That's The Way I Understand It - Series

The Pattern Of Prime Numbers
Plus A Prime Numbers Formula

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For prime number P and code C for P:

$$\mathbf{P_{\{n\}} + C_{\{n\}} = P_{\{n+1\}}}$$

[Page 2 is blank.] [Hole punch the pages of your printing of this document and put it in a three-ring notebook.]

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The Pattern Of Prime Numbers Plus A Prime Numbers Formula

I believe that I have found the pattern of prime numbers. It is a humbling experience to be shown something about a mathematical mystery that has been contemplated since before the time of Christ. The writer is very much aware of the fact that it seems presumptuous for a musician to say that he has observed the pattern of prime numbers which is a mystery that has been secret since the proverbial beginning of the infinite time that precedes our time on earth. However, the writer feels led and compelled to tell you what he sees without which no one could decide its worth. To keep things in perspective, though, it would indeed be unfortunate to understand some mathematical wisdom about the universe but miss the larger theological understanding and wisdom that surround that mathematical understanding. What are the larger theological implications for our mathematical understanding that exist in our short time on this planet and extend into that infinite future expanse of time which we call infinity or eternity? When we are at death's door facing eternity, it will do no good to tell God that we found the pattern of prime numbers. He will likely say that He already knew it. Then He will also likely tell us that we did not find it, He showed it to us! We will need a better plan than saying we found the pattern of prime numbers. The writer's pursuit of theology has gone hand-in-hand with his intellectual/artistic pursuits. The writer has documents that may be of help to your theological pursuit by seeing the theological documents which you can find on the website danielhookemusic.com where you got the document that you are now examining. Here is a theological secret yet to be revealed for the mathematician: *But as it is written, "Eye has not seen, nor ear heard, neither have entered into the heart of man, the things which God has prepared for them that love Him." The Bible, First Corinthians 2:9.* Here are some theological thoughts concerning seeking wisdom and understanding in matters that underlie the universe:

For after that in the wisdom of God the world by wisdom knew not God, it pleased God by the foolishness of preaching to save them that believe. … the foolishness of God is wiser than men; and the weakness of God is stronger than men. … but God has chosen the foolish things of the world to confound the wise; and God has chosen the weak things of the world to confound the things which are mighty; … that no flesh should glory in His presence. The Bible, Excerpts from First Corinthians 1:21-29

"For My thoughts are not your thoughts, neither are your ways My ways," says the Lord. "For as the heavens are higher than the earth, so are My ways higher than your ways, and My thoughts than your thoughts." The Bible, Isaiah 55:8-9

Great is our Lord, and of great power: His understanding is infinite. The Bible, Psalm 147:5

Daniel answered in the presence of the king, and said, "The secret which the king has demanded cannot the wise men, the astrologers, the magicians, the soothsayers, show to the king; but there is a God in heaven that reveals secrets …" *The Bible, Daniel 2:27-28*

Introduction Comments

What is the first prime number after a trillion? 1,000,000,000,039. How did I know? I have a formula for prime numbers. What is the ten thousandth prime number? 104,729. How did I know? I have a formula for prime numbers. It is a consecutive prime numbers formula starting with any number. It is limited by the current size of computers and computer programs plus the speed of the computer. This also means that if given any prime number that can be placed within the limitations of a computer, then you can find the next prime number using the formula. [U.S. numeration used herein.]

Let's first look at this formula for prime numbers, its development, and its implications. Note that this formula is this document's principal, most practical formula for prime numbers and is presented in the first part of this document. It is not the formula for prime numbers presented on the title page. The title page formula for prime numbers will be examined later in the document with yet another formula for prime numbers. So, first we will look at this document's principal formula for prime numbers. Then we will look at the pattern of prime numbers along with the two other formulas for prime numbers which are more useful for illustrating the pattern of prime numbers.

The Definition Of A Prime Number

Prime numbers are whole numbers that are divisible only by themselves and 1; furthermore the multiplication product of any two or more prime numbers gives a new number other than any of the multipliers. [This is a more precise definition of prime numbers in line with what the numbers are actually doing such as some things like the patterns that support the prime numbers pattern require the fact that 1 is not a prime number.] [To simplify our discussion, we will only deal in "positive" prime numbers in this document.]

A Look At The Definition Of A Formula

In mathematics we generally think of a formula as something to give us a desired mathematical result. We usually give values to some known variables to find out the value of an unknown variable which is our desired result. It is a great joy for a mathematician to take some known values of some variables, apply some mathematics, and give people the value of an unknown variable.

Enter the computer. In a computer spreadsheet there are things called formulas and functions which are both like what we normally think of as formulas. The distinction is for the purposes of the spreadsheet. However, with the computer we now have a whole new level of dimension and complexity for formulas. With the use of computer programs and computer macros, which are really small computer programs, we can consider these computer programs and computer macros to be very powerful, complex formulas that may involve many formulas, layered logic construction, and mathematic principles. The formula for positive prime numbers used in this document is an MS Excel spreadsheet macro which is in the MS Excel file "primenumbers.xls".

Using The Computer To Study Numbers

Another good use of the computer is to study numbers. The use of the computer to study numbers is something that should not be overlooked by mathematicians. In the development of the positive prime number formula and the observing of the pattern of prime numbers, the computer was used to visually and intellectually look for number patterns and draw conclusions. From the study of these patterns and the conclusions, the positive prime number formula was refined. Also, the observing of the pattern of prime numbers was done using computers to study numbers and patterns in many different ways.

How To Use The Formula For Positive Prime Numbers

It is assumed that you know how to use the MS Excel spreadsheet for a Windows based computer. It is beyond the scope of this document to show how to use spreadsheets. They are simple to use so you can easily learn to be able use the spreadsheets for the purposes of this document.

Special Note: In newer versions of Excel, you MUST change the "Security Level" in the menu "Tools/Macro/Security/Security Level tab" to "Medium" before you open the file or the file will not open in Excel since there is a macro in the file. If you forget to do this, close the file, change to security setting, and then open the file again. Use your virus protection checker, etc. before opening to check the file for your security. Or you may have to click Enable Macro. Or you may have to click Macro Options and Enable Content or do something else to let Security run a Macro.

Open MS Excel file "primenumbers.xls". Again, if it asks, click "Enable Macros".

Follow the directions on the computer screen.

Do not make any changes in the macro or spreadsheet.

Do not save this file while using it in order to maintain the integrity of the file. Copy and paste your results to another spreadsheet workbook and save it there.

When finished, close the file without saving.

Do not run the macro with another program or workbook running and/or open.

See the first worksheet in the file for further directions and comments.

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The Development And Refinement Of The Formula For Positive Prime Numbers

Definition, again: For the purposes of this document we will be dealing only in "positive" prime numbers. A prime number we will consider to be any whole number greater than 1 that is divisible only by itself and the number 1; furthermore the multiplication product of any two or more prime numbers gives a new number other than any of the multipliers. By divisible we mean that when you divide, there is no remainder.

The formula is a macro which generates consecutive prime numbers beginning at any number only limited by computer limitations.

If the prime number search started with the number 1, 2 or 3, the macro just basically listed the first one or two prime numbers as needed.

Then, each consecutive whole number was tested to see if it fit the definition of a prime number. Using loops, generally speaking, the number being tested was divided by all of the whole numbers that were smaller than the tested number and, in line with the prime number definition, the number was not divided by itself or the number 1. When the number being tested could be divided with a smaller number and leave no remainder, it was considered not to be a prime number in accordance with the definition of a prime number. If the number being tested could not be divided with any smaller number without leaving a remainder, it was listed as the next prime number. Then, the next consecutive number was tested, etc.

[MS Excel macros make use of a kind of computer "Basic" language called Visual Basic. Learning a very few things about Basic computer language and you can write macros. The logic of a given macro is not always evident. However, for someone who knows Basic language, the macro we are using is somewhat obvious as to what is happening when you know the comments in the document you are reading.]

The positive prime numbers formula was then run to generate consecutive prime numbers. This list was studied for patterns and drawing observation conclusions.

Observation. The number 2 is the only even number that can be a prime number because all of the rest of the even numbers can be divided by 2 and are thus not a prime number by the definition. The formula was then refined so that only odd numbers after the number 2 were tested to see if they fit the definition of a prime number. This made the formula faster.

Observation. The prime numbers 2 and 3 are the only consecutive prime numbers that are also consecutive whole numbers. We just observed that 2 is the only even prime number. Thus, the rest of the prime numbers have to be odd numbers. Odd numbers are every other number and, therefore, after 3 there can be no consecutive prime numbers that are also consecutive numbers. This observation did not help with the formula.

Observation. After the prime number 5 there can be no number divisible by 5 that is a prime number meaning that a number >5 in the base 10 number system that ends in 0 or 5 cannot be a prime number. A number ending in 0 is really "n × 10" with n≥1. 5 will divide into the ten 2 times thus making any number ending in 0 to be not a prime number. [Really, we have already noted that any number ending in 0 also could not be a prime number because it is an "even" number.] After 5, a number ending in 5 is really "(n × 10) + 5" with n≥1. On the left hand side of the "+", 5 will divide into the ten 2 times; and on the right hand side of the "+", 5 will divide into the 5 once thus making any number ending in 5 to be not a prime number. The formula already skips numbers ending in 0 since it only does odd numbers after 2. Steps were tried in the formula macro to find numbers divisible by 5 or which have the right most digit to be a five. However, when a number was tested to see if it ended in 5 in order to skip those numbers, it slowed down the formula so these kinds of steps were not used.

Observation. From the previous observations we see that after the number 5 in the base 10 number system, there can be no prime numbers ending in 2, 4, 5, 6, 8, or 0. After the prime number 5, all of the rest of the prime numbers will end in either 1, 3, 7, or 9. This observation provided no more help to the formula.

Observation. The formula at this point of development divided each tested number with every number greater than 1 and less than the number being tested. However, based on the Fundamental Theorem Of Arithmetic, we only need to divide by previous prime numbers (since the rest if these numbers are products of primes) to test a number to see if it is a prime number. The Fundamental Theorem Of Arithmetic tells us, among other things, that a number is either a prime number or a product of primes. But this observation, too, slowed down the formula to go back and read each prime number as a part of the test.

Along these same lines, it was recalled that multiplication is really a higher form of addition but this recollection never provided any help for us at the present time. It was also noticed (giving no additional help at this time) that a simple "times" table for each prime number (2 × 2, 2 × 3, 2 × 4, etc.) is an arithmetical progression in nature to create one of the future numbers in the consecutive number series of all whole numbers with each of these future numbers resulting from the "times" table being some kind of multiples of prime numbers with the prime number that the "times" table was made for. Furthermore, there is one special case in the "times" table that is a geometric progression in nature using only one prime number repeatedly and that is the case in which one of the future numbers in the consecutive whole number series resulting from the "times" table is a number that can be expressed as an exponent expression of the prime number alone (2^2, 2^3, 2^4, etc.). No new helpful patterns are seem at this time.

Comment. At this point the formula was changed so that we could start at any number to find the next prime number. This made it easy to check for very large prime numbers by starting with a large number. This also made it possible to find the next prime number after any given prime number by starting the formula with the given first prime number.

A Related Pattern Of Observations. Next, the process of testing each number by every number greater than 1 and less than the tested number was refined. We are looking to see if the tested number is divisible by one of these smaller numbers thus making it to be not a prime number. If this testing shows that no appropriate number is available to rule out the tested number to not be a prime number, then we know we have a prime number by definition.

However, when we test a number, it was observed that we only have to divide by each of the first half of the previous numbers. Any number greater than half of the number being tested is too large to divide into the tested number 2 or more times so it unusable to test for products of primes equaling 2 or greater. Thus, we only have to test with every number greater than 1 up to the number that is half of the number being tested. But, upon closer examination it was determined that we usually do not even need to use all of these numbers.

If the number being tested is a product of any number times the prime number 2, we only need to divide the tested number by 2 to find this out which shows that the tested number is not a prime number by definition. In testing we do not need to also divide by any of the numbers which are a product with some number and the number 2 nor do we need to divide by a 2 powered number to see if any of these products would equal the tested number thus making it not a prime number. Therefore, (tested number)/2 takes care of any number that is a multiple of 2 which would, with possibly other numbers included, make a product equaling the tested number. Combining our thoughts from this paragraph and the previous paragraph we thus have: when testing the tested number by using a number related to the number 2, we only need to test with numbers between and including 2 and ((1/2) × (tested number)).

In a like manner, if the number being tested is a product of any number times the prime number 3, we only need to divide the tested number by 3 to find this out which shows that the tested number is not a prime number by definition. In testing we do not need to also divide any of the numbers which are a product with some number and the number 3 nor do we need to divide by a 3 powered number to see if any of these products would equal the tested number thus making it not a prime number. Therefore, (tested number)/3 takes care of any number that is a multiple of 3 which would, with possibly other numbers included, make a product equaling the tested number. Also, any number times the number 3 would only involve the first 1/3 of the numbers that we are using to test because 3 times any of the other numbers would be larger than the tested number. Any number greater than 1/3 of the number being tested is too large to divide into the tested number 3 or more times so it unusable to test for products of primes equaling 3 or greater (we will have already checked 2 in the formula by this time). Therefore we come up with what we had for the number 2 only now the same is for the number 3: when testing the tested number by using a number related to the number 3, we only need to test with numbers between and including 3 and ((1/3) × (tested number)).

The same could be similarly be said about the next number [next consecutive number or prime number] and then the next number and so on. Therefore, we see that we only need to test the tested number with the number 2 up to only a very small amount of the possible test numbers between 1 (really 2 because 1 is of “no” effect) and the tested number! This gives us the conclusion: <u>when testing the tested number by using a number related to the number (testing number), we need only test with numbers between and including (testing number) and ((1/(testing number)) × (tested number))</u>. So the question becomes, “How many of these consecutive numbers beginning with the number 2, then 3, then 4, etc. do we need to use for testing before we say that we have a prime number in the tested number?”

Therefore our concluding observation in this pattern of related observations is: we only need to test a tested number with the consecutive testing numbers beginning with the number 2 and going up to, but not including, the number (testing number) > ((1/(testing number) × (tested number)). This observation works great with the loop design concept available to us in the macro that we are using for a prime number formula. The reason behind this concluding observation is that we said earlier that ((1/(testing number)) × (tested number)) is the largest number we need to test when working with that particular testing number because any number that is larger than ((1/(testing number)) × (tested number)) gives a product result with the (testing number) that is larger than the (tested number) making it of no use. Also, if ((1/(testing number)) × (tested number)) is the largest number we need to work with and the testing number is larger than that number, then it means that we have already done any required tests since the testing numbers have passed through all consecutive numbers up the that particular testing number. Note also that our concluding observation can be reduced to: we only need to test a tested number with the consecutive numbers beginning with the number 2 and going up to, but not including, the number (testing number) > ((tested number)/(testing number)).

Does your brain feel like it is going to dissolve? It is hard to get the preceding discussion clearly into words and keep the logic straight. I hope that I have explained this adequately and with enough clarity for you. If not, I apologize. If this discussion was not clear, please read the discussion again now that you somewhat familiar with where we are going and maybe the second reading will make more sense. Thanks!

This discussion on this pattern of related observations made the formula much faster. It also made the formula more realistic from a practical speed standpoint to work with very large numbers to check for prime numbers. This new formula was also given a reality check in that the results from it was compared to results from the original formula that used every number from the number 2 to ((tested number) – 1) and the results were the same.

Prime Numbers Generator

Open MS Excel file “primenumgenerator.xls” and follow the directions in the section entitled “How To Use The Formula For Positive Prime Numbers” in the document that you are now reading except that we are using a different file. This formula is for generating a large list of sequential prime numbers. On today’s faster home computers, this prime numbers generator formula starting from 1 will give you the first 1,000,000 prime numbers in a matter of hours; however, check your work because of computer glitches, power surges, etc.

Our earlier formula only generated 65,500 sequential prime numbers at a time. The formula we are discussing in this section will generate 16,702,500 prime numbers at a time but at a slower rate than the earlier formula if both formulas start generating at the same beginning number. The earlier formula is the faster formula. However, generating prime numbers with either formula starting with a large number will generate each new prime number at a slower rate than if you started at 1.

Current home computers begin to give us a problem when dealing with very large lists and very large numbers. MS Excel is accurate up through 14 significant digits and some numbers at the 15 digit level. This means that you can correctly find all prime numbers up through 100,000,000,000,000. And that means that your generating of prime numbers that lie between 1 and 100,000,000,000,000 would fill a huge number of worksheets. Are you able to live long enough to generate such a list even if you divided the task with some others and ran your computers around the clock? We are talking about a one person job of a huge number of years. Computers have been getting faster and faster as the years go by though.

Thus, the best use of the formulas is to find a list of prime numbers within a certain range of whole numbers. It may be useful to someone if a table of prime numbers were generated over the years that lists all prime numbers in sequence from 1 to as high as it has been generated. This would be like the reference trigonometry tables only it would be a table of sequential prime numbers numbered in order so that you could look up, for example, the 1,000,999th prime number. This might be designed like the table of segments given on the third worksheet in the prime numbers formula spreadsheet or it could be just a numbered tabled of prime numbers. To sequentially number a column of generated prime numbers in your Excel worksheet, insert a blank column beside the generated column and learn how to do a "fill series".

A Few More Comments
About Using MS Excel Visual Basic To Develop A Formula, Etc.

Some general comments:

- To see how a macro might look for a procedure, record a macro while doing the procedure in the spreadsheet. Then open the macro and see what happen. Then refine.
- The written out logic in a macro is not always written out the same way you would write it in mathematics.
- Cell reference using variables instead of numbers does not work with all types of cell references.
- Cell references may even need the drive in the path along with the workbook and worksheet to make it work on a network. Normally you do not need the drive reference but there are occasions in which a macro will work on one computer in

a network but not work on another computer. Including the drive name in the path has seemed to be the solution to these problems.

- A few comments, many of which are unrelated to each other: The size of things in a computer is limited which may limit your formulas. The memory of a computer is finite. The number of rows in an MS Excel spreadsheet is “65,536” and the number of columns goes to “IV” [256]. In the case of the prime number formula it was made to stop at 65,500 instead of listing more prime numbers somewhere else. If you want a longer list of prime numbers, you will have to copy, paste elsewhere, delete the original, and continue with the next number to run the macro again. Using the formula in “primenumgenerator.xls” may be a better choice for your purposes. The largest number in a spreadsheet is 10 to the 307th power. However, the spreadsheet only has 14 significant digits plus some of the 15^{th} digit is significant. See “Excel specifications and limits” in the Excel Help files. You will need to format the column to see a very large number.
- Memory allotted for a macro is limited. But there are ways that you can go from one macro to another macro to get a longer macro. However, the values of the variables are not carried from one macro to another. One solution to this problem is to write the value for each variable in some remote cells in the spreadsheet that are never used before jumping to another macro. Then the first thing you do in the new macro is to read the values of the variables by letting the variables equal each of those cells. Then, delete the cell contents used to write the value of the variables.
- Loops are a valuable tool in macros. If you want a loop to do different things under different conditions, use a variable in the loop with a different value when you are under a different condition. If the variable has a certain value then the macro tells you to do a certain things or go to a certain place using something like an If-Then statement.
- Int and Trunc seem to be the same in a spreadsheet but there are conditions in which they will give different results.
- The mathematical basis and logic of a step in a macro may not be readily apparent. In one macro by the writer of this document there is a step that is based on the truth sets of the various possibilities at that point. The step made the macro run twice as fast but the mathematical logic behind the design of the step and why it is used is not apparent. However, the logic of the prime numbers macro is rather apparent for those familiar with Visual Basic and mathematics.
- Newer versions of spreadsheets may have better limits than we have just mentioned. Also, the way a formula/function is written changes in various releases of a spreadsheet program and even there are changes within various releases of the same year’s spreadsheet program. Always test all of the possibility cases and check your work. Macros have seemed to be consistent from release to release which would make the prime number formula likely to work on any computer.
- If you ever need to compare two columns of numbers listed side by side in an Excel worksheet, then in a third column put the formulas "=A1-B1" or whatever the cell references for the first row in the two side by side columns might be. Of course, the result would be "0" if both of the numbers being compared are the

same. Then click the cell with the "=A1-B1" in it. Choose Copy. Select all of the rest of the cells in the formula column down to the bottom of the two lists that you are comparing. Hit Enter. Every cell in the formula column should now have a "0" in it if both of the columns being compared have the same numbers in them. However, you do not need to look at every cell in the formula column to see this fact. Click the cell right underneath the bottom of the formula column. Click the "∑", that is the Sum symbol, on the toolbar. Hit Enter. The sum should be "0" if all cells match between the two columns. Hope that was an adequate explanation. If not, think through it again.

[Please go to next page.]

The Pattern Of Prime Numbers

In order to see where we are going, let's mention that the pattern of prime numbers is: segmented and based on both the multiplication tables of the primes and based on other more primary layered patterns which have a cyclic element in these more primary patterns upon which the pattern of prime numbers is based. Now let's look at how the pattern of prime numbers became evident.

The prime numbers formula was run starting from 1. It was also run from other numbers including very large numbers. Visually looking at the lists of prime numbers showed that the prime numbers seemed almost random in dispersement which later was found out to not be the case.

Another prominent feature of the prime numbers was that all through the prime numbers list, regardless of the largeness of the number, there would be two prime numbers that were two whole numbers apart such as the prime numbers 1,000,000,000,061 and 1,000,000,000,063. This seemed to imply that the pattern of prime numbers was not likely to be some repeatable clever numbering scheme like +1+2+3+2+4+2+7+2, etc. since you suddenly every now and then had two numbers only two whole numbers apart. Really, in a sense, two whole numbers apart is two prime numbers beside each other when you consider that after the prime number 2 that only odd numbers can be prime numbers. It would indeed be a repeatable clever numbering scheme of the +1+2+3+2+4+2+7+2 variety to produce these numbers together at various places in the pattern. These numbers together in the pattern make it appear that the pattern of prime numbers starts over but it does not and neither are these the points where a new segment of the prime numbers pattern starts. Also, at other times the prime numbers have big spaces in the numbers series in which there are no prime numbers at all - - the prime numbers are far apart at these places in the whole number series. Two comments; first: the reason that the repeatable numbering scheme idea would not work or at least be exceedingly difficult was found to be that the numbering scheme would not be continuous because the pattern of prime numbers turned out to be in segments of different, though related patterns. These patterns are based on other patterns which I will refer to as "Foundation Patterns". The "Foundation Patterns" are based on the what we call the multiplication tables. And, these "Foundation Patterns" are layered. It should not be surprising that the pattern of prime numbers is based on layered thinking. God thinks in layers. We are created in layers of bones, muscles, nerves, blood vessels, etc. Trees are made in layers from year to year which is how you tell the age of a tree. So it is not surprising that God developed the counting whole numbers in layered thinking. One segment of the pattern of prime numbers is based on one Foundation Pattern. The next segment of the pattern of prime numbers is based on the next layer which is the next Foundation Pattern, etc. Second: the thing that came to mind that was similar to numbers being far apart at one moment and then close together at another moment and so on was cycles such as the orbits of planets. Heavenly bodies are far apart in orbits and then at times they are close enough together to even cause an eclipse. And indeed, it was seen that the "Foundation Patterns" were cyclic and usually within each cycle were cycles. Furthermore, rapidly these “Foundation Pattern cycles” from pattern to pattern, or really layer to layer, become so huge in size that they are hard for the human mind to comprehend much less see the cycles visually in the numbers. And even furthermore those close together prime numbers are based on a kind of reverse mathematics that punches out numbers within the “Foundation Patterns” and what is left becomes the prime numbers pattern and in this process prime numbers close together are because of “Foundation Patterns” in which the numbers in the cycle of the punch out numbers are far apart. That last phrase is important but may slip by unnoticed for significance so I am going to repeat it: in this process prime numbers close together are because of “Foundation Patterns” in which the numbers in the cycle of the punch out numbers are far apart. In a somewhat similar manner the opposite of that also turns out to be true. These comments show why the pattern of prime numbers has been so hard to visually discern for all of these years.

Here is a little bit more about the concept of “reverse mathematics”. I use the term reverse mathematics based on the concept of reverse video. In reverse video on computers the letters are white and the background is black instead of the other way around such as when you “select” words in a word processor so that you can do a font change to those words. The letters are “punched out” leaving a white letter instead. For example, in reverse mathematics we first have a set such as "2, 3, 5, 8, 22". Then we have a set "3, 8" that will be “punched out”. The Resulting Set in reverse mathematics would be "2, 5, 22". The pattern of prime numbers comes from such a “Resulting Set” in reverse mathematics for the segment of prime numbers under consideration because the Foundation Pattern is a “Resulting Set”.

Let’s do a mental exercise with the pattern of prime numbers that may expand our thinking. The purpose here is not to say that this exercise is true but rather to use the exercise to look at the pattern of prime numbers to expand our thinking and possibly to get new ideas. There is an old preacher’s story about a man watching a weaver. What the weaver was weaving was just a meaningless pattern to the man watching. However, the weaver turned his weaving over and it revealed a rug with a beautiful pattern woven into it. The point being is that what we see from our perspective in life is like looking at the pattern on the back of a rug weaving but God sees the front of the rug and understand the larger view of what is going on for our benefit. Let’s transfer this illustration to God’s rug of whole numbers. For thousands of years we have been looking to see if we could see a beautiful pattern in the prime numbers. Let’s assume for a minute that we have been looking at the back of the rug all of this time and that the beautiful pattern in numbers is on the other side of the rug. The sequential counting whole numbers are the warp of the weaving warp and woof of threads upon which we weave a pattern. The weaving of the multiplication tables grows out of the whole numbers and forms the background pattern as each multiplication table individually and uniformly in an arithmetic manner arcs cycles down the numbers. The multiplication tables have an interlacing arc effect in that, for example, 2 times 3 in the 2 table is also in the 3 table as 3 times 2. Multiplication tables based on composites rather than prime numbers add layers of beautiful interwoven lace to the prime numbers multiplication tables. The weaving of the arithmetically cycled, layered and internally mirrored “Foundation

Patterns" which we will examine more about shortly grows out of the multiplication tables and makes the large, beautiful, mosaic patterns with glittering reflections in the numbers and these patterns become so large that they can only be seen from a heavenly perspective. The cycles of the Foundation Patterns grow geometrically larger and larger from Foundation Pattern to Foundation Pattern adding lace and frills in broad, discernable, expanding kaleidoscope patterns of beauty. Paired numbers which we will also examine later do their part to add layered, glossy patterns to this beautiful, artistic composition. In a special, colossal way, what is happening is comparable to a beautiful piece of aesthetic art music. What we have so far is the beautiful rhythmic and harmonic background pattern of the numbers. The arcing thread through each prime number with its patterned values that for each prime number makes larger and larger expanding, cycling arches create infinitely rising, soaring, colorful, vibrant countermelodies in the numbers. The prime numbers are the strength and power on the back of the weaving giving underlying structure to the harmony and they are the places where we had to knot two threads of numbers together when by logic they ran out of threads (numbers) at that point. However, the thread on top of all of the weaving, that goes between the points which look like brilliantly sparkling, colored, gorgeous jewels of numbers representing each prime number squared which is the beginning of each new segment of the pattern of prime numbers on the back of the rug, this thread and points on the front of the rug rising onward and upward through the heavens moving through the infinity of eternity compose a melodic focal point of tremendous beauty overlaying all of the other beautiful number patterns. The aesthetic beauty of this glorious, heavenly art work is beyond words. Please understand that this is an exercise in mind stretching and is not intended to be an illustration of the pattern of prime numbers as presented in the document that you are reading. However, in some places there are similarities.

That should be enough to get you thinking in the direction that we are going.

[Please go to next page.]

Now let's start our look at the pattern of prime numbers.

Given: The sequential series of whole numbers from 0 to Infinity [∞], without the 0 they are the counting numbers of 1, 1+1,1+1+1, etc. [This is also the 1 times multiplication table.]

Problem: See how the whole number series could be developed for the purposes of understanding more about prime numbers and the pattern of prime numbers.

Method: Use a systematic procedure of analysis and observation using the computer.

Definition: Prime numbers are whole numbers that are divisible only by themselves and 1; furthermore the multiplication product of any two or more prime numbers gives a new number other than any of the multipliers. [This is a more precise definition of prime numbers in line with what the numbers are actually doing such as some things like the patterns that support the prime numbers pattern require the fact that 1 is not a prime number.] [To simplify our discussion, we will only deal in "positive" prime numbers in this document.]

Comment: For the study of prime numbers within positive whole numbers, whole numbers including 0 can be separated into four mutually exclusive subsets: 0, 1, prime numbers, and composite numbers by definition. All whole numbers, then, will fit into one and only one of these subsets by definition of the subsets (we will define "composite" in a moment).

Further Comment: These subsets are not to be confused with the "segments" that we break the series of whole numbers into for the purpose of seeing the pattern of prime numbers; these segments are a linear type of subsets that divide the counting number series into segments that can be laid end to end to make up all of the counting numbers (positive whole numbers). 0 will not be included in this pattern since it is the absence of any number. A Sill Further Comment: The idea of segments foreshadows the pattern of primes that this document will develop; seeing this pattern of the primes is for those who need to know more about the properties of the primes. And, this presentation of the pattern of the primes may be a possible basis for someone to make a more useful, more concise, with more mathematical predictability, etc. analysis of the pattern of the primes.

Definition and Extension: Composite numbers are the product of two or more prime numbers (which would including a product that involves the same prime more than once). Note that composites are in multiplication tables based on a prime [prime x 1 {which is the prime number itself by definition}, prime x 2, prime x 3, etc.]. Prime times 1 is the prime; all of the rest of the multiplication table products are composites based on that prime. Thus, if in the whole numbers series after 1 we removed all composites from all these multiplication tables of primes, we would have only primes left by definition (see the four earlier mentioned subsets). Actually, after the first number in any multiplication table of any number the rest of the entries are composites by definition. Remove all numbers in all multiplication tables of all numbers after the first number of each table and only primes would be left by definition while noting the fact that any first number of a table that itself is a composite would lie in some prime's multiplication table and get removed there thus leaving only all of the primes. The source of prime numbers is not a great mystery: prime numbers ultimately come from the multiplication tables which we have always known by definition but need to explore more deeply.

PROCEDURE AND OBSERVATIONS: Now, let's develop (or examine) the whole number series for the purposes of understanding more about prime numbers and the pattern of prime numbers. Why do we develop the whole number series in the following way? Because it shows us the pattern of prime numbers. The procedure shows us the "exact" pattern of the prime numbers and not an "approximate" pattern.

[Zero {0}]
0 is none like an empty pot; it is neither prime nor composite by definition and thus does not affect our development of prime numbers and composites. In number representation like the base 10 system, 0 also acts as a place holder such as 905 which is nine 100's + zero 10's + 5 units. Since zero is the absence of any number, it will not be considered in a segment in the pattern of prime numbers.

SEGMENT 1 OF THE PATTERN OF PRIME NUMBERS

After the number 1, all whole numbers are either prime or composite by definition. Prime numbers give us composite numbers. But, composites give us primes by "what's left" after the composites are made. Primes create composites and those composites create new primes by "what's left" in the whole number series after the composites are made. It is what we call the multiplication tables of each prime that make the composites.

Notice that if a number is not in any previous prime's multiplication table, then that number is a prime because it could not be a product of primes making it to be a composite. But this previous statement is too broad to show us the pattern of the primes and the statement needs to be broken down into smaller steps. We do not work with all of the generated primes at once but we instead go through them one by one.

The fact that composites create primes is the principal path that we will follow to get our conclusions because composites creating primes shows us both structure and substructure.

The pattern of prime numbers is in segments because the pattern changes from segment to segment.

To see the pattern in the prime numbers, we need to notice the fact that the point in the whole number series at which a prime's composites creates a "unique and changing effect" is "the point of a change" in the pattern of prime numbers because that is where the prime's composites begin to affect the whole number series in regard to primes and composites. THIS MAKES THE SEGMENTS IN THE PATTERN OF PRIME NUMBERS. This is the first time that a prime gets involved with affecting the number series and will thus affect the number series from there on forward. This point of "unique and changing effect" represents a special dividing effect on the number series of when the prime's composites do not effect to when the prime's composites do effect the number series. As we do our analysis, notice that the prime itself was created in an earlier segment.

There will also be other underlying facts to observe as we do our analysis.

Now let's look at the development of Segment 1 of the pattern of prime numbers.

Segment 1 is based on no prime's composites having an unique and changing effect on the number series. That is, no prime will make a unique composite changing effect in this segment. By unique effect we mean a composite that is not in an earlier multiplication table of an earlier prime. Of course, in this first segment there is no earlier multiplication table so the first entry of the first multiplication composite makes the unique as well as the changing effect. By changing effect we mean changing in regard to primes and composites as mentioned earlier. Since there are no primes in the whole number series before the number 1, there can be no composites made until we get some primes.

Segment 1 in the pattern of prime numbers obviously starts at 1. The range of segment 1 continues until a prime number makes a unique composite and change and then we are into the second segment which would now have a different pattern since composites are involved. We need a prime to make a unique composite changing effect. At the number 1 we do not have a prime by definition. The number 2 would be our first prime since there are no earlier, smaller primes that could make a composite being 2. Actually all of the numbers greater than 1 in segment 1 will be primes. The first and smallest prime would then be 2. The first number in the prime number 2 multiplication table that would be a unique composite would be 2 x 2 or 2 square $\{2^2\}$ which is our first composite in the whole number series. This would be a unique composite effect since it is not in an earlier multiplication table because there are no earlier multiplication tables in this case. And, this is a change in relation to primes and composites since we are going from a segment of all primes after the number 1 to a segment that has composites in it. Where did this rule about unique composite effect and change in relation to primes and composites come from? It was observed as something that shows the pattern of the primes. So, the range of segment 1 in the pattern of prime numbers is 1 to ((first prime number)^2 – 1) or 3. The range starts at 1 because there are no previous primes. The range of the segment stops at ((first prime number)^2 – 1) or 3 because (first prime number)^2 starts the next segment. (First prime number)^2 is where the change in the pattern of prime numbers occurs. This statement about the range of the segment stated in this manner for this first case of a segment is needed to keep things in parallel with the statements of the future segments of the patterns of prime numbers. Note that (first prime number)^2 is really ("next" prime number)^2 as it will be stated in the final form of the pattern statement. At the very beginning the "next" prime number is really the first prime number.

Again, by unique effect we mean that it is a composite that does not also exist in the multiplication table of an earlier prime number than the prime number affecting this segment. We are looking for a composite that is uniquely new so that it can change the pattern of the prime numbers for the next segment to start.

Also, there are higher powers of the next prime that are uniquely only in that next prime's multiplication tables and not in earlier multiplication tables. However, the ("next" prime number)^2 is both unique to that next prime which does not exist in an earlier prime's multiplication table and also this is the number that represents a change from the multiplication tables of earlier primes making composites changing to a new prime making composites without any help from an earlier prime. Prime square of next prime is where the multiplication tables of all preceding primes are still continuously punching out numbers but now the new prime also punches out numbers and this leaves the new primes for this new segment under consideration. Thus we have a new and changed segment because of the entrance of the new prime punching out numbers in this new segment.

At the next prime squared that next prime's multiplication table is now uniquely affecting the pattern and not uniquely doing so before. The composite from the next prime squared now uniquely involves that next prime in making composites which only affects the number series forward from that next prime and not backward thus the pattern has to change. At the point of the next prime squared we have a composite by definition since two numbers other than 1 are multiplied together but it is not a composite from a prime smaller than that next prime so the pattern has to make some kind of change to involve this next prime at this unique point.

By logic working up the whole numbers sequentially in segments starting from the beginning of the whole number series we see that any number not in the multiplication table of the primes up to that point would have to be a prime since those in the tables would be a composite and the rest by definition would be primes since they are not composites. At ("next" prime number)^2 this logic breaks down and we are starting the next segment which can use the same logic for that segment. This process by expanding the logic in the same manner continues to infinity.

These segments make up the pattern of prime numbers and furthermore each segment will be in a different pattern as we can see from the above discussion. Is there any rhyme or reason to the patterns within the segments? Yes. Later we will more thoroughly examine the basis for the patterns within each segment.

Since there are no multiplication table composites in this first segment, there is no "Foundation Pattern" from which any numbers were removed from the whole number series leaving a "Resulting Set" that is the "Foundation Pattern". Thus all of the numbers after 1 in this segment are primes. We will define and discuss “Foundation Patterns” momentarily.

Thus, after 1, which is not a prime number, all numbers in the whole number series in this segment will be prime numbers because no prime numbers are affecting this segment with composites to make numbers that are not primes. So, the pattern of prime numbers for this segment 1 is 1 and then all numbers are prime numbers [1 which is neither prime nor composite by definition, prime number 2, prime number 3]. We will shortly see more details showing that the prime numbers in this segment are 2 and 3.

[One {1}]
1 is the first whole number and the unit; it is neither prime nor composite by definition and thus does not affect our development of prime numbers and composites except that the first whole number which is “1” cannot be a prime or composite by definition. The fact that 1 is not a prime number is important in our development of “Foundation Patterns” to be defined later. If 1 were to be a prime, then the “Resulting Set” that is the “Foundation Pattern” in those steps would not be internally somewhat mirrored and cyclic in conjunction with the “Foundation Pattern” itself being cyclic to infinity. Thus, we have arbitrarily defined 1 to not be a prime number for that reason.

At this point in our procedure all numbers greater than 1 are available to be either prime numbers or composites. These numbers after 1 must be primes or composites of primes because for both primes and composites they are all divisible by 1 and themselves and their product with another number other than 1 will be a new number since the only time two numbers can be multiplied together and not get a new number is when one of the numbers is 1 [if in the equation xy=z we have y=z, then x solves to be 1]. Therefore, the rest of the numbers after 1 are primes or composite products of primes.

It might be mentioned in passing that it has already been established in mathematics that we never run out of prime numbers as we go up the whole number series. Hence we will not take time to examine how the logic of developing these segments would support the fact that we would never reach a place that the rest of the segments would be segments in which the composites would punch out all of the numbers in the segments and thus there would be no more prime numbers. After any given number there will always be a prime number. However, our later twin prime discussion does show why there will always be a prime.

There is an interest in the “Density” of prime numbers in the whole number series. As the whole numbers get larger the density of prime numbers goes down when comparing significant ranges of whole numbers. This is obvious and logical since we are getting more and more prime numbers as we go up the number series and the multiplication tables of all of these prime numbers are creating more and more composites with each multiplication table going to infinity even though the larger the prime the further it reaches down the number series to make another composite or multiple. Every segment of the pattern of prime numbers adds another prime to punch out its related composites up to infinity. Density does not go down randomly as it seems. Admittedly it is a puzzle at first. For instance, do not be confused by such things as the fact that the 1,000 just before 10,000,000,000,000 has 26 prime numbers and the 1,000 just after 10,000,000,000,000 has 34 prime numbers but this 1,000 before and the 1,000 after 10,000,000,000,000 are unrelated to the segments in which a new prime starts decreasing the density by making more composites. But really density does not always go down from segment to segment. So what is going on here? Density obviously drops at a new segment in the Foundation Pattern because the prime of that segment starts punching out composites related to the prime. We will see later that this punching out is cycled and uniform from cycle to cycle in the Foundation Pattern of that prime but the segment does not start and end with the Foundation Pattern thus the density drop in the whole numbers series and from segment to segment appears erratic. It may even temporarily go up from one segment to another depending on where the segment is cut from the Foundation Pattern. Also, a segment may involve more than one Foundation Pattern cycle including parts of a Foundation Pattern cycle at the beginning of the whole number series and then later segments of primes involve only smaller and smaller pieces of a Foundation Pattern cycle. The dropping of density in a segment can be puzzling without this knowledge about the Foundation Pattern which we will examine more later. This can be seen when we look at Foundation Patterns. After Foundation Patterns are explained, look at the illustration of Foundation Pattern Actions worksheet in the prime numbers formula spreadsheet to observe these preceding facts.

The prime numbers formula spreadsheet has a third worksheet in it that is a summary table of the Pattern Of Prime Numbers with other related facts such as density. Also, the worksheet of Foundation Pattern Actions is in that same spreadsheet and can be used to observe the basis of density from the Foundation Patterns.

[Two {2}]
2 is the next whole number after 1 and it is a prime because there are no previous primes for it to be a multiple of to make it a composite number and it fits the definition of a prime. Thus, it is in the earlier mentioned subset called prime numbers because that is the only one of the four subsets it would qualify for by definition.

After 1 and 2, the prime number 2 makes half of the remaining whole numbers into composite numbers being the multiples of 2.

We call this list of numbers, including the 2, the “2 times multiplication table” with 2x1 being the prime and the rest of the numbers being composites: 2 x 2, 2 x 3, 2 x 4, 2 x 5, 2 x 6, etc.

Any multiple of 2 must by definition be in the 2 times multiplication table

Multiplication is the mathematical easy way of continually adding 2's to 2: 2 [one 2 or 2 x 1 to fit the pattern], 2+2 [two 2's or 2 x 2], 2+2+2 [three 2's or 2 x 3], 2+2+2+2 [four 2's or 2 x 4], 2+2+2+2+2 [five 2's or 2 x 5], 2+2+2+2+2+2 [six 2's or 2 x 6], etc.

The two times multiplication table can be written as: 2N For N = 1 To ∞. ∞ is infinity.

The two times multiplication table we call the “even” numbers I assume because they can each be divided evenly in half giving two equal parts - - each part is “even” with the other part.

All of the other whole numbers, including 1 and other than 0, we call odd numbers which can be written as: (2N – 1) For N = 1 To ∞.

The odd number "1" would be written in this preceding notation as: (2N – 1) For N = 1.

After the entrance of the prime number 2, only the odd numbers other than 1 are now available as possibilities to be primes because all of the even numbers are used up in the 2 times multiplication table and we are already finished with the odd number 1 which is not available to be a prime or a composite by definition; thus (2N - 1) for N = 2 To ∞ are now the only numbers remaining that possibly could be a prime.

The spreadsheet was continually useful to visually study and observe the numbers as different patterns emerged. The left edge of the worksheet is the whole number series. Writing odd numbers, for instance, at their respective places in a column {cell 1 would be (2N - 1) for N = 1, cell 3 would be (2N - 1) for N = 2, cell 5 would be (2N - 1) for N = 3, etc.} and then use fill series to fill the column proved very helpful to see what was going on and to raise issues to check out as ideas were developed. Several columns of these numbers were made side by side to examine what was happening as new primes entered the picture. This particular visual study resembles the illustration of Foundation Pattern Actions worksheet in the prime numbers formula spreadsheet.

[Four {4}] (We will get to 3 in a minute)
As we just said, 4 is the first composite and it is 2 x 2 which is the smallest product of the first and smallest prime. It actually is the first prime squared {2^2} which is significant because it uniquely breaks and changes the pattern of the segment of prime numbers that we are in and thus starts another segment of the pattern of prime numbers. 2^2 is the second number in the 2 times multiplication table. It is unique in that it is only in the 2 times multiplication table and not in an earlier multiplication table since we have no earlier multiplication table and it makes a change since we go from all primes after the number 1 to a segment that contains composites.

[Three {3}]
3 thus is the second prime number because we just said that we cannot have a composite until the number four; therefore, 3 is a prime number since it is before four and thus cannot be a composite and furthermore it fits the definition of a prime. And, thus, it is in the earlier mentioned subset called prime numbers because that is the only one of the four subsets that it would qualify for by definition.

More on the prime number 3 later.

It is time to introduce our second segment of the pattern of prime numbers.

SEGMENT 2 OF THE PATTERN OF PRIME NUMBERS

Segment 2 is based on the number 1 prime which is prime number 2 which is now affecting the number series with composites from the 2 times multiplication table to punch out and we will also now punch out prime 2 square since it is having a changing influence and punch out larger products using 2. [It might be noted in passing that the 2 times multiplication table has other primes in it such as 2 x 3 but it is because of the prime number 2 multiplication table introduced it and not because of the prime number 3 multiplication table first introduced it and more important is the fact that the 3 does not uniquely make its first and changing effect on the whole number series here.]

In the segments with the process we are using, we allow for all of the composites that would be possible up to that point in the whole number series. Then, the rest of the numbers in the segment would be primes by definition since they are not composites.

From now on the range of each new segment of the pattern of prime numbers will be "(prime square) to ((next prime square) - 1)". The range of segment 2 of the pattern of prime numbers starts at 4 $\{2^2\}$ as we established in the previous segment. The range continues until the next prime number makes a unique composite effect with change and then we are into the segment 3 which would now have a different pattern since another layer of composites from another multiplication table is involved. We need the next prime to make a unique composite effect with a changing effect. We established in the previous segment that the next prime after 2 would be 3. So, what is the first number in the prime number 3 multiplication table that would be a unique composite and a changing effect? It would not be 3 x 2 because that is introduced in the multiplication table of the previous prime. Again it is the square of the next prime $\{3^2\}$ because up until the square of the next prime all of the numbers in the multiplication table of the next prime would involve smaller primes or composites of smaller primes. Any numbers smaller than the prime times itself has already been considered since we are going up the number series one by one starting at the beginning. By going up the number series one by one starting from the beginning we are always in a position of having already considered all primes and their composites that are smaller than the next prime square. The next prime squared is where all previous primes and their composites stop punching out numbers and leaving primes in the segment under consideration. So, the range of segment 2 in the pattern of prime numbers is 4 $\{2^2\}$ to ((next prime number)^2 – 1) or 8 which is $\{(3^2 – 1)\}$.

All of the remaining numbers in the segment are primes by definition because all possible composites have been punched out up to that point.

Definition of "Foundation Pattern" from observation and logic: The "Foundation Pattern" for the segment under consideration is the "Resulting Set" after the multiplication tables of all of the primes up to and including the prime of the current segment have been punched out or removed. The length of the Foundation Pattern cycle is the product of all of the primes up to and including the prime in the segment under consideration. The Foundation Pattern starts at 1 and cycles to infinity. After segment 1 of the pattern of prime numbers, each segment has a “Foundation Pattern” upon which the pattern of prime numbers is based. THE PATTERN OF PRIME NUMBERS FOR THE SEGMENT UNDER CONSIDERATION IS CUT FROM THE CYCLES OF THE FOUNDATION PATTERN FOR THE RANGE OF THE SEGMENT AND THAT RANGE IS (THE PRIME OF THE SEGMENT) ^{2} TO ((NEXT PRIME) ^{2} - 1). [Again, prime square of the prime of the segment is where the multiplication tables of all preceding primes are still continuously punching out numbers but now the new prime also punches out numbers and this leaves the new primes for this new segment under consideration. Thus we have a new and changed segment because of the entrance of the new prime punching out numbers in this new segment. Since we are going sequentially in our examination we know that all numbers that are not composites of any prime up to and including the prime of our segment have to be primes by definition because they are not a composite. However, the number at next prime square is not a prime but instead a composite since it is a product of primes and it is not a composite from any prime up to and including the prime of the segment so we are thus into a new segment.] The segments are the pattern of the prime numbers. However, does anything show us where the pattern of the prime numbers within each segment comes from? Yes, the Foundation Pattern shows us the design from which the pattern of each segment is cut. Each Foundation Pattern has a specific design which is related to the designs of the preceding Foundation Patterns. Each Foundation Pattern starts at 1 and uniformly cycles to infinity. Each Foundation Pattern is uniform within itself and all but the first Foundation Pattern is somewhat internally mirrored within itself. Where does the design of the Foundation Pattern come from? This will be explored as we go along.

THE “FOUNDATION PATTERN” FOR THE SEGMENT OF THE PRIME UNDER CONSIDERATION IS THE BASIS FOR DERIVING THE PATTERN OF PRIME NUMBERS IN THAT SEGMENT! Foundation Patterns are layered on to Foundation Patterns from earlier segments of the pattern of prime numbers. The prime is created in an earlier segment but that prime later punches out in its own Foundation Pattern for the purposes of making its own segment. Compared to earlier Foundation Patterns, each new Foundation Pattern “punches out” more numbers because one more prime is involved and thus makes a new, less dense in numbers Foundation Pattern usually resulting in a segment that is less dense in prime numbers because more primes are punching out composites to leave fewer primes. In some cases though, depending on where the range of the segment is cut out of the Foundation Pattern cycles we can have a segment that may go up in density of prime numbers such as segment 8 based on prime number 17 and segment 9 based on prime number 19. Also, at the beginning there may be several cycles or parts of cycles of the Foundation Pattern within the range of the segment under consideration. But very quickly as we go to the next segments of the pattern of prime numbers here we see that the range of the pattern of prime numbers is just a small part of just one cycle, the first cycle, of the Foundation Pattern because the Foundation Patterns quickly get very large. Look at the illustration of Foundation Pattern Actions worksheet and the Pattern Of Prime Number worksheet in the prime numbers formula spreadsheet to observe these preceding facts.

The cycle or length of the "Foundation Pattern" is based on the current prime for the segment and the Foundation Pattern of the previous primes. Each prime punches its multiplication table out of the Foundation Pattern when that prime is the prime of the segment related to the Foundation Pattern. As each of the various primes punches out its multiplication table when it is the prime of the segment related to the Foundation Pattern, cycles begin to emerge in the Foundation Pattern. Segment 1 has no Foundation Pattern because as we said earlier: since there are no multiplication table composites in this first segment, there is no "Foundation Pattern" from which any numbers were removed from the whole number series leaving a "Resulting Set" that is the "Foundation Pattern". [Note that "Resulting Set" is used in this document for two Resulting Sets: the one that makes the Foundation Pattern and occasionally the one that is the segment.] Segment 2 is based on the prime number 2 and the 2 times multiplication table is punched out in the Foundation Pattern. The prime number 2 cycles at each multiple of 2 in the Foundation Pattern so the length of the Foundation Pattern in segment 2 is 2. It will help to visualize this discussion by referring to the illustration of Foundation Pattern Actions worksheet in the prime numbers formula spreadsheet. Segment 3 is based on the prime number 3 and the 3 times multiplication table is punched out of the previous Foundation Pattern. The prime number 2 cycles at each multiple of 2 and the prime number 3 cycles at each multiple of 3 in the Foundation Pattern but the whole pattern cycles at 6 which is the product of the primes 2 and 3 so the length of the Foundation Pattern in segment 3 is 6. The 2 arcs down the number series 3 times while the 3 arcs down the number series twice and then they are together again like at the beginning so the cycle can now repeat and keep repeating to infinity. Thus the length of the Foundation Pattern cycle is the product of all of the primes up to and including the prime that the segment is based on. So, if 2 and 3 were the primes involved, that would mean the length of the cycle would be 6 {2 x 3 or 3 steps of the 2 times table and 2 steps of the 3 times table}; for 2, 3, and 5 the cycle length would be 30 {2 x 3 x 5}; for 2, 3, 5, and 7 the cycle length would be 210 {2 x 3 x 5 x 7}. Thus we see that the Foundation Patterns get very large very quickly. Each segment of the pattern of prime numbers is based on another prime. The current prime for the segment has a Foundation Pattern that has numbers that are "punched out" in the whole number series and as you go from segment to segment more and more numbers are punched out.

The Foundation Pattern always starts at 1 as we are defining the Foundation Pattern. Foundation Pattern is not to be confused with "segment" which always starts at prime square of the prime of the segment. The segment cuts from the Foundation Pattern to get the pattern of prime numbers for that segment. The segments then makes up the pattern of prime numbers. These newly created prime numbers in each segment are "what's left" after the composites are punched out. Not every number in the Resulting Set that makes the Foundation Pattern is a prime. However, for the range of the segment cut from the Foundation Pattern, every number that is left is a prime because our process has punched out all composites possible up to that point in the whole number series for the range of the segment so the remaining numbers would be primes by definition since they are not composites.

Segment 2 of the pattern of prime numbers is based on the number 1 prime which is the Prime Number 2. There is only one multiplication table of composites in this segment which is the 2 times table. The "Foundation Pattern cycles" of the punch outs and the multiplication table are the same in this segment. The Foundation Pattern of punch outs for this segment is 2 x 1 {2}, 2 x 2 {4}, 2 x 3 {6}, 2 x 4 {8}, [8 is as far as we need to go because of the range of this segment]. <u>In the range of 4 to 8, this Foundation Pattern "punches out" 4, 6, 8 leaving the Resulting Set of 5, 7 which is the pattern of prime numbers for segment 2 [blank, prime number 5, blank, prime number 7, blank] (they are primes by definition since we have eliminated all possible composites).</u> This segment involves only on one prime which is the prime number 2. Thus, the Foundation Pattern cycles after every 2 whole numbers with the Foundation Pattern being: leave 1 {number 1}, punch out 1 {number 2}; next cycle, leave 1 {number 3}, punch out 1 {number 4}; next cycle, leave 1 {number 5}, punch out 1 {number 6}; next cycle, leave 1 {number 7}, punch out 1 {number 8}. [Note the further support for the range always ending at ((next prime number)^2 – 1) because (next prime number)^2 would be inaccurate in that it was not punched out even though it was not a prime (it is always a composite being a square and cannot be punched out by a smaller prime since this composite involves "only" the "next" prime).]

Note that a prime does not suddenly jump up in the whole number series and start exercising its mathematical muscle. It comes about in a earlier segment of the pattern of prime numbers and waits until a later segment before it makes an effect. (In our process the prime punches itself out in the segment that it makes an effect and not in the segment in which it was created.) In due time all primes will come up with their own segment of the pattern of prime numbers.

In later Foundation Patterns the 3 times multiplication table has first the prime number 3 and the rest of the numbers in the multiplication table are composites in a similar manner to the 2 times multiplications table. The 3 times multiplication table could be written as 3N for N = 1 To ∞. The same similar manner things could be said for all multiplication tables.

Also in later Foundation Patterns, 4 and other composites containing 4 are not considered for a segment since the 4 times multiplication table lies in an earlier segment (4 times multiplication table is in the 2 times table). A multiplication table based on a composite has no unique and changing effect on the number series like the multiplication tables of the primes. A multiplication table based on a composite is swallowed up by the multiplication tables of the primes that are involved to make the composite. Multiplication tables based on composites like the 4 times table make another type of layers growing out of earlier multiplication tables, in this case the 2 times table, which add to the beauty of the whole number system but does not seem to help us at this time in the pattern of prime numbers.

After the first two segments, the Foundation Pattern is somewhat mirrored in the number positions in the whole number series comparing the beginning and end of the cycle and working to the middle which also gives the Foundation Pattern some symmetry. With an examination of the mirroring in the Foundation Pattern, we readily see much uniformity and design to the Foundation Pattern. So then why do we not readily see this great uniformity and design in the pattern of prime numbers? Because the segment is not the same as the Foundation Pattern. The segment is cut from a Foundation Pattern and does not include the whole Foundation Pattern. But now we should see the fact that the pattern of prime numbers is based on great uniformity and very noticeable design!!! We just cannot readily see that grand, magnificent design without looking at the Foundation Patterns that show us the underlying design in the pattern of the prime numbers!

Let's look more at the design of the Foundation Patterns which appear in segments 3 on to infinity. Again, look at the illustration of Foundation Pattern Actions worksheet in the prime numbers formula spreadsheet to observe our discussion. The Foundation Pattern for segment 3 already has the multiplication table of prime 2 punched out. Note that in making the Foundation Pattern for segment 2 based on prime number 2 that every 2nd number was punched out because of the 2 times multiplication table. We are punching out 1/2 of the numbers. In the Foundation Pattern for segment 3 based on prime 3 that we do not need to punch out every 3rd number because of the 3 times multiplication table. The 2 times table earlier has already punched out every 2nd entry in the 3 times multiplication table. Thus to make the Foundation Pattern for segment 3 we are not punching out 1/3 more of the numbers but instead 1/6 more of the remaining numbers for a total of 4/6 of the numbers punched out. When we get to segment 4 based on prime number 5, we do not need to punch out every 5th number because of the 5 times multiplication table. Every 2nd 5 was punched out in the 2 times multiplication table. Every 3rd 5 was punched out in the 3 times table. Our process continues in the same manner in all future Foundation Patterns; for example, segment 5 based on prime 7 every 2nd, 3rd, and 5th 7 are already punched out in the Foundation Pattern. Also notice that the numbers in the Foundation Pattern which are the additional punched out numbers when compared to the previous Foundation Patterns would involve: the prime of the segment, the prime squared, and any numbers that are composites of the prime with itself (exponential powers of the prime of the segment) or the prime itself with primes that are higher (larger) than the prime of the segment including any exponential powers of any of these including exponential powers of the prime of the segment (we have punched out all other earlier, smaller primes and their composites including any composites of earlier primes and the current prime of the segment); this is what the prime of the segment punches out that is not already punched out. This discussion also speaks to density of the primes but remember that this present examination is about density of numbers in the Foundation Patterns. The pattern of primes is cut from the Foundation Patterns making the density of the numbers in the Foundation Pattern have a bearing on the density of primes in the pattern of primes for the segment. Density of numbers goes down from one Foundation Pattern to the next but the drop in density of numbers available to be primes is not always immediately reflected in the density of the primes for a segment which may go slightly up because of where the segment is cut in the Foundation Pattern. There is obviously a drop in the density of numbers available to be primes in each new Foundation Pattern because we punch out a new prime with it additional punch outs because of its multiplication table. But as stated earlier, this uniformity in number drop density does not always correspond to the drop in density of the primes because of where the cut for the segment is. To accurately reflect density of primes, density of primes must be calculated segment by segment because the segment is cut from the Foundation Pattern which is the place of the uniform drops in number density of numbers available to possibly be prime numbers. Density can also be calculated from 0 to the end of any given segment to get the density of primes up that far in the number series.

The mirror in Foundation Patterns begins with the segment 3 Foundation Pattern which is based on prime 3. In the multiplication tables based Foundation Pattern cycle for prime 3 starting at 0 we earlier had a 2 punched out, we have a 3 punched out, we had a second 2 punched out earlier, and at the end of the cycle another 2 was punched out earlier. This makes the Resulting Set for the cycle (which is the Foundation Pattern) to be: number, blank, blank, blank, number, blank. See the illustration of Foundation Pattern Actions worksheet in the prime numbers formula spreadsheet and look at prime 3 Foundation Pattern. Notice that starting at the last number of the cycle letting that blank be like the 0 and punching out the multiplication tables going backwards in reverse, you get the same basic effect because each multiplication table involved arcs both forwards and backwards in a uniform manner regardless of which direction you go in the number series: number, blank, blank, blank, number. Look at segment 4 Foundation Pattern based on prime 5 and see the mirror with the last number position where the cycle ends being a blank. Again, the reason for the mirror is the fact that each multiplication table involved arcs forwards and backwards in a uniform manner. Note that if 1 were a prime it would be punched out by now and the Resulting Set which is the Foundation Pattern would no longer be neither cyclic nor mirrored when in fact it is both which is why this document does not define 1 to be a prime number. These are the blanks in segment 5 Foundation Pattern based on prime number 7 (notice the symmetrical mirror with the center in quotes): 9;1;3;1;3;5;1;5;3;1;3;5;5;1;5;3;1;5;3;5;7;3;1;"3";1;3;7;5;3;5;1;3;5;1;5;5;3;1;3;5;1;5;3;1;3;1;9. Some observations can be made about the design of the mirror. The last number of the cycle is not a part of the mirror as mentioned before; it is where all multiplication tables involved punch out at the same time to end the cycle. Because the 1 is not punched out, the first number position will never be punched out in a cycle. Because of the mirror of the 1 position, the next to last number position will never be punched out in the cycle of the Foundation Pattern under consideration (until, of course, a larger prime's Foundation Pattern's cycles possibly punches out these numbers in the current Foundation Pattern cycles). Now note that every cycle of the Foundation Pattern has the same positioning of blanks and numbers not punched out because the multiplication tables doing the punching out just repeat the same arcing patterns in relation to each other. For example, in segment 4 Foundation Pattern based on prime 5, the 25 position is punched out because it is a composite of 5 (and should not contain a composite prime smaller than 5 or it would not have been punched out by prime 5 square composite). In the 101st cycle of this Foundation Pattern at the same position in the cycle the number 3,025 is punched out as it should be which has the composites: 5 square and 11 square. The 1 position at 3,001 should be left and it should have a prime larger than 5 or be punched out by a composite with all involved primes being larger than 5 so that it would not have been punched out by a multiplication table of any prime up to prime 5; 3,001 is a prime larger than 5. In the 10,001st cycle of this Foundation Pattern at the 25 position in the cycle the number 300,025 is punched out as it should be which has the composites: 5 square, 11, and 1091. The 1 position at 300,001 should be left and it should have a prime larger than 5 or be punched out by a composite with all involved primes being larger than 5 so that it would not have been punched out by a multiplication table of any prime up to prime 5; the composites of 300,001 are: 13, 47, and 491 which are all larger than 5. Thus we see that there is much design in the Foundation Patterns and their cycles. The pattern of prime numbers segments are cut from these magnificent, grand designs but they are cut in such a way that it makes the design hard to see without seeing the underlying <u>layers</u> of Foundation Patterns. In addition to the cycles of the Foundation Patterns and the segments, we are very quickly looking through layers and layers of numbers as we go hunting the pattern of prime numbers and this fact makes it hard to see the pattern of prime numbers at first. By the time we get to prime number 8,009 we are looking through over 1,000 layers of numbers to try to see the pattern of prime numbers.

We will see more about the patterns in the Foundation Pattern cycles when later we look at major and minor paired numbers.

Also, see the Composites worksheet which is in the prime numbers formula spreadsheet on sixth worksheet to quickly find the composites, if any, of a number. You may have to click the little tab arrows at the bottom left of the screen to see the tabs for all of the worksheets.

SEGMENT 3 OF THE PATTERN OF PRIME NUMBERS

Segment 3 is based on the number two prime number which is prime number 3 which is now affecting the number series with composites from the 3 times multiplication table and we will also now punch out prime 3 square since it is having a changing influence and punch out larger products using 3.

The next prime number after 3 is 5 we already know from the previous segment of the pattern of prime numbers. 5 uniquely makes its first unique and changing effect on the whole number series at 5 square.

The range of each new segment of the pattern of prime numbers is (prime square) to ((next prime square) - 1). Thus, the range of segment 3 of the pattern of prime numbers starts at 3^2 {9} which we established in the previous segment. The range continues until the next prime number makes a unique composite with a changing effect and then we are into the segment 4 which would now have a different pattern since another layer of composites from another multiplication table is involved. We need the next prime to make a unique composite changing effect. We established in the previous segment that the next prime after 3 would be 5. Again, the first composite of the 5 times multiplication table that makes a unique composite change is the square of the next prime {5^2} because up until the square of the next prime all of the numbers in the multiplication table of the next prime (other than 5 x 1) would involve composites of smaller primes. Any numbers smaller than the next prime times itself has already been considered since we are going up the number series one by one starting at the beginning. By going up the number series one by one starting from the beginning we are always in a position of having already considered all primes and their composites that are smaller than the next prime square. So, the range of segment 3 in the pattern of prime numbers is 9 {3^2} to ((next prime number)^2 – 1) or 24 {(5^2 – 1)}.

Segment 3 of the pattern of prime numbers is based on the number 2 prime which is the Prime Number 3. There are two multiplication tables of composites in this segment which are the 2 times table and the 3 times table. The “Foundation Pattern” grows out of the 3 times multiplication tables. The “Foundation Pattern” is developed from previous primes, if any, and the multiplication table for the current prime in the segment under consideration giving us a “Foundation Pattern” that cycles allowing the observer to see more patterns in the numbers that are the basis of the pattern of prime numbers for the segment under consideration. The current prime {3} and the previous primes {2} combine to give us the Foundation Pattern cycle length of 6. The Foundation Pattern additional punch outs through its segment for this Foundation Pattern is 3 [the current prime] x 1 {3}, 3 x 2 {6}, 3 x 3 {9}, 3 x 4 {12}, etc., up to 3 x 8 {24} [24 is as far as we need to go because of the range of this segment]. In the segment range of 9 to 24, besides earlier punch outs, with multiples of 3 this Foundation Pattern additionally “punches out” 9, (12 was previously punched out), 15, (18 was previously punched out), 21, (24 was previously punched out) leaving the Resulting Set of 11, 13, 17, 19, 23 which is the pattern of prime numbers for segment 3 [blank, blank, prime number 11, blank, prime number 13, blank, blank, blank, prime number 17, blank, prime number 19, blank, blank, blank, prime number 23, blank]. This segment involves two primes which are the prime number 2 and prime number 3. Thus, the Foundation Pattern cycles after every 6 whole numbers with the Foundation Pattern being given above and the Resulting Set to make the Foundation Pattern being: leave 1 {number 1}, (number 2 is already punched out), punch out 1 {number 3}, (number 4 is already punched out), leave 1 {number 5}, number 6 is already punched out); next cycle; etc. Note that this same cycle pattern repeats over and over: leave 1, 1 is already punched out, punch out 1, 1 is already punched out, leave 1, 1 is already punched out. Notice what was punched out additionally just now by the 3 multiplication table? No multiples of 3 that are “even” punches out since they are already punched out because the 2 times table contained all multiples of 2 which are the even number multiples of 3. This principle of multiplication tables in preceding segments having multiples of future primes and already punching them out earlier happens in the construction of future segments. [Again, note the further support for the range always ending at ((next prime number)^2 – 1) because (next prime number)^2 would be “inaccurate in that it was not punched out even though it was not a prime” (it is always a composite being a square and cannot be punched out by a smaller prime since its composites involve “only” the “next” prime).]

Again, the prime numbers formula spreadsheet has a second worksheet in it that is an illustration of Foundation Pattern Actions to help you visualize these discussions.

There is an interest in prime number twins which are two prime numbers separated by one number such as 11 and 13. At segment 3, after the number 3, the punched out number series left after the number 3 punch outs is only pairs of numbers that could possibly be twin primes. Because of the arcing of the various multiplication tables in the Foundation Patterns of the various primes in future segments some of the pairs of numbers still have not been punched out in segments so we have twin primes in futures segments. Remember earlier we described this arcing to be similar to the orbits of heavenly bodies in which sometimes things are far apart and sometimes things are close together even making an eclipse effect. Using the illustration in the Foundation Pattern Actions mention earlier, let's examine the segment 3 Foundation Pattern more closely. The prime number 3 Foundation Pattern cycles the same number pattern every six numbers to infinity because of the arcing of the repeatable permutations of the 2 and 3 multiplication tables. The first pair of numbers left after the punching out in segment 3 is 5 and 7. Carefully note that the cycling nature of the Foundation Pattern leaves pairs that are 6 numbers apart. Thus, the pairs are $(5 + 6n)$ and $(7 + 6n)$ for $n = 0$ to ∞ increasing n by 1 each time. These pairs are available to be twins if they do not get punched out. The complete whole number series becomes a segment at sometime because the segments linearly connect at the end of each prime square segment and the beginning of the next prime square segment. But note that new primes, when it is their segment to punch out, do not often punch out a number in one of these pairs available to be twins. Some primes do not even connect (in terms of this document) with one of the two numbers in a pair until quite a way down the numbers series such as the prime number 13 does not punch out a number in a pair until the number 169. Once a prime punches out a number in a pair it only punches out two other numbers in any pair in the next 6-times-the-prime numbers such as the next time the prime 13 punches out numbers is $169 + (4 \times 13)$ or the number 221 and $169 + (6 \times 13)$ or the number 247. These preceding facts will be examined more later. With such large gaps in the arcs of a prime not punching out one of the numbers in the pairs we have plenty of pairs left to be a set of twins in a future segments. If the cycles of a prime came at such a point that one of the numbers in the pairs that could be a twin was punched out, then this would necessitate a large gap in the numbers skipping many pairs of twin numbers before this same prime could punch out other numbers that would be a part of a twin. The larger the prime the larger the gap. We have already seen in the Foundation Patterns that the primes up to the point of consideration punch out some numbers and then skip some numbers because of the arcing effect of the multiplication tables of these primes. There can be no Foundation Pattern and thus no segment that contains no numbers because the arcing effect of all the multiplication tables of all of the primes up to that point do not punch out all of the numbers. When all or part of the primes arc and land at the same point, then they have to arc skipping a lot of remaining numbers to get to their next punch outs. As the density of the numbers in the Foundation Patterns get less, more and more numbers are skipped by the increasing size of the arcing of the multiplication tables of the larger and larger primes making fewer punch outs per unit of measure than was punched out by earlier primes in a same length unit of measure but more primes are punching out which decreases the density of the numbers and the primes. All of the comments in this twin discussion build up to the fact that the density of numbers is less but numbers set aside to be possible twin primes still remain because of the skipping of the increasingly larger arcs of new primes as we go down the whole number series. As mentioned elsewhere, sometimes there may be a variation to these principles in an individual segment. But, we are never able to have all numbers punched out in all remaining segments. Another reason that there are numbers available to be twin primes as we go from segment to segment is that the segments are generally getting larger in length even though the density makes only slight changes. Remember our earlier discussion of how few additional punch outs the prime of the segment makes and only a few of these possibilities happen within the segment: the prime of the segment, the prime squared, and any numbers that are composites of the prime with itself (exponential powers of the prime of the segment) or the prime itself with primes that are higher (larger) than the prime of the segment including any exponential powers of any of these including exponential powers of the prime of the segment (we have punched out all other earlier, smaller primes and their composites including any composites of earlier primes and the current prime of the segment). The Foundation Patterns are getting tremendously larger as we go along. They are increasing in length geometrically as a product of many multipliers (the product of all primes up to and including the prime of the segment). The segments are generally getting less in proportion to the size of the Foundation Patterns but the segments themselves are generally getting larger since the size of prime square and next prime square is getting larger.

Now let's a moment to look at the distance between squared numbers. Notice that 5^2 to 6^2 is +11 {36-25} and 6^2 to 7^2 is +13 {49-36} and the increase between those two distances is "2". Thus, we can see that the distance between (a number k squared to the next consecutive number squared) and (the distance between that next consecutive number squared to the following consecutive number squared) increases by "2" as we go up by consecutive numbers. Here is why. Let's look at the distance between the squares of two consecutive numbers. Let k = a whole number, (k + 1) = the next whole number, (k + 2) = the following whole number, etc. The distance between two consecutive numbers k and (k + 1) each squared, that is k^2 to $(k + 1)^2$, that distance would be $[(k + 1)^2 – k^2]$ or $[(k^2 + 2k + 1) – k^2]$ which reduces to "2k + 1". Likewise, the distance between the next two consecutive numbers (k + 1) and (k + 2) each squared, that is $(k + 1)^2$ to $(k + 2)^2$, that distance would be $[(k + 2)^2 – (k + 1)^2]$ or $[(k^2 + 4k + 4) – (k^2 + 2k + 1)]$ which reduces to "2k + 3". Thus, with any consecutive numbers the increase between those two distances is "2"; (2k + 3) – (2k + 1) is "2". 2^2 to 3^2 = 5; 3^2 to 4^2 = 7; 4^2 to 5^2 = 9; etc. shows that the distance from a number squared to the next consecutive number squared is "2(k or the first number) + 1". And it also shows that the increase of the distances is "+2" as you go up consecutive numbers squared {2^2 to 3^2 = 5; 3^2 to 4^2 = 7; 4^2 to 5^2 = 9; etc.} as we just examined. However, we are not measuring consecutive numbers, we are measuring the distance of squared numbers that are 2 or more apart before being squared since prime numbers are odd after 2 because of the 2 punching out all even composites being multiples of 2. So for x being the distance between the 2 numbers before being squared {k and (k + x)}, to get the distance between their squares we have: $[(k + x)^2 - k^2$ which would be $(k^2 + 2kx + x^2) - k^2$ which reduces to "$2kx + x^2$"]. (Please keep it straight that we are now letting "k" be the first prime number before being squared and "k + x" is the second prime number. And, "x" is the distance between these two prime numbers before being squared while "$2kx + x^2$" is the distance between their squares.) Thus 3^2 to 5^2 = 16 {we see from our formula and you might also note in passing that it is the sum of (see above) 3^2 to 4^2 plus 4^2 to 5^2}. "$2kx + x^2$" then also gives us the length of a segment if k is a prime number and x is the distance to the next prime number but a clarification in a minute. Also, we cannot say if there is an increase in the distance (length) of a prime segment because it depends on how close the second prime that establishes the next segment is to the first prime - - the next segment may even decrease if the next segment has a prime to establish the segment that are very close to the first prime.

One clarification here about the ranges or distances: the range of each new segment of the pattern of prime numbers is (prime square) to ((next prime square) - 1) which starts counting with the prime square and not start counting with the first number after the squared number like with 3^2 to 5^2; but the segment counting ends counting at 1 less than next prime square and not at the 5^2 as in 3^2 to 5^2; so our counting of the distance between numbers squared is the same as in the counting as in the segment ranges except that it is shifted backward 1 number. Thus we see the various ways that the length of the segment generally increases in some manner from segment to segment.

Now back to our prime twins discussion. The consecutive group of primes in a Foundation Pattern cannot punch out all of the numbers in any given Foundation Pattern because they arc and skip numbers in an orderly manner. The various permutations of all of the primes with their multiplication tables making composites in a Foundation Pattern make subgroups of primes with each subgroup making subcycles in the Foundation Pattern that are regular, arcing the same forward and backward, orderly, in mirrored patterns. (A quick insert about the mirror of the Foundation Patterns: each next Foundation Pattern is larger and skips a bigger part of the beginning of each of these repeating cycles and that skip at the beginning of each cycle for the same reasons is mirrored at the end of the cycle except for the number 1 and its mirror; the 1 being left at the beginning of the Foundation Pattern is mirrored at the next to last number in the Foundation Pattern cycle {the last number in the cycle is a composite being the multiple of all of the primes up to and including the prime of the segment}. The next to last cycle number is there as the mirror, then the last number of the cycle is skipped as a composite, and then the first number at the beginning of the next cycle is there because of the 1 at the beginning of the first cycle. This means that a possible twin is left at the end of each cycle with the beginning of the next cycle for some later segment to make into twin primes as the cycles arc to infinity. All primes up to infinity in their Foundation Patterns have these mirror-based cycled possible twins unless a larger prime or its composite punches out one or both of the pair. The mirror is not the only possibility for twins but it does show that there are always possibilities for twins. Because of the principles of the Foundation Pattern cycle, there is no prime number so large that its Foundation Pattern cycles does not have these mirror-based possible twins! An example: the Foundation Pattern for Segment 4 of the Pattern Of Prime Numbers based on number 3 prime which is Prime Number 5 at the end of its 70,000,079th cycle and the beginning of the next cycle has such a pair of numbers resulting from the mirror and these paired numbers indeed are twin primes 2,100,002,369 and 2,100,002,371 in Segment 4747 based on number 4746 prime which is Prime Number 45,823.) Some summary points on twin primes would be: because of the size of the increasing size of the primes and the increasing size of the arcing involved there are always regular skips of three or many more numbers in a row leaving some pairs of numbers to be possible twins plus the mirror beginning and end of the Foundation Pattern cycles leaves possible twins plus (even though the density of numbers is decreasing per same lengths) the generally increase in the length of segments compared to the low amount of additional numbers which the prime of the segment punch outs that could be twins plus the next section shows that because of the increasing size of the primes, paired numbers will be skipped and these paired numbers, if skipped, are twin primes; all of the preceding means that for these four reasons there will always be twin primes. And if there are always twin primes, there must also always be primes numbers. Twin primes should be better understood in the next section of this document when we examine paired numbers which are the basis of twin primes.

BEFORE WE GET TO SEGMENT 4 AND BEYOND OF THE PATTERN OF PRIME NUMBERS INCLUDING SUMMARY, LET'S LOOK AT PAIRED NUMBERS WHICH ARE THE BASIS OF TWIN PRIMES AND AT A PRIME NUMBERS FORMULA BASED ON THAT INFORMATION AND ALSO LET'S LOOK AT A PRIME NUMBERS FORMULA BASED ON THE KNOWLEDGE OF FOUNDATION PATTERNS

The principal prime numbers formula presented earlier in this document is based on an efficient use of the definition of prime numbers and composites. The two prime numbers formulas in this section are theoretically correct but are too cumbersome to be practical. The main purpose of these two formulas is to show more about patterns in numbers and show more about the pattern of prime numbers.

After Segment 3 of the Pattern Of Prime Numbers based on number 2 prime which is Prime Number 3, the whole number series has left the prime numbers 2 and 3 plus the rest of the whole number series to infinity is paired numbers which are possible twin primes with prime numbers 5 and 7 being the first set of paired numbers and they are indeed twin primes. 5 and 7 were made primes in segment 2. The paired numbers are one number apart like the 5 and 7. Four numbers after the 7 is another set of paired numbers. And this paired numbers process continues to infinity because of the Foundation Pattern cycles for prime number 3. Prime number 2 punches out all of the even numbers in its Foundation Pattern cycles. This makes all of the numbers one number apart starting with the number three since now only odd numbers are available to be possible primes. When the prime number 3 segment comes, it punches out the 3 and then every 6^{th} number because of the cycles of the prime 3 Foundation Pattern. This then leaves the whole number series as prime 2, prime 3, and the rest is paired numbers to infinity because of the cycles of the prime 3 Foundation Patterns. See the prime numbers formula spreadsheet second worksheet that is an illustration of Foundation Pattern Actions and look at segment 3.

5 and 7 are the first pair of paired numbers and not 3 and 5 because prime 3 sets up the pattern for the paired numbers. The paired numbers have characteristics. Numbers based on the first number in the pair does one thing and numbers based on the second number in the pair does another thing. For this reason we are calling the first number in each set of paired numbers the minor number in the pair and the second number in each set of paired numbers we are calling the major number in the pair. The major number makes some midway bigger skips than does the minor number midway skips. The major

numbers also have all of the prime squares which are the beginning of segments. Other squared numbers are also major paired numbers and they, too, will be removed (punched out) because they are composites but they are other than prime square composites. We are not concerned with composites squared because they will be punched out already by the process of an earlier prime that makes it a composite. 2 and 3 square will not be in the major paired numbers column because we have dealt with them already.

Because of the cycles of the Foundation Pattern of prime 3, each consecutive minor numbers are 6 numbers apart and each consecutive major numbers are 6 numbers apart as they go from step to step. See the five middle columns in the prime numbers formula spreadsheet fourth worksheet which is a Paired Numbers Illustration showing the paired numbers and how they are set up. The two outside columns in the illustration can be looked at in a moment as we see how numbers are removed (punched out) leaving the rest of the numbers to be prime numbers.

Hence, a minor paired number is 5 or 5 plus any multiple of 6. A major paired number is 7 or 7 plus any multiple of 6.

Also, looking at the paired numbers illustration we see that a minor number goes up by 2 to get to the major number in the pair and the major number goes up by 4 to get to the minor number in the next pair. Note that to get to the next available whole number the minor number always goes up by 2 and the major number always goes up by 4 which is because of the prime 3 Foundation Pattern.

Why are all of the prime squares in the major column? (For convenience of our thinking we are separating the paired numbers into two columns in our minds (see paired numbers illustration) with one column being the minor numbers column and the other column being the major numbers column.)

Let's begin by looking at minor numbers to see if all of them squared will be a major number. The first number in the first pair in the paired numbers is the minor paired number 5 which is a prime number we know already. So, the first prime squared will be 25 and that prime square is in the major paired numbers column if we look at the illustration. For all primes squares to be in the major column, the distance to each and every prime square added to 25 would have to equal some step in the major paired number column. We just stated that the major paired numbers go up by 6 from step to step {because the Foundation Pattern cycle is 6, that is 2 times 3, when we get to the paired numbers} so thus starting at the prime square equaling 25 we have "$25 + 6y$ for whole numbers $y = 0$ to ∞" being a statement of all of the numbers in the major paired numbers column from prime square 25 to ∞. Hence, if y is a whole number, then we will have a number in the major paired numbers column. We noted in the discussion of segment 3 that "$2kx + x^2$" with k being a number and x being the distance between that number and the next number under consideration is the formula for the distance between each of these numbers squared. This formula works for primes or composites since they are both numbers. Our whole discussion of squares being in the major paired numbers column applies to all paired numbers even though we are primarily interested in primes here. Thus, for any minor paired number prime to be a prime square to be in the major paired number column, starting at 5 square {25} the distance to the next prime squared and some steps in the major paired numbers column would have to be the same and thus the following equation would have to be true: "((25) + (2kx + x^2) – (7))/(6)". Here is the basis for the for the just mentioned equation: ((25 {minor number 5 squared}) + ((2kx + x^2) {the distance to next prime squared}) – (7 {7 is the first major number and if we subtract it then we could divide the total results by 6 which is the size of the next step(s) in the major numbers and if it goes evenly then we have a major number}))/(6 {so as we just stated, we divide by 6 the size of the step(s) between the major numbers}). Now "k" which is 5 is the number being squared to give us the 25. "x" is the distance between two numbers before being squared and our first number is 5 a minor number so "x" is the distance to any other minor number before being squared since we are first working with minor numbers to see if all of them squared are major numbers. Thus the (2kx + x^2) in our equation becomes ((2 times 5 {or 10})x + x^2) which we want for any value of "x". So our equation now reduces to: (18 + 10x + x^2)/6 which we want for any value of "x". But "x" is 6 or a multiple of six for any value of "x" since that is the distance between minor numbers. Let's let "w" be a whole number for w = 1 to ∞". Thus our "x" distances in the minor numbers could be now stated as "6w" for w = 1 to ∞. So our equation could now be stated as "(18 + 6w10 + $(6w)^2$)/6" which would be "(18 + 60w + $36w^2$)/6" and simplified would be "3 + 10w + $6w^2$" meaning that we could divide the total results evenly by 6 and thus we have a major number as stated above. So a minor number squared will be a major number! Thus any minor paired number that was a prime would have its square in the major paired number column based on the success of our equation.

In a similar way we will now show that all major numbers squared are in the major numbers. 7 is the first major number in the first pair of numbers and it is a prime number we know already so we will calculate from 7 square {which is 49} and that prime square is in the major paired numbers column if we look at the illustration. Thus, for any major paired number prime to be a prime square to be in the major paired number column, starting at 7 square {49} the distance to the next prime squared and some steps in the major paired numbers column would have to be the same and thus the following equation would have to be true: "((49) + (2kx + x^2) – (7))/(6)". Here is the basis for the for the just mentioned equation: ((49 {major number 7 squared}) + ((2kx + x^2) {the distance to next prime squared}) – (7 {7 is the first major number and if we subtract it then we could divide the total results by 6 which is the size of the next step(s) in the major numbers and if it goes evenly then we have a major number}))/(6 {so as we just stated, we divide by 6 the size of the step(s) between the major numbers}). Now "k" which is 7 is the number being squared to give us the 49. "x" is the distance between two numbers before being squared and our first number is 7 a major number so "x" is the distance to any other major number before being squared since we are now working with major numbers to see if all of them squared are major numbers. Thus the (2kx + x^2) in our equation becomes ((2 times 7 {or 14})x + x^2) which we want for any value of "x". So our equation now reduces to: (42 + 14x + x^2)/6 which we want for any value of "x". But "x" is 6 or a multiple of six for any value of "x" since that is the distance between major numbers. Let's let "w" be a whole number for w = 1 to ∞". Thus our "x" distances in the major numbers could be now stated as "6w" for w = 1 to ∞. So our equation could now be stated as "$(42 + 6w14 + (6w)^2)/6$" which would be "$(42 + 84w + 36w^2)/6$" and simplified would be "$7 + 14w + 6w^2$" meaning that we could divide the total results evenly by 6 and thus we have a major number as stated above. So a major number squared will be a major number! Thus any major paired number that was a prime would have its square in the major paired number column based on the success of our equation.

Now that we have checked all of the numbers in the minor paired numbers column to see if all minor paired numbers squared would be in the major paired numbers column and we looked to see if all major paired numbers squared would be in the major paired numbers column, we have finished our examination of seeing that all primes squared from prime 5 or greater would be in the major paired numbers column. Hence, we see that all paired numbers squared will be in the major paired numbers column; thus, all of the rest of the prime numbers squared 5 square and greater will be in the major paired numbers column since all of the rest of the prime numbers and their composites not involving prime 2 and 3 are in the paired numbers.

Now let's examine more closely the distance between two squared primes.

Squared primes establish the length of the segments of the pattern of prime numbers. Thus, after the prime number segments before the paired numbers (which each have a known segment length), the segments of the pattern of prime numbers always have a length that is a multiple of 6 {that is, the segments lengths are always evenly divisible by 6} because all prime squares are in the major numbers and these numbers go up by 6. However, we now know enough to say that the length of these prime number segments are 24 or a multiple of 24. The distance between a minor prime number k and the next closest major number if it is a prime number is 2. So with our formula for the distance between the squares of prime numbers (these squares establish the segment) is "$2kx + x^2$" and we said that x would be the distance between the unsquared numbers. Here our x would be 2 so our formula would be "$2k2 + 2^2$" which gives "4k + 4". When k is 5, the distance between the squares of our first paired numbers, both of which are primes, would then be "24".

But here is a more complete statement of the distance between the squares of any minor number "k" that is a prime and its major paired number if it is a prime (knowing that the "x" distance between the unsquared numbers is 2. The first possible minor number is k = 5 and we know that that distance to the major prime is 24. The minor numbers go up by 6 so any minor number could expressed as 5 + 6a for a = 0 to ∞. Thus "$2kx + x^2$" would be "$2(5 + 6a)2 + 2^2$" for a = 0 to ∞ which is "4(5 + 6a) + 4" or "20 + 24a + 4" which is "24 + 24a" for a = 0 to ∞. 24 divides evenly into that meaning that the distance between any two primes squares that are a pair of numbers is a multiple of 24 for any value of a. If we are dealing with a minor and major number that are not in the same pair and thus further apart than 2, we just add up all of the distances involved in the first to last pair each of which are a multiple of 24 so we still see that the distance between the first minor number squared and the last major number squared would just be more multiples of 24.

Now let's look at the first major number squared {7} to the next minor number squared {11} which would be a distance of 4 apart. Thus "$2kx + x^2$" would be "$2(7)4 + 4^2$" which is "56 + 16" or "72". 24 divides evenly into that meaning that the distance between a major number 7 squared and the next minor number squared, both being a prime, is a multiple of 24.

But here is a more complete statement of the distance between the squares of any major number "k" that is a prime and the next minor number if it is a prime (knowing that the "x" distance between the unsquared numbers is 4. The first possible major number is k = 7 and we know that that distance to the minor prime is 72. The major numbers go up by 6 so any major number could expressed as 7 + 6c for c = 0 to ∞. Thus "$2kx + x^2$" would be "$2(7 + 6a)4 + 4^2$" for a = 0 to ∞ which is "8(7+ 6a) + 16" or "56 + 48a + 16" which is "72 + 48a" for a = 0 to ∞. 24 divides evenly into that meaning that the distance between any two primes squares that are a major number and the next minor number is a multiple of 24 for any value of a. If we are dealing with a major number and any future minor number that is not the next minor number and thus further apart than 4, we just add up all of the distances involved with their squares which are all multiple of 24 so we still see that the distance between all of these numbers involved would just be more multiples of 24.

Now we have just seen that the distance between the squares of a minor number and the next major number is a multiple of 24 and the distance between the squares of that next major number and the following next minor number is another set of multiples of 24 so we see by adding these two sets of multiples of 24 that the squares of any two minor numbers is a multiple of 24 and if it is between squares of minor numbers that are far apart we just add more multiples of 24.

With like reasoning we can see that the distance between the squares of any two major numbers is also a multiple of 24. Over and back lengths {minor to major to minor or major to minor to major} are each divisible by 24 so add as many lengths as needed to get between two squared numbers [prime or composite] and they are all multiples of 24.

Now that we have considered all of the cases, we know that the distance between any two numbers in the paired numbers configuration is a multiple of 24. That is important because we now know that the prime segment length is a multiple of 24 since it is between two squares! Adding these lengths as needed from a prime square to the next prime square makes each prime segment {each end shifted back by 1 as we discussed earlier}. Thus, a prime segment length is a multiple of 24!

Now notice that all paired numbers in a pair are primes unless one or both of them are removed (punched out) and if both of them are left, they are twin primes. All primes up through the prime of the segment punch out (however any new punching out in a segment is done by the prime of the segment because the other primes punched out earlier throughout the total whole number series to infinity). It is true that we can say that all of the numbers left after any prime has done its segment process, not just after primes 2 and 3 have processed, leaves primes unless the numbers are removed (punched out); (of course, up through the whole numbers up through that prime segment). But here with the paired numbers we have a special place to see patterns, we have a special place to show the basis of twins, we have a special place to see things about the length of the prime numbers segment of the pattern of prime numbers, and we have a special place to show paired numbers with their unique number characteristics.

So, all of the remaining numbers are primes when we get to the paired numbers unless one of them is removed. Only multiples of 2 and 3 have been punched out so all remaining numbers still remain to be punched out by larger primes {than 2 and 3} or to remain in appropriate segments to be a prime. The question is: are these numbers removed erratically or are they removed in patterns? The answer is that they are removed in patterns!! And these patterns help us better see the pattern of prime numbers and the grand designs in the whole numbers. The patterns are wonderfully designed. Just when you need it to make the patterns work, up jumps something like a 13 squared! What a complex, awesome mind God must have to come up with a number system like the whole number series that is patterned and integrated with a magnificent, layered, intricate design with complex but easy to see subdesigns that gives us such a many-colored, mathematical jewel of infinite, glistening facets that sparkles with numerical mathematical brilliance!!!

Let's look at the patterns involved as the rest of the numbers in the whole number series are punched out. We are not looking at number patterns in the quite the same way that we looked at the prime of a segment punching out in a Foundation Pattern. Here we are looking at the patterns of numbers as they go beyond the segment and even into other cycles of the Foundation Pattern up to infinity. This means that this look at patterns may have several patterns hit the same number like the number 175 but it is because of different ordering of the same primes that make up the composite number that was hit. 175 is hit in the prime 5 pattern as 5 times 5 times 7 and it is also hit in the prime 7 pattern as 7 times 5 times 5 even though 175 was already punched out by the earlier prime 5. Also, recall our discussion at the end of Segment 2 mentioned earlier about numbers being punched out in the same position of each cycle and the design of the Foundation Pattern cycle. Now we will make a closer look at the pattern of the numbers.

In our Paired Numbers Illustration on the prime numbers formula spreadsheet fourth worksheet, we want to keep our original entry of each prime so that we will end up with only a list of the prime numbers in order - - remember that we are doing something different here than we did in developing Foundation Patterns so what we do here will be different. So, after the entry of a prime, when is the first time a prime punches out a number on its own as a composite and begins a pattern in the Paired Numbers Illustration? It is at prime square because any earlier composite made by that prime will have already been punched out by an earlier prime and its pattern. When is the next time, and the next time, etc. that a prime punches out or removes a number? It depends on whether the prime when it appeared was a minor paired number or a major paired number.

The prime numbers pattern changes at each prime square. The pattern lasts until the (next prime square – 1). The primes were generated in earlier segments. Within a segment the multiples of the prime of the segment and multiples of all earlier primes are punched out leaving the pattern of the primes for that segment.

Is there a pattern to the way these punch outs happen or are they erratic?

There is a pattern.

The patterns are based on the multiplication tables which are patterned. However our study of paired numbers helps us see the pattern in each prime segment.

Segment 1 is 1 to 3 and since there are no prime squares yet there are no punch outs.

Segment 2 has 2 as the prime so all multiples of 2 [even numbers] are punched out of the segment. Prime 2 Foundation Pattern goes to infinity [odd numbers] and prime 2 segment is cut out of it. So after prime number 2, the multiplication table of 2 punches out all multiples of 2 in all of the whole numbers which is every other number after 2, the even numbers. Prime 2 punches out in a pattern then.

Segment 3 has 3 as the prime so all multiples of 3 are punched out in the segment at 3 square and also 3 square + 6n for n = 1 to ∞. The preceding statement is because, after prime number 3, the multiplication table of 3 punches out all multiples of 3 in all of the whole numbers. But actually every other 3 has already been punched out by the multiplication table of 2. So, after prime number 3, the multiplication table of 3 only needs to punch out 3 square and also 3 square + 6n for n = 1 to ∞. The preceding shows that the multiplication table of 3 has all of the multiples of 3 that are earlier than 3 square are already punched out. Prime 3 Foundation Pattern goes to infinity and prime 3 segment is cut out of it. Prime number 3 punches out in a pattern then.

With primes 2 and 3 done we now have the paired numbers set up.

The next prime to start the next segment (segment 4) is prime 5. 5 is a minor number. In all of the whole numbers then we need to punch out 5 square first (multiples of 5 that are earlier than 5 square are already punched out by the multiplication tables of earlier primes). Prime square is always a major number. Major number prime square 5 is a minor number 5 times a minor number 5. So to get to the next number to multiple with minor number 5, we need to add 2 to get to the next number in the paired numbers which is in the major number column. [Remember how we added to get from a minor number in the minor numbers column to the next number in paired numbers which would be a major number in the major numbers column.] So we are now at major number 7. So we punch out 5 times 7. Why not punch out 5 times a number smaller than 7? Because all of the numbers smaller than 7 have already been punched out as we just said. Paired numbers, that have not been punched out by primes earlier than the prime of the segment, are all that is left after all earlier primes have punched out up through the current prime segment. Again see the Paired Numbers illustration on the spreadsheet. Now to get to the next number to multiply with minor number 5, we need to add 4 to major number 7 to get back to the minor numbers column to get the next number to multiply with 5. We get minor number 11. So we punch out 5 times 11.

Are you seeing a pattern based on Paired Numbers?

Now we just keep repeating the described pattern just as we learned that we need to do to get from minor number column to major number column, and back and forth, etc. Note that by the same logic this is the punch out pattern for all prime “minor” numbers. Thus minor prime number 5 punches out in a definite pattern. It punches out 5 square {or 5 times minor number 5} {25}, then 5 times (5 + 2) {which is 5 times major number 7} {35}, then 5 times (7 + 4) {which is 5 times minor number 11} {55}, then 5 times (11 + 2) {which is 5 times major number 13} {65}, then 5 times (13 + 4) {which is 5 times minor number 17} {85}, etc. Looking at it another way, notice that we are increasing by 2 times 5 {10} and then 4 times 5 {20} over and over. So to get the punch out number we are really start at 25 {the prime of the segment squared}, then add 10 to punch out 35, the add 20 to punch out 55, the add 10 to punch out 65, then add 20 to punch out 85, etc. Thus minor prime number 5 punches out in a definite pattern.

(Note that we are talking here about a different use of “patterns” than we have used before but it grows out of our discussion of our earlier use of “patterns”.)

The next prime to start the next segment (segment 5) is prime 7. 7 is a major number. In all of the whole numbers then we need to punch out 7 square first (multiples of 7 that are earlier than 7 square are already punched out by the multiplication tables of earlier primes). Prime square is always a major number. Major number prime square 7 is a major number 7 times a major number 7. So to get to the next number to multiple with major number 7, we need to add 4 to get to the next number in the paired numbers which is in the minor number column. [Remember how we added to get from a major number in the major numbers column to the next number in paired numbers which would be a minor number in the minor numbers column.] So we are now at minor number 11. So we punch out 7 times 11. Why not punch out 7 times a number smaller than 11? Because all of the numbers smaller than 11 have already been punched out as we just said. Paired numbers, that have not been punched out by primes earlier than the prime of the segment, are all that is left after all earlier primes have punched out up through the current prime segment. Again see the Paired Numbers illustration on the spreadsheet. Now to get to the next number to multiply with major number 7, we need to add 2 to minor number 11 to get back to the major numbers column to get the next number to multiply with 7. We get major number 13. So we punch out 7 times 13.

Are you seeing a pattern based on Paired Numbers?

Now we just keep repeating the described pattern just as we learned that we need to do to get from major number column to minor number column, and back and forth, etc. Note that by the same logic this is the punch out pattern for all “major” numbers.

Thus major prime number 7 punches out in a definite pattern. It punches out 7 square {or 7 times major number } {49}, then 7 times (7 + 4) {which is 7 times minor number 11} {77}, then 7 times (11 + 2) {which is 7 times major number 13} {91}, then 7 times (13 + 4) {which is 7 times minor number 17} {119}, then 7 times (17 + 2) {which is 7 times major number 19} {133}, etc. Looking at it another way, notice that we are increasing by 4 times 7 {28} and then 2 times 7 {14} over and over. So to get the punch out number we are really start at 49 {the prime of the segment squared}, then add 28 to punch out 77, the add 14 to punch out 91, the add 28 to punch out 119, then add 14 to punch out 133, etc. Thus major prime number 7 punches out in a definite pattern.

The punch out summary that follows is shown in the Paired Numbers illustration on the spreadsheet. In the Paired Numbers illustration punches out prime square first. Then in order in the paired numbers that prime punches out each number, including composites, that is larger than the prime times the prime {example: prime 5 punches out 5 times 5 which is 5 square or 25, then prime 5 punches out 5 times the next number in the paired numbers which would be 5 times 7 or 35, then prime 5 punches out he next number in the paired numbers which would be 5 times 11 or 55, the 5 times 13 or 65, then 5 times 17 or 85, etc.}. The preceding is the first part of each Summary below. Let's look at that and also a more descriptive explanation of punch patterns the following punch out summaries.

<u>Punch Out Pattern Summary</u>. So, for any minor prime number the punch out pattern is minor prime number squared {or minor prime number times minor prime number}, then minor prime number times (that minor number + 2) {which is the next major number}, then minor prime number times (that major number + 4) {which is the next minor number}, then minor prime number times (that minor number + 2) {which is the next major number}, then minor prime number times (that major number + 4) {which is the next minor number}, etc. with this pattern of punch outs. Or, punch out prime square. Notice that we are increasing by 2 times the minor number and then 4 times the minor number over and over {with prime 5 you would add 10 [2 times 5] and then add 20 [4 times 5] over and over}. Also note from this description that the punch out pattern for each minor number cycles at 6 times the prime {prime 5 punch out pattern cycles at every 30 [6 times 5], prime 11 punch out pattern cycles at every 66 [6 times 11], etc.}.

<u>Punch Out Pattern Summary</u>. [This is the previous paragraph with some points elaborated to help understanding.] So, for any minor prime number the punch out pattern is minor prime number squared {or minor prime number times minor prime number} [MINOR NUMBER SQUARED], then minor prime number times (that minor number + 2) {which is the next major number} [THAT IS MINOR NUMBER TIMES MINOR NUMBER {which is minor number squared} + MINOR NUMBER TIMES 2 AND IF WE SUBTRACT THE PREVIOUS PUNCH OUT {minor number squared} THEN WE SEE THAT IT IS <u>2 TIMES THE MINOR NUMBER ADDED TO THE PREVIOUS PUNCH OUT NUMBER {that is, added to minor number squared}</u>], then minor prime number times (that major number + 4) {which is the next minor number} [{realizing that that major number, as we just said, is minor number squared + 2 times the minor number} THEN THAT IS MINOR NUMBER TIMES MINOR NUMBER {which is

minor number squared} + 2 TIMES MINOR NUMBER + 4 TIMES MINOR NUMBER AND IF WE SUBTRACT THE PREVIOUS PUNCH OUT {minor number squared + 2 times the minor number} THEN IT IS 4 TIMES THE MINOR NUMBER ADDED TO THE PREVIOUS PUNCH OUT NUMBER], then minor prime number times (that minor number + 2) {which is the next major number}, then minor prime number times (that major number + 4) {which is the next minor number}, etc. with this pattern of punch outs. Or, punch out prime square. Notice that we are increasing by 2 times the minor number and then 4 times the minor number over and over {with prime 5 you would add 10 [2 times 5] and then add 20 [4 times 5] over and over}. Also note from this description that the punch out pattern for each minor number cycles at 6 times the prime {prime 5 punch out pattern cycles at every 30 [6 times 5], prime 11 punch out pattern cycles at every 66 [6 times 11], etc.}.

Punch Out Pattern Summary. And, for any major prime number the punch out pattern is major prime number squared {or major prime number times major prime number}, then major prime number times (that major number + 4) {which is the next minor number}, then major prime number times (that minor number + 2) {which is the next major number}, then major prime number times (that major number + 4) {which is the next minor number}, then major prime number times (that minor number + 2) {which is the next major number}, etc. with this pattern of punch outs. Notice that we are increasing by 4 times the major number and then 2 times the major number over and over {with prime 7 you would add 28 [4 times 7] and then add 14 [2 times 7] over and over}. Also note from this description that the punch out pattern for each major number also cycles at 6 times the prime {prime 7 punch out pattern cycles at every 42 [6 times 7], prime 13 punch out pattern cycles at every 78 [6 times 13], etc.}.

Note again that cases such as 5 times 35 and 7 times 25 both hit the same number (composite). The arcing of both of their patterns hit 175.

These preceding descriptions show where multiplication tables of the primes that are larger than 2 and 3 punch out.

Now we continue what we have been doing with the rest of the minor and major numbers that are prime numbers. But some of these paired numbers are already composites that we have already punched out earlier. The punch out pattern hits them again because a composite number could be 5 times 7 and also 7 times 5 for example. Here we are looking to see that numbers in a prime number segment pattern are punched out in a patterns and now we can see that!

So, finally, the punch out pattern in a prime segment is cut out from all of these punch out patterns and what is left are the new primes in the prime segment. The punch outs are not erratic - - they are done in a patterns!

Shortly we will do a punch out in a prime segment.

Now, from these descriptions we are ready to write another formula/procedure for prime numbers besides the computer based formula. We will do two examples. First we will find prime numbers starting at 1 and then we will find prime numbers in a prime segment.

Using the formula based on this discussion of paired numbers, we first set up the paired numbers by formula and then we removed those numbers by formula that will not be primes because of the patterns. What is left are the prime numbers. The following, then, is a formula for prime numbers with an example {same as the Paired Numbers Illustration} that goes from 1 up to and including 217; (after that we will use this formula to find the prime numbers within a prime segment without starting back at 1).

[Please go to next page.]

A Traditional Mathematical Type Formula/Procedure
Generating Consecutive Primes Numbers
Based On The Pattern Of Prime Numbers

Problem:
Find the primes from 1 up to and including 217
using paired numbers ideas

Given: Definition of a prime number.
Definition of a composite.
0 and 1 are neither prime or composite by definition.

Procedure: (see these steps completed below)
2 and 3 are primes because there are no punch outs
until 2 square {4}
5 and 7 are primes because that is what is left after 2 punches out
from 4 to 8
11, 13, 17, 19, and 23 are primes because that is what is left
after 3 punches out from 9 to 24
(of course after 2 has punched out there also)
With 2 and 3 punched out throughout the whole number series,
we now have the paired numbers
Set up paired numbers through 217
The first number in each pair is the minor number
The second number in each pair is the major number
5, the first paired number and a minor number,
we know is a prime
so square it and punch out that number {25}
Add 10 {2 times 5}
and punch out that number
and add 20 {4 times 5}
and punch out that number
and do this over and over through 217
{minor number punch out pattern}
Square the next prime after 5 which is 7, a major number,
and punch out that number {49}
Add 28 {4 times 7} and punch out that number
and add 14 {2 times 7} and punch out that number
and do this over and over through 217
{major number punch out pattern}
Square the next prime after 7 which is 11, a minor number,
and punch out that number {121}
Add 22 {2 times 11} and punch out that number
and add 44 {4 times 11} and punch out that number
and do this over and over through 217

{minor number punch out pattern}
Square the next prime after 11 which is 13, a major number,
and punch out that number {169}
Add 52 {4 times 13} and punch out that number
and add 26 {2 times 13} and punch out that number
and do this over and over through 217
{major number punch out pattern}
Square the next prime after 13 which is 17, a minor number,
and punch out that number {289},
but it is not needed since it is beyond 217}

2
3
5, 7
11, 13
17, 19
23, ~~25~~ : punch out 5 square {25}
29, 31
~~35~~, 37 : punch out 25 + 10 {35 based on the 5}
41, 43
47, ~~49~~ : punch out 7 square {49}
53, ~~55~~ : punch out 35 + 20 {55 based on the 5}
59, 61
~~65~~, 67 : punch out 55 + 10 {65 based on the 5}
71, 73
~~77~~, 79 : punch out 49 + 28 {77 based on the 7}
83, ~~85~~ : punch our 65 + 20 {85 based on the 5}
89, ~~91~~ : punch out 77 + 14 {91 based on the 7}
~~95~~, 97 : punch out 85 + 10 {95 based on the 5}
101, 103
107, 109
113, ~~115~~ : punch out 95 + 20 {115 based on the 5}
~~119~~, ~~121~~ : punch out 91 + 28 {119 based on the 7}
: punch out 11 square {121}
~~125~~, 127 : punch out 115 + 10 {125 based on the 5}
131, ~~133~~ : punch out 119 + 14 {133 based on the 7}
137, 139
~~143~~, ~~145~~ : punch out 125 + 20 {145 based on the 5}
: punch out 121 + 22 {143 based on the 11}
149, 151
~~155~~, 157 : punch out 145 + 10 {155 based on the 5}
~~161~~, 163 : punch out 133 + 28 {161 based on the 7}
167, ~~169~~ : punch out 13 square {169}
173, ~~175~~ : punch out 155 + 20 {175 based on the 5}
: punch out 161 + 14 {175 based on the 7}
179, 181

~~185~~, ~~187~~ : punch out 175 + 10 {185 based on the 5}
: punch out 143 + 44 {187 based on the 11}
191, 193
197, 199
~~203~~, ~~205~~ : punch out 185 + 20 {205 based on the 5}
: punch out 175 + 28 {203 based on the 7}
~~209~~, 211 : punch out 187 + 22 {209 based on the 11}
~~215~~, ~~217~~ : punch out 205 + 10 {215 based on the 5}
: punch out 215 + 20 {225 based on the 5,
but it is not needed since it is beyond 217}
: punch out 203 + 14 {217 based on the 7,
no need to do any more since we are at 217}
: punch out 209 + 44 {253 based on the 11,
but it is not needed since it is beyond 217}
: punch out 169 + 52 {221 based on the 13,
but it is not needed since it is beyond 217}

What is left above are the prime numbers from 1 to 217 which are: 2, 3, 5, 7, 11, 13, 17, 19, 23, 29, 31, 37, 41, 43, 47, 53, 59, 61, 67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, 113, 127, 131, 137, 139, 149, 151, 157, 163, 167, 173, 179, 181, 191, 193, 197, 199, and 211.

Now, using the paired numbers, let's look at how to do the punch outs in a prime segment without starting back at 1 and doing all of the punch outs up to the prime segment. Remember that the prime numbers pattern changes in each segment so the punch out pattern in each segment will be different. As an example let's do the prime segment for prime number 11. From earlier prime segments we know that the next prime after prime 11 is prime 13. So prime number 11 segment will go from 121 {prime squared} to 168 {the next prime 13 squared minus 1}.

First make a list of paired numbers in prime 11 segment (see below).
List prime square, then add 4 because prime square is always a major number.
Then add 2, then keep adding 4 and 2 but do not pass 168.
Next in the paired numbers we punch out prime of the segment squared
which is 121.
Now we have to do the punch outs for all primes smaller than 11.
We already know these primes for earlier prime segments.
In the paired numbers, prime 2 and 3 have already been punched out everywhere.
Next we do the punch outs related to prime 5 in prime number 11 segment.
We noted in the earlier punch out summaries that the a prime's punch out
pattern cycles at 6 times the prime.
So prime 5 punch out pattern cycles at every 30 after the prime 5 square.
We need to know where is the beginning of a prime 5 punch out cycle
that begins to reach into prime 11 segment.
The first punch out cycle of prime 5 begins with prime 5 square {25}.
Subtract 25 from the first number in prime 11 segment {121}

and we have 96.
Divide 30 into 96 to find out how many complete cycles
of prime 5 punch outs we have before prime 11 segment and we get 3.
Add 3 times 30 to 25 to find the beginning of the prime 5 punch out cycle
that begins to reach into prime 11 segment. It is 115.
Recall how we add 2 times the prime and then 4 times the prime over and
over for the prime's punch out pattern if it is a minor number.
(Note that we are beginning after a complete cycle.)
To check a paired number to see if it minor or major, for minor subtract 5
and divide by 6 to see if it goes evenly
and for major subtract 7 and divide by 6 to see if it goes evenly.
This because the minor number start at 5 and then go up by 6's
and the major numbers start at 7 and go by 6's.
unless of course they are 5 and 7 the first minor and major.
5 is the first minor number we know so we add 2 times 5 to 115
which is 125.
This first part of the prime five punch out pattern does reach
into the prime 11 segment so we punch out that number {125}.
Then add 4 times 5 to 125 which is 145 and punch it out.
Then add 2 times 5 to 145 which is 155 and punch it out.
Then add 4 times 5 to 155 which is 175 and stop since that is beyond 168.
(Actually prime 5 punch outs are easy to do.
We mentioned earlier that composites based on 5 end in zero or 5.
All numbers ending in zero have been punched out by prime 2
since zero is even. Any other number that is a composite of 5 ends in 5.
So all you have to do for prime 5 punch out pattern is
punch out all numbers ending in 5.)

Next we do the punch outs related to the next prime which is prime 7
in prime number 11 segment using a similar procedure.
We noted in the earlier punch out summaries that the a prime's punch out
pattern cycles at 6 times the prime.
So prime 7 punch out pattern cycles at every 42 after the prime 7 square.
We need to know where is the beginning of a prime 7 punch out cycle
that begins to reach into prime 11 segment.
The first punch out cycle of prime 7 begins with prime square {49}.
Subtract 49 from the first number in prime 11 segment {121}
and we have 72.
Divide 42 into 72 to find out how many complete cycles
of prime 7 punch outs we have before prime 11 segment and we get 1.
Add 1 times 42 to 49 to find the beginning of the prime 7 punch out cycle
that begins to reach into prime 11 segment. It is 91.
Recall how we add 4 times the prime and then 2 times the prime over and
over for the prime's punch out pattern if it is a major number.
(Note that we are beginning after a complete cycle.)

To check a paired number to see if it minor or major, for minor subtract 5
and divide by 6 to see if it goes evenly
and for major subtract 7 and divide by 6 to see if it goes evenly.
This because the minor number start at 5 and then go up by 6's
and the major numbers start at 7 and go by 6's
unless of course they are 5 and 7 the first minor and major.
7 is the first major number we know so we add 4 times 7 to 91
which is 119.
This first part of the prime 7 punch out pattern does not reach into
the prime 11 segment so we do not punch out that number {119}.
Then add 2 times 7 to 119 which is 133 and punch it out.
Then add 4 times 7 to 133 which is 161 and punch it out.
Then add 2 times 7 to 161 which is 175 and stop since that is beyond 168.
(Note that if 175 would have been available that it would have been
punched out by both prime 5 and prime 7 but that is all right.)

Next we do the punch outs related to the next prime which is prime 11
in prime number 11 segment using a similar procedure
but this is the prime of the segment.
We have already punched the prime square of the segment {121}.
To check a paired number to see if it minor or major, for minor subtract 5
and divide by 6 to see if it goes evenly
and for major subtract 7 and divide by 6 to see if it goes evenly.
This because the minor number start at 5 and then go up by 6's
and the major numbers start at 7 and go by 6's
unless of course they are 5 and 7 the first minor and major.
11 is a minor number.
Recall how we add 2 times the prime and then 4 times the prime over and
over for the prime's punch out pattern if it is a minor number.
11 is a minor number so we add 2 times 11 to 121 {prime square}
which is 143 and punch out that number.
Then add 2 times 7 to 119 which is 133 and punch it out.
Then add 4 times 11 to 133 which is 177 and stop since that is beyond 168.

~~121~~ - - prime 11 square
~~125~~ - - prime 5 punch out pattern
127
131
~~133~~ - - prime 7 punch out pattern
137
139
~~143~~ - - prime 11 punch out pattern
~~145~~ - - prime 5 punch out pattern
149
151
~~155~~ - - prime 5 punch out pattern

157
~~161~~ - - prime 7 punch out pattern
163
167

The numbers that are left above are the prime numbers in prime 11 segment and is the pattern of prime numbers in prime 11 segment!

It is now the time to look at the formula/procedure for prime numbers that is on the title page of this document.

Another Traditional Mathematical Type Formula/Procedure
Generating Consecutive Primes Numbers
Based On The Pattern Of Prime Numbers

For prime number P and code C for P:

$$\mathbf{P_{\{n\}} + C_{\{n\}} = P_{\{n+1\}}}$$

So what is the code that we can add to a prime number to get the next prime number? From our studies this far we can sense that it will be some kind of rather cyclic or oscillating code. Where does this code come from? Where else? - - the Foundation Patterns! Let's see how this code would be developed from the Foundation Patterns and then be applied.

We will be making a Table of Codes to add to each prime to get the next prime. The development of this Table also shows patterns.

The "code" is actually "codes". The "codes" are in linear "Code segments" and these segments are cut from Foundation Codes just as prime number "segments" are cut from the Foundation Patterns. The Foundation Codes are a number to add to each prime to get the next sequential prime. Please note carefully whether we are talking about prime number "segments" which go with Foundation Patterns or "Code segments" which go with Foundation Codes although these four terms involve transformations of the same information. For clarity please remember the distinction in our definitions between prime number "segments" and "Code segments". The prime of the segment, which came from earlier shown-to-be primes, applies to all four of these terms just mentioned. The Foundation Codes are made from the Foundation Pattern. These are the codes that we are ultimately interested in: Codes segments are cut from the Foundation Codes which are in the range of the prime segment. Only those Foundation Codes that apply to the prime number segment give us the Code segments.

Again, our codes cut from the Foundation Code segments take us from one prime number to the next prime number. The logic of this discussion is to study just a few cycles and then that is the logic into infinity since we have seen the cyclic nature of our overall study.

A purpose of this prime numbers formula is to show how these codes develop from prime to prime. This development of codes is based on our other understandings of primes and the pattern of prime numbers. The code is based on the Foundation Patterns and is developed in segments just as we have discussed. For clarity note that we come up with numbers that are the Foundation Codes and then we cut the actual code numbers from the Foundation Codes numbers to make Code segments. The derived Foundation Codes are in oscillating cycles of numbers. These numbers in the oscillating cycles circle around somewhat like a clock face but please note that we are not getting into something called clock arithmetic. The clock face of numbers tends to get larger as we go from segment to segment. Instead of graphically going around number circles here like a clock, we are instead going to make lines of numbers that repeat over and over as needed. We will use the music symbol for a repeat "**:||**" except that instead of repeating once as in music, we will repeat as often as we need to. This symbol "**||:**" tells use where we go back to in order to start another repeat. We will set up the Foundation Codes in something like Foundation Code tables for codes with development explanations as we go along.

Now let's do a few Code segments, etc. to make clear how we can come up with a code to add to a prime number to get the next prime number. This is the procedure but it may not be clear until we do a few segments.

- First, look back at earlier results in previous prime segments to find out what is the next new prime number we have developed that we now need to generate codes for. This prime will be used to establish the beginning of our new prime segment. And we will also need to know the prime number after that because it will be the "next" prime which we use to find the end of the prime segment. (Of course, if this is the first segment of codes we start at 1 with what we know. Segment 1 has no punch outs and thus no Foundation Pattern. Thus if this is Foundation Codes for segment 1 things are developed slightly differently as the logic dictates.) Note that Foundation Patterns develop from zero and Foundation Codes develop from 1.
- Second, after segment 1, starting at 1, fill up the new Foundation Codes segment for the length of the product of all of the primes up to and including the prime of the current prime segment which is the length of the cycle for that Foundation Codes segment. It will actually go just beyond the end of the prime segment because of the + 2 bridge code [defined later]. The number of cycle lengths of the previous Foundation Code segment needed for the cycle length of the new Foundation Codes

will be that length of the previous segment's Foundation Code times the value of the current prime of the segment. The last + 2 of the cycle is always the bridge code. This will make one cycle of our new Foundation Codes segment but we need another step. Of course the Foundation Codes segment goes to infinity but for our purposes we only need to do what we just described to make one cycle of the new Foundation Codes segment.

- Third, then, starting at the number 1, punch out every occurrence of multiples of the new prime of the segment including prime times 1. At the same time or as a second step, combine the value of the code that hit the prime (and later, that hit a multiple of the prime) just made by the punch out and combine this value with the next Foundation Code value because that is what it will take to add to the last number preceding the punch out number to get to the next number just after the punch out. This what we have done to find the punch outs: the first punch out will be the prime which has not been touched since it was established and no more multiples of the prime will be punched out until prime squared because earlier multiples have been pinched out by earlier primes; then, multiples of the prime greater than the prime will be punched out as needed if they do not contain composites made of primes smaller than the prime of the segment. We now have our completed Foundation Codes new segment.
- Fourth, starting at 1, put down as many cycles of our new Foundation Codes segment as is needed to go through the end of the current prime segment. We actually need to go just beyond the end of the prime segment.
- Fifth, and finally, to get the "Code segment" for the range of the current prime segment we start at the number 1 and count up the Foundation Codes to prime square and use the codes in the range of the prime "segment". The first code in the current code segment is added to the prime just before the current Code segment. These codes then will give us each new prime in the current prime segment.

- We shall see that <u>Foundation Codes for segment 1</u> are **||:** + 1 **:||** to ∞ with no prime of the segment.
- (We can figure out this segment from what we know.)
- There are no earlier primes or prime of the segment to punch out any numbers. Thus the length of the prime cycle obviously is 1 which repeats over and over to infinity.
- The Foundation Codes for segment 1 begins at the number 1, which is not a prime, and goes to the first prime squared {which is 2 squared} minus 1 = 3. (Note that the number 1 is NOT a code number and it is not involved in later prime's Foundation Codes in the cyclic repeating of the code numbers.)
- Again, there are no earlier primes or prime of the segment to punch out any numbers.
- <u>Code segment 1</u> for the range of 1 to 3 is: + 1, + 1; identifying primes 2, and 3 {number 1 + 1 is prime 2, + 1 is prime 3}.

- From segment 2 and thereafter the rules change; segment 1 was a special case.
- We shall see that <u>Foundation Codes for segment 2</u> are **||:** + 2 {the bridge} **:||** to ∞ for prime 2.
- The only punch out is 2, thus the length of the prime cycle is 2 which repeats over and over to infinity. After this the length of a prime cycle is the product of all of the primes up to and including the prime of the cycle. For example, segment 4 has prime 5 for the prime segment and the cycle which repeats over and over for prime 5 would be 30 {2 times 3 times 5} (2 cycles of 3 times 5 times; 3 cycles of 2 time 5 times; 5 cycles 2 time 3 times; and they all meet at 30 to start a new cycle for all 3 of the numbers).
- Also note that in these earlier Foundation Codes segments it takes several prime cycles to figure out the Code segment. In later segments it takes only one prime cycle to figure out the Code segment because the prime cycles rapidly get very large from each prime cycle to the next prime cycle.
- The last number of the cycle (the only cycle number in the case of segment 2) goes beyond the cycle to the next cycle so we call it "the bridge".
- The segment 2 goes from the prime squared {$2^2 = 4$} to the next prime squared minus 1 {$3^2 – 1 = 8$}.
- Fill the length of Foundation Codes for segment 2 from number 1 to number 8 using the code numbers of the previous segment and then put the next code number that comes after 8.
- [Starting at number 1, then] + 1, + 1, + 1, + 1, + 1, + 1, + 1, + 1 {the next code number after 8}.
- Punch out the number that would hit each multiple of the prime of the segment {2} but remember the numbers punched out. Also remember that these codes are added starting at number 1.
- ~~+ 1~~, + 1, ~~+ 1~~, + 1, ~~+ 1~~, + 1, ~~+ 1~~, + 1 {the next code number after 8}.
- Add any punched out number to the next number. Note that a punch out does not eliminate whole numbers, it just changes the space between whole numbers.
- + 2, + 2, + 2, + 2.
- Then, count in the codes from 1 up until you are in the prime segment.
- These numbers in the prime segment make the Code segment.
- These Code numbers are added to the last prime of the previous segment.
- <u>Code segment 2</u> for the range of 4 to 8 is: + 2, + 2; adding this to prime 3 of the last segment identifies primes 5, and 7 {3 + 2 = 5, 5 + 2 = 7}. Note that in adding these codes that we do not go beyond the 8 because we started adding before the 4.

- We shall see that <u>Foundation Codes for segment 3</u> are **||:** + 4, + 2 {the bridge} **:||** to ∞ for prime 3.
- The length of the prime cycle is 6 {prime 2 times prime 3} which repeats over and over to infinity. From our calculations below we can see the derivation of the above Foundation Codes for segment 3 which we know has a length of 6.
- The last number of the cycle goes beyond the cycle to the next cycle so we call it "the bridge".

- We now know the next prime always because it was generated in an earlier segment.
- The segment 3 goes from the prime squared {$3^2 = 9$} to the next prime squared minus 1 {$5^2 – 1 = 24$}.
- Fill the length of Foundation Codes for segment 3 from number 1 to number 24 using the code numbers from the previous segment and then put the next code number that comes after 24.
- [Starting at number 1, then] + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge}, + 2 {the bridge} {the next code number after 24}.
- Punch out the number that would hit each multiple of the prime of the segment {3} but remember the numbers punched out. Also remember that these codes are added starting at number 1.
- ~~+ 2~~, + 2, + 2, ~~+ 2~~, + 2, + 2, ~~+ 2~~, + 2, + 2, ~~+ 2~~, + 2, + 2 {the next code number after 24}.
- Add any punched out number to the next number. Again, note that a punch out does not eliminate whole numbers, it just changes the space between whole numbers.
- + 4, + 2 {Foundation Codes cycle bridge}, + 4, + 2, + 4, + 2, + 4, + 2.
- Then, count in the codes from 1 up until you are in the prime segment.
- These numbers in the prime segment make the Code segment.
- These Code numbers are added to the last prime of the previous segment.
- <u>Code segment 3</u> for the range of 9 to 24 is: + 4, + 2, + 4, + 2, + 4; adding this to prime 7 of the last segment identifies primes 11, 13, 17, 19, and 23 {7 + 4 = 11, 11 + 2 = 13, 13 + 4 = 17, 17 + 2 = 19, 19 + 4 = 23}. Note again that in adding these codes that we do not go beyond the 24 because we started adding before the 9.

- We shall see that <u>Foundation Codes for segment 4</u> are **||:** + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {bridge} **:||** to ∞ for prime 5. (Also, do you see the mirror not counting the bridge?)
- The length of the prime cycle is 30 {prime 2 times prime 3 times prime 5} which repeats over and over to infinity. From our calculations below we can see the derivation of the above Foundation Codes for segment 4 which we know has a length of 30.
- The last number of the cycle goes beyond the cycle to the next cycle so we call it "the bridge".
- We now know the next prime always because it was generated in an earlier segment.
- The segment 4 goes from the prime squared {$5^2 = 25$} to the next prime squared minus 1 {$7^2 – 1 = 48$}.
- Fill the length of Foundation Codes for segment 4 from number 1 to number 48 using the code numbers from the previous segment and then put the next code number that comes after 48.

- [Starting at number 1, then] + 4, + 2 {the bridge}, + 4, + 2 {the bridge}, + 4, + 2 {the bridge}, + 4, + 2 {the bridge}, + 4, + 2 {the bridge}, + 4, + 2 {the bridge}, + 4, + 2 {the bridge}, + 4, + 2 {bridge} {the next code number after 48}.
- Punch out the number that would hit each multiple of the prime of the segment {5} but remember the numbers punched out. Also remember that these codes are added starting at number 1.
- ~~+ 4~~, + 2, + 4, + 2, + 4, + 2, + 4, ~~+ 2~~, + 4, + 2, ~~+ 4~~, + 2, + 4, + 2, + 4, + 2 {the next code number after 48}.
- Add any punched out number to the next number.
- + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {Foundation Codes cycle bridge}, + 6, + 4, + 2 + 4, + 2 {not a bridge because it is not the end of a Foundation Codes cycle}. (Note that you can check your work by seeing if there is a mirror in the Foundation Codes cycle up to but not including the bridge.)
- Then, count in the codes from 1 up until you are in the prime segment.
- These numbers in the prime segment make the Code segment.
- These code numbers are added to the last prime of the previous segment.
- <u>Code segment 4</u> for the range of 25 to 48 is: + 6, + 2, + 6, + 4, + 2 + 4, + 2; adding this to prime 23 of the last segment identifies primes 29, 31, 37, 41, 43, and 47 {23 + 6 = 29, 29 + 2 = 31, 31 + 6 = 37, 37 + 4 = 41, 41 + 2 = 43, 43 + 4 = 47, + 2}. Note again that in adding these codes that we do not go beyond the 48 because we started adding before the 25.

- We shall see that <u>Foundation Codes for segment 5</u> are **||:** + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}**:||** to ∞ for prime 7. (Also, do you see the mirror not counting the bridge?)
- The last number of the cycle goes beyond the cycle to the next cycle so we call it "the bridge".
- The length of the prime cycle is 210 {prime 2 times prime 3 times prime 5 times prime 7} which repeats over and over to infinity. From our calculations below we can see the derivation of the above Foundation Codes for segment 5 which we know has a length of 210.
- Now we begin to have prime cycles that are longer than what we need for our Code segment calculations. So let's set up the long prime cycle first and then do our calculations from there.
- The length of the prime cycle is 210 {prime 2 times prime 3 times prime 5 times prime 7} which repeats over and over to infinity. So how many of the previous prime cycles do we need to begin? We need the number of the current prime, that many, of the previous prime cycle. Thus we need 7 of the prime 5 cycles.
- + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}.

- Punch out the number that would hit each multiple of the prime of the segment {7} but remember the numbers punched out. Also remember that these codes are added starting at number 1.
- (We are still leaving “the bridge” from the previous Foundation Codes cycle in here for now to help us visually keep our place.) ~~+ 6~~, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, ~~+ 2~~, + 4, + 6, + 2 {the bridge}, + 6, + 4, + 2, ~~+ 4~~ {be careful of the + 4 punch out because it only shows up on the plus if the 4 is on the next line}, + 2, + 4, + 6, ~~+ 2~~ {the bridge}, + 6, + 4, + 2, + 4, + 2, + 4, ~~+ 6~~, + 2 {the bridge}, + 6, + 4, ~~+ 2~~, + 4, + 2, + 4, + 6, + 2 {the bridge}, + 6, ~~+ 4~~, + 2, + 4, + 2, + 4, [175 was punched out by prime 5 earlier in Foundation Codes for segment 4 if we would have kept going with prime 5 cycles] + 6, + 2 {the bridge}, + 6, + 4, + 2, + 4, + 2, ~~+ 4~~, + 6, + 2 {the bridge}.
- [Some comments on the “175” above: Some numbers can be punched out by several different primes. However, if you just go through the list and punch out multiples of “7”, you would not see that 175 was already punched out. But the punch outs can be made by using major and minor paired numbers and you would come to 175 and there would be no number there because it is already punched out. Using paired numbers, you first punch out the prime {7} of the segment, then the square of the prime {7}, and then the minor number prime does 2 times prime followed by 4 times prime and major number prime does the reverse. (Remember that primes from 5 on are minor or major numbers.) With paired numbers we could hit a number more than once.]
- Add any punched out number to the next number.
- + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge for this Foundation Codes cycle}. This is the current Foundation Codes cycle.
- We now know the next prime always because it was generated in an earlier segment.
- The segment 5 goes from the prime squared {$7^2 = 49$} to the next prime squared minus 1 {$11^2 – 1 = 120$}.
- Now that we have the Foundations Codes segment for segment 5, we can proceed differently because some of our steps we used in earlier segments are already done.
- Count in the codes from 1 up until you are in the prime segment.
- These numbers in the prime segment make the Code segment.
- These code numbers are added to the last prime of the previous segment.
- <u>Code segment 5</u> for the range of 49 to 120 is: + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8; adding this to prime 47 of the last segment identifies primes 53, 59, 61, 67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, and 113 {47 + 6 = 53, 53 + 6 = 59, 59 + 2 = 61, 61 + 6 = 67, 67 + 4 = 71, 71 + 2 = 73, 73 + 6 = 79, 79 + 4 = 83, 83 + 6 = 89, 89 + 8 = 97, 97 + 4 = 101, 101 + 2 = 103, 103 + 4 = 107, 107 + 2 = 109, 109 + 4 = 113, + 8}. Note again that in adding these codes that we do not go beyond the 120 because we started adding before the 49.

- [Calculating Foundation Codes for segment 6 are not complete here.] We shall see that <u>Foundation Codes for segment 6</u> are **||:** [incomplete] **:||** to ∞ for prime 11.
- The last number of the cycle goes beyond the cycle to the next cycle so we call it "the bridge".
- The length of the prime cycle is 2310 {prime 2 times prime 3 times prime 5 times 7 times prime 11} which repeats over and over to infinity. From our calculations below we can see the derivation of the above Foundation Codes for segment 6 which we know has a length of 2310.
- Now we continue to have prime cycles that are longer than what we need for our Code segment calculations. So let's set up the long prime cycle first and then do our calculations from there.
- The length of the prime cycle is 2310 {prime 2 times prime 3 times prime 5 times prime 7 times prime 11} which repeats over and over to infinity. So how many of the previous prime cycles do we need to begin? We need the number of the current prime, that many, of the previous prime cycle. Thus we need 11 of the prime 7 cycles.
- + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4,

+ 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}.

- Punch out the number that would hit each multiple of the prime of the segment {11} but remember the numbers punched out. Also remember that these codes are added starting at number 1.
- [The punch outs are not done.] (We are still leaving "the bridge" from the previous Foundation Codes cycle in here for now to help us visually keep our place.) + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}, + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge},s + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}.
- Add any punched out number to the next number.
- [The adding of the punched out numbers to the next number is not done here to get the current Foundation Codes cycle.]
- We now know the next prime always because it was generated in an earlier segment.
- The segment 6 goes from the prime squared {11^2 = 121} to the next prime squared minus 1 {13^2 – 1 = 168}.

- Now that we have the Foundations Codes segment for segment 5, we can proceed differently because some of our steps we used in earlier segments are already done.
- Count in the codes from 1 up until you are in the prime segment.
- These numbers in the prime segment make the Code segment. (This has not been checked out but sometimes we may have to use numbers beyond the prime segment since we start adding to a number that is before the prime segment to get the Code segment.)
- These code numbers are added to the last prime of the previous segment.
- Code segment 6 for the range of 121 to 168 is: + 14, + 4, + 6, + 2, + 10, + 2, + 6, + 6, + 4; adding this to prime 113 of the last segment identifies primes 127, 131, 137, 139, 149, 151, 157, 163, and 167 {113 + 14 = 127, 127 + 4 = 131, 131 + 6 = 137, 137 + 2 = 139, 139 + 10 = 149, 149 + 2 = 151, 151 + 6 = 157, 157 + 6 = 163, 163 + 4 = 167}. Note again that in adding these codes that we do not go beyond the 168 because we started adding before the 121.

FORMULA SUMMARY

For prime number P and code C for P:

$$\mathbf{P_{\{n\}} + C_{\{n\}} = P_{\{n+1\}}}$$

Code Table:

Foundation Codes for segment 1 are **||:** + 1 **:||** to ∞
with no prime of the segment.
Code segment 1 for the range of 1 to 3 is: + 1, + 1;
Adding this to number 1, which is not a prime, identifying primes 2, and 3.

Foundation Codes for segment 2 are **||:** + 2 {the bridge} **:||** to ∞
for prime 2.
Code segment 2 for the range of 4 to 8 is: + 2, + 2;
adding this to prime 3 identifies primes 5, and 7.

Foundation Codes for segment 3 are **||:** + 4, + 2 {the bridge} **:||** to ∞
for prime 3.
Code segment 3 for the range of 9 to 24 is: + 4, + 2, + 4, + 2, + 4;
adding this to prime 7 identifies primes 11, 13, 17, 19, and 23

Foundation Codes for segment 4 are **||:** + 6, + 4, + 2, + 4, + 2, + 4, + 6, + 2 {bridge} **:||**
to ∞ for prime 5.
Code segment 4 for the range of 25 to 48 is: + 6, + 2, + 6, + 4, + 2 + 4, + 2;
adding this to prime 23 identifies primes 29, 31, 37, 41, 43, and 47.

Foundation Codes for segment 5 are **||:** + 10, + 2, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8 + 6, + 4, + 6, + 2, + 4, + 6, + 2, + 6, + 6, + 4, + 2, + 4, + 6, + 2, + 6, + 4, + 2, + 4, + 2, + 10, + 2 {bridge}**:||** to ∞ for prime 7.
Code segment 5 for the range of 49 to 120 is: + 6, + 6, + 2, + 6, + 4, + 2, + 6, + 4, + 6, + 8, + 4, + 2, + 4, + 2, + 4, + 8; adding this to prime 47 identifies primes 53, 59, 61, 67, 71, 73, 79, 83, 89, 97, 101, 103, 107, 109, and 113.

Foundation Codes for segment 6 are **||:** [incomplete] **:||** to ∞ for prime 11.
Code segment 6 for the range of 121 to 168 is: + 14, + 4, + 6, + 2, + 10, + 2, + 6, + 6, + 4; adding this to prime 113 identifies primes 127, 131, 137, 139, 149, 151, 157, 163, and 167.

This final formula for prime numbers shows the fact of a pattern prime numbers formula that develops in a patterned way from segment to segment. However, as with the last illustration formula relating to paired numbers, these illustration formulas get very cumbersome very quickly as we develop more of the Code Table but they do illustrate patterns!

To change the subject, there is one more item to examine. Some people are interested in very large prime numbers. The ideas in this document have not found any way to get an exceedingly large prime number.

<u>Tests for very, very large number being a prime</u>:

From paired numbers:

We can show that a number is either not a prime or possible a prime but we cannot show that it is a prime with the following test:

Prime numbers after prime 5 must end in 1, 3, 7, 9 proven earlier, that is, it must be an odd number other than 5.

Use the following pattern is more definitive:

Minor paired numbers are:
5 + 6(n) for n = 0 to ∞
Major paired numbers are:
7 + 6(n) for n = 0 to ∞

Test for very, very large number being a prime: [to test for “possible” prime but we do not know if it is punched out]:

(tested number – 5)/6 = n {a whole number}
(tested number – 7)/6 = n {a whole number}

Examples:
(91 – 5)/6 = n {a whole number}? Not work
(91 – 7)/6 = n {a whole number}? Yes a possibly a prime but not know if it is punched out
Thus 91 is a possible prime

(81 – 5)/6 = n {a whole number}? Not work
(81 – 7)/6 = n {a whole number}? Not work
Thus 81 is not a prime

(161 – 5)/6 = n {a whole number}? Yes a possibly a prime but not know if it is punched out
(161 – 7)/6 = n {a whole number}? Not work
Thus 161 is a possible prime; it is not, we did not know that it was punched out being a composite of 17 x 23

We can show that a number is either not a prime or possible a prime but we cannot show that it is a prime with the following test:

Prime numbers after prime 5 must end in 1, 3, 7, 9 proven earlier.

Use the following pattern is more definitive:

Starting at prime 11, this is a repeating pattern every 30 numbers for the last number in a prime number being 1,3,7,9,3,9,1,7 {11, 13, 17, 19, 23, 29, 31, 37, then, 41, 43, 47, 49 [but it is pinched out], 53, 59, 61, 67, and then the next 30 number pattern etc. unless one of these numbers has been punched out. This happens because composites of primes 2, 3, and 5 being all punched out leave this 30 number cycling pattern.

Thus we have:

11 + 30(n), 13 + 30(n), 17 + 30(n), 19 + 30(n), 23 + 30(n), 29 + 30(n), 31 + 30(n), 37 + 30(n) for n = 0 to ∞.

We have two numbers ending in 1 {11, 31}, two ending in 3 {13, 23}, two ending in 7 {17, 37}, and two ending in 9 {19, 29}. If a number ends in 1, we do the 11 and 31 test; if a number ends in 3, we do the 13 and 23 test; etc.

For numbers ending in 1 to test for "possible" prime but we do not know if it is punched out:

(tested number – 11)/30 = n {a whole number} (tested number – 31)/30 = n {a whole number}

Examples:
(91 – 11)/30 = n {a whole number}? Not work
(91 – 31)/30 = n {a whole number}? Yes a possibly a prime but not know if punched out
Thus 91 is a possible prime

(81 – 11)/30 = n {a whole number}? Not work
(81 – 31)/30 = n {a whole number}? Not work
Thus 81 is not a prime

(161 – 11)/30 = n {a whole number}? Yes a possibly a prime but not know if punched out
(161 – 31)/30 = n {a whole number}? Not work
Thus 161 is a possible prime; it is not, we did not know that it was punched out being a composite of 17 x 23

Do a similar test pattern for numbers ending in 3, 7, and 9.

It has not been checked to see if these tests are very practical. But again, they show patterns.

SEGMENT 4 AND BEYOND OF THE PATTERN OF PRIME NUMBERS INCLUDING SUMMARY

Much earlier in this document we left off the examining of Segment 4. Now let's finally go back and examine Segment 4 and beyond of the pattern of prime numbers. Segment 4 is based on the number 3 prime number which is prime number 5. For this segment of the pattern of prime numbers and all future segments just continue the process similar to what we did in segment 3. We now have established the process which by the same logic goes on to infinity. All ideas in the processes in this document are established sequentially going down the whole number series and the same logic extended would take you to infinity. Thus, we have the pattern of all prime numbers described!

Range Of Segment: (current prime square) to ((next prime square) - 1)
except for segment 1 which is (1 for there are no primes) to
((first prime square by definition) - 1).
Each segment of prime numbers is a unique pattern which together make the total Pattern Of Prime Numbers.

Foundation Pattern which is a Resulting Set, And PATTERN OF PRIME NUMBERS:
The entire Foundation Pattern usually does not need to be calculated to find the segment since these Foundation Patterns can get very large. Instead, for the range of the current segment within the Foundation Pattern, punch out the composites of

the current and all previous primes to get the Resulting Set that lies within the range of the current segment and this will be your pattern of prime numbers for the segment although you will not see the Foundation Pattern design from where the segment was derived. These composites can be punched out by punching out each entry in each prime's multiplication table that lies in the range of the segment. This is more easily done using the paired numbers explanation we did earlier.

Study the process and you should see that the preceding simplification is what is happening.

Here is an easier way to find the pattern of prime numbers around a given number. Let the given number be 1,000 for example. Quickly run the prime numbers formula in the spreadsheet and find the two adjacent consecutive prime numbers in which the square of the first lies before or on 1,000 and the square of the second lies on or after 1,000. That would be 31 with squared = 961 and 37 with squared = 1,369. (See the Finding Prime Squares worksheet which is in the prime numbers formula spreadsheet on fifth worksheet to find squares quickly. You may have to click the little tab arrows at the bottom left of the screen to see the tabs for all of the worksheets.) Now run the prime numbers formula starting at 961 and stopping after 1,369. Remember that your segment of the pattern of prime numbers stops 1 less that the square of the next consecutive prime number; so, our segment here would end at 1,368. Thus our pattern of prime numbers for the segment around 1,000 would be made by the prime numbers (use the formula to find these numbers) in the range of whole numbers 961 to 1368 with the other whole numbers in this range being blanks: 967; 971; 977; 983; 991; 997; 1,009; 1,013; 1,019; 1,021; 1,031; 1,033; 1,039; 1,049; 1,051; 1,061; 1,063; 1,069; 1,087; 1,091; 1,093; 1,097; 1,103; 1,109; 1,117; 1,123; 1,129; 1,151; 1,153; 1,163; 1,171; 1,181; 1,187; 1,193; 1,201; 1,213; 1,217; 1,223; 1,229; 1,231; 1,237; 1,249; 1,259; 1,277; 1,279; 1,283; 1,289; 1,291; 1,297; 1,301; 1,303; 1,307; 1,319; 1,321; 1,327; 1,361; 1,367. The density of prime numbers in the segment would be 57 prime numbers divided by 408 which is the length of the segment or .139705882. The density of prime numbers from 0 would be 219 prime numbers (if you also know the number of prime numbers in earlier segments) divided by 1368 which is the last number in the segment or .160087719.

<u>What is the pattern of prime numbers?</u>

The pattern of prime numbers is in segments because the pattern changes from segment to segment. The segments up to infinity make up the pattern of prime numbers. Note that the pattern of prime numbers changes at each prime square!!!!

<u>Where does the pattern within each segment come from?</u>

The pattern of prime numbers in each segment comes from its Foundation Pattern from which the segment is cut.

Where does the design in the Foundation Pattern come from?

The design in the Foundation Pattern comes from the multiplication tables of all primes up to and including the prime of the segment punching out the number products from the multiplication tables and this produces a cycle whose length is the product of all of the primes up to and including the prime of the segment. Major and minor paired numbers concepts show us more patterns in these numbers especially in the pattern of the punch outs in the segments - - which segments we now know give us The Pattern Of Prime Numbers. Code segments are also an interesting exercise using our learning and (in theory but not in practicality) they give the primes in sequential order. Our study of Paired Numbers and Foundation Codes show us more about patterns, especially twin primes and the pattern within a prime numbers segment.

The Method and Procedure are now complete.

The Problem is solved for our purposes which is: See how the whole number series could be developed for the purposes of understanding more about prime numbers and the pattern of prime numbers.

Now that you see where this document is going and how it goes about the task at hand, it may be worth your time to read it again for better understanding and to get a better picture of the what was said. Concepts like those in this document are difficult to get into words with a simple, logical presentation. Thank you for your efforts to understand this document!

[Please go to next page.]

Conclusions And Implications

[1] We have a practical formula for positive prime numbers. Several things about prime numbers were observed along the way. And, we have a statement about the pattern of prime numbers.

[2] Further Study. It may be worth the time to apply the ideas in this study to number systems other than the base 10. Applying it to the base 2 may [or may not?] come up with something useful for computers since they make use of base 2 numbers [on and off electric switches].

[3] Hopefully a pure mathematics mathematician may see some use for the study in this document. A pure mathematician may also be able to make a more mathematically concise statement of the pattern of prime numbers than the writer of this document has made.

[4] Hopefully a mathematician who can bridge the gap between pure mathematics and applied mathematics can make use of the study in this document.

[5] The definition of a formula giving a result should be broad enough to include the use of computer programs and macros as viable formulas.

[6] Mathematics can be applied to the mathematics that is already in an MS Excel spreadsheet using Visual Basic macros to make powerful formulas. Concepts are in this document to assist this use. For an example of this kind of use, see: **"A Mathematical And Computer Analysis Method For Catching A Sniper, Etc."** which is in the website [danielhookemusic.com] where you got the document you are now reading.

[7] Words are really numbers in a computer. Thus, mathematics can be applied to the mathematics that is already in an MS Excel spreadsheet in order to apply to word data in computers to do amazing things and save tremendous amounts of time in manipulating and analyzing the data to make the data more useful.

[8] The computer can be used to study numbers to look for patterns and conclusions. This study can assist mathematicians in the development of mathematics and in the development of specific formulas.

[Please go to next page.]

Closing

We have come to the end of our journey. It has been an exciting trip through the magnificent land of mathematics and numbers! Hope you had a good time!

Please spread the word about this document in hopes that it may connect with someone who can make good use of it. Thank you for any good use that you may be able to make of this document!

Thank you for your time to read this document. May it prove useful to someone! Otherwise, I hope that you enjoyed the intellectual stimulation and entertainment! They tell me that this kind of thinking can help keep the mind young which at my age is something good to know.

<u>That's The Way I Understand It - Series</u>

See the website danielhookemusic.com

<u>Concerning Music Documents in "That's The Way I Understand It - Series"</u>: Read all of the music documents to get a picture of what has worked for the writer.

<u>Concerning Religious Documents in "That's The Way I Understand It - Series"</u>: These religious documents are An Advocate for interpreting the Bible the way Jesus of Nazareth interprets the Bible. Jesus will honor the Bible if we use it the way He interprets it. … Jesus our Savior believed the Bible as He interpreted it; so we know that what the Bible says about diligently seeking God and Jesus will be rewarded and honored in some way. Hebrews 11:6; John 14:15, 21; 15:4-6; I Sam. 2:30.

Bible Lessons For Those Who Want To Be Better Informed About This Famous Book

Do you know what the Bible really says and what it offers? Do you know what are some of the main issues in a Bible interpretation position that is An Advocate for interpreting the Bible the way Jesus of Nazareth interprets the Bible and what kind of Biblical understanding it offers? Requires a few minutes a day of reading. Uses documents from That's The Way I Understand It - Series. [Another approach to the materials in **Studies In Biblical Christianity, A Self-Directed Course Of Study**.]

THE BIBLICAL GOD IS A REWARDER

Are You Informed About Where Biblical Christians Are Coming From As You Make Decisions?

Bible Rewards from God.

A Case For Art Music To Be The Core Of The Church Music Program

Persuasion to help us not to lose the great depth of Worship that is possible with a particular kind of music assuming that it is properly done.

An Easy Bible Reading Plan

Do you know what the Bible really says? With a few minutes a day you can read the entire Bible. The readings are divided into episodes to make your reading more logical and easier.

Encouraging Hope For The Adult Beginning Harpist

Encouragement for adult harpist. Discussion of musicianship for any musician and for many who are not musicians.

The Essence Of Teaching

Provides the professional teacher or the parent as teacher with a momentary reflection on the natural process of teaching hopefully with a more comprehensive, helpful look at teaching.

The Welcoming Committee For The Second Coming

A study in Biblical prophecy and the end times of earth time. **{<u>Help to save you time in figuring out Bible Prophecy.</u>}**

How To Sing At Sight For The Singer And Instrumentalist

(How To Hear Printed Music In Your Mind)

Just what the title says. For the professional and the amateur. Get a copy of this document for each member of your performance organization especially if it is a singing group. Drill on it at the beginning of each rehearsal should pay good dividends.

That's The Way I Understand It - Series (continued)

Instant Sunday School – A Ten Year Verse-By-Verse Trip Through The Bible

Requires very little preparation time for a person to lead this group study. All of the work is already done for you. Thus, it is an easy Bible Study to present. This Bible Study goes through the Bible verse-by-verse alternating from time to time between the Testaments. This study can also be done as an individual study. Please see the document for more details and uses. Do you know what the Bible really says to help you discern error and grow? *"Blessed are they that hear the Word of God, and keep it." Luke 11:28*

IS THE CROSS OF JESUS CHRIST CENTRAL TO HUMAN HISTORY?

Has anyone ever told you about Biblical Christianity? Do you know some of the issues about the Bible and Bible interpretation including the issue of is God a rewarder? Uses "The seven last words of Jesus Christ". Uses the story of the thief on the cross beside Jesus. The thief on the cross bad-mouthed Jesus severely. Then, in less than a few hours he converted. What happened? Why did the thief convert? Sinners can be forgiven and redeemed by God. An Advocate for interpreting the Bible the way Jesus of Nazareth interprets the Bible. **{Help to save you time in figuring out the Bible. }**

A Layered Aesthetic Interpretation Of Music For The Performer, Composer, And Listener

A new look at music in human existence. For anyone who makes music at any level and for anyone's enjoyment of music. Not as complex as the title might imply. The principles in this document have application to all of the arts.

A Mathematical And Computer Analysis Method For Catching A Sniper, Etc.

An inexpensive, simple to use tool for law enforcement to identify the law breaker in serial, multiple incident law breaking situations. For law enforcement professionals.

The Pattern Of Prime Numbers
Plus A Prime Numbers Formula

The Pattern of Prime Numbers. For the mathematician. Contains information on macro writing thus making it also for the computer person.

Studies In Biblical Christianity
A Self-Directed Course Of Study

Provides a Picture Study, a Linear Study, and Additional Studies that should go far in giving you the opportunity to examine the explanations, clarifications, and reasons in the view of a Bible interpretation position that is An Advocate for interpreting the Bible the way Jesus of Nazareth interprets the Bible to see some of the issues in Biblical Christianity for an introduction or review. Uses documents from That's The Way I Understand It - Series. [Another approach to the materials in **Bible Lessons For Those Who Want To Be Better Informed About This Famous Book**.]

A Quick Look At Biblical Christianity

Do you know why Jesus of Nazareth is important? Do you know what He claims His purpose is? Do you know how He supports and interprets the Bible? Compare your answers with this document. Many people who know that Jesus is important have never really investigated Biblical Christianity. Many people are restrained by peer pressure (both social and professional), threat of death, etc. from investigating Jesus of Nazareth or from investigating Biblical Christianity. This is a good document to use to begin your investigation of Biblical Christianity. This document could have also been titled "The Intellectual Basis Of Belief And The Belief Basis Of Intellect".