Unconventional Method of Multiplication

Dr. Tejmal Rathore SMIEEE, FIETE
Independent Researcher, G-803, Country Park, Dattapada Road, Borivali (E), Mumbai 400 066 Maharashtra, India
tsrathore43@gmail.com

Abstract -- **A new method of multiplication, where the multiplicand *M* and product *P* are not specified, only multiplier *m* is specified, is presented. It evaluates *M* and *P* such that the two strings of digits in *M* are interchanged in *P*. The process of multiplication is explained with examples and represented pictorially as a closed loop. Maximum possible numbers of such numbers with the same number of digits in *M* and *P* is 9. However, if *M* has number of zeros at the end digits, then *R* will have one additional digit. These sets may consist of *the* same or different numbers. Properties of such a closed loop are summarized. Some very interesting numbers are generated.**

Keywords: *Conventional multiplication, Unconventional multiplication, Integer numbers, Cyclic numbers*

I. INTRODUCTION

THE conventional method of multiplication is very simple. It is being taught in primary schools. When a multiplicand *M* is multiplied by a multiplier *m*, the result is the product *P*. Mathematically, expressed as

$$M \times m = P. \quad (1)$$

Let an *n*-digit number *M* be expressed as

$$M = d_n\, d_{n-1} \ldots d_3\, d_2\, d_1 = [X][Y] \quad (2)$$

where [*X*] and [*Y*] are two strings of digits of *M*.
Our aim is to get *P*, when *M* is multiplied by *m*,

$$P = M \times m = [Y][X], \quad (3)$$

i.e., the [*X*] and [*Y*] interchange their positions.

Only *m* is specified and we have to find *M* such that Equation (3) is satisfied. We achieve this using a different type of multiplication presented next.

II. UNCONVENTIONAL METHOD OF MULTIPLICATION

Method: The method of multiplication is explained with examples.

Example 1**:** Let $m = 3$. To start with, let us take *Y* as a single digit number 1, and $X = n$-1 digit number. Then

$$M = d_n\, d_{n-1} \ldots d_3\, d_2\, 1. \quad (4)$$

It is required that

$$P = 1 d_n\, d_{n-1} \ldots d_3\, d_2.$$

Other digits of *M* are obtained as explained in Table 1.

Table 1

$d_n d_{n-1} \ldots d_3 d_2 1$ $\times 3$ -------------------- $1 d_n d_{n-1} \ldots d_3 3$	$d_n d_{n-1} \ldots d_3 31$ $\times 3$ ---------------------- $1 d_n d_{n-1} \ldots d_4 93$
(a)	(b)
$d_n d_{n-1} \ldots 931$ $\times 3$ ------------------------- $1 d_n d_{n-1} \ldots d_5 793$	$d_n d_{n-1} \ldots 7931$ $\times 3$ --------------------------- $1 d_n d_{n-1} \ldots d_6 3793$
(c)	(d)

Likewise, remaining digits are determined. This process is pictorially shown in Figure 1. In the number *x,y, x* represents the first digit of multiplication and *y* represents the carry.

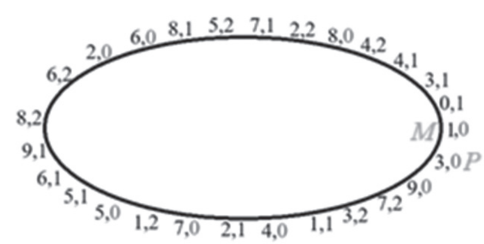

Figure 1. Process of multiplication.

We will write this operation, for convenience, as
R{m} = *M* = .
Thus, R{3}=
*M*1 = 0344827586206896551724137931
*P*1 =1034482758620689655172413793,
both clockwise in Figure 1. The *M*1 will be called as the basic number (BN).

Other possible values of M

(*a*) Instead of starting with 1 (which has no carry), one can start with any of the numbers 2 to 9 which also do not have a carry as can be seen from Figure 1. Thus, *M*sare
*M*1 = 0344827586206896551724137931
*M*2 = 1034482758620689655172413793
*M*3 = 3103448275862068965517241379
*M*4 = 1379310344827586206896551724
*M*5 = 2413793103448275862068965517
*M*6 = 1724137931034482758620689655
*M*7 = 0689655172413793103448275862
*M*8 = 2068965517241379310344827586
*M*9 = 2758620689655172413793103448

Thus, all the digits 1 to 9 at d_1 have been covered. Hence 9 are the only possible *M*s. Note that from BN to get *M*2, *Y* = 1, to get *M*3, *Y* = 31, to get *M*4, *Y* = 137931, and so on.

(*b*) In (*a*), if we do not get all the nine *M*s, we can get them by starting with the remaining numbers as .

(c) From *M, P* can be obtained by shifting $d_1$to the left most place. However, this fails when *n* number of zerosexist at the end in *M*. This difficulty can be overcome as follows: Shift last (*n*+1) digits to the left most place and insert *n* number of zeros at the end. Thus, *P* will have *n* extra digit.

*M*10 = 3448275862068965517241379310
*P*10 = 10344827586206896551724137930
*M*11= 6896551724137931034482758620
*P*11 = 20689655172413793103448275860

Example 2**:** All R{4} are obtained as below.
(i) 025641 is obtained with This is shown in Figure 2.

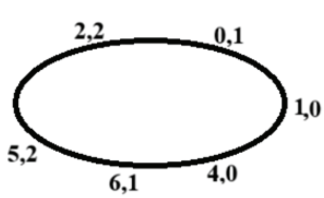

Figure 2. R{4}.

Then 102564 is obtained from this number with no carry digit 4.Thus, 1 and 4 are covered, and 2,3,5,6,7,8,9 are left out.

(ii) *M*s (051282,205128, 128205) are obtained choosing = 2 and no carry digits 8 and 5.
Left out numbers are 3,6,7,9.
(iii) Numbers (076923, 230769) are obtained by choosing =3 and then no carry digit 9. Left out numbers are 6 and 7.
(iv) 153846, 179487, are obtained by choosing = 6 and 7, respectively.

These 9 *M*s consist of 5 sets of 6 digits (0,1,2,4,5,6),(0,1,2,2,5,8), (0,2,3,6,7,9) (1,3,4,5,6,8), (1,4,7,7,8,9)

(v) More *M*s when there is a 0 at the end.
*M*10= 256410,then *P*10 = 1025640
*M*11 = 512820,then *P*11 = 2051280
*M*12 = 769230, then *P*12 = 3076920
Though *M*s are 6-digit numbers, corresponding *P*s are 7-digit numbers.

Interesting examples

(i) Multiplication by a 2-digit number

Example 3 **:**R{11} =

*M*1 =
0091743119266055045871559633027522935779816513761467889908256880733944954128440366972477064220183486238532 11

It has 108 digits, a very auspicious number. Surprisingly, it is the number same as 1/109 ignoring the decimal point. In general, we don't know *M* and even if we know, we don't know how to relate it to the reciprocal of a number, such as 109.

The following 8 more *M*s can be derived by finding the no carry digits.

*M*2 =
01834862385321100917431192663027522935779816513761467889908256880733944954128440366972477064 22

*M*3 =
02752293577981651376146788990825688073394495412844036697247706422018348623853211009174311926605504 5871559633

*M*4 =
03669724770642201834862385321100917431192660550458715596330275229357798165137614678899082568807339 4495412844

*M*5 =
04587155963302752293577981651376146788990825688073394495412844036697247706422018348623853211009174 3119266055

*M*6 =
05504587155963302752293577981651376146788990825688073394495412844036697247706422018348623853211009 1743119266

*M*7 =
06422018348623853211009174311926630275229357798165137614678899082568807339449541284403669724 77

*M*8 =
073394495412844036697247706422018348623853211009174311926605504587155963302752293577981651376146788990825688

*M*9 =
082568807339449541284403669724770642201834862385321100917431192660550458715596330275229357798165137614678899

All have the last two digits distinct and multiples of 11. Since all the digits 1 to 9 are considered at the last digit, no more *M*s can be derived. However, additional *M*s are possiblewhen the zeros are present at the end of *M.*

When *M* has 2zeros at the end

If *M*10 =
917431192660550458715596303027522935779816513761467889908256880733944954128440366972477064220183486238532110 0, then
*P*10=
100917431192660550458715596303027522935779816513761467889908256880733944954128440366972477064220183486238532100.
Since *M* has two zeros at the end, *P* has 108 + 2 = 110 digits.

When *M* has 1 zero at the end

*M*11 = 0917431192660550458715596330275229357798165137614678899082568807339449541284403669724770642201834862385321 10

*P*11
1009174311926605504587155963302752293577981651376146788990825688073394495412844036697247706422018348623853210
This has 108 +1 = 109 digits.
Similarly, other *M*s and corresponding *P*s are

*M*12 =
550458715596303027522935779816513761467889908256880733944954128440366972477064220183486238532110 0917431192660

*P*12 =
605504587155963030275229357798165137614678899082568807339449541284403669724770642201834862385321100917431192 60

*M*13=
458715596303027522935779816513761467889908256880733944954128440366972477064220183486238532110091743119266055 0

*P*13 =
504587155963030275229357798165137614678899082568807339449541284403669724770642201834862385321100917431192660 50.

*M*14 =
275229357798165137614678899082568807339449541284403669724770642201834862385321100917431192660550458715596330

*P*14 =
302752293577981651376146788990825688073394495412844036697247706422018348623853211009174311926605504587155963 0

*M*15 =
825688073394495412844036697247706422018348623853211009174311926605504587155963302752293577981651376146788990

*P*15=
908256880733944954128440366972477064220183486238532110091743119266055045871559633027522935779816513761467889 0

*M*16 =
733944954128440366972477064220183486238532110091743119266055045871559633027522935779816513761467889908256880

*P*16 =
807339449541284403669724770642201834862385321100917431192660550458715596330275229357798165137614678899082568 0

*M*17 =
366972477064220183486238532110091743119266055045871559633027522935779816513761467889908256880733944954128440

*P*17 =
403669724770642201834862385321100917431192660550458715596330275229357798165137614678899082568807339449541284 0

*M*18 =
642201834862385321100917431192660550458715596330275229357798165137614678899082568807339449541284403669724770

*P*18 =
70642201834862385321100917431192660550458715596330275229357798165137614678899082568807339449541284403669724 70

*M*19
18348623853211009174311926605504587155963302752293577981651376146788990825688073394495412844036697247706422 0

*P*19 =
2018348623853211009174311926605504587155963302752293577981651376146788990825688073394495412844036697247706420

Note that all the above *P*s are having first two and the last two digits same and multiples of 10.

(ii) Multiplication by 10^n

Example 4 R{10^n} = (*n* zeros)1. *P* = 1(10^nzeros)
R{100} = 001, and *P* = 100.

Properties of the closed loop

1. It is simple to draw.
2. It forms a closed loop.
3. It gives both *M* and *P* simultaneously.
4. It gives all possible values of *M* and *P*.

III. CONCLUSION

A new method of multiplication, where the multiplicand *M* and product *P* are not specified, only multiplier *m* is specified, is usedto evaluates *M* and *P* such that the two strings of digits in *M* are interchanged in *P*. The process of multiplication is explained with examples and represented pictorially as a closed loop. Maximum possible numbers of such numbers with the same number of digits in *M* and *P* is shown to be 9. However, additional *P*s can be obtained when *M*s have zeros at the end. These sets may consist of the same or different numbers. Properties of such a closed loop are summarized. Some very interesting numbers are generated. It will be an interesting exercise for the researchers to write the algorithm and verify the results.

Prof T S Rathore served SGSITS, Indore, IIT Bombay, SFIT, Mumbai and IIT Goa. He was a Post Doctoral Fellow (PDF) at Concordia University, Montreal, Canada and a Researcher at University of South Australia. He was an ISTE visiting professor for two years.
He is the author of *Digital Measurement Techniques*; the book has been translated in Russian (2004) and Hindi (2020). He is the co-author of the 3rd revised edition of the book *Network Analysis* with M E Van Valkenburg.
He was the Guest Editor of the *Journal of Inst. of Engineers on Instrumentation Electronics* and Editor for *IETE Journal of Education*.
Prof Rathore is a Life Senior Member of IEEE, Fellow of IETE and IE, Life Member of ISTE, Instrument and Computer Societies of India. He has received IEEE Silver Jubilee Medal, and several awards from IETE and ISTE. His detailed bio is available at ee.iitb.ac.in/wiki/faculty/tsrathor