-grandchildren---not of ourselves. But if we cannot ourselves reap the benefit of a simpler system might we not at least lay the foundations of one? Apart from a minority the population of the world knows no arithmetic. Why should they and the countless millions yet unborn not be given the best? In the meantime let us preserve at all costs those valuable units with the factors 2, 3 and 4.

The Choice of a Better System

Which is the best number to replace ten? Let us consider its factors in order of smallness:

two: this is the base of the *binary* system used in computers but useful for that purpose only.

six---2 x 3: too small for practical purposes.

twelve---3 x 4: long recognized as the ideal base.

five dozen---3 x 4 x 5; too large.

Twelve Arithmetic

Because it has the three smallest factors twelve is ideal both for measures and arithmetic. Professor A. C. Aitken found its efficiency to be at least 50% greater than decimals.

But a great many people still think that decimal arithmetic came from heaven and that no other system is possible; so let us see how the Hindus constructed it about twelve centuries ago. Their greatest break-through was the invention of *place-value*. In the number, 3333, for instance, each 3 has a different value depending on its place in the number--it is ten times greater than the next on its right.

The Hindus also for the first time introduced ten figures, one for each finger, appropriately called digits from digitus, the Latin for finger. These are the figures 0 to 9, found on the keyboard of every typewriter. Using only ten digits and place-value they were able to write down any number however large. Starting from 0 they wrote down the digits and then by putting a 1 before each they got the numbers 10 to 19 for ten to nineteen. If they had had twelve fingers instead of ten, 10 would have stood for twelve, 11 for thirteen, and so on.

But clearly the same method can be used to make a new arithmetic based on *any* number.

In the binary system for instance, there are only two digits, 0 and 1, and we get:

$$0, \quad 1,$$
$$10, \quad 11,$$
$$100, \quad 101,$$

and so on; and these, in binary language, are the numbers 0, 1, 2, 3, 4 and 5. Here 10 stands for 2, and 100 for 2 x 2. To avoid confusion the reader is asked always to call these one-0 and one-0-0 and *never ten or a hundred*. For the same reason call 11 one-one, 12 one-two, 13 one-three, 26 two-six in twelve arithmetic.

In twelve arithmetic new digits are needed for ten and eleven. In Britain the inverted figures of 2 and 3 have been adopted until something better is standardized. Now, following the same method as the Hindus, we can write down the first two dozen numbers:

0	1	2	3	4	5	6	7	8	9	↊	↋
10	11	12	13	14	15	16	17	18	19	1↊	1↋
20	etc	etc									

Now *10* (one-0) becomes twelve, *20* is two dozen, *100* is one gross and so on.

What Benefits Would Result

It certainly looks strange at first but it leads to a very simple arithmetic. Here, for example, are a few common frac-

tions:

3/4 = ;9	1/3 = ;4	1/8 = ;16	1/14 = ;09
2/3 = ;8	1/4 = ;3	1/9 = ;14	1/16 = ;08
1/2 = ;6	1/6 = ;2	1/10 = ;1	1/54 = ;023

Are not these much simpler than the same fractions in ten-arithmetic? The last in above group (pronounced one over five-four) is equal of the base-ten 1/64 = .015625, needing twice as many digits. Some fractions such as 1/5 and 1/7 recur but there are fewer recurring fractions than in decimals.

Multiplication

Our greatgrandchildren will have to learn a new multiplication table, shown at the end of this article. But it is one *already known to anyone who has served behind the shop counter.* For example: 5/3d., the cost of 7 bars of chocolate @ 9d. or of 9 bars @ 7d., appears in the table as *7 x 9 = 53.*

Products ending in 0 are always welcome. If we omit the *10*-times tables in each base we find 80% more such products in the twelve table than in the decimal one. The table is simpler in other ways: note the regular endings under 4-times and 8-times: 8, 0, 4 and 4, 0, 8; and under 3-times and 9-times: 6, 9, 0, 3 and 6, 3, 0, 9. In the £-times table the sum of the two digits is always £.

Shortcuts

To multiply by 25 in decimals it is generally quicker to add two 0s and divide by 4. In twelve arithmetic there are many such shortcuts. In the following cases add a 0 before dividing:

```
To multiply by 3, add 0 and divide by 4
    "           4, "  0        "        3
    "           6, "  0        "        2
    "           8, double, add 0 and divide by 3
    "           9, triple, "  0        "        4
```

Example: $3333 \times 8 = \frac{66660}{3} = 22220.$

Compound Sums

Compound sums would be much simpler (and need no longer exist in fact). Let us suppose, in the future, the £ divided into *twelve* shillings and each shilling into twelve pence.

Example: Find the cost of *4 ft. 4 in.* of material @ *13d.* a ft.

    Using the new table we get:

        4;4 x 13 = 55d. = 5;5s = £ 0;55,

showing all the advantages of the moving point in full display.

Example: Find the cubic volume of a timber batten, *8" x 3" x 9' 6".*

    Again using the new table:

        0;8 x 0;3 x 9;6 = 0;2 x 9;6 = 1;7 cu. ft.

Why Was It Not Thought Of Before?

For more than two centuries architects and surveyors have used twelve arithmetic under the name *duodecimal* and until recently the subject was explained in standard books on arithmetic. *But sad to say, these men did their best to strangle it at birth.* Like the figures on a clock they dress it up in decimal clothes, using double figures for ten and eleven. *All the advantages of place-value are lost and the calculations look most forbidding.*

Evolution is a slow runner and is occasionally held up by what appear to be simple hurdles. In this case there are two: ignorance (hard to overturn) and the missing digits. To call 10 by any other name than ten appears to many grown-ups little less than lunacy. But children now being taught binary arithmetic at school should find it less difficult---perhaps quite normal in this very generation.

How to popularise the use of new digits for ten and eleven is a much more difficult problem. But a solution might be found by introducing them on the ordinary clock face. This now shows a strange combination of symmetry and want of symmetry; the spacing of the hours shows the beauty of the factors 2, 3 and 4. A change to all single figures would appeal to the discerning and intelligent housewife and might act as leaven leading to a simpler system.

A suggested clock face:
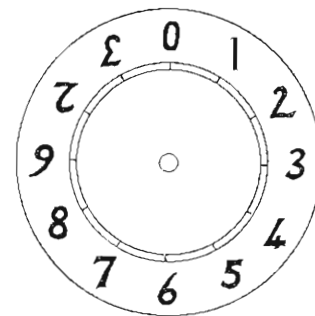
DOZEN MULTIPLICATION TABLE

1	2	3	4	5	6	7	8	9	X	£	10
2	4	6	8	X	10	12	14	16	18	1X	20
3	6	9	10	13	16	19	20	23	26	29	30
4	8	10	14	18	20	24	28	30	34	38	40
5	X	13	18	21	26	2£	34	39	42	47	50
6	10	16	20	26	30	36	40	46	50	56	60
7	12	19	24	2£	36	41	48	53	5X	65	70
8	14	20	28	34	40	48	54	60	68	74	80
9	16	23	30	39	46	53	60	69	76	83	90
X	18	26	34	42	50	5X	68	76	84	92	X0
£	1X	29	38	47	56	65	74	83	92	X1	£0
10	20	30	40	50	60	70	80	90	X0	£0	100

RENAISSANCE IN ARITHMETIC

Henry C. Churchman

Within four months we should see the coming of *1180* (one-one-eight-zero). Let us carry our thoughts back to another medieval period bracketed by the base-ten years A. D. 1180 to 1220. Francis of Assisi, born 1181, died 1226, gradually came to signify the end of what men now are pleased to call the Dark Ages.

Some of the most beautiful works of Western Art were produced in and around the year of 1200. It was the crucial period of transition from Romanesque to Gothic styles in more ways than construction of great cathedrals which still are found in Europe to enliven man's thoughts.

Within that bracket, southern Europe, being introduced to the Indo-Arabic numerals or symbols, the then powers *outlawed them.*

Looking ahead now requires no imagination at all to conjure up the sad state endured by people in what many persisted in calling the Enlightened Twentieth Century: when wars were rife, the economy floated on a sea of anarchy, and strife obtained in every populated area then called cities----which in later years were to be frankly labeled "pig sties" after they produced the Purple Plague in the twenty-first century to dozenate the human population of the earth to one-twelfth of its greatest expansion and to leave the skin of all survivors purple-like, but again ONE people (the purple people to all not colorblind). All then again tended to increase and multiply---suggested as the divine command of a purple god.

Let us, for the moment, return to and concentrate our thought processes on today. Here we find ourselves existing in the dozenal year of one-one-seven-el *(117£)* when many of mankind are wont to smile indulgently at the thought of ever moving into the efficient age of dozenals. A suggestion that dismal decimals might join the stadia, the cubit, the old Roman mile of one thousand paces, was simply beyond the reasoning, even the imagination, of many otherwise intelligent beings.

The demise of the base-two computer should have been seen as plainly as any grafito on the wall, but none is so blind as one who will not see. The efficiency to be achieved by combining base-three with base-two in some suitable ratio in the newer computers, giving that machine the choice of left, right, or straight on (the same choice as exists in any efficient one-way city street), was a dream in *117£* excepting possibly in Russia, where they do not immediately tell all they have uncovered.

True to a medieval age in which governments stalked about, bolstered by a multitude of votes of confidence (or stung fatally by defeat) and ever searching for more tax-dollars, the Euro-Asian decidactylonomy was believed to be eternal, a deity from everlasting to everlasting.

(Watch this space tomorrow for additional current enigmas).

(Excerpts from)
*THE CASE AGAINST DECIMALISATION, PART II.

By A. C. Aitken, M.A., D.Sc., F.R.S.,
Professor of Mathematics at Univ. of Edinburgh

Recapitulation.

These (electronic computers) will transform not merely arithmetic, but education in arithmetic; and a younger generation, familiar with binary and octonary systems as well as with decimal, will be sure to ask: What, reckoned in terms of time and efficiency, is the worth of the decimal system, and is there a better (a duodecimal)? We shall without doubt see this happen, probably in Russia and America almost simultaneously, while we, who of all nations in the world are in the special and most favourable position to make the change (to base twelve), may be left behind; may well in fact have made a belated change (embracing base-ten metric) only to have to make a further belated one.

Monetary and Metrical Units

Why are we in that special and most favourable position? Because we already have the duodecimal system with us in all but claim, and to a certain but lesser extent even in notation. I refer not to electronic machines, which can convert from their idiomatic binary into any other prescribed scale, but to the numberless transactions of ordinary life, in banks, ticket offices, behind counters, on board buses, wherever and whenever there is buying and selling and giving of change. Consider a railway clerk giving tickets and change, often at top speed to a heavy queue. Does he ever think of decimal tables in handing back 5s. 7d. as change from a 10s. note on a ticket of 4s. 5d.? Not he; like hundreds of thousands of men behind counters he is a highly versed duodecimalist, though it would not occur to him to give so publicly useful a faculty so high-sounding a name. I say this from having spoken recently with dozens of such men.

Here is a typical comment from a Scots bus conductor: "We get on weel eneuch; yon would muck it all up again". Some may think they might get on weel eneuch with decimal coinage; the most manage perfectly well. There is no cogent evidence that the public wish this change in the least; though the will of the public, strong as it might be either way, is neither the only nor the chief consideration. The French, at the very height, in 1790, of their enthusiasm for liberty, equality and fraternity, so qualified equality as to set up an academic commission of the most distinguished mathematicians in the land.

However, I propose---and it is not at all original with me--a certain change, a slight one, by which in a phased gradualness, an interregnum of years of quiet habituation and consolidation, we may bring in the more efficient system. It is: to have a pound, call it R for this discussion (a stag of twelve points is a royal!), of twelve shillings, a gross of pence. It banishes at a stroke all oddments from twelve shillings and a halfpenny to nineteen shillings and elevenpence halfpenny; it

is a paper note, a "royal", that mediates between and supersedes the pound and ten-shilling note, requires no new minted coinage whatever, and is very close to one and two-thirds dollars. Call it then R 1:0:0. Its half is R 0:6:0 shillings. Its quarter R 0:3:0. Its eighth R 0:1:6. *All very much as at present.*

The half-crown might stay for a while, but eventually might be superseded by a three-shilling piece, a "quarter", easier than the half-crown to distinguish from the florin. Pennies and the rest are exactly the same as now. For example, except that we have this R of new value, we shall write R 3:2:1½ and the like as before.

So also for feet and inches. There might be---I do not know whether it is suitable or not, and would not presume to dictate to the practical measurer----a new "rod" simply of twelve feet, but this would make parallelism complete. Duodecimalists should not dictate too much what is desirable; they may well leave it to practical craftsmen to find what is the best accommodation---provided only that the final outcome is indeed cast in a duodecimal hierarchy of units. Here I differ from many duodecimalists; for I believe that, if the principle is once accepted, practical and intelligent men can be trusted to find possibly an even better solution than any duodecimalist or duodecimalist society might have proposed.

General Arithmetic

However, to go further, let us pass from the monetary or metrical units and super- or sub- units to the general arithmetic of the matter. Thus, let the fraction one-half, itself, in whatever context, be denoted by 0:6, a third by 0:4, a quarter by 0:3, a sixth 0:2, a twelfth 0:1, where the colon (most duodecimal publications use a semicolon) serves for the duodecimal point, and will move right or left under multiplication or division by *twelve*. For example, movement to the left. What is a twenty-fourth? A half of a twelfth, hence 0:06; a thirty-sixth is 0:04. The thirty-sixth of a new royal is indeed fourpence. And so on. Contrast this with the inexact and inadequate third as 0.33333..., sixth as 0.16666..., twelfth as 0.83333..., and so on to more turgid examples.

Someone may say: What about a fifth or a tenth? Certainly, since five does not go exactly into twelve, we shall here obtain a non-terminating duodecimal. For example, a tenth comes out as 0:12497..., the last four digits forming the recurring period; but a close approximation to this is 0:125, committing the slight error, in excess, of 1/8640. (For comparison the approximation 0.333 for one-third commits, in defect, an error of one three-thousandth).

However, to go slightly further still. A shilling, 1:0s., is a dozen pence. Shift the colon to the right and in fact, since it is not then necessary, remove it, and write down the dozen itself as *10, the prefixed asterisk (functioning like the American dollar sign) indicating that we are in a special system,

that of the dozens, the meaning of the symbols being: one dozen and no units.

Similarly thirteen, being one dozen and one unit, is *11; fourteen is *12; twenty-five is *21; and so on. The gross likewise is *100; meaning one gross, no dozens, no units; I will attend to names later. But all of this is just another way of writing 1:0:0 in the new R way, the kind of thing that faces us every day on a bill. Duodecimalism is nothing but this, though of course we have to know our tables, e.g. that 7 times 9 (asterisk with single-digit numbers not required) is *53, five dozens and three.

But this is the smallest part, in a slightly different notation, *of the first entries in any ready reckoner,* and we have seen that already great sections of the population know these elementary tables, from habit, from serving customers and giving change.

Consider the number, in decimal notation, 457. It is three gross, two dozen and one, *321. If these happened to be pence, then, in pounds, R 3:2:1; in shillings, *32:1s., three dozen and two shillings and a penny. But this is to labor the habitual; we are doing this kind of thing all the time. Everyone who knows (some do not) that twelve articles at sevenpence each is seven shillings is simply saying that a dozen times seven is seven times a dozen, namely *10 x 7 = *70 in pence, or in shillings *10 x 0:7s = 7s.

I showed some of this, doing some simple addition of fractions by it, to a bank teller and likewise to a stationer. The reaction was identical; each man involuntarily shielded his eye with his hand, doubtless to ward off the blinding flash of the obvious. Well, it is some of this that, in a very uninspiring and differently couched form, is taught in the chapter of any school algebra dealing with "scales of notation", though often treated in such a perfunctory fashion that the pupil may be excused from regarding it as so much tediously useless manipulation. I exclude from my condemnation those admirable American school textbooks.

We have suggested, provisionally, *10 for twelve, *11 for thirteen: for we hope eventually to use our system exclusively and to drop the asterisk. Confusion will be caused unless we devise new *single* symbols to replace ten and eleven; we can keep the names. Is it beyond the power of artistic typography (I suggest an inverted 2 for ten; and an inverted 3 for eleven) to invent simple, distinctive, cursive and aesthetically satisfying symbols for these two integers?

The Hindus had to invent *all ten* of their symbols; and I could show many unsuspected situations in ordinary arithmetic where an alternative *ten*, at least, would have been valuable. On the Chinese and Japanese abacus there were and are *two* ways of expressing five, appropriate to different situations. For myself, I do my calculations with no great need for symbolic representation, but the above inversions of 2 and 3 served me well enough.

Certain duodecimal societies, as well as a good many idiosyncratic individuals, have advocated various symbols, quite commonly χ or X for ten, E or ε for eleven, and so on. This will not do: *letters of the alphabet must be kept for algebra, not arithmetic.* Let us think of the confusion in trying to write in such a way $X \times X$. So also for nomenclature.

For myself, I do not depend much on auditory impression for number, but thinking of the Scots "twal" I sometimes imagined "twel-one", "twel-two", and so on for thirteen, fourteen and the rest; but of course in dictation one would mention "asterisk" and call out, just as we do in decimal, "one one", "one two" and the like for *11, *12, etc. There should be no difficulty here.

Once again, duodecimalists should not prescribe too much for others in this matter; language and linguists should be able to find, as the French language does with never-failing felicity, euphonious and idiomatic equivalents for any new entity that may arise. For example Icelandic also, when faced with the necessity of finding words for radio, television and so on, merely drew on its own resources. Let the principle be once stated; we can weigh later the merits of different suggestions.

As for early education in the properties of numbers, it is evident that twelve is a far more interesting number than ten, and two sets of six or twelve coloured blocks, to be arranged in various ways by twos, threes, fours and so on, would show to the growing mind the mutual relations of small integers better than any of the usual devices based on ten, some of them in any case open to criticism. Above all, no dependence on fingers.

This will be enough of description for a first summary. A graduated set of simple exercises would lead anyone, even a child, easily into this realm thus simplified. But it will be asked: are the reasons for change sufficient, both qualitatively and quantitatively, to justify, so late in the history of the world, such a radical transformation of mental habit and customary practice? The replies are: First, it is very early in the history of the world. Second, that in our case at least the change is not radical; we do much of it already every day. Third, partly qualitative, that since the dozen, helped by its multiples and submultiples, is so extraordinarily superior to ten in all that concerns parcelling, packaging, arrangement, subdivision, to say nothing of a host of applications which could be cited from mathematics, the practical use of the dozen and its adjuncts should go hand in hand and step for step with the corresponding numerical use; and this implies the duodecimal system and no other.

Finally, the quantitative advantage. To begin with, the multiplication tables are simpler than the decimal ones; there are only 55 (duodecimally *47) essential products to be learned, exactly the same number as have to be learned in our school tables up to twelve times twelve---and observe that even there we had to go to the dozen. (Incidentally in duodecimal the square

of *11 is *121, of *12 is *144, with different numerical meaning, of course.) For multiples of 2, 3, 4, 6, 8, 9 and 10 we see in the last digits a simple and useful periodicity.

For example, the four times table: last digits 0, 4, 8, 0, 4, 8, 0, 4, 8, and so on; in the three times table: last digits 0, 3, 6, 9, 0, 3, 6, 9, and so on. Tests for divisibility: for divisibility by 2, 3, 4, 6, look at the last digit only; by 9, 16, 18, the last two; and so on.

Duodecimal fractions, as we indicated by a few examples earlier, are in the usual fundamental ones of low denominator *remarkably simpler* than decimal. Consider the table below:

Fraction	Decimal	Duodecimal
1/2	0.5	0:6
1/3	0.3333	0:4
1/4	0.25	0:3
1/5	0.2	0:2497
1/6	0.1666	0:2
1/8	0.125	0:16
1/12	0.0833	0:1
1/24	0.04166	0:06

Tables of successive halvings, as for example the table for conversion of sixty-fourths into decimals that hangs on the wall of many tool shops, shows comparisons such as the following, thus:

Fraction	Decimal	Duodecimal
25/64	0.390625	0:483
27/64	0.421875	0:509
29/64	0.453125	0:553
31/64	0.484375	0:599
33/64	0.515625	0:623

With only three digits, the duodecimal fractions are all exact. Comment is needless.

But the final quantitative advantage, in my own experience, is this: in varied and extensive calculations of an ordinary and not unduly complicated kind, carried out over many years, I come to the conclusion that the efficiency of the decimal system might be rated at about 65 or less, if we assign 100 to the duodecimal.

Others (but so far I have not heard of even one such investigator) might arrive at a slightly different estimate; but I am certain that in every case a marked superiority for the duodecimal system would be established.

If such a waste of time and effort (about 350 hours lost in every 1000) were found to be trickling away in any department of a modern production unit, a time-and-work study would be set up at once. Some altruist might even come in with a take-over bid. Is it to be doubted that such time, saved and turned to more productive ends, social or economic, would give an advantage much outweighing any advantage assumed to accrue now, at

this late stage of decision, in moving over to the decimal system; an assumption moreover implying, since the decision has taken about 150 years to make, that the new status of things would last for at least another 150 years.

Nothing stands still, not even arithmetic. That arbitrary division of time, the next millennium, is approaching, heralded as it has been somewhat prematurely from a distance of forty years; and no doubt a few thousands of superstitious decimalists will sit up on that eve to await the new dawning of heaven and earth.

In the interim there is bound to be incredible technological progress, enough possibly to give us some glimpse of "the uses of leisure".

Among these novelties the transition from a defective metric system of numeration to a new one, attainable by easy and gradual phase, will be viewed in remote retrospect as one of the most ordinary pieces of belated tidying-up that ever was delayed for so long past its due time.

It will be viewed, indeed, by the future historians of mathematics, as completing the work of Leonardo, in a direction which, with the added knowledge of 800 years, *he would have approved.*

−o−0−o−

"The New Day", 1932 lithograph by Ernest Barlach.

Heralding the Base-ten Metric System?

BASE-TEN---A DOUBLE PRIME

Egbert Pardiggle

If you will devote one moment of thinking to it, the reason you can divide base-ten by two or five is that you first multiplied your five fingers by two. Base-ten is really twice five, so of course the factors of base-ten must be 2 and 5.

One might quite as readily employ base-fourteen (divisible by two or seven), by first doubling the seven days in a week as we appear to have doubled the five fingers on a hand.

But what factors obtain in 5? Why, the same factors that exist in any prime number---the prime and unity alone.

If only the Romans (who definitely employed uncials and the septetquincunx *7;5*) had just counted up to a dozen (and down by Roman reciprocals), perhaps using I, II, III, IIII, IV, V, VI, VII, VIII, VIIII, IX, and X, what a boon to Roman civilization!

Or if the Arabs, so steeped (as are Americans today) in the use of dozenal packaging and counting, especially in transportation, had only taken the trouble to invent one new symbol for 9 plus 1 and another for 9 plus 2 regardless of what those two numerals might have been called, how much more efficient they might have made their own and the world of today. Was Omar Khayyam afraid he would lose his job with the Sultan and subtly kept at praising wine and women, and forever seeking the secret of life? The French Metric Commission were mathematicians of great ability but feared to disturb the revolutionary rabble by espousing revolutionary notation. It is not good to be unemployed---worse to lose your head.

If Newton had anticipated Andrews by counting to a dozen, using a script or capital X for nine-plus-one, and a script or capital E for nine-plus-two, other British mathematicians would have followed his path even as they grasped his theory of gravity. But great men are simple men and use such tools as they have in their hands---these tools must be created by a voice calling in the wilderness "Make straight the way! What was needed then was another John the Baptist. Coming at a later date, F. Emerson Andrews is apt to be so regarded among the upcoming generation of mathematicians in America.

Since 5 is no better than prime 1, it was a foreclosed decision that the computer people would avoid one, five or ten--- twice five---for the modern computer base, and move up one simple step to the binary. Two, being twice one, is not much better than ten (twice 5) but it is five times smaller, and therefore more precise in dividing 4, 6, 8, and sixteen.

Now when base-three (a prime number like 5, but smaller) has taken its place in computer fields and we shall have a surplus of base-two parts, perhaps someone will combine both of them to give the computer those factors of twelve known to us as two, three, four, six and twelve and the last protestor will perhaps be persuaded into base-twelve notation. Happy the man who will lead his own discipline into the new notation.

TELEPHONE AND SOCIAL SECURITY NUMBERS
Westbourn Grove

The United States and Canada, says a Bell Telephone Company Directory of telephone subscribers, are now divided into more than 120 areas, each with a three digit "Area Code." On an accompanying map Iowa, for example, was shown divided into three such areas; Manitoba (Canada) was constituted as one; California contained eight.

It is perhaps one of our greatest modern conveniences to be able to dial a friend 2000 or 3000 miles away and immediately hear the familiar voice, as clear as next door. The Area Code is not needed when the place you are calling has the same area code. This covers most daily telephone calls.

Double Our Population?

What can Bell do when the increase in new subscribers begins to exceed five million annually across the nation? To more than double today's total of telephone numbers in each of these 120 areas, still dialing only four digits plus the three exchange symbols, we might move peacefully---or be dragged screaming---- from base-ten to base-twelve arithmetic symbols. Our children are learning in the "New Arithmetic" about notations other than base-ten. Even for oldsters no reason to resist obtains. None need be injured or even slightly inconvenienced.

In the literature of The Duodecimal Society of America, and its founders, as used now and for more than thirty years past, their "dek" may be indicated in base-twelve arithmetic symbols by the familiar Roman numeral X found on some parlor and most American and European tower clock faces; and "el" by a printed or script capital E.

None of the dozen symbols in base-twelve is wholly unfamiliar to most people. You might easily recognize them as 0, 1, 2, 3, 4, 5, 6, 7, 8, 9, X, E. These may be described simply as zero, one, two, three, four, five, six, seven, eight, nine, dek, and el. Thus X6X is dialed or spoken as dek-six-dek, E is called el---and EE is called el-el. By the same custom 1E should be called one-el, and 11 is simply one-one (never eleven).

Today in America to reach a party in an area other than where you are calling, you might dial a number such as 1-712-322-7391 or one of similar make-up. Later, when the dozen becomes our common counting base in the United States and Canada (in addition to electronic computer operations), those same symbols described by their very same names *might remain as they are today dialed or spoken on the telephone!* In other words, we speak them today on the telephone as we would in a base-twelve notation tomorrow. So who is afraid of the dozen symbols! If we are to be driven by necessity to base-twelve symbols the change might be rather gentle so far as the man in the street is concerned. The girl on the telephone might notice no change whatever.

Social Security Unique Groupings

Not all large numbers must be divided into triple-digit parts or described by hundreds, thousands, millions. Perhaps they are easier to memorize when they are given unusual groupings. This suggestion is based on the retentive ability of the American army private in World War I to tell you his service number. For example, compare the 1917 service number 1,074,319 embedded in a soldier's memory not by millions and thousands just shown, but gathered in such unorthodox groupings as 10-74-319. Equally so with telephone numbers, social security numbers, and any other four-digit groupings today.

Social Security numbers in the United States, somewhat in the 1917 military manner plus one more digit here and there, contain nine symbols. At present composed of three groupings, the leftmost contains three digits, the second two digits only, and the third encompasses four digits, such as 478-48-9072. Nothing is said about millions or thousands here either, as each digit is individually spoken, fast becoming a universal habit.

Now thinking in terms both of telephone numbers and of Social Security symbols, contemplate this fact---in base-twelve the digits *10 000* (one zero, zero zero zero) represent a quantity more than twice as large in quantity as the base-ten same digit group of 10 000, which we now call ten thousand. That is to say, in our present system 20,736 units (individual telephone numbers) are contained in the base-twelve expression of *10 000* (one zero, zero zero zero). And 20,735 of them can be shown by use of only *four* digits!

Numbers are Symbols

In base-twelve (will you not read this sentence twice?) the four-digit telephone or Social Security number £6X8 (el, six, dek, eight) equals the exact quantity of 20,000 in our present base-ten number system. Thus, base-ten is here suggested to be fifty percent less efficient than base-twelve when it comes to listing, speaking, or dialing individual telephone numbers, or giving a Social Security number, the part shown in four digits.

All telephone and Social Security and automobile licensing plate numerals, in the manner of separate letters of the alphabet, are mentally no more than symbols if spoken individually, with no mention of tens, hundreds, thousands (or dozens, gross, or greatgross).

It would seem to be unnecessary for the user to know anything whatever about base-twelve arithmetic merely to list the names of or to dial the symbols themselves. Accordingly, a mechanical move to the use of base-twelve symbols might be made TODAY if only Bell's and Western Electric technicians had two new symbols and knew how to count in the ever growing popular base-twelve arithmetic. *And you'd better believe they do!*

With the installation of new mechanical equipment, it is just possible that you might tomorrow find yourself dialing in base-

twelve notation without knowing the other six-twelfths about
it or about how you got into it. And any other symbols for dek
and el are just as practicable as those we now use.

Other Uses

We might remark that motor vehicle license plate numbers will
cover twice the number in base-twelve that are now shown in the
same space by base-ten notation, in each four-digit grouping.
And no person would be required to learn twelve-base arithmetic
as a condition for the change. By reason of the current use of
the alphabetic numerals X and E on license plates by many of
the state licensing departments, people in the U.S.A. are al-
ready conditioned for the advance to base-twelve.

Below is shown a rough conception of what a TRIMLINE[R] tele-
phone might look like, employing base-twelve notation. Without
doubt a period of advertising and training might be required to
educate people not to call dek "ten" or el "eleven". A great
many persons, from long training, would be inclined to write
down one-one if you so much as mention "eleven". And then dial
one-one when they more correctly should dial el or ℰ to reach
the party they are calling. Perhaps the new symbols should be
named "not-ten" and "not-eleven", to provide us with a helpful
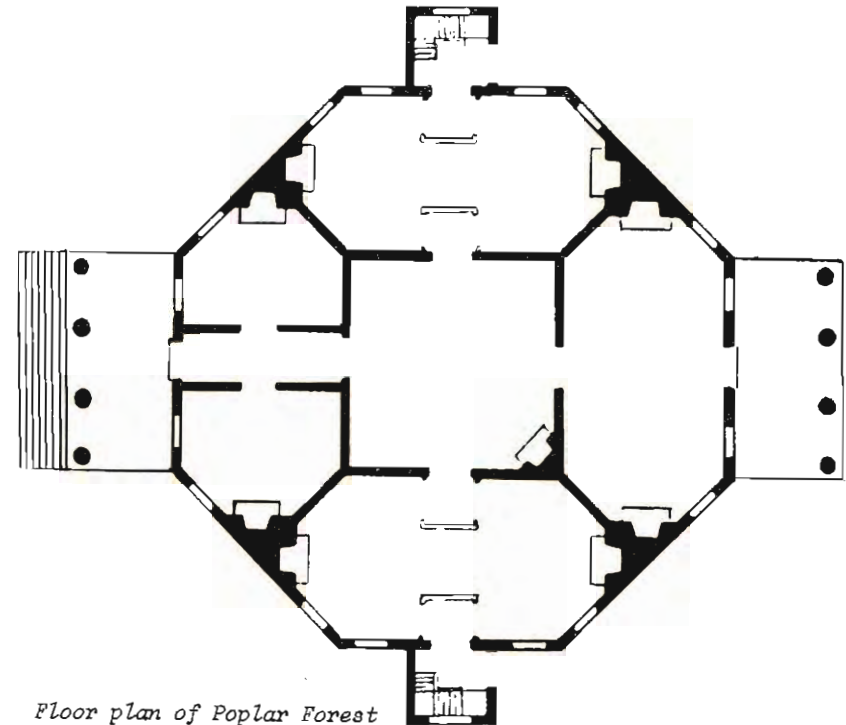"no-no".
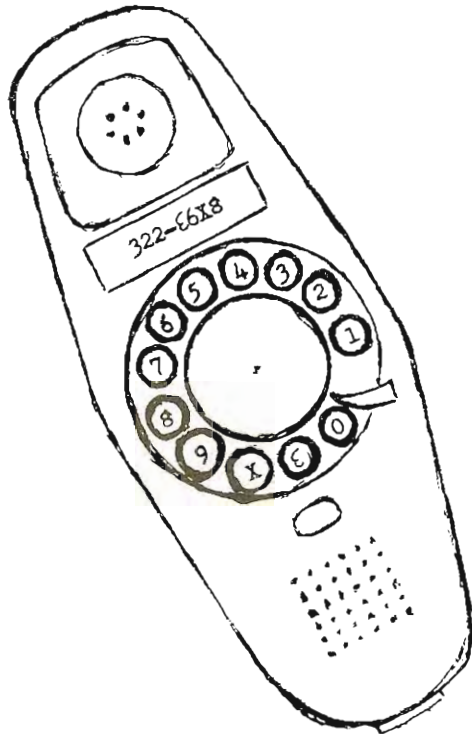
POPLAR FOREST

The most distinctive of Jefferson's four dozen octagonal rev-
eries took the form of a "retreat" to which he escaped from his
guests who sometimes overran Monticello. It was set up at Pop-
lar Forest, a farm of some 7.23 Sections owned by him at Lynch-
burg, perhaps 60 to 70 miles southwest of Charlottesville.

The eight outside walls were each half a duodecimal decameter
(twenty-two feet) in length. The center room was square, some
twenty feet from wall to wall, the elongated octagonal outer
rooms being 14 feet wide and perhaps 28 feet from fireplace to
opposite fireplace. The proportions were beautiful, expansive;
and all outside rooms enjoyed sunshine at some part of the day.
The center room with cross ventilation combined perhaps with an
extra high ceiling, suited the climate. See Floor Plan below.

All doorways, inner and outer, were designed for comfortable,
44-inch wide (one dometron) doors. Its final design was com-
pleted in 1806, and by 1809 "he was able to stay in the house,
although it was not painted until 1817." The great achievement
of Jefferson's architectural career was at Charlottesville, in
designing buildings for the University of Virginia, of which he
was Rector at the time of his death in 1826.

                                                        H.C.C.

Floor plan of Poplar Forest