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A New System Of Arithmetick, Theorical And Practical

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A SHORT HISTORY OF ARITHMETICK.

THAT Arithmetick was very early in the World, no body can doubt, becauſe the Idea of Number ariſes from all things about us. In the beginning, while the Way of Living was ſimple, and things were in a manner common, the Knowledge of Numbers would make a ſmall Progreſs: But when *Property* and *Commerce* began to be eſtabliſhed, Men would ſoon find the Neceſſity of enquiring into the Nature of Numbers, and contriving an *Art* of *Numbering;* without which no Buſineſs can be carried on. This was, no doubt, very rude at the firſt, and improved by degrees; as all our Knowledge is: But where, and by whom, Arithmetick received its firſt Form of an *Art* or *Science*, we know little about it. If the *Phœnicians* were, as it is conjectured, the firſt Merchants after the Flood, (and before that we know nothing of the Affairs of Mankind) then it is probable, the *Art* began among them; by whom *Trade* and *Arithmetick* were carried into *Egypt;* and here, 'tis thought, began the *myſtical* Application of Numbers: For the *Egyptians* explained every thing by theſe; the Nature of the *Gods*, of *Human Souls*, the *Virtues*; in ſhort, for every thing *divine* and *human*, they found ſome Symbol or Repreſentation in Numbers: Hence we hear of the wonderful Virtues and Properties of ſome particular Numbers, as *One*, *Two*, *Three*, *Four*, *Seven*, and *Nine*. From *Egypt* this Knowledge paſſed into *Greece*, which added its own Improvements to the myſterious Part; of which a great deal is to be ſeen in *Plato*; the Life of *Pythagoras* by *Jamblichus*; and more lately in the Commentators upon *Boethius's* Arithmetick. Now we are come to the Country where we may expect to find the firſt diſtinct Rudiments of the Science.

The firſt thing Men were obliged to do to make their *Ideas* and Knowledge of Numbers uſeful in Society, was to eſtabliſh ſome Method of *Notation*, and then upon this found an Art of *Computation:* after this they would gradually enquire into the *Relations* and *Properties* of Numbers; and ſo the Science went on.

The *Greeks*, *Hebrews*, and other Eaſtern Nations, uſed a Notation by the Letters of their Alphabet. The *Greeks*, particularly, had two different Methods; the firſt was much the ſame with the *Roman* Notation, explain'd in *Chap.* 2. *Book* 1. of the following Work, which is a very imperfect Method. Afterwards they had a better Method, in which the firſt nine Letters of their Alphabet repreſented the firſt Numbers from One to Nine, and the next nine Letters repreſented any Number of Tens from One to Nine, that is, 10, 20, 30, *&c.* to 90. Any Number of Hundreds they expreſſed by other Letters, ſupplying

ſupplying what they wanted with ſome other Marks: And in this Order they went on, uſing the ſame Letters again with ſome different Marks to expreſs *Thouſands*, *Tens of Thouſands*, *Hundreds of Thouſands*, &c. As to this Method, 'tis to be obſerv'd, that they were upon the very Point of diſcovering the *Arabian* Notation: For, as they made the Progreſſion to 9, they wanted but one Step further, *viz.* Inſtead of uſing other 9 Letters, to make the ſame 9 change their Values in a decuple Progreſſion according to their Places, which would in courſe diſcover the Neceſſity of a Character that of itſelf ſignifies Nothing, only fills up a Place.

The Manner of their *Computation*, (*i. e.* of *Addition*, *Subtraction*, &c.) and the Difficulty of it, eſpecially in great Numbers, we may eaſily diſcover from the *Notation*. As to any expreſs Treatiſes upon the *Art* of *Computation*, they have left us none. There is a Commentary by *Eutocius*, upon *Archimedes*'s Treatiſe of the Dimenſions of a Circle; and ſome Fragments of *Pappus*, in Dr. *Wallis*'s Works, which relate particularly to the Work of *Multiplication*, and ſhew us the great Difficulty of their Practice, owing to the imperfect Notation.

The moſt perfect Method of *Notation*, which we now uſe, was owing to the Genius of the *Eaſtern* Nations; the *Indians* being reckoned the Inventors of our Notation; which we call the *Arabian*, becauſe we had it from them, and they from the *Indians*, as themſelves acknowledge. When the *Indians* invented this Method, and how long it was before the *Arabs* got it, we cannot tell: Theſe things only we know, 1. That we have no ground to believe, the antient *Greeks* or *Romans* knew any thing about it: For *Maximus Planudes*, the firſt *Greek* Writer who treats of Arithmetick according to this Notation, lived about the Year of Chriſt 1370, as *Voſſius* ſays; or about 1270, according to *Kircher*; long after the *Arabian* Notation was known in *Europe*: And owns it for his Opinion, that the *Indians* were the Inventors, from whom the *Arabs* got it, as the *Europeans* from them. 2. That the *Moors* brought it into *Spain*; whither many learned Men from other Parts of *Europe* went to ſeek that, and the reſt of the *Arabick* Learning (and even the *Greek* Learning, from *Arabick* Verſions; before they got the Originals themſelves) imported there by the *Saracens*. As to the Time when this new Art of Computation was firſt known in *Europe*, *Voſſius* thinks it was not before the Year 1250; but Dr. *Wallis* has, by many good Authorities, proved that it was before the Year 1000; particularly that a Monk called *Gerbertus*, afterwards Pope by the Name of *Sylveſter* II. who died in the Year 1003, was acquainted with this Art, and brought it from *Spain* into *France*, long before his Death. The Doctor ſhews alſo, that it was known in *Britain* before the Year 1150, and brought a conſiderable length, even in common Uſe, before 1250, as appears by the Treatiſe of Arithmetick of *Joannes de Sacro Boſco*, who died about 1256.

Tho' the numeral Figures which we now have are a little different from what the *Arabians* uſe, having been changed ſince they came firſt among us; yet the *Art* of *Computation* by them is ſtill the ſame.

Having ſaid all that's neceſſary about the *Notation* of *Numbers*, we ſhall go back again, and ſee what kind of *Science* of *Arithmetick* is to be found among the Antients, with the Progreſs of it till now.

The oldeſt Treatiſe extant upon the *Theory* of *Arithmetick*, is *Euclid*'s 7th, 8th, and 9th Books of Elements; wherein he gives us the Doctrine of *Proportion*, and that of *Prime* and *Compoſite* Numbers. Both of which have received Improvements ſince his time, eſpecially the former. The next, of whom we know any thing, is *Nicomachus* the *Pythagorean*, who wrote a Treatiſe of the Theory of Arithmetick, which conſiſted chiefly of the Diſtinctions and Diviſions of Numbers into certain Kinds and Claſſes, as *Plain* and *Solid*, *Triangular*, *Quadrangular*, and the reſt of the Species of *Figurate* Numbers (as they called them) Numbers *Odd* and *Even*, *&c.* with ſome of the more general Properties of the

the ſeveral kinds. As to the time in which *Nicomachus* lived, ſome place him before *Euclid*; others long after. His Arithmetick was publiſhed at *Paris* 1538. What kind of Work it is, we may gueſs by the *Latin* Treatiſe of Arithmetick of *Boethius* the Philoſopher, who lived at *Rome* in the time of *Theodorick* the *Goth*; and is the next remarkable Writer extant upon this Subject. He is ſuppoſed to have ſeen and copied moſt of his Work from *Nicomachus*.

From this Work of *Boethius*, with a few ſmall Abſtracts of the ſame nature, made very long after his Time, as that of *Pſellus*, and *Jodochus Willichius*, both in *Greek*; ſome have ſaid that the antient Arithmetick conſiſted of nothing elſe but theſe Diviſions and Diſtinctions of Numbers. I confeſs I was ſurprized to find this Account from ſuch an Author as *Wolfius*, to whom *Euclid* is no Stranger; whoſe Books contain things much more important in the Science of Arithmetick than theſe Diſtinctions; and want many of them, that are in *Boethius*: For *Euclid* ſpeaks nothing of the *Figurate Numbers*, and their various Species and Claſſes; except what relates to Squares and Cubes. And, on the other hand, *Boethius* has very little of *Euclid*'s Doctrine.

We muſt come next to the Times when the *Arabian* Notation was known in *Europe*; after which we find many Writers both upon the *Theory* and *Practice*. The oldeſt of them, who is very conſiderable, is *Jordanus* of *Namur*, who flouriſh'd about 1200. His *Arithmetick* (from which I have taken ſeveral things) was publiſhed and demonſtrated by *Joannes Faber Stapulenſis* in the fifteenth Century, (who has given us himſelf a Compendium of *Boethius*) ſoon after the Invention of Printing. It's altogether upon the Theory; and contains moſt of what *Euclid* and *Boethius* have, and many other curious Theorems. The ſame Author wrote alſo upon the new Art of Computation by the *Arabick* Figures, and called this Book *Algoriſmus Demonſtratus*; the Manuſcript of which, Dr. *Wallis* ſays, is in the *Savilian* Library at *Oxford*. But it has never been printed, as I know.

As Learning advanced in *Europe*, ſo did the Knowledge of Numbers; which by degrees received large Improvements both in the *Theory* and *Practice*, owing in a great meaſure to a more perfect Notation. To trace out every Step in that Improvement, is impoſſible; therefore I ſhall only name a few of the remarkable Writers after *Jordanus* and *Sacro-Boſco*, both named already. As to the Writers, theſe were moſt remarkable in *Italy*, viz. *Lucas de Burgo*, about the Year 1499, whoſe Arithmetick, which is both Theorical and Practical, Dr. *Wallis* commends much: *Nicholas Tartaglia*, whoſe Work is chiefly *Practical*. He is called by ſome the *Prince* of the *Practitioners*; which muſt be underſtood only for his own Times. In *France*, there were *Clavius* and *Ramus*. In *Germany*, *Stifelius* and *Heniſchius*. In *England*, *Buckley*, *Diggs*, and *Record*. All theſe, and many more, were before the Year 1600. But ſince that, our Writers are almoſt innumerable.

As to the Improvements made ſince the *Arabick* Notation was known in *Europe*; beſides many things in the Theory, particularly in the Nature of *Progreſſion*, both Arithmetical and Geometrical, in the Nature of *Powers*, and in the *Extraction of Roots* and the *Combinations of Numbers*, which we do not ſo well know the Hiſtory of; there are a few very conſiderable Improvements, in the *practical* Part, of which we can give a better Account. But that I may connect the Antient and Modern Hiſtory, we muſt go back to the ſecond Century of *Chriſtianity*, in which *Claudius Ptolomeus* lived, who is ſuppoſed to be the Inventor of the *Sexageſimal Arithmetick*; which was a new Method of *Notation*, and conſequently of Computation, deſigned to remedy the Difficulty of the common Method, eſpecially with regard to *Fractions*. The Nature of it was this: Every Unit was ſuppoſed to be divided into 60 Parts, and each of theſe Parts into 60 Parts, and ſo on; hence any Number of ſuch Parts were called *Sexageſimal* Fractions. And to make the Computation in Integers alſo more eaſy, he made the Progreſſion in theſe alſo *Sexageſimal*. Thus, From one to fifty-nine were marked in the common way; then ſixty was called a *Sexagena prima*, (or firſt *Sexageſimal* Integer) and marked with the Sign of *Unity* and one single Dash over; so sixty was thus expressed I′. Two sixtys, or 120, thus II′; and so on to 59 times 60, (or 3540) which is LIX′. Then for 60 times 60, (or 3600) this he called a *Sexagena secunda*, (or second *Sexagesimal* Integer,) and marked any Number of them less than 60, by the Signs of Numbers less than 60, with two Dashes: Thus, 60 times 60 (or 3600) was marked I″; two times 3600, thus II″; ten times 3600, thus X″; and so on to 59 times 3600. In this manner the Notation went on: And when a Number less than 60 was joined with any of these *Sexagesimal* Integers, their proper Expression was annexed without the Dash: Thus, the Sum of 4 times 60 and 25 is expressed thus, IV′,XXV. The Sum of twice 60, ten times 3600, and 15 is expressed X″,II′,XV; the highest *Sexagesimal* being set next the Left-hand. As for the *Sexagesimal* Fractions, they were marked the same way, their Numerators by the Signs of Numbers less than 60, and their Denominators by one or more Dashes (according as they were Primes, Seconds, *&c.* *i. e.* 60, 3600, and so on in the order of the Powers of 60) set either over the Numerator upon the Left-hand, or under it upon the right. Thus five sixty Parts are marked ′V or V,. And fourteen 3600 Parts ′XIV or XIV,. The Practice by this Notation would be easier than their common Method; yet still very difficult, especially in Multiplication and Division, as appears by the Work of *Barlaamus Monachus*, called *Logistica*; wrote in *Greek* about 1350; translated into *Latin*, and published 1600. And here it is remarkable how very near this Method is in the general Nature of it to the *Arabick*. He wanted no more, but instead of *Sexagesimal* Progression, to make it Decimal; to make the Signs of Numbers from one to nine simple Characters; and lastly, to make a Character which signifies nothing by itself, serving only to fill up Places. But every Age and Nation has its Genius; and therefore we owe this to others.

As this *Sexagesimal* Notation was used chiefly in the Astronomical Tables, so for the sake of these, it was not laid aside immediately after the Introduction of the *Arabick* Notation. The *Sexagenæ Integrorum* went first out; but the *Sexagesimal* Fractions continued till the Invention of the *Decimals*. *Regiomontanus* about the Year 1464, is the first we know who in his *Triangular Tables* divided the Radius into 10,000 Parts instead of 60,000; and so tacitly introduced decimal Parts in place of *Sexagesimals*. *Ramus* in his Arithmetick, written about 1550, (and published by *Lazarus Schonerus* in 1586) uses decimal Periods in carrying on the Extraction of Square and Cube Roots to Fractions. The same did our Country-men *Bucklæus*, before *Ramus*; and *Record* about the same time. But the first who wrote an express Treatise of Decimals, was *Simon Stevinus*, about 1582.

As to the *Circulating Decimals*, Dr. *Wallis* was the first among us who took much notice of them. But I have spoke of this already.

Another most wonderful Improvement that the Art of Computation has received from the Moderns, is the *Logarithms*; the unquestionable Invention of the Lord *Neper*, Baron of *Merchiston* in *Scotland*, towards the end of the sixteenth Century, or beginning of the seventeenth.

Dr. *Wallis* is the Author of the *Arithmetick of Infinites*; which has been very usefully applied in *Geometry*.

But the Consummation of the Art is in the *Algebraick* Method of resolving Questions: The particular History of which, I have said nothing of; because, tho' *Algebra* belongs to *Arithmetick* in a larger view, yet I have limited myself to Arithmetick taken in a more strict sense, as it is distinguished from *Algebra*: Therefore I shall only say, that most of the Authors mentioned have also wrote upon the Algebraick Art, which came into *Europe* at the same time, and by the same hands, as the Numeral *Notation*: *Lucas de Burgo* being reckoned the first *European* Writer on this Subject.