Roman Numerals

#19 of Gottschalk's Gestalts

A Series Illustrating Innovative Forms
of the Organization & Exposition
of Mathematics
by Walter Gottschalk

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◻ the Roman system of numeration
is a summation-by-juxtaposition numeration system;
it consists of
an additive/subtractive notation for positive integers
as described below

Δ the seven basic Roman numerals

are the following capital/lowercase Latin/English letters
with values as indicated
in the Indo-Arabic system of numeration
which is a positional decimal numeration system:

I i   = 1

V v   = 5

X x   = 10

L l   = 50

C c   = 100

D d   = 500

M m   = 1000

GG19-3

Δ the seven basic Roman numerals
represent
the first four nonnegative integer powers of ten
viz

$I = 10^0 = 1$

$X = 10^1 = 10$

$C = 10^2 = 100$

$M = 10^3 = 1000$

&

their integer halves
viz

$V = 5$

$L = 50$

$D = 500$

GG19-4

Δ the Roman system of numeration
uses
the decreasing-additive increasing-subtractive
principles of notation
applied to the seven basic Roman numerals
to denote any positive integer
by a finite sequence,
written in juxtaposition form,
of the seven basic Roman numerals,
altho not uniquely

• in particular

P, Q, R, $\cdots$ ∈ BRN

⟹ by def

P Q = P + Q if P ≥ Q

P Q = Q − P if P < Q

PQR = P + Q + R if P ≥ Q ≥ R

PQRS = P + Q + R + S if P ≥ Q ≥ R ≥ S

etc

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Δ hence

$$I \quad = I \qquad\qquad = 1 \qquad\qquad = 1$$

$$II \quad = I + I \qquad = 1 + 1 \qquad = 2$$

$$III \quad = I + I + I \qquad = 1 + 1 + 1 \quad = 3$$

$$IV \quad = V - I \qquad = 5 - 1 \qquad = 4$$

$$V \quad = V \qquad\qquad = 5 \qquad\qquad = 5$$

$$VI \quad = V + I \qquad = 5 + 1 \qquad = 6$$

$$VII \quad = V + I + I \qquad = 5 + 1 + 1 \qquad = 7$$

$$VIII = V + I + I + I = 5 + 1 + 1 + 1 = 8$$

$$IX \quad = X - I \qquad = 10 - 1 \qquad = 9$$

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X	= X	= 10	= 10
XX	= X + X	= 10 + 10	= 20
XXX	= X + X + X	= 10 + 10 + 10	= 30
XL	= L - X	= 50 - 10	= 40
L	= L	= 50	= 50
LX	= L + X	= 50 + 10	= 60
LXX	= L + X + X	= 50 + 10 + 10	= 70
LXXX	= L + X + X + X	= 50 + 10 + 10 + 10	= 80
XC	= C - X	= 100 - 10	= 90

C   = C   = 100   = 100

CC   = C + C   = 100 + 100   = 200

CCC = C + C + C   = 100 + 100 + 100   = 300

CD   = D - C   = 500 - 100   = 400

D   = D   = 500   = 500

DC   = D + C   = 500 + 100   = 600

DCC = D + C + C   = 500 + 100 +100   = 700

DCCC = D + C + C + C = 500 + 100 + 100 + 100 = 800

CM   = M - C   = 1000 - 100   = 900

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M = 1000

MM = 1000 + 1000 = 2000

MMM = 1000 + 1000 + 1000 = 3000

MMMM = 1000 + 1000 + 1000 + 1000 = 4000

etc

Δ more particularly

for numbers (= positive integers) less than 5000 say

• to convert
from Indo-Arabic numerals
to Roman numerals:
write the given number as a sum of multiples of
decreasing powers of ten up to one thousand
& convert each summand to Roman numerals
& juxtapose in the given order
eg
   3456
= 3000 + 400 + 50 + 6
= MMM + CD + L + VI
= MMMCDLVI

• to convert
from Roman numerals
to Indo-Arabic numerals:
parenthesize each consecutive letter pair PQ with P < Q
& then add together the values of all
parenthesized letter pairs
and
unparenthesized individual letters
eg
   MCDLIV
= M(CD)L(IV)
= 1000 + 400 + 50 + 4
= 1454

GG19-10

Δ some examples of notable dates
expressed in Roman numerals

476 = CDLXXVI

1000 = M

1001 = MI

1066 = MLXVI

1492 = MCDXCII

1564 = MDLXIV

1616 = MDCXVI

1642 = MDCXLII

1687 = MDCLXXXVII

1727 = MLCCXXVII

1776 = MDCCLXXVI

1861 = MDCCCLXI

1918 = MCMXVIII

2000 = MM

2001 = MMI

Δ the overbar

is used on Roman numerals
to denote multiplication by 1000
eg

$\overline{VI} = 6000$

Δ the square cap of three unconnected strokes

is used on Roman numerals
to denote multiplication by 100,000
eg

$\left|\overline{VI}\right| = 600,000$

Δ to illustrate:

$123,456,789$

$= \left|\overline{MCCXXXIV}\right| \overline{LVI} DCCLXXXIX$

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Δ Roman numerals are

distinctive & beautiful & dignified
& grace many occasions
& are sometimes useful
as in
classification headings,
nouns with numbers attached
(eg acts of plays, names of royalty, etc),
ceremonial records of notable dates,
and the like;
BUT Roman numerals are cumbersome
& appropriate for
calculation/arithmetic/mathematics
they are not;
the simple examples

- CXXXIV × XXVIII = MMMDXXLII

$$134 \times 28 = 3752$$

- $\dfrac{III}{IV} + \dfrac{VIII}{IX} = \dfrac{LIX}{XXXVI} = I \ \& \ \dfrac{XXIII}{XXXVI}$

$$\frac{3}{4} + \frac{8}{9} = \frac{59}{36} = 1\frac{23}{36}$$

are sufficiently discouraging   GG19-13

Δ the seven basic Roman numerals

are letters now but they were not so originally;
their earlier forms evolved into letters
apparently with no special reference to
the particular letters they became
except for shape
& the reinforcement accompanying three letters
viz

I = suggestive of the original vertical tally mark

C = the capitalized initial letter of
the Latin word 'centum' meaning 'hundred'

M = the capitalized initial letter of
the Latin word 'mille' meaning 'thousand'

GG19-14

Δ it has been suggested

that the Roman numeral V for five
was originally adopted because
it represents the human hand
with four fingers together
and the thumb outstretched,
making a total of five fingers;
it has also been suggested
that the Roman numeral X for ten
was originally adopted because
it represents the two human arms crossed,
making a total of ten fingers;
another suggestion about the origin of X for ten
is that it is two V's, one upside down,
stuck together;
these are pleasant thoughts but it is hard to see
how historical evidence can be attained

Δ Roman numerals were used

in the Roman Republic and later the Roman Empire
from its beginning ca 500 BCE
and continued to be used thruout Europe until
the Indo-Arabic numeration system
began to be widely known and used
in Europe ca 1275 say;
however the replacement was gradual
and Roman numerals were well used into the 1500's

GG19-15

Δ the ancient Romans used other signs

for various numbers;
for example, the lazy eight sign ∞
(or something similar)
was also used by them to denote 1000;
in 1655 the sign ∞
was used to denote infinity by
John Wallis
1616-1703
English
mathematician, physicist, logician,
historian of mathematics, calculating prodigy, cryptanalyst, grammarian,
theologian, royal chaplain (to King Charles II),
linguist, teacher of deaf & dumb

Δ note that

666 = DCLXVI

which is the decreasing sequence of
the basic Roman numerals except for M
&
which helps to explain the particular uniqueness
of this number as
The Number of the Beast

• Revelation 13:18 KJV
Here is wisdom. Let him that hath understanding
count the number of the beast; for it is
the number of a man; and his number is
Six hundred threescore and six.

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