The Duodecimal Bulletin

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THE DUODECIMAL SOCIETY OF AMERICA

20 Carlton Place ~ ~ ~ ~ ~ Staten Island 4, N. Y.

THE DUODECIMAL SOCIETY OF AMERICA

is a voluntary nonprofit organization for the conduct of research 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.

Full membership with voting privileges requires the passing of elementary tests in the performance of twelve-base arithmetic. The lessons and examinations are free to those whose entrance applications are accepted. Remittance of $6, covering initiation fee ($3) and one year's dues ($3), must accompany applications.

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The Duodecimal Bulletin

AN IMPORTANT REPRINT

The following is a reprint of the introduction of an unsigned article on, "The Base of the Decimal Metric System," appearing in the Edinburgh Review, Vol. IX, p. 376, 1807.

It is remarkable that some of the clearest of our ideas are incapable of being accurately expressed by means of language, or of any arbitrary symbols whatsoever. This happens with respect to certain ideas of quantity, while, with respect to others not more clear or definite, the contrary takes place. Of the magnitude of a line, for instance, no precise notion can be conveyed in words from one man to another except by comparing it with a line already known to them both; and if such a standard of comparison is wanting, the ordinary means of information fail entirely and there is no recourse but in the actual exhibition of the line itself.

It is quite otherwise where either the ratio or the angular position of magnitudes are concerned; these can be fully explained by verbal communication and never require the production of the articles themselves. We know what a Greek geometer meant by a right angle, or by an angle of one degree, just as well as if we had before our eyes a circle divided by some artist of Athens or Alexandria. We understand, too, what he means when he speaks of the ratio of two to one, or of the ratio of the diagonal of a square to its side; but if he specifies some individual length, of a foot for example, a spithame, or a stadium, we comprehend nothing of the matter unless he has made a reference to some common standard, that is, to some magnitude which remains the same now as when he wrote.

So also, when Eratosthenes tells us that the distance between Alexandria and Syene subtends, at the earth's centre, an angle which is the fiftieth part of four right angles, we are at no loss to comprehend what is meant; but when he says that the distance between the two places is 5000 stadia, we receive no accurate information, and much critical discussion has been required to extract even a very uncertain meaning from his words.

This imperfection of language is founded in the nature of things, and it is impossible to be removed. The inconveniences arising from it have been felt not only by the learned and scientific, but by all who have been concerned about measuring,

weighing, or computing, even in the most imperfect state of the arts. In the measures of every country we may perceive attempts to obviate the difficulties which have been just mentioned, and must feel some interest in remarking the expedients adopted for that purpose by rude and unenlightened men.

The foot, which we recognize among the measures of almost all nations, was taken from the standard of the human foot, and varies, accordingly, within limits of no very considerable extent. Other standards, supposed more precise, were sometimes had recourse to. Among agricultural nations, the inch has been determined by the length of three barley corns; and to the equestrian tribes of Arabia, the breadth of a certain number of hairs from a horse's tail afforded a standard of the same kind. In weights, a drop of water appears to have been regarded as a unit, according to some methods of reckoning; and, according to others, a grain of wheat stood for the weight which still takes its name from that origin.

Some authors would have us believe that the ancients, in their attempts to form a standard measure, had proceeded very far beyond these rude essays. Paucton, in his "Metrologie," will have it, that the circumference, or the diameter, of the earth was the standard to which they referred in their measures of length. Bailly has supported the same opinion, with the ingenuity and learning displayed in all his speculations; and he endeavors to prove that the stadium was always taken for an aliquot part of the earth's circumference, that part being different with different nations, and with different authors. No ingenuity, however, can render this supposition probable.

The ancients had no means of determining, with any tolerable precision, the magnitude of that great unit to which their measures are supposed to refer. Besides, if such a reference had been intended, it could not surely have been unknown to themselves; yet we are well assured that neither Aristotle, nor Possidonius, nor Pliny, nor any other ancient author who leys down the dimension of the globe, conceived that the difference between him and other writers was only apparent, or that he agreed with them about the magnitude of the earth, and differed only about the length of the measure in which he chose that his dimensions should be expressed.

The first attempt at fixing such a standard of measure as should be accurate and universal, both as to place and time, is due to the inventive genius of the celebrated Huygens. That philosopher demonstrated that the times of vibration of pendulums depend on their length only; and, whatsoever be their structure, that a certain point may be found which, in pendulums that vibrate in the same time, is constantly at the same distance from the centre of suspension. Hence he conceived that the pendulum might afford a standard, or unit, for measures of length; and, though a correction would be necessary because the intensity of gravitation was not the same in all latitudes, he believed that

science furnished means of determining this correction with sufficient accuracy.

Picard laid hold of the same notion, and Cassini, in his book "De la Grandeur de la Terre," proposed another unit, taken also from nature, though not so easily obtained, viz., the six-thousandth part of a minute of a degree of a great circle of the earth. A similar idea had even earlier occurred to Mouton. No attempt, however, was made to raise upon any of these standards a regular system of measures adapted either to the purposes of science or of ordinary life. Among the measures and weights that actually prevailed throughout Europe, the utmost confusion and perplexity continued to take place. In each sort of measure, units of different magnitude were admitted. These were inaccurately divided and variously reckoned, to the disgrace of the economical arrangements of every country where they were found. The inconveniences which arose from thence were generally felt, and complained of. Remedies were everywhere proposed, but no serious attempt was made to apply them.

France was, in these respects, in the same condition with other nations. A system, however, that had nothing to support it but the authority of past time and the inactivity of the present, was not likely to maintain itself long against the spirit of reform which became so general in that country at the commencement of the Revolution. This system too, besides the other objections to it, had the misfortune to appear connected with all the abominations of the feudal times. The abolition of it, therefore, was resolved on. And it would have been happy for France and for Europe, if everything which was then destroyed had been replaced by as solid and useful a structure as that which we are going to describe.

In the reformation proposed, two principal objects were kept in view. The first was the establishment of a natural standard for the measures of linear extension, and of course for the measures of all other quantities. The second was, to render the computation of those measures subject to the same arithmetical system that it used in other calculations. For this purpose, the unit of measure was to be divided decimally in order to constitute the other measures which it might be necessary to employ. No fractions but decimal were to be used in expressing quantities of any sort; and the great improvement of having but one arithmetical scale for reckoning integers and fractions of every kind, was in this way to be introduced, - an improvement so obvious, and withal so little difficult, that it is a matter of surprise that it should not have been attempted till nearly a thousand years after decimal arithmetic itself was first introduced into Europe.

In treating of this reform, however, we cannot help remarking that the French Academicians, though freed at the moment we now speak of, like the rest of their countrymen, from the dominion of that INERTIA which reigns so powerfully both in the natural

and in the moral world, and gives the time that is past such influence over that which is to come, - though delivered from the action of this force in a degree that was perhaps never before exemplified, they may be accused, at least in one instance, of having innovated too little, and of having been too cautious about departing from an established practice, though reason was by no means on its side. What we allude to is the system of arithmetical computation, in which they resolved to adhere to the decimal scale instead of adopting the duodecimal which, from the nature of number, is so evidently preferable.

This preference, we believe, is generally admitted in theory; and there can be no doubt that a rational being, conversant with the nature of number, if called on to choose his own arithmetical system, and having no bias from custom, prejudice, or authority, would not hesitate a moment about adopting the duodecimal system in preference to the decimal, and, as we think, in preference to all other systems whatsoever. The property of the number twelve which recommends it so strongly for the purpose we are now considering, is its divisibility into so many more aliquot parts than ten, or any other number that is not greater than itself. Twelve is divisible by 2, 3, 4, and by 6; and this circumstance fits it so well for the purposes of arithmetical computation that it has been resorted to, in all times, as the most convenient number into which any unit either of weight or of measure could be divided.

The divisions of the As, the Libra, the Jugerum, the Foot, are all proofs of what is here asserted; and this advantage, which was perceived in rude and early times, would have been found of great value in the most improved state of mathematical science. Ten has indeed no advantage as the radix of numerical computation, and has been raised to the dignity which it now holds merely by the circumstance of its expressing the number of a man's fingers. They who regard science as the creature of pure reason, must feel somewhat indignant that a consideration so foreign and mechanical should have determined the form and order of the most intellectual and abstract of all the sciences.

The duodecimal scale would nowhere have been found of greater use than when applied to the circle, the case in which the decimal division is liable to the strongest objections. The number by which the circumference of the circle is expressed, ought not only to be divisible into four integer parts, (as in the French system,) but also into six; for the sixth part of the circumference, having its chord equal to the radius, naturally calls, in the construction of instruments and in the computations of trigonometry, to be expressed by an integer number. According to the decimal division of the quadrant, the sixth part of the circumference not only is without an integer expression, but the decimal fraction by which it is measured is one that runs on continually without any termination. This is at least a deformity that arises from the rigid adherence to the decimal division; and it is probably the main cause why that division has

been found so difficult to introduce into trigonometrical and astronomical calculation. In astronomical tables, we believe, it has never been adopted.

The adopting of twelve for the radix of the arithmetical scale would have obviated all these difficulties; it could have been extended with equal ease to quantities of every kind; and the introduction of it would not have been accompanied with any present inconvenience of such magnitude as should have deterred geometers from making the attempt. We have lately seen a manuscript containing the system of duodecimal arithmetic pursued into all its detail. Two new names are necessary for the numbers eleven and twelve; and the whole arithmetical language for the numbers above ten is consequently changed, but in a manner so analogical as to remove all difficulty, whether in the contrivance or in the acquisition of this new vocabulary. The arithmetical characters must also undergo an entire change; the first eleven letters of the Greek alphabet are adopted in the scheme to which we refer; and by means of them, and the cypher, which is still retained, the notation proceeds by rules that are easy and well known.

We regret, therefore, that the experiment of this new arithmetic was not attempted. Another opportunity for trying it is not likely to occur soon. In the ordinary course of human affairs, such improvements are not thought of; and the moment may never again present itself, when the wisdom or delirium of a nation shall come up to the level of this species of reform.

ATTENTION, PLEASE!

UNITED NATIONS SPEAKING

The formation of the United Nations Standards Coordinating Committee has been publicly announced, as follows:-

> The Executive Committee of the United Nations Standards Coordinating Committee, after an extensive survey of present conditions in the field of international standards and the rapidly changing events on the international scene, has come to the conclusion that the time is now ripe for setting up a permanent standards organization. The Executive Committee consists of the British Standards Institution, the Canadian Standards Association, and the American Standards Association.
>
> Invitations to attend the meeting have been sent out to the national standardizing bodies comprising the United Nations Standards Coordinating Committee. These are:-

The American Standards Association
The Standards Association of Australia
Associacao Brasileira de Normas Tecnicas
The British Standards Institution
The Canadian Standards Association
The Chinese Standards Committee
L'Association Francaise de Normalisation
The New Zealand Standards Institute
The South African Standards Institution

It is enticipated that representatives from practically all the countries will attend.

A full program of the detailed discussions to be undertaken at the meeting will be announced at an early date. In a general way, however, it can be said that the meeting will concern itself with the immediate problem of establishing the closest practical relations between the national standardizing bodies of the countries of the world; with the providing of a forum through which these bodies can harmonize their activities internationally; and finally the meeting will deal with the major problem of integrating national standards and harmonizing them for the benefit of the total economy of the world.

This announcement is of prime importance to all who are interested in duodecimals. We can expect, from the strong current recrudescence of the pro-metric propaganda, that representations will be made to the UNSCC for the adoption of the French Metric System as the world's official standard. A step was taken in this direction in 1894 with the international adoption of the centimeter-gram-second system of absolute units for scientific use.

We can, however, equally expect that the strong American and English representation on the UNSCC, and on its Executive Committee, will be prepared to resist this pressure, and that permissive use of the Anglo-American and the French standards will result.

But the publication of this announcement emphasizes the necessity of expediting our agreement upon a duodecimal metric system so that our proposal may be filed with the National Bureau of Standards and the American Standards Association, and the steps toward securing legislation for permissive use of the duodecimal standards may be inaugurated.

Each One Teach One

ABOUT DECIMAL-FORM FRACTIONS

by F. Emerson Andrews

Attempts to explain counting by dozens to the layman, and sometimes even to the mathematically trained who should know better, usually encounter the argument, "Oh, but we have to count by tens or we couldn't have decimals."

This is of course true if by 'decimal' we mean the entire system of counting by tens. But these people really think, or are perhaps convinced without thinking, that the convenient decimal-form fraction is the special prerogative of 10-system counting.

Fortunately, it is easy to demonstrate that decimal-form fractions are available in any number system which employs a zero and place-value. To the base XII, .3 is quite as accurate an expression for one-quarter as the conventional .25 , and more compact. To the base III, .01 is the accurate expression for one-ninth, for which base XII requires .14 and base X finds no exact statement.

All of us who have experimented with counting by dozens are aware of these relationships. It may, however, be worth while to examine the decimal-form fractions developed for the low fractions (for example, one-half to one-twelfth) by each of the radixes from II through XII. An objective comparison of the results furnishes useful information on the relative efficiency of the various bases in expressing common fractional quantities, and helps us to express some of the common rules governing decimal-form fractions to any base.

Decimal-Form Fractions to Various Bases

Base	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
1/2	.1	.1111̄	.2	.222222	.3	.333333	.4	.444444	.5	.555555	.6
1/3	.01(01)	.1	.1111̄	.131313	.2	.222222	.252525	.3	.333333	.373737	.4
1/4	.01	.020202	.1	.111111	.13	.151515	.2	.222222	.25	.282828	.3
1/5	.001100	.012101	.030303	.1	.1111̄1̄	.125412	.146314	.171717	.2	.222222	.249724
1/6	.001(01)	.01111	.022222	.040404	.1	.1111̄1̄	.125252	.144444	.166663	.191919	.2
1/7	.001(001)	.010212	.021021	.032412	.050505	.1	.1111̄1̄	.125125	.142857	.163163	.186X35
1/8	.001	.010(10)	.02	.030303	.043	.060606	.1	.111111	.125	.141414	.16
1/9	.000(111)	.01	.013013	.02342[1]	.04	.053053	.070707	.1	.1111̄1̄	.[1]24986	.14
1/A	.000(110)	.002200	.012121	.022222	.033333	.046204	.063140	.080808	.1	.111111	.124972
1/B	.000(101)	.002110	.011310	.021140	.031345	.043116	.056427	.073240	.090909	.1	.111111
	.1101				.242[1]	.2355	.2135				
1/C	.000(100)	.002020	.01111	.020202	.03	.040404	.052525	.066666	.083333	.0X0X0X	.1

Note 1. In this table single endlessly repeating decimals are indicated by a bar. Longer repetends are the numerals enclosed between two bars. Unclosed decimals are expressed to six points except in several cases under 1/C, where the complete repetend requires ten places.

Here are some of the relations between 'decimal' and radix which are obvious from this table, but less quickly observed in working with a single decimal system:

1. In any decimal-form system, a fraction can always be expressed as a whole 'decimal' if all the prime factors of its denominator are included among the prime factors of the number base.

Examples: One-half "comes out even" in all number systems with an even base, and is a repeating 'decimal' in all others. One-third can be evenly expressed as a 'decimal' only to bases 3, 6, 9, 12, . . . Conversely, because VI and XII contain the two lowest factors, 2 and 3, they express exactly more fractions in this table than any other number bases; indeed, they are not surpassed in this respect by any number base lower than XXX, which is far too large for convenient manipulation.

2. The number of figures in a 'decimal' which comes out even is determined by the highest power to which a factor of the number base must be raised to include all the factors of the denominator of the fraction.

Examples: One-ninth (3·3) contains no factor which is not available in the base XII (2·2·3), but requires the square of one of these factors. To the base XII it is therefore a two-place 'decimal' .14 . One-eighth is a three place 'decimal' to base II, runs to two places to base IV, and is expressed in one place to base VIII.

3. A fraction whose denominator includes a prime factor not found in the number base, cannot be expressed evenly to that base in 'decimal' form. It will always resolve into an endlessly-repeating 'decimal'.

A glance at the table demonstrates this rule. It often happens that this repetend runs just one place shorter than the denominator-numeral. That is, one-seventh has a six-place repetend to bases III, V, X, and XII. When this is the case, the repetend is a perfect circulatory number. Even when this is not the case, the repetend will be found to be a sub-multiple of one-less-than the denominator factor which is prime to the number base. This sub-multiple will have limited circulatory characteristics.

A circulatory (or revolving) number is one like 142857 (see one-seventh to the base X) which can be multiplied by any number from one through six and will reproduce the same digits and in the same general order, but beginning at a different digit. Possibly the easiest way to discover such numbers is to express as a 'decimal' any fractions whose denominators are prime to the number base.

Some members of this Society have been exploring these circulatory numbers. They have been important in the history of number theory, and they may furnish some clues in the study of primitive roots. It is possible that in them, particularly if they are explored in more than one number system for purposes of comparison, some of the ultimate secrets of Number may be discovered.

THE OPPOSED PRINCIPLES

An Editorial

Members of the Duodecimal Society are somewhat accustomed to the mention of the Principle of Least Change, and the Principle of Separate Identity. But comment from the members seems to show that a clearer exposition of these principles would be appreciated.

Since it is important that these principles, and the divergence which they represent, be thoroughly understood so that they may be advantageously applied, an attempt will be made to bring these principles into better definition.

Duodecimal proposals divide themselves, readily, into two groups. These groups are named for the principle which typifies each.

Classification under the Principle of Least Change

Most duodecimal proposals are conceived with the fundamental purpose of making that specific proposal most acceptable to the mind of the general public. They are quite easily characterized as embodying the Principle of Least Change.

They usually contemplate no change in the names and the symbols for the first nine numbers, and sometimes propose to retain the customary names for ten and eleven when used duodecimally.

They exhibit a similar approach to the duodecimal weights and measures. The sizes and names of the accepted Anglo-American standards are retained as faithfully as possible, and these are adjusted by minor changes into a duodecimally unified metric system.

Classification under the Principle of Separate Identity

The outstanding characteristic of duodecimal proposals that fall within this group, is that they are designed to prevent any possible confusion with decimal quantities or measures. They generally propose entirely new symbols for all numbers and new names for these numbers.

Since they already embrace the necessity for complete change, they afford the opportunity for the suggestion of every novel practice and method that may seem to improve our current procedures. New practices in grouping, denominating, and punctuating numbers are typical.

There is a corresponding revisionary attitude as to the weights and measures. These are generally to be based upon some specific method of determining a new unit of length, and around this unit is erected a conformal duodecimal metric system.

Traits typical of this group, then, are the general disregard of customary methods and practices, and the proposal of radical and novel procedures in numeration, notation, nomenclature and metrology.

Rationale

These classifications seem simple and clear. But confusion will continue unless it is comprehended that this separation means more than at first appears. There is a fundamental difference in ideologies involved.

As one becomes more familiar with duodecimals, and duodecimal proposals, one begins to perceive that there are supporting factors for both groups. One begins to see that in some applications there would be greater advantage in the one type of system than in the other. And that under other conditions, the reverse would be true, and that what had been considered essential had become secondary.

As an analogy, the general public makes little use of the Kelvin Temperature Scale which is based on Absolute Zero, but prefers a scale emphasizing the freezing and boiling points of water. For some scientists, however, there are advantages in the use of the Kelvin Scale which make it indispensable.

It must be realized that it is from the proposals under the Principle of Separate Identity that the innovations and inventions are developed which constitute progress. And these new ideas are valuable. But to the general public, the idea of changing all the names and symbols for numbers would be simply repulsive, and entirely unthinkable, and proposals involving as little change as possible are required.

So both systems are necessary. It should be the responsibility of the Society to develop both. And when a practical degree of unanimity is expressed in a proposal under either of the two principles, that proposal should be endorsed by the Society. It must be clear that such endorsement does not mean acceptance of the one principle and the suppression of the other. Nor does it imply the necessity of blending both principles into a single solution. Both are necessary. Both are important. But they are opposed, and relatively unblendable.

Different necessities, different viewpoints, different logics, are inherent in each. We will only create confusion and useless dissension if we apply to some proposal under the Principle of Least Change the arguments and critiques that are entirely proper to the Principle of Separate Identity. And the reverse. This just won't work. Since opposed lines of thought are involved, there must be a corresponding change of attitude as we consider the one or the other.

Since each of these groups has its own definite factors of preference, it would be well to avail ourselves of these advantages intelligently, - to analyze each new proposal from the viewpoint specifically proper to it, - and to aid in the development of a concensus as to each, by making our judgments known.

Recently there has been a considerable amount of discussion of the duodecimal terms and symbols used by the Society. Perhaps it would be well to set forth the Society's attitude in the matter.

When formal organization of the Society was undertaken, it was decided that we would continue to use the Dek (↊), El (↋), and Do, which, over a period of some eight or nine years, had become accepted as the usage of the informal society.

All of the Society's duodecimal material, currently in the hands of the public, employs this usage. Moreover, there is a solid basis for its preference. The symbol "X" for ten, was used exclusively throughout western civilization from early Roman days until the last years of the 13th Century. And all European names for ten are derived from the Latin "decem," pronounced "dekem."

A review of all duodecimal proposals has shown that there is a preponderance of preference for these terms, Dek and El, over any other names and symbols. No other terms which have been considered can marshall an equal weight of argument. Since confusion of the public mind is to be avoided if duodecimals, and the Society, are to make solid progress, this usage is not to be lightly changed.

When the weight of preference shifts to some other usage, and we can be confident of unanimity and finality in that choice, then the change should be made through official action of the Society. This possibility is not to be neglected. For this reason, there will be unbiased presentation of all such proposals, and the adoption of an accepted usage by the Society does not in the least preclude consideration of any and every proposal under the Principle of Least Change.

For our personal use, of course, we shall employ those terms and symbols preferable to each of us. When any of our papers are selected for publication it will be easy to substitute the accepted usage.

CONSOVOCALIC

by Lewis Carl Seelbach, C.P.A.

Mr. Kingsland Camp's paper on a duodecimal nomenclature based on digit-pairs, has suggested to me that there would be some advantage in a nomenclature which would designate the places, or orders, of the figures used.

To give the system a name, I have dubbed it Consovocalic, though this name might, with equal appositeness, apply to Mr. Camp's synthesis, and indeed might be used as a generic term for any such system, with a Sino-polynesi-hawaiian complexion.

As far as I have developed the Consovocalic idea, it provides a system of nomenclature for numbers up to five integral places and five places of fractions. It has not been developed in sufficient amplitude to express astronomical distances, much less war-costs. There are several ways in which it could be extended to afford unlimited numerical expression, so that this factor need not obstruct presentation of the basic idea.

Consovocalic has an x-axis ten vowels wide, and a y-axis twelve consonants high, - to use an analytic analogy. The vowels are keyed to the places or orders, and the consonants are keyed to the digits. In fully stated numbers, consonants and vowels alternate, but final vowels, and some of the intermediate ones, may be omitted provided that no ambiguity results. The consonants are uncial coefficients of powers of twelve, positive and negative, and therefore precede the vowels. Provision is made for pronouncing zeros when necessary or desirable. But these may generally be omitted.

Consonants are Assigned to the Digits

Numerals	Assigned Consonants	Mnemonics
0	Z and S	ZeroS. Z and S are cognate letters.
1	T and D	Each is made with one upright.
2	N	Made with two uprights.
3	M	Three uprights.
4	R	FouRth letteR in woRd fouR.
5	V and F	V is Roman for FiVe, and is cognate of F.
6	Sh	SIX pence, half-SHilling.

Numerals	Assigned Consonants	Mnemonics
7	J and Y	(Consonantal Y.) Seventh heaven JoYs.
8	hard G	8 and g made with two loops. Eight Gate.
9	P and B	Nine Pin Bowling.
X	K and Q	DeK Quite Kognate.
£	L	ELeven ELves.

Vowels are Assigned to Places, or Orders

Vowels	Assigned Places	Mnemonics
U	Units	Units.
O	Do and Edo	DOzens.
I	Gro and Egro	Grow hIgh.
E	Mo and Emo	MonEy.
A	Do-mo and Edo-mo	Ademo and Edomo.

The vowels are pronounced approximately as in 'Pa let mi go tu,' (Pa, let me go too,) or in 'Alles in Ordnung.' There will inevitably be some ablaution, influenced by adjacent consonants.

From the higher to the lower integral places, the key vowels are assigned in natural alphabetical order, A, E, I, O, U, and in reverse order, O, I, E, A, as assigned to fractionals. The vowel U cannot appear in fractionals because it represents units, and any notation after U must be fractional. The recurrence of any vowel in a number indicates a mixed number, and the repeated vowel is in the fractional part of the quantity.

I have coined the word AYF to express the separatrix, a vocalization of the initials I and F, for Integer and Fraction; and use the semicolon, instead of the point, to represent it. In speaking a mixed number, it will generally add clarity to use the word ayf to express the separatrix, but the reversed order of the vowels is sufficient to indicate the appended fraction.

An expression using one or two digits, and only one vowel, is to be presumed to be integral, and the indicated digits occupy consecutive places; thus 'dit' means *11O*, and not *;O11* . In fractionals, a final consonant after the vowel A, will apply to the egro-mo place; thus 'ayf sad', or 'ayf ad' , would represent the quantity *;000,01* .

Exemplifications

Units:	Zu or Su	0	Ru	4	Gu	8		
	Tu or Du	1	Fu	5	Bu	9		
	Nu	2	Shu	6	Ku	ᘔ		
	Mu	3	Ju or Yu	7	Lu	ᘓ		
Dozens:	Do	10	Doru	14	Nomu	23	Joju	77
	Dotu	11	Dofu	15	Nobu	29	Bodu	91
	Donu	12	Doku	1ᘔ	Mofu	35	Konu	ᘔ2
	Domu	13	Dolu	1ᘓ	Roju	47	Loshu	ᘓ8
Larger Numbers:	Tizotu, or Titu		101	Te		1,000		
	Nisomu, or Nimu		203	Re		40,000		
	Midofu		315	Fajidu		50,701		
	Bijolu		972	Tatu		10,001		
Fractions and Mixed Numbers	Ayf mo, or Sumo, or Sum		0;3					
	Ayf go, or Zug		0;8					
	Sul		0;ᘔ					
	Togo		10;8					
	Psluka		90,00ᘔ;000,ᘔ					
	Terilogad		1,ᘔᘓ0;000,91					

Flexibility in articulating digits is achieved by using either one of the assigned correlative consonants for any particular numeral. One or the other will blend better with the adjoining vowels. The ear and the tongue are safe guides, and there will be no ambiguity with either letter.

The words may be built to express digit pairs or trines, and conventionalized groupings and accents will facilitate rapid comprehension of the quantities expressed. Thus a three digit number would have a quick first syllable, an accented second syllable with long O, and a lowered voice on the U of the final syllable. Any A and E orders preceding , would be pronounced spondee style.

Consovocalic is not a new system of notation, but applies to nomenclature only. It is pasilalic, not pasigraphic. Part of the mnemonics used in this correlation is over a hundred years old, and may be studied by ordering a copy of Lefax Data Sheet No. 10-255, on Memory Training, by James Underhill, Jr.,Ph.D., from Lefax Co., Philadelphia. Cost 25 cents.

Systems of Weights and Measures
by Walter Renton Ingalls, B.S., D.Eng.

Dr. Ingalls' recent monograph is a revision of his earlier work, "Modern Weights and Measures," and is a valuable contribution to the literature on the metric question.

Dr. Ingalls is President of the American Institute of Weights and Measures, a membership organization whose rolls include representation from most of America's major manufacturing companies and whose concern with maintaining the established standards may be gaged by the gigantic total of the investment of these constituent concerns in machine tools and product designs.

The Institute takes no position in opposition to the French metric system, believing that industry should be free to apply the standards best suited to a particular operation. But the Institute does oppose the growing pressure for official adoption and compulsory use of the metric standards, which seeks to make the use of the English and American standards illegal.

In this respect the attitude of the Duodecimal Society parallels that of the Institute. The Society is naturally opposed to official adoption and compulsory use of the metric system since it believes that the duodecimal weights and measures offer the American public and world industry in general the possibility of a far superior metric system which would involve relatively negligible costs in the conversion from the present asymmetry.

Dr. Ingalls' analysis of the virtues and faults of the French metric system, and of the English and American unsystemized standards, is searching and dispassionate. He builds an argument of logical strength for the development of systems of standards through the evolution of the most desirable form in free competition. His material is of absorbing interest, and its clear presentation makes this monograph of vital importance.

DUODECIMAL BIBLIOGRAPHY

Because of the unusual nature of the subject, duodecimal material has presented a difficult problem for the librarian, as to the proper listings to be used. We are suggesting the following headings, and reference listings, as a guide in such matters.

Suggested headings and reference listings

Arithmetic, also see Duodecimal
Base, also see Duodecimal
Decimal, also see Duodecimal
Denary. also see Duodecimal
Dozen System, also see Duodecimal
Duodecimal Arithmetic
Duodecimal Nomenclature
Duodecimal Notation
Duodecimal Numeration
Duodecimal Tables
Duodecimal System
Duodecimal Weights and Measures
Duodenary, see Duodecimal
Mathematical Tables, also see Duodecimal
Metric, also see Duodecimal

Suggested headings and reference listings (continued)

Metrology, also see Duodecimal
Nomenclature, also see Duodecimal
Notation, also see Duodecimal
Number, also see Duodecimal
Numeration, also see Duodecimal
Standards, also see Duodecimal
System, also see Duodecimal
Tables, also see Duodecimal
Theory of Numbers, also see Duodecimal
Twelve, also see Duodecimal
Twelve System, also see Duodecimal
Weights and Measures, also see Duodecimal

With these listings and references, the public will have little difficulty in locating the duodecimal material that is available, and any material to be listed will be readily classifiable.

Since there have been many recent additions to our records of duodecimal bibliography, we publish the list as it now stands. Supplemental lists will be published from time to time.

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GROWING TEACHER INTEREST

That the general public is becoming more aware of the advantages of duodecimals and of the work of our Society is reflected in our increasing publicity. An indication of this trend that is of especial value is the growing interest shown by teachers and educational groups.

The Duodecimal Bulletin for June, through embarrassing inadvertence, failed to mention that our President Andrews was the guest-speaker at a special dinner-meeting of the mathematics section of the New York Society for the Experimental Study of Education. This meeting was held at the Men's Faculty Club of Columbia University on the 24th of February. Thirty or more teachers, both college and secondary level, were present.

Professor Charles D. Wildrick opened the meeting with some pleasantries about the advantages of the duodecimal count in

making us all seem younger, and as a painless way to reduce a 250-pounder to a comfortable *18%*. Mr. Andrews then had the floor for an hour's lecture on the duodecimal arithmetic, its origins, its advantages, and the development of the Duodecimal Society of America.

A discussion period followed, and it was noteworthy that the superiority of the duodecimal arithmetic over the ten base was conceded by every teacher who expressed an opinion. Great interest was shown in the use of the second base in present-day classrooms as a means of getting pupils to understand the basic meanings of the fundamental mathematical operations. Descriptive announcements of the Society were distributed to all those present.

As a further indication of growing interest, the talks of Dr. Nathan Lazar of Teachers College, Columbia University, deserve comment. In addition to his classroom lectures on the History of Mathematics, Dr. Lazar delivers many addresses in and around the New York metropolitan area under the auspices of the Friends of Scripta Mathematica. It is evident from the many requests that we receive for our literature from his audiences, that Dr. Lazar lays adequate emphasis on the development of duodecimals, and the function of the Duodecimal Society. Our thanks to Dr. Lazar. Thanks too, to Scripta Mathematica for the many kindnesses it has extended to us.

DOSENILE DEPARTMENT

Mary Lloyd, Editor

Well, folks, the answers to the puzzles in the last issue were 'Lycanthropes', and 'The Vain World', . . as if you didn't know. Maybe you are one of those who get a bang out of puzzles, but have never tried a diviso-crypt. If you are, don't try. The procedure is simple enough, but habit forming.

Rule off vertical columns on a piece of scratch paper for the do numbers, and horizontal lines for the do letters used. Or, better still, use a piece of quadrille ruled paper. Then, working by a process of elimination, using product possibilities, greater-than and less-than relationships, letter repetitions in multiplications, sequences through subtractions, and pure intuition, the letters will finally fall into their assigned one-two-three order, and spell out a word (if I can think of one,) or a phrase.

No, don't tear up the paper yet; think of all the trouble you took to find a straight-edge! Generally, the zero can be identified by inspection (as T - T = S.) So the S is written in, and the other S and Zero columns are blocked out. Simple, isn't it? But if the S turns out to be £, and not nothing nohow, I

wish to be absolved from all further responsibility. The next easy step is to determine which letters cannot represent *1*. And so on. Here are a couple of puzzles to try this out on.

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          E Y M
V I C ) V V M N E E
        V V N S
          S C E
          A C S
          V N I E
            E M R
              T O
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            A R L
U N S ) A F N U W E
      M E M U
        W S N W
        W O E Y
          F F F E
          F A F W
            A N E
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When we yielded to an impulse that was scatterbrained, or worse, and included in this column Mr. Haendigeses verse, we were starting an infection that has taken a direction to which soberer reflection finds this editor averse. For we only sought to lighten the sobriety and brighten up this journal. But the frightening result is there mingles with my daily work these jingles, and my mind itches and tingles from suppression of this curse.

Duodecimals enthrall me with their flexibility, and the dozens weights and measures must inevitably be internationally chosen. With the decimal system frozen, then we'll have for measures those in which the twelve is usually dominant through evolution, and they offer a solution to the 'decimal-point' delusion. Inch and Yard and Pint and Pound will surprisingly be found metrologically sound, - based on truest symmetry. Now, my dears, if you'll excuse me, here's a jingle to amuse ye.

There is a new system of twelves
Helps problems figure themselves.
The base is so good
It naturally should
Put all other methods on shelves.

Mary.

OFFICIAL ANNOUNCEMENTS

Chairman Beard of the Committee on Awards announces that the Annual Award of the Duodecimal Society of America for 1944 has been conferred upon our President, F. Emerson Andrews, as a pioneer in the use of Base Twelve, and as the author of many articles on duodecimals, in addition to the outstanding work, "New Numbers."

Mr. George S. Terry, Chairman of the Board of Governors, was named as the recipient of the Annual Award for 1945, which cited his many papers on duodecimals, the imposing work, "Duodecimal Arithmetic," the popular brochure, "The Dozen System," and Mr.

Terry's generosity in establishing the Endowment Fund of the Society.

The Society's Annual Award is conferred each year upon that person who has made the outstanding contribution to the progress and development of duodecimals and of the Society. The Award is in the form of a certificate, beautifully but simply hand-lettered in red and black.

. . . . .

Mr. Kingsland Camp announces the appointment of Mr. Lewis Carl Seelbach as a member of the Committee on Nomenclature and Symbology, of which Mr. Camp is Chairman.

. . . . .

Our Treasurer acknowledges, with thanks, the receipt of a further donation of $100 from Mr. George S. Terry, toward defraying the expenses of the Society, and its promotional work.

. . . . .

Vice-President F. Howard Seely, in charge of Advanced Standing and Training, announces the promotion of Mr. Paul E. Friedemann to the status of Member. Also announced is the admission of a new Aspirant, Mr. Edward W. Pharo, Jr., of 638 East Rosalie St., Philadelphia 20, Pa.

THE MAIL BAG

Our Bill Crosby has moved again. It is always a pleasure to have his lovely calligraphy meet the eye. There's one soldier with a job waiting for him, when he gets home. We propose his name now, for appointment as the Society's "Herald", and as the Chairman of the Committee on Awards. Here's his letter:-

Pvt. William Shaw Crosby, 39148677, 41 Cml. Lab. Co., APO.75, San Francisco, Calif. . . . Just a note to keep you apprised of the latest change of my unstable military address. My last letter to you was mailed in Rome. Vol. I, No. 1, of the Bulletin reached me in Naples; Vol. I, No. 2, and my membership card, as we lay at anchor in Manila Bay; and Mr. Seely's letter reached the bamboo hut in which I now dwell only this afternoon. . . . Vol. I, No. 2 is certainly full of meat. I should have time during the next few weeks to formulate my reactions to it. Offhand, I'd say we can reach virtual agreement on most applications of the "principle of least change," since usage and familiarity will guide our preference for one notation or nomenclature over another. . . . I'm not so confident of a future concensus on applications of the "principle of separate identity"

or on the privately conceived reforms for which we individually may be inclined to use the uncial system as a vehicle. But this may be for the best in that we'd be incapable of agreeing on anything so formidably complete and complicated that the public would shy away from it. . . . Cordially yours. . . . W. S. C. .

A letter from Paul Friedemann relates an amusing incident. He had become so much interested in duodecimals that they absorbed all his spare time, somewhat to the annoyance of his wife. He was working hard at accumulating the material for a book on duodecimals, when he discovered "New Numbers." He was highly elated, but feigned deep dejection over this discovery that some one else had written his book. His little daughter, Nancy, 5, said consolingly: "Daddy, don't feel bad about that man writing your book. There are lots of other numbers you can write a book about. There is the number thirteen; you can write about it, and it's right next to twelve." His wife felt that she should write that Mr. Andrews a letter of thanks. . . . Mr. Friedemann offers some excellent counsel on methods of propaganda:-

"My experience reveals that any presentation of the subject matter with too much emphasis produces a reaction opposite to that intended. A presentation, on the other hand, that is in just enough of a light vein to be entertaining, yet leave the listener with the impression that the speaker is dead serious, has a desirable effect. Further, demonstrations of calculations that leave no doubt of the merits of twelve as a base, and presented in such a manner that people can follow the demonstrations, are of unquestioned value.

"There are other general recommendations I may offer, that the members of the Society do not get themselves involved in any debates that tend to become passionate in the slightest degree, nor tolerate a protagonism that must now and immediately save someone or something.

"I am one of those few people who are confident that twelve will become the number base of the future; but my belief is that the New Numbers, to become part of the cultural structure of mankind, will have to come through the proving ground of history. The process may even be as slow as was the growth of the present Hindu system of dealing with numbers, unless our modern pace, coupled with the trait of the group-mind to take up fads, comes to our assistance. What we are doing will constitute merely a shortening of the length of the pendulum of history, so that its periods, perchance, may be shortened."

We would like to remind Mr. Friedemann that, though the present resurgence of interest in duodecimals may be regarded as starting in 1925 or 1935, we know that the advantages of duodecimals were recognized as early as 1806, and it is possible that they may date from the early 17 hundreds.

And that reminds us of a suggestion we wish to make. One of

the duodecimal pioneers, Sidney Armor Reeve, made it a practice to refer to the "17 Hundred" rather than to the more usual "18th Century." The greater clarity of Reeve's statement is quite apparent. We should adopt the parallel construction and refer to the current period as the *11* Groennium.

Vice-President Howard Seely writes that the work of handling the lessons and examinations has proven very interesting. He says:- "The thing that strikes me most forcibly is the great amount of enthusiastic interest displayed by the Aspirants, and the plans that many of them have for developing and perfecting the duodecimal system. I am also interested in the way that a number of them like to complicate a simple question, perhaps with the idea of demonstrating that they have passed beyond simple arithmetic. It has been fascinating to see how different persons go at these problems in different ways, and how many, surprisingly, get the right answers." That last is probably a crack at Ye Ed. who enjoyed working out the square of the hypotenuse to determine Mr. Tweet's distance from home.

Cpl. Dallas H. Lien has returned to civil life, and is taking courses in physics and electrical engineering at Purdue University. Welcome home, Corporal, and more power to you. Mister Lien's present address is 226 Pierce St., West Lafayette, Ind.

Bill Crosby's suggestion of the use of the word "uncial" has met with approval and disapproval. Most of the respondents wish to retain the use of "dozenal" and add "uncial" to our vocabulary. This would seem profitable.

The papers on new nomenclatures for duodecimals have elicited a flood of response. Mr. J. D. Shea of 3254 Cambridge Ave., New York 63, N.Y., who is a subscriber to the Bulletin, writes that he uses the letters from A to L, in place of the usual number symbols, to escape confusion. This corresponds fairly well with the old Greek practice, and Mr. Shea might find some improvement in his method through the use of the Greek characters.

There is an amusing letter from a Mr. Ernest Stryver of San Francisco, who suggests a similar practice. Because there seems to be a slight bulge in Mr. Stryver's cheek, we will share our chuckles with you:- 'I had never heard of duodecimal counting until I lately ran across one of your publications. Having glanced through it, I am convinced that you are doing everything wrong. You should not limit your reform to the mere changing of the base from 10 to 12, but should take in everything in sight. No one is going to learn the system anyway, and it is just as easy not to learn a hundred things as it is not to learn one. You ought to tackle the entire arithmetical system, which is badly in need of improvement.

'Take the number symbols. A straight line stands for 1. Put a hook on top and it means 7. A circle means nothing. Put a handle on it, sticking up, and it means 6. Make the handle go down and it means 9. No sense to it. The Greeks did better; they used the letters of the alphabet for number symbols. You have adopted the X to honor the Romans, and call it Dek to honor the Greeks. I suggest that you honor the Greeks still more by using the alphabet for all the number symbols. My plan, which would for once and for all remove the senseless and arbitrary jumble of symbols, is as follows:

'For	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*X*	*E*	*0*
Substitute	a	b	c	d	f	g	h	i	l	m	n	o

'Some letters are omitted to avoid confusion. These numbers would be called: a (ah), ba, ca (ka), etc., and the zero would be called "oh" as at present. *10* would be written ao, *11* aa, *20* would be bo, *25* bf, *£4,28X* becomes dn,bjm. Nomenclature may have to be extended so that larger amounts can be called by name, but usually a listing of the digits will suffice. I imagine that you do not usually say - three gro eight do four, but simply three eight four, - or in my system, cajada.

It will be a great saving to have each digit spelled with two letters, instead of wasting five letters on seven and eight, and three or four on the others. The one good thing you have done is to reduce eleven to el. There may be occasional complications for a sensitive person in the accidental forming of words in numerical combinations. For instance, *604,41X* would become "god dam", which a lady would hesitate to say in the presence of a gentleman. However, such accidents would occur infrequently, and should not militate against the excellence of the system.

Ernest Stryver.'

Mary Lloyd and husband, who are stationed at Mare Island, dropped in at Howard Seely's home and were cordially welcomed. Howard has always disliked the use of *X*, and would prefer that we use any letters in the top row of the typewriter, and use them in lower case, so that a carriage shift would not be required. Similarly, he sees no need to depart from the use of the word "ten".

We have had an interesting letter from H. K. Humphrey:-"I want to propose for the serious consideration of the Committee on Nomenclature and Symbology the following suggestions: (1) In order to avoid the requirement of italics, to permit the use of the semicolon as the "decimal" point (or "uncial" point, or "unit" point,) and (2) in order to avoid carriage-shifts of the typewriter, to permit the use of 'd' for '*X*', and of 'k' for '*E*'.

"I suppose the greatest enthusiast must admit that there is grave doubt whether the duodecimal system of numbers can ever supersede the decimal; whether the intrenchment of the older system can ever be overcome; whether the advantages to generations yet unborn can ever induce any "present" generation to ac-

cept the nuisance attendant to making the change. But, 'a guy can dream, can't he?' and this one proposes to.

"Then surely the enthusiasts who make up the Duodecimal Society must keep in mind the "present" generation which will do the work if the change ever comes, and must be very careful to keep the nuisance of the change as little onerous as possible. And, good as the present conventions of the Society are, I do believe that they have a tendency to increase inertia against the change.

"These conventions first came to my attention in a printed book, Andrews' "New Numbers." In printing they are excellent; special type forms can be used, and Italic is just as easily set as any other type-face. But many more numerals are going to be made on the typewriter and by hand, than will ever be printed.

"Furthermore, for a long generation or two, both systems of numbers will have to exist side by side, and be distinguished one from the other. Shall we require everyone who writes numbers to have two typewriters, one for decimals and one for duodecimals? We fanatics might be willing to do this, or anything else that might be necessary. But what about people who are not dozen minded, whose inertia is to be overcome if the dozen system is to be generally used? It would be better to adopt a convention which is less graceful, but which can easily be executed on ordinary typewriters, as well as by hand.

"The use of the semicolon (;) in place of the 'decimal' point is such a convention. This would facilitate easy recognition and differentiation between decimals and duodecimals, and is a very simple practice to use. For example, it is not difficult to distinguish between 144 - one hundred and forty four, - and 144; - one gross four dozen and four.

"The use of X for the usual number of a man's toes, and £ for one more than that, involves a good deal of slowing up, too, in that each requires a shift on the typewriter. This takes not only the time of the shift itself, but also serves to interrupt the thought of the typist seriously. I know this of my own knowledge, and, after his experience in stencil cutting, I believe that Vice President Seely will agree.

"There is further objection to X in its confusion with the sign for multiplication, and with the most common symbol for an unknown quantity in algebraic work. This confusion is as great in handwritten, as in typewritten, work.

"Now, all numerals are the height of a capital letter, and if we are to use a lower case type symbol, - one which is already on the typewriter,- we should use a lower case letter of full height. These are: b, d, f, h, k, and l. We cannot use 'l', for it is already appropriated for 'one'; and 'b' is much too likely to be confused with '6' in handwritten work. Of the remaining four, 'd' stands for Dek almost as well as does 'X'; it

lends itself to a very graceful handwritten numeral, a sort of left-handed '6'.

"None of the other three has any special connection with eleven except 'k', which is the eleventh letter of the English alphabet. It is a rather rough, uncompromising, 'prime' letter, which fits the character of eleven as a number, and it can also be handwritten as a distinctive numeral.

"It is helpful that these symbols are located symmetrically on typewriter keyboard, the 'd' under the third finger of the left hand, the 'k' under the third finger of the right, next to the 'l' which is used for 'one'.

"In my prejudiced view, these symbols fit into long strings of figures as well as those now in use. True, there is a somewhat bizarre effect to 103,d67,89k,542; but that does not seem any worse to me than *103,X67,89£,542*, and it is lots easier to write.

"I firmly believe that the inertia which will oppose the change to duodecimal numbers would be at least slightly lessened if the Society would accept these alternative conventions, and encourage their use wherever they make the writing of numbers easier, and I have tried to set forth the reasons on which this belief is based. I trust that the Committee on Nomenclature and Symbology will give these suggestions careful attention, and that they will permit the use of these forms along with the present ones. H. K. Humphrey. "

In sending the letter to us, Chairman Camp writes as follows:- "Mr. Humphrey's letter very much deserves publication; and Mr. Seely, as was pointed out, has had acute practical reasons for disliking our present notation. He was far too self-restrained to express himself about it profanely, at least in correspondence.

"In considering the naming of cities, islands, etc., by geographical co-ordinates, a decision will have to be reached as to the prime meridian. Instead of using the meridian of London, and east and west longitude, I would suggest using the international date-line as the prime meridian, and reckoning all longitude westerly from this prime meridian. It might be well to consider shifting the date-line some ten degrees, or so, eastward, to secure a prime meridian crossing least land area. The present meridian crosses some five hundred miles of Siberia, and along the date-line, except at the exact instant of midnight, it is always two days at once. The present date-line was located to give London and Paris approximately zero longitude.

"In reading the last Bulletin, the article on "Twelve Fingered People" reminded me to suggest that we ten-fingered folk can also count by twelves with nature's equipment by depressing one hand at the count of six, and the other at the count of twelve.

"As to Mr. Beard's nearly-classic essay on weights and measures, I wonder if it is necessary to use a new name at every step of *10*, - whether the doyard and the groyard will ever find popular use. In the French Metric System, I understand that decimeters, dekameters, and hektometers, have completely fallen into disuse, and that milligrams, grams, and kilograms are the only surviving measures of weight. Kingsland Camp."

Mr. Beard would like to answer that he has provided names to correspond with the names now in customary use. Many of these can be dropped, by the use of a uniform set of names founded on the basic units. Mr. Camp has misconceived the situation a little. To express *10* yards, we would say, "One do yards." Or, we could also say, "One Doyard." There is a negligible difference between them, and the usage generally preferred would rule.

This illustrates one point which has received little attention and deserves a great deal. It is important that duodecimal quantities be, without exception, expressed in the proper duodecimal terms. Carelessness about this practice can only produce confusion. If we are letting ourselves think of *100* as one hundred, only errors can be expected. *100* is one gro. And it must always be so expressed, and be so thought of.

The comment on the prime meridian, above, accents the fact that we have done little about the application of duodecimals to the problems of navigation. For instance, latitude has generally been expressed as north or south of the equator. Yet, when navigational problems are being calculated, the complement of the latitude, the polar distance, is universally used. The polar-distance is one of the elements of the celestial triangle. Perhaps we should consider substituting polar-distance, as measured from the North Pole, in place of north and south latitude.

There are many such problems in navigation which deserve more attention than they are currently being given. Mr. Beard, as Chairman of the Committee on Navigation, would like to discuss these problems with anyone who may be interested.

Mr. Camp included in his letter a quotation from "Science and the Modern World," by Professor A. N. Whitehead, which seems to me to have especial appeal to us dodekanecrs.

> "If you have had your attention directed to the novelties of thought in your own lifetime, you will have observed that almost all really new ideas have a certain aspect of foolishness when they are first produced."

We need be concerned with only doing the best that is in us, with being comprehensive, with being exact, with being logical. What we do will be our best argument.

Whiskers.

HOW TO COUNT BY DOZENS

Our common number system is decimal - based on ten. The dozen system uses twelve as the base. This requires two additional symbols: ↊, called *dek*, is used for ten, and ↋, called *el*, is used for eleven. Twelve 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.

Modern numeration employs one of the greatest of man's inventions, the zero - symbol for nothing. It permits the use of place values. 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.

64	*136*	Five ft. nine in.	*5.9'*
31	*684*	Three ft. two in.	*3.2'*
96	*3↊2*	Two ft. eight in.	*2.9'*
19↊	*1000*	Eleven ft. seven in.	*↊.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 38 years old, dozenally you are only 2↋, which is two dozen and eleven. For larger numbers, keep dividing by 12, and the successive remainders are the desired dozenal number.

```
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 ↊, and the successive remainders are the desired decimal number.

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

Numerical	Progression			Multiplication Table
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.		

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

Each One Teach One