Murrey Math Study Notes

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Introduction

Murrey Math is a trading system for all equities. This includes stocks, bonds, futures (index, commodities, and currencies), and options. The main assumption in Murrey Math is that all markets behave in the same manner (i.e. All markets are traded by a mob and hence have similar characteristics.). The Murrey Math trading system is primarily based upon the observations made by W.D. Gann in the first half of the 20'th century. While Gann was purported to be a brilliant trader in any market his techniques have been regarded as complex and difficult to implement. The great contribution of Murrey Math (T. H. Murrey) was the creation of a system of geometry that can be used to describe market price movements in time. This geometry facilitates the use of Gann's trading techniques.

The Murrey Math trading system is composed of two main components; the geometry used to gauge the price movements of a given market and a set of rules that are based upon Gann and Japanese candlestick formations. The Murrey Math system is not a crystal ball, but when implemented properly, it can have predictive capabilities. Because the Murrey Math rules are tied to the Murrey Math geometry, a trader can expect certain pre-defined behaviors in price movement. By recognizing these behaviors, a trader has greatly improved odds of being on the correct side of a trade. The overiding principle of the Murrey Math trading system is to recognize the trend of a market, trade with the trend, and exit the trade quickly with a profit (since trends are fleeting). In short, "No one ever went broke taking a profit".

The Murrey Math geometry mentioned above is "elegant in its simplicity". Murrey describes it by saying, "This is a perfect mathematical fractal trading system". An understanding of the concept of a fractal is important in understanding the foundation of Murrey Math. For readers interested in knowing more about fractals I would recommend the first 100 pages of the book,"The Science of Fractal Images" edited by Heinz-Otto Peitgen and Dietmar Saupe. The book was published by Springer-Verlag, copyright 1988. An in depth understanding of fractals requires more than "8'th grade math", but an in depth understanding is not necessary (just looking at the diagrams can be useful).

The size (scale) of basic geometric shapes are characterized by one or two parameters. The scale of a circle is specified by its diameter, the scale of a square is given by the length of one of its sides, and the scale of a triangle is specified by the length of its three sides. In contrast, a fractal is a self similar shape that is independent of scale or scaling. Fractals are constructed by repeating a process over and over. Consider the following example depicted in Figure 1.

Suppose some super being could shrink a person down so that their height was equal to the distance between the points O and P. Suppose also that this super being drew the large rectangle shown in Figure 1 and sub-divided the large rectangle into four smaller sub-rectangles using the lines PQ and RS. This super being then places our shrunken observer at point O. Our observer would look down and see that he/she is surrounded by four identical rectangles. Now, suppose our super being repeats the process. Our observer is further shrunk to a height equal to the distance between the points O' and P'. The super being then sub-divides the quarter rectangle into four smaller sub-rectangles using the lines P'Q' and R'S'. Our shrunken observer is then moved to the point O'. Our observer looks down and sees that he/she is surrounded by four identical rectangles. The view that is seen from the point O' is the same as the view that was seen from the point O. In fact, to the observer, the two scenes observed from the points O and O' are indistinguishable from each other. If the super being repeated the process using the points O'', P'', Q'', R'' and S'' the result would be the same. This process could be repeated ad-infinitum, each time producing the same results. This collection of sub-divided rectangles is a fractal. The geometry appears the same at all scales.

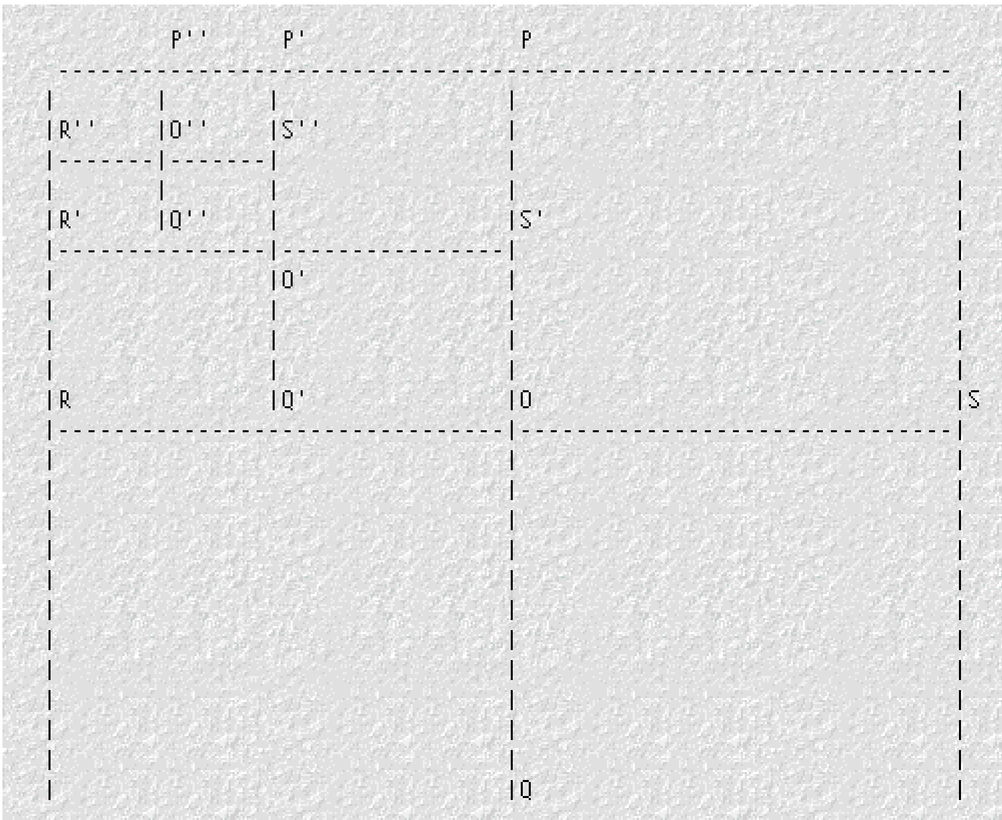

FIGURE 1

The next question, of course is, "What does a fractal have to do with trading in equity markets?" Imagine if someone presented you with a collection of price-time charts of many different equities and indices from many different markets. Each of these charts have been drawn using different time scales. Some are intraday, some are daily, and some are weekly. None of these charts, however, is labeled. Without labels, could you or anyone else distinguish a daily chart of the Dow from a weekly chart of IBM, or from an intraday chart of wheat prices. Not very likely. All of these charts, while not identical, appear to have the same general appearance. Within a given time period the price moves some amount, then reverses direction and retraces some of its prior movement. So, no matter what price-time scales we use for our charts they all look pretty much the same (just like a fractal). The "sameness" of these various charts can be formally characterized mathematically (but this requires more that 8'th grade math and is left as an exercise to the interested reader).

Gann was a proponent of "the squaring of price and time", and the use of trend lines and various geometric angles to study price-time behavior. Gann also divided price action into eighths. Gann then assigned certain importance to markets moving along trendlines of some given angle. Gann also assigned importance to price retracements that were some multiple of one eigth of some prior price movement. For example, Gann referred to movement along the 45 degree line on a price-time chart as being significant. He also assigned great significance to 50% retracements in the price of a commodity. The question is, "A 45 degree angle measured relative to what?" "A 50% retracement relative to what prior price?"

These angle or retracement measurements are made relative to Gann's square of price and time. Gann's square acted as a coordinate system or reference frame from which price movement could be measured. The problem is that as the price of a commodity changes in time, so must the reference frame we are using to gauge it. How should the square of price and time (the reference frame) be changed so that angles and retracements are measured consistently? This question is one of the key frustrations in trying to implement Gann's methods. One could argue that Gann recognized the fractal nature of market prices changing in time. Gann's squaring of price and time, however, did not provide an objective way of quantifying these market price movements.

If one could construct a consistent reference frame that allowed price movement to be measured objectively at all price-time scales, then one could implement Gann's methods more effectively. This is exactly what Murrey Math has accomplished.

The following discussions assume that one has access to the Murrey Math book.

Squares

As mentioned above, Murrey Math has identified a system of reference frames (coordinate systems) that can be used to objectively gauge price movement at all price-time scales. Taken collectively, these reference frames or "squares in time" constitute a fractal. Each square in time can be thought of as being a part of (1/4) a larger square in time. Recall the simple example of the fractal described in the introduction of this paper. Each set of four squares was created by subdividing a larger square. Unlike a mathematically ideal fractal, we cannot have infinitely large or small squares in time since we do not get price data over infinitely large or small time frames. But for all practical purposes, the Murrey Math squares in time are a fractal.

Fractals are created by recursiveley (repeatedly) executing a set of steps or instructions. This is also true of Murrey Math "squares in time".

The first step in constructing a square in time for a particular entity (NOTE: The word "entity" will be used as a shorthand to refer to any traded equity or derivative such as stocks, commodities, indices, etc.) is identifying the scale of the smallest square that "controls" the price movement of that entity. Murrey refers to this as "setting the rhythm". Murrey defines several scales.

Let's use the symbol SR to represent the possible values of these scales (rhythms). SR may take on the values shown below in TABLE 1.

A larger value of SR could be generated by multiplying the largest value by 10. Hence, 10 x 100,000 = 1,000,000 would be the next larger scale factor.

The choice of SR for a particular entity is dictated by the maximum value of that entity during the timeframe in question. TABLE 1 defines the possible choices of SR.

The value of SR that is chosen is the smallest value of SR that "controls" the maximum value of the entity being studied. The word "controls" in this last statement needs clarification. Consider two examples.

EXAMPLE 1)
Suppose the entity being studied is a stock. During the timeframe being considered the maximum value that this stock traded at was 75.00. In this case, the value of SR to be used is 100. (Refer to TABLE 1)

EXAMPLE 2)
Suppose the entity being studied is a stock. During the timeframe being considered the maximum value that this stock traded at was 240.00. In this case, the value of SR to be used is also 100. (Refer to TABLE 1)

TABLE 1:

IF (the max value of the entity is less than or equal to)	AND (the max value of the entity is greater than)	THEN (SR is)
250,000	25,000	100,000
25,000	2,500	10,000
2,500	250	1,000
250	25	100
25	12.5	12.5
12.5	6.25	12.5
6.25	3.125	6.25
3.125	1.5625	3.125
1.5625	0.390625	1.5625
0.390625	0.0	0.1953125

In EXAMPLE 2, even though the maximum price of the stock exceeds the value of SR, the stock will still behave as though it is being "controlled" by the SR value of 100. This is because an entity does not take on the characteristics of a larger SR value until the entity's maximum value exceeds 0.25 x the larger SR value. So, in EXAMPLE 2, the lower SR value is 100 and the larger SR value is 1000. Since the price of the stock is 240 the "controlling" SR value is 100 because 240 is less than (.25 x 1000) 250. If the price of the stock was 251 then the value of SR would be 1000. TABLE 1 shows some exceptions to this ".25 rule" for entities priced between 12.5 and 0.0. TABLE 1 takes these exceptions into account.

Murrey Math Lines

Let us now continue constructing the square in time for our entity. The selection of the correct scale factor SR "sets the rhythm" (as Murrey would say) for our entity.

Remember, Gann believed that after an entity has a price movement, that price movement will be retraced in multiples of 1/8's (i.e. 1/8, 2/8, 3/8, 4/8, 5/8, 6/8, 7/8, 8/8). So, if a stock moved up 4 points Gann believed the price of the stock would reverse and decline in 1/2 point (4/8) increments (i.e. 1/2, 2/2, 3/2, 4/2, 5/2, 6/2, 7/2, 8/2 ...). Since prices move in 1/8's, Murrey Math divides prices into 1/8 intervals. The advantage of Murrey Math is that a "rhythm" (a scale value SR) for our entity has been identified. Traditional Gann techniques would have required one to constantly chase price movements and to try to figure out which movement was significant. If a significant price movement could be identified then that price movement would be divided into 1/8's. Murrey Math improves upon traditional Gann analysis by providing a constant (non-changing) price range to divide into 1/8's. This constant price range is the value of SR (the "rhythm") that is chosen for each entity.

So, having selected a value for SR, Murrey Math instructs us to divide the value of SR into 1/8's. For the sake of consistency, let's introduce some notation. Murrey refers to major, minor, and baby Murrey Math lines. Murrey abbreviates the term "Murrey Math Lines" using MML. Using the MML abbreviation let;

The symbol: MML be defined as: Any Murrey Math Line
The symbol: MMML be defined as: Major Murrey Math Line
The symbol: mMML be defined as: Minor Murrey Math Line
The symbol: bMML be defined as: Baby Murrey Math Line

and, using the abbreviation MMI to mean "Murrey Math Interval", let;

The symbol: MMI be defined as: Any Murrey Math Interval
The symbol: MMMI be defined as: Major Murrey Math Interval = SR/8
The symbol: mMMI be defined as: Minor Murrey Math Interval = SR/8/8
The symbol: bMMI be defined as: Baby Murrey Math Interval = SR/8/8/8

where the symbol /8/8/8 means that SR is to be divided by 8 three times. For example, if SR = 100 then the Baby Murrey Math Interval bMMI is: 100/8/8/8 = 12.5/8/8 = 1.5625/8 = 0.1953125

Let's also introduce the term octave. An octave consists of a set of 9 Murrey Math Lines (MML's) and the 8 Murrey Math Intervals (MMI's) associated with the 9 MML's. Major, minor, and baby octaves may be constructed. For example, if SR = 100 then the major octave is shown in FIGURE 2. The octave is constructed by first calculating the MMMI. MMMI = SR/8 = 100/8 = 12.5. The major octave is then simply 8 MMMI's added together starting at 0. In this case 0 is the base.

100	8/8	MMML
87.5	7/8	MMML
75	6/8	MMML
62.5	5/8	MMML
50	4/8	MMML
37.5	3/8	MMML
25	2/8	MMML
12.5	1/8	MMML
0	0/8	MMML

FIGURE 2

A minor octave is constructed in a manner similar to the method shown for the major octave. Again, let SR = 100. First calculate the mMMI. mMMI = SR/8/8 = MMMI/8 = 12.5/8 = 1.5625. The minor octave is then simply 8 mMMI's added together starting at the desired base. The base must be a MMML. In this case let the base be the 62.5 MMML. The result is shown in Figure 3.

Naturally, a baby octave would be constructed using the same method used to construct a minor octave. First calculate bMMI (bMMI = mMMI/8). Then add bMMI to the desired mMML 8 times to complete the octave.

75	8/8	mMML
73.4375	7/8	mMML
71.875	6/8	mMML
70.3125	5/8	mMML
68.75	4/8	mMML
67.1875	3/8	mMML
65.625	2/8	mMML
64.0625	1/8	mMML
62.5	0/8	mMML

FIGURE 3

Characteristics of MMLs

Since, according to Gann, prices move in 1/8's, these 1/8's act as points of price support and resistance as an entity's price changes in time. Given this 1/8 characteristic of price action, Murrey assigns properties to each of the MML's in an a given octave. These properties are listed here for convenience.

8/8 th's and 0/8 th's Lines (Ultimate Resistance)
These lines are the hardest to penetrate on the way up, and give the greatest support on the way down. (Prices may never make it thru these lines).

7/8 th's Line (Weak, Stall and Reverse)
This line is weak. If prices run up too far too fast, and if they stall at this line they will reverse down fast. If prices do not stall at this line they will move up to the 8/8 th's line.

6/8 th's and 2/8 th's Lines (Pivot, Reverse)
These two lines are second only to the 4/8 th's line in their ability to force prices to reverse. This is true whether prices are moving up or down.

5/8 th's Line (Top of Trading Range)
The prices of all entities will spend 40% of the time moving between the 5/8 th's and 3/8 th's lines. If prices move above the 5/8 th's line and stay above it for 10 to 12 days, the entity is said to be selling at a premium to what one wants to pay for it and prices will tend to stay above this line in the "premium area". If, however, prices fall below the 5/8 th's line then they will tend to fall further looking for support at a lower level.

4/8 th's Line (Major Support/Resistance)
This line provides the greatest amount of support and resistance. This line has the greatest support when prices are above it and the greatest resistance when prices are below it. This price level is the best level to sell and buy against.

3/8 th's Line (Bottom of Trading Range)
If prices are below this line and moving upwards, this line is difficult to penetrate. If prices penetrate above this line and stay above this line for 10 to 12 days then prices will stay above this line and spend 40% of the time moving between this line and the 5/8 th's line.

1/8 th Line (Weak, Stall and Reverse)
This line is weak. If prices run down too far too fast, and if they stall at this line they will reverse up fast. If prices do not stall at this line they will move down to the 0/8 th's line.

Completing the square in time requires the identification of the upper and lower price boundaries of the square. These boundaries must be MML's. The set of all possible MML's that can be used as boundaries for the square were specified with the selection of the scale factor (rhythm) SR. Given SR, all of the possible MMMI's, mMMI's, bMMI's and MMML's, mMML's, and bMML's can be calculated as shown above. The following rules dictate what the lower and upper boundaries of the square in time will be.

Rules and Exceptions

Rule 1:

The lower boundary of the square in time must be an even MML (i.e. 0/8 th's, 2/8 th's, 4/8 th's, 6/8 th's, or 8/8 th's). It may be a MMML, a mMMl, or a bMML. Generally, the lower boundary will be a mMML.

Rule 2:

The MML selected for the bottom of the square in time should be close to the low value of the entity's trading range. The word "close" means that the distance between the square's bottom MML and the low value of the entity should be less than or equal to 4/8 of the next smaller octave.

For example, suppose a stock is trading within a range of 28 1/4 to 34 1/2. In this case the value of SR is 100. The MMMI is 12.5 (i.e. 100/8). The next smaller MMI is a mMMI = 12.5/8 = 1.5625. The MMML closest to 28 1/4 is the 2/8 th's (i.e. 2 x 12.5 = 25). The closest mMML (measured from 25) is also a 2/8 th's MML (i.e. 2 x 1.5625 = 3.125). So, the bottom of the square is 25 + 3.125 = 28.125 (i.e. 28 1/8).

The 28 1/8 MML is the base of the square in time. This MML satisfies rule 1 (it is an even numbered line, 2/8 th's) and it is close to 28 1/4 (28 1/4 - 28 1/8 = 1/8 = .125). The result of .125 is less than 4/8 th's of the next smaller octave which is a "baby" octave (bMMI = 1.5625/8 = .1953125). Specifically .125 is less than .78125 (4 x .1953125 = .781254).

Rule 3:

The height of the square in time must be 2, 4, or 8 MMI's. The type of MMI (major, minor, or baby) must be the same as the type of MML being used for the lower boundary. Generally this will be a mMMI.

NOTE: If the bottom MML of the square in time is an even MML, and the top MML of the square in time is 2, 4, or 8 MMI's above the bottom MML, then the top MML is also an even numbered MML.

Rule 4:

The MML selected for the top of the square in time should be close to the high value of the entity's trading range. The word "close" means that the distance between the square's top MML and the high value of the entity should be less than or equal to 4/8 of the next smaller octave. This is simply rule (2) being applied to the top of the square.

For example, consider the same stock trading within the range 28 1/4 to 34 1/2. The base of the square in time was identified as the 2/8 th's mMML 28.125. In this case the top of the square is the mMML that is 4 mMMI's above the base: 28.125 + (4 x 1.5625) = 34.375. This MML can also be shown to be "close" to the high end of the trading range, since, 34.5 - 34.375 = .125 and .125 is less than .781254 (4 x .1953125 = .781254). Recall that .1953125 is the bMMI (i.e. the next smaller octave).

Exception to Rule 1:

The rule, "The lower boundary of the square in time must be an even MML...", appears to have exceptions. Murrey states, "When a stock is trading in a narrow range rotating near a MMML you may use only 1 line above and below. Since a MMML is always an even MML (a 0 or 8 line for the next smaller octave) then one line above or below would be an odd MML (1 or 7).

An example of this can be seen on Chart #91 in Murrey's book. This is a chart of Chase Manhatten. In this case the bottom and top MML's of the square in time are the 5/8 th's and 7/8 th's MML's respectively. These are obviously odd MML's. Another example of an exception is Chart #83 in Murrey's book. In this case the bottom of the square in time is 37.5 (an odd 3/8 th's line) and the top of the square in time is 62.5 (an odd 5/8 th's line).

Exception to Rules 2, 4:
Rules 2 and 4 address how close the boundaries of the square in time are to the actual trading range of the entity in question. Murrey states;
"Then you simply count up 2, 4, or 8 lines, and include the top of its trading range, as long as it's no higher than a) 19, b) 39, c) 78 cents above the 100% line. (there are exceptions where it will run up a full 12.5, or 25 or 50% line above the 100% line and come back down..."

At this point Murrey leaves us on our own to review the charts. The book is replete with examples in which the bottom and top MML's of the square in time are far from the actual trading ranges (by as much as 2 mMMl's).

Consider the two charts (both are labeled Chart #85) of McDonalds. The lower chart espcially shows McDonalds trading in a range from 28 to 34. Clearly, the set of mMML's that would best fit this trading range are the lines 28.125 (2/8 th's) and 34.375 (6/8 th's). Murrey, however, draws the square from 25 (0/8 th's) to 31.25 (4/8 th's).

Given the above rules and exceptions I have developed a set of "rules of thumb" to assist in the construction of squares in time. Using these "rules of thumb" I have written a simple C program that calculates the top and bottom MMLs for squares in time. This offers a fairly mechanical approach that may prove beneficial to a new Murrey Math practitioner. Once a Murrey Math neophyte becomes experienced using this mechanical system he/she may go on to using intuition and methods that are a little (a lot) less tedious.

I have tested this program against all of the charts in Murrey's book and it seems to work fairly well. There are some exceptions/weaknesses that are discussed below. First, to illustrate the methodology, a few detailed examples are included here.

Calculating the MMLs -- Example 1

Refer to Chart #85B of First American in the Murrey Math book. During the time frame in question, First American traded in a range with a low of about 28.0 and a high of about 35.25 (the wicks on the candlesticks are ignored).

Let's define a parameter called PriceRange. PriceRange is simply the difference between the high and low prices of the trading range.

STEP 1:
Calculate PriceRange.
PriceRange = 35.25 - 28.0 = 7.25

STEP 2:
Identify the value of SR (the scale factor).
Murrey refers to this as "setting the rhythm" or identifying the "perfect square". Refer to TABLE 1 in this paper. Reading from TABLE 1 SR = 100 (This is because the high price for First American was 35.25. Since 35.25 is less than 250 but greater than 25, SR = 100).

STEP 3:
Determine the MMI that the square in time will be built from.
Let's define two new parameters. The first parameter is RangeMMI. RangeMMI = PriceRange/MMI. RangeMMI measures the price range of First American (or any entity) in units of Murrey Math Intervals (MMI's).

The second parameter is OctaveCount. The purpose of OctaveCount will become evident shortly. The question to answer is, "What MMI should be used for creating the square in time?" This question will be answered by dividing the SR value by 8 until the "appropriate MMI" is found. So:

MMI = MMMI = SR/8 = 100/8 = 12.5

This is a MMMI. Is this the "appropriate MMI"? To answer that question divide PriceRange by this MMI.

RangeMMI = PriceRange/MMI = 7.25/12.5 = 0.58

Now compare RangeMMI to 1.25. If RangeMMI is less than 1.25 then a smaller MMI is needed. This is indeed the case because 0.58 is less than 1.25. Since the first MMI calculated was a MMMI, then the next MMI will be a mMMI. Simply divide the prior MMI by 8 to get the new MMI.

MMI = mMMI = MMMI/8 = 1.5625

This is a mMMI. Is this the "appropriate MMI"? To answer that question divide PriceRange by this latest MMI.

RangeMMI = PriceRange/MMI = 7.25/1.5625 = 4.64

Now compare RangeMMI to 1.25. If RangeMMI is less than 1.25 then a smaller MMI is needed. Since RangeMMI is 4.64 and 4.64 is greater than 1.25 we're done. The correct MMI to use is the mMMI which is 1.5625. (Naturally, in other cases, this process may be repeated further, continuing division by 8, until RangeMMI is greater than 1.25.)

Since we had to divide the perfect square (SR) by 8 two times to arrive at the appropriate MMI (SR/8/8 = 100/8/8 = 12.5/8 = 1.5625) we'll set the value of OctaveCount to be 2. The value of OctaveCount will act as a reminder as we proceed through this example.

Now the question of 1.25. Where did this number come from? Partly trial and error and partly reasoning. Remember that the parameter RangeMMI describes the trading range of First American in units of Murrey Math Intervals. Remember also that the rules for the square in time require that the square be at least 2 MMI's high, and that the square be close to the high and low values of the trading range.

If we used the MMMI to build the square in time for First American the result would have been a square with a height of (2 x 12.5) 25. Because First American has only traded within a range of 7.25 points, this square would not represent First American's' behavior very well. The trading range of First American should approximately fill the square. By choosing a smaller MMI (i.e. mMMI = 1.5625) the result is a square in time that will be 4 MMI's high (RangeMMI = 4.64 which is rounded to 4. The actual height selected for the square in time will be determined in STEP 4). Again, recall the rule that the square must be 2, 4, or 8 MMI's high. (Is the number 1.25 perfect? NO! But, tests conducted on the charts in the Murrey Math book indicate that 1.25 works in nearly all cases).

STEP 4:
Determine the height of the square in time.
In STEP 3 above, we selected the appropriate value for the MMI and calculated the final value of RangeMMI. Given the value of RangeMMI, TABLE 2 may be used to select the actual height of the square in time.

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TABLE 2
ALLOWED SQUARES IN TIME:
RangeMMI                 Square in Time is Bounded by These MML's

1.25 < RangeMMI < 3.0    (0,2) (1,3) (2,4) (3,5) (4,6) (5,7) (6,8) (7,1)
3.0 <= RangeMMI < 5.0    (0,4) (2,6) (4,8) (6,2)
5.0 <= RangeMMI < ...    (0,8) (4,4)
```

TABLE 2 was arrived at using trial and error. The results of the C program I had written were compared to the charts in the back of the Murrey Math book. Is TABLE 2 perfect? NO! But it works fairly well. TABLE 2 specifies the allowed upper and lower MML numbers that may be used to create the square in time. Note that once the upper and lower MML's are specified so is the height of the square. TABLE 2 attempts to accomodate Murrey's rules for creating the square in time as well as the exceptions to those rules.

The first row of TABLE 2 addresses squares that are two MMI's high. Note that the exception of having squares in time with odd top and bottom MML's is included.

The second row of TABLE 2 addresses squares that are four MMI's high. Note that these squares are required to lie on even MML's only.

The third row of TABLE 2 addresses squares that are eight MMI's high. Note that these squares are required to lie on (0,8) or (4,4) MML's only. The notation (0,8) means that the bottom of the square will be a 0/8 th's MML and the top of the square will be an 8/8 th's MML.

Continuing with First American, recall that RangeMMI = 4.64. Reading from TABLE 2 we see that the square in time will be 4 MMI's high and will lie on one of the MML combinations (0,4), (2,6), (4,8), or (6,2).

STEP 5:
Find the bottom of the square in time.
The objective of this step is to find the MML that is closest to the low value of First American's trading range (i.e. 28.0). This MML must be a mMML since the MMI we are using is a mMMI (i.e. 1.5625). Actually, the MML we will find in this step is the mMML that is closest to but is less than or equal to First American's low value.

This is fairly simple. To repeat, the MML type must correspond to the MMI type that was selected. We chose an MMI that is a mMMI (i.e. 1.5625), hence, the MML must be a mMML. We now make use of the parameter OctaveCount. In this example, OctaveCount = 2. Since OctaveCount = 2 we will perform 2 divisions by 8 to arrive at the desired MML.

MMI = MMMI = SR/8 = 100/8 = 12.5

The base of the perfect square is 0.0, so subtract the base from the low value of First American's trading range (28.0 - 0.0 = 28.0). Now we find the MMML that is less than or equal to 28.0. In other words, how many MMMI's could we stack up from the base (i.e. 0.0) to get close to (but less than 28.0).

28.0/MMMI = 28.0/12.5 = 2.24 ==> 2 (Since there are no partial MMI's)

0.0 + (2 x 12.5) = 25.0
25.0 is the 2/8 th's MMML that is closest to but less than 28.0

Since OctaveCount = 2, this process will be repeated a second time for the mMMI. The only difference is that the base line is the MMML from the prior step. So, once again, subtract the base (i.e. 25) from the low value of First American's trading range (28 - 25 = 3.0). Now find the mMML that is less than or equal to 28.0. In other words, how many mMMI's could we stack up from the base (i.e. 25) to get close to (but less than 28.0).

3.0/mMMI = 3.0/1.5625 = 1.92 ==> 1 (Since there are no partial MMI's)

25 + (1 x 1.5625) = 26.5625
26.5625 is the 1/8 th mMML that is closest to but less than 28.0

So, mMML = 26.5625

This mMML is the "best first guess" for the bottom of the square in time. But there is a problem...

STEP 6:
Find the "Best Square"
By the end of STEP 5, a square in time has been defined that will be 4 mMMI's in height and have a base on the 1/8 th mMML = 26.5625. Recall, however, that the rules in TABLE 2 state that a square that is 4 MMI's in height must lie on an even numbered MML. A 1/8 th line is odd. So, two choices are available. Referring to TABLE 2 we can choose either a (0,4) square or a (2,6) square. Which do we choose?

Let's define an error function and choose the square that minimizes this error. The error function is:

Error = abs(HighPrice - TopMML) + abs(LowPrice - BottomMML)

Where:

HighPrice is the high price of the entity in question
(in this case the high price of First American 35.25)

LowPrice is the low price of the entity in question
(in this case the low price of First American 28.0)

TopMML is the top MML of the square in time

BottomMML is the bottom MML of the square in time

abs() means take the absolute value of the quantity in parentheses (i.e. If the quantity in parentheses is negative, ignore the minus sign and make the number positive. For example, abs(-2.12) = abs(2.12) = 2.12.
Having now defined an error function it can now be applied to the problem at hand. The square in time that was determined in STEP 5 has a bottom MML of 26.5625 and a height of 4 mMMI's. The top MML is therefore 26.5625 + (4 x 1.5625) = (26.5625 + 6.25) = 32.8125. Recall, however, this is still the square lying upon the 1/8 mMML (a (1,5) square on odd MML's). We want to use the error function to distinguish between the (0,4) square and the (2,6) square.

The (0,4) square is simply the (1,5) square shifted down by one mMMI and the (2,6) square is the (1,5) square shifted up by one mMMI.

0/8 th mMML = 26.5625 - 1.5625 = 25.0
4/8 th's mMML = 32.8125 - 1.5625 = 31.25

So, the bottom of the (0,4) square is 25.0 and the top of the (0,4) square is 31.25.

Likewise for the (2,6) square:

2/8 th's mMML = 26.5625 + 1.5625 = 28.125
6/8 th's mMML = 32.8125 + 1.5625 = 34.375

So, the bottom of the (2,6) square is 28.125 and the top of the (2,6) square is 34.375.

Now apply the error function to each square to determine "the best square in time".

Error(0,4) = abs(35.25 - 31.25) + abs(28.0 - 25.0) = 7.0

Error(2,6) = abs(35.25 - 34.375) + abs(28.0 - 28.125) = 1.0

Clearly the (2,6) square is the better fit (has less error). Finally, we have arrived at a square in time that satisfies all of the rules. We can now divide the height of the square by 8 to arrive at the 1/8 lines for the square in time.

(34.375 - 28.125)/8 = 6.25/8 = .78125

So the final square is:

100.0%	34.375
87.5%	33.59375
75.0%	32.8125
62.5%	32.03125
50.0%	31.25
37.5%	30.46875
25.0%	29.6875
12.5%	28.90625
0.0%	28.125

Exactly as seen on Chart #85B of the Murrey Math book.

Calculating the MMLs -- Example 2

Refer to Chart #294, the OEX 100 Cash Index in the Murrey Math book. During the time frame in question (intraday), the OEX traded in a range with a low of about 433.5 and a high of about 437.5 (the wicks on the candlesticks are ignored). EXAMPLE 1 above contains all of the detailed explanations regarding the mechanics of setting up the MML's. The following examples will just show the basic steps.

STEP 1:
Calculate PriceRange.
PriceRange = 437.5 - 433.5 = 4.0

STEP 2:
Identify the value of SR (the scale factor).
Refer to TABLE 1: SR = 1000

STEP 3:
Determine the MMI that the square in time will be built from.
Octave 1:

MMI = MMMI = SR/8 = 1000/8 = 125
RangeMMI = PriceRange/MMI = 4.0/125 = .032
(RangeMMI is less than 1.25 so divide by 8 again)
Octave 2:

MMI = mMMI = MMMI/8 = 125/8 = 15.625
RangeMMI = PriceRange/MMI = 4.0/15.625 = .256
(RangeMMI is less than 1.25 so divide by 8 again)
Octave 3:

MMI = bMMI = mMMI/8 = 15.625/8 = 1.953125
RangeMMI = PriceRange/MMI = 4.0/1.953125 = 2.048
(RangeMMI is greater than 1.25 so 1.953125 is the desired MMI)
Since the scale factor SR was divided by 8 three times, OctaveCount = 3.

STEP 4:
Determine the height of the square in time.
Refer to TABLE 2: RangeMMI = 2.048 so the height of the square is 2.

STEP 5:
Find the bottom of the square in time.
First Octave:

433.5 - 0.0 = 433.5
433.5/MMMI = 433.5/125 = 3.468 ==> 3.0
0.0 + (3.0 x 125) = 375 (3/8 th's MMML)
Second Octave:

433.5 - 375 = 58.5
58.5/mMMI = 58.5/15.625 = 3.744 ==> 3.0
375 + (3.0 x 15.625) = 421.875 (3/8 th's mMML)

Third Octave:

433.5 - 421.875 = 11.625
11.625/bMMI = 11.625/1.953125 = 5.952 ==> 5.0
421.875 + (5.0 x 1.953125) = 431.640625 (5/8 th's bMML)
This results in a square with a height of 2 bMMI's and a base on the 5/8 th's bMML 431.64.

STEP 6:
Find the "Best Square"
The result of STEP 5 is a square with a height of 2 bMMI's and a base on the 5/8 th's bMML 431.64. Refer to TABLE 2: The likely "best square" is either the (5,7) or the (6,8).

The bottom and top of the (5,7) square are:
Bottom: 431.64
Top: 431.64 + (2 x 1.953125) = 435.55

The bottom and top of the (6,8) square are:
Bottom: 431.64 + 1.953125 = 433.59
Top: 435.55 + 1.953125 = 437.50

Calculate the fit errors:

Error(5,7) = abs(437.5 - 435.55) + abs(433.5 - 431.64) = 3.81

Error(6,8) = abs(437.5 - 437.50) + abs(433.5 - 433.59) = 0.09
The "best square" is the (6,8) square since the (6,8) square has the smallest error.

So the final square is:

100.0%	437.5
87.5%	437.01
75.0%	436.52
62.5%	436.03
50.0%	435.54
37.5%	435.05
25.0%	434.57
12.5%	434.08
0.0%	433.59

Calculating the MMLs -- Example 3

Refer to Chart #300, the Deutsche Mark, in the Murrey Math book. During the time frame in question (intraday), the Mark traded in a range with a low of about .7110 and a high of about .7170 (the wicks on the candlesticks are ignored). The Deutsche Mark is an example of an entity that trades on a scale that is different from the literal choice on TABLE 1. The price values for the Deutsche Mark must be re-scaled so that the appropriate SR value is selected. All of the Deutsche Mark prices are multiplied by 10,000. So, the trading range to be used to calculate the square in time is 7110 to 7170. After the square in time is determined, the resulting MML values may be divided by 10,000 to produce a square that can be directly compared to the quoted prices of the Deutsche Mark.

STEP 1:
Calculate PriceRange.
PriceRange = 7170 - 7110 = 60.0

STEP 2:
Identify the value of SR (the scale factor).
Refer to TABLE 1: SR = 10000

STEP 3:
Determine the MMI that the square in time will be built from.
Octave 1:

MMI = MMMI = SR/8 = 10000/8 = 1250
RangeMMI = PriceRange/MMI = 60/1250 = .048
(RangeMMI is less than 1.25 so divide by 8 again)
Octave 2:

MMI = mMMI = MMMI/8 = 1250/8 = 156.25
RangeMMI = PriceRange/MMI = 60/156.25 = .384
(RangeMMI is less than 1.25 so divide by 8 again)
Octave 3:

MMI = bMMI = mMMI/8 = 156.25/8 = 19.53125
RangeMMI = PriceRange/MMI = 60/19.53125 = 3.072
(RangeMMI is greater than 1.25 so 19.53125 is the desired MMI)
Since the scale factor SR was divided by 8 three times, OctaveCount = 3.

STEP 4:
Determine the height of the square in time.
Refer to TABLE 2: RangeMMI = 3.072 so the height of the square is 4.

STEP 5:
Find the bottom of the square in time.
First Octave:

7110 - 0.0 = 7110
7110/MMMI = 7110/1250 = 5.688 ==> 5.0
0.0 + (5.0 x 1250) = 6250 (5/8 th's MMML)
Second Octave:

7110 - 6250 = 860
860/mMMI = 860/156.25 = 5.504 ==> 5.0
6250 + (5.0 x 156.25) = 7031.25 (5/8 th's mMML)
Third Octave:

7110 - 7031.25 = 78.75
78.75/bMMI = 78.75/19.53125 = 4.032 ==> 4.0
7031.25 + (4.0 x 19.53125) = 7109.375 (4/8 th's bMML)

This results in a square with a height of 4 bMMI's and a base on the 4/8 th's bMML 7109.375.

STEP 6:
Find the "Best Square"
The result of STEP 5 is a square with a height of 4 bMMI's and a base on the 4/8 th's bMML 7109.375. Refer to TABLE 2: The likely "best square" is the (4,8). One could, of course, perform a test using the error function and check other squares as was done in the prior examples. A quick visual check of Chart #300, however, shows that the (2,6) or (6,2) squares will result in errors that are greater than the error associated with the (4,8) square.

The bottom and top of the (4,8) square are:
Bottom: 7109.375
Top: 7109.375 + (4 x 19.53125) = 7187.5

Since the original price values were multiplied by 10000, the reverse operation is performed to arrive at MML values that match the quoted prices of the Deutsche Mark.

The "corrected" bottom and top of the (4,8) square are:
Bottom: .7109
Top: .7187

So the final square is:

100.0%	.7187
87.5%	.7177
75.0%	.7168
62.5%	.7158
50.0%	.7148
37.5%	.7138
25.0%	.7129
12.5%	.7119
0.0%	.7109

Calculating the MMLs -- Example 4

Refer to Chart #298, the 30 Year Bond, in the Murrey Math book. During the time frame in question (intraday), the 30 Yr Bond traded in a range with a low of about 102.05 and a high of about 102.75 (the wicks on the candlesticks are ignored). The 30 Yr Bond is another example of an entity that trades on a scale that is different from the literal choice on TABLE 1. The price values for the 30 Yr Bond must be re-scaled so that the appropriate SR value is selected. All of the 30 Yr Bond prices are multiplied by 100. So, the trading range to be used to calculate the square in time is 10205 to 10275. After the square in time is determined, the resulting MML values may be divided by 100 to produce a square that can be directly compared to the quoted prices of the 30 Yr Bond.

STEP 1:
Calculate PriceRange.
PriceRange = 10275 - 10205 = 70.0

STEP 2:
Identify the value of SR (the scale factor).
Refer to TABLE 1: SR = 10000

STEP 3:
Determine the MMI that the square in time will be built from.
Octave 1:

MMI = MMMI = SR/8 = 10000/8 = 1250
RangeMMI = PriceRange/MMI = 70/1250 = .056
(RangeMMI is less than 1.25 so divide by 8 again)
Octave 2:

MMI = mMMI = MMMI/8 = 1250/8 = 156.25
RangeMMI = PriceRange/MMI = 70/156.25 = .448
(RangeMMI is less than 1.25 so divide by 8 again)
Octave 3:

MMI = bMMI = mMMI/8 = 156.25/8 = 19.53125
RangeMMI = PriceRange/MMI = 70/19.53125 = 3.584
(RangeMMI is greater than 1.25 so 19.53125 is the desired MMI)
Since the scale factor SR was divided by 8 three times, OctaveCount = 3.

STEP 4:
Determine the height of the square in time.
Refer to TABLE 2: RangeMMI = 3.584 so the height of the square is 4.

STEP 5:
Find the bottom of the square in time.
First Octave:

10205 - 0.0 = 10205
10205/MMMI = 10205/1250 = 8.164 ==> 8.0
0.0 + (8.0 x 1250) = 10000 (8/8 th's MMML)
Second Octave:

10205 - 10000 = 205
205/mMMI = 205/156.25 = 1.312 ==> 1.0
10000 + (1.0 x 156.25) = 10156.25 (1/8 th's mMML)
Third Octave:

10205 - 10156.25 = 48.75
48.75/bMMI = 48.75/19.53125 = 2.496 ==> 2.0
10156.25 + (2.0 x 19.53125) = 10195.3125 (2/8 th's bMML)
This results in a square with a height of 4 bMMI's and a base on the 2/8 th's bMML 10195.3125.

STEP 6:
Find the "Best Square"
The result of STEP 5 is a square with a height of 4 bMMI's and a base on the 2/8 th's bMML 10195.3125. Refer to TABLE 2: The likely "best square" is the (2,6). One could, of

course, perform a test using the error function and check other squares as was done in the prior examples. A quick visual check of Chart #298, however, shows that the (0,4) or (4,8) squares will result in errors that are greater than the error associated with the (2,6) square.

The bottom and top of the (4,8) square are:
Bottom: 10195.3125
Top: 10195.3125 + (4 x 19.53125) = 10273.4375

Since the original price values were multiplied by 100, the reverse operation is performed to arrive at MML values that match the quoted prices of the 30 Yr Bond.

The "corrected" bottom and top of the (4,8) square are:
Bottom: 101.95
Top: 102.73

So the final square is:

100.0%	102.73
87.5%	102.63
75.0%	102.54
62.5%	102.44
50.0%	102.34
37.5%	102.24
25.0%	102.15
12.5%	102.05
0.0%	101.95

Calculating the MMLs -- Example 5

Refer to Chart #85 (the one at the top of the page), McDonalds, in the Murrey Math book. During the time frame in question McDonalds traded in a range with a low of about 26.75 and a high of about 32.75 (the wicks on the candlesticks are ignored). In EXAMPLES 1 through 4 the MML's that were determined for the square in time matched the examples the the Murrey Math book. This example will not match the result in the Murrey Math book. This will lead to a discussion regarding the weaknesses of this calculation method.

STEP 1:
Calculate PriceRange.
PriceRange = 32.75 - 26.75 = 6.0

STEP 2:
Identify the value of SR (the scale factor).
Refer to TABLE 1: SR = 100

STEP 3:
Determine the MMI that the square in time will be built from.
Octave 1:

MMI = MMMI = SR/8 = 100/8 = 12.5
RangeMMI = PriceRange/MMI = 6/12.5 = .48

(RangeMMI is less than 1.25 so divide by 8 again)
Octave 2:

MMI = mMMI = MMMI/8 = 12.5/8 = 1.5625
RangeMMI = PriceRange/MMI = 6/1.5625 = 3.84
(RangeMMI is greater than 1.25 so 1.5625 is the desired MMI)
Since the scale factor SR was divided by 8 two times, OctaveCount = 2.

STEP 4:
Determine the height of the square in time.
Refer to TABLE 2: RangeMMI = 3.84 so the height of the square is 4.

STEP 5:
Find the bottom of the square in time.
First Octave:

26.75 - 0.0 = 26.75
26.75/MMMI = 26.75/12.5 = 2.14 ==> 2.0
0.0 + (2.0 x 12.5) = 25.0 (2/8 th's MMML)
Second Octave:

26.75 - 25.0 = 1.75
1.75/mMMI = 1.75/1.5625 = 1.12 ==> 1.0
25.0 + (1.0 x 1.5625) = 26.5625 (1/8 th's mMML)
This results in a square with a height of 4 mMMI's and a base on the 1/8 th's mMML 26.5625

STEP 6:
Find the "Best Square"
The result of STEP 5 is a square with a height of 4 mMMI's and a base on the 1/8 th's mMML 26.5625. Refer to TABLE 2: Two squares are candidates for the "best square", the (0,4) square and the (2,6) square.

The bottom and top of the (0,4) square are:
Bottom: 26.5625 - 1.5625 = 25.0
Top: 25.0 + (4 x 1.5625) = 31.25

The bottom and top of the (2,6) square are:
Bottom: 26.5625 + 1.5625 = 28.125
Top: 28.125 + (4 x 1.5625) = 34.375

Now apply the error function to each square to determine "the best square in time".

Error(0,4) = abs(32.75 - 31.25) + abs(26.75 - 25.0) = 3.25

Error(2,6) = abs(32.75 - 34.375) + abs(26.75 - 28.125) = 3.0

The (2,6) square has the smallest error and one would expect it to be the square of choice. Refer to Chart #85 in the Murrey Math book. The square selected in the book was the (0,4) square.

Other Considerations When Selecting the MMLs

EXAMPLE 5, shown above, illustrates the weakness of the method that has been described here for calculating the square in time. As mentioned, the method described was a simple C language computer program that I wrote to facilitate my understanding of Murrey Math. The weakness is the fact that the program only gets two pieces of information about the entity (stock, index, etc.) being traded, the high price and the low price.

The high and low price do not provide enough information to completely describe the behavior of the entity. For example, a stock may have bounced up and down between the high and low values three or four times during the timeframe of interest. Alternatively, a stock may trade in a narrow low range and then shoot up to the high value at the end of the timeframe of interest. This latter case is what happened with McDonalds in Chart #85. Since, McDonalds tended to trade in a lower range, the (0,4) square in time was a better choice than the (2,6) square in time (which the program selected).

In short, to be completely accurate in the selection of the square in time, one needs to consider the entire price history of the entity being studied. Anyone writing a computer program to calculate the square in time would need to look at all of the data points in the chart, not just the high and low values. Given all of the price data, one could create a more sophisticated error function and a more sophisticated set of selection rules (i.e. TABLE 2).

EXAMPLE 5 (McDonalds) illustrates another consideration when selecting the square in time. In this example, after calculating the fit errors, one could select between two different squares that had nearly identical fit results. The fit errors of the two squares are shown here:
Error(0,4) = abs(32.75 - 31.25) + abs(26.75 - 25.0) = 3.25
Error(2,6) = abs(32.75 - 34.375) + abs(26.75 - 28.125) = 3.0

In a case where one square is about as good as another at representing the behavior of the traded entity, choose the square that has a 0/8 th, 4/8 th, or 8/8 MML as the bottom MML of the square. The reason for this choice is that the lines of the square in time will "map into" the MML's more effectively.

Mapping of Murrey Math Lines

Recall that Murrey assigns various support and resistance properties to the 0/8, 1/8, 2/8, 3/8, 4/8, 5/8, 6/8, 7/8, and 8/8 MML's. Recall also that the square in time is the coordinate system (reference frame) that the Murrey/Gann trading rules will be applied against. In order for the Murrey/Gann trading rules to work, the properties of the lines of the square in time should match the properties of the MML's. More formally stated, the properties of the 1/8 lines of the square in time should map identically to the MML's.

The 0/8, 4/8, and 8/8 MML's are essentially equal to eachother in the sense that they have the most influence over price support and resistance. The 0/8, 4/8, and 8/8 MML's are followed by the 2/8 and the 6/8 MML's, which are in turn followed by the 3/8 and 5/8 MML's. Finally, the 1/8 and the 7/8 MML's have the least influence over price support and resistance.

Looking at TABLE 3, one can see how the 1/8 lines (i.e. 0%, 12.5%, 25%, 37.5%, ... 100%) of the square in time map into MML's.

TABLE 3

# of MMI's in Square	0.0%	12.5%	25%	37.5%	50%	62.5%	75%	87.5%	100%
2	0/8	2/8s	4/8s	6/8s	1/8	2/8s	4/8s	6/8s	2/8
2	1/8	2/8s	4/8s	6/8s	2/8	2/8s	4/8s	6/8s	3/8
2	2/8	2/8s	4/8s	6/8s	3/8	2/8s	4/8s	6/8s	4/8
2	3/8	2/8s	4/8s	6/8s	4/8	2/8s	4/8s	6/8s	5/8
** 2	4/8	2/8s	4/8s	6/8s	5/8	2/8s	4/8s	6/8s	6/8
2	5/8	2/8s	4/8s	6/8s	6/8	2/8s	4/8s	6/8s	7/8
2	6/8	2/8s	4/8s	6/8s	7/8	2/8s	4/8s	6/8s	8/8
2	7/8	2/8s	4/8s	6/8s	8/8	2/8s	4/8s	6/8s	1/8
4	0/8	4/8s	1/8	4/8s	2/8	4/8s	3/8	4/8s	4/8
4	2/8	4/8s	3/8	4/8s	4/8	4/8s	5/8	4/8s	6/8
4	4/8	4/8s	5/8	4/8s	6/8	4/8s	7/8	4/8s	8/8
4	6/8	4/8s	7/8	4/8s	8/8	4/8s	1/8	4/8s	2/8
8	0/8	1/8	2/8	3/8	4/8	5/8	6/8	7/8	8/8
8	2/8	3/8	4/8	5/8	6/8	7/8	8/8	1/8	2/8
8	4/8	5/8	6/8	7/8	8/8	1/8	2/8	3/8	4/8
8	6/8	7/8	8/8	1/8	2/8	3/8	4/8	5/8	6/8

A simple example will help illustrate how to read TABLE 3. Suppose one had a stock trading in a range of 50 to 75. The obvious choice for the square in time would be the row marked by **. The price of 50 lies on a 4/8 th's MMML and the price of 75 lies on a 6/8 th's MMML. This makes a (4,6) square in time with a height of 2 MMMI's the best choice.

Now the MMMI bounded by the 50 and 62.5 MMML's can of course be divided by 8 to yield the sub-octave mMML's and mMMI's. The MMMI bounded by the 62.5 and 75 MMML's can likewise be divided into its mMML's and mMMI's.

The bottom of this square in time (0.0% line) lies on the 50 MMML (a 4/8 th's MMML). The top of this square in time (100% line) lies on the 75 MMML (a 6/8 th's line). The 50% line of this square in time lies on the 62.5 MMML (a 5/8 th's MMML). The remaining lines of the square in time (12.5%, 25%, 37.5%, 62.5%, 75%, and 87.5%) lie on 2/8, 4/8, and 6/8 mMML's from the sub-octave (In fact the "s" that appears in the table entries denotes sub-octave).

All of this has been presented simply to point out the fact that squares in time with a height of 4 or 8 MMI's tend to have 0%, 50%, and 100% lines that lie on MML's with similar price support and resistance properties. Hence, if one can place the base of a square in time on a 0/8, 4/8, or 8/8 MML (espcially if the square has a height of 4 or 8 MMI's) one gets a better mapping of properties.

How much one should concern oneself with this issue of mappings is problematic. To really answer this question would require a formal quantinization of the support/resistance properties of MMML's, mMML's, and bMML's with respect to eachother. This would be a great research project for ambitious individuals with time on their hands.

Gann Minor 50% Lines, and 19- & 39-cent Reversals
The prior discussion on the mapping of MML properties provides a nice lead into this topic (the Gann Minor 50%, 19 cent and 39 cent lines). These lines are simply the result of the subdividing the MMI currently being used for the square in time.

Consider a stock trading between 50 and 62.5. Referring to TABLE 1, the scale factor, SR = 100. The square in time would be composed of eight mMMI's. Each mMMI would have a height of 1.5625 (i.e. MMMI=100/8 = 12.5, and mMMI = MMMI/8 = 12.5/8 = 1.5625). Now suppose one of the mMMI's as subdivided into its eight bMMI's (bMMI = mMMI/8 = 1.5625/8 = .1953125). One can now see that the 1/8 th bMML is the 19 cent line (i.e. $ 0.1953125 is rounded off to 19 cents). Likewise the 39 cent line is just the 2/8 th's bMML (i.e. 2 x 19 cents = 39 cents). What Murrey refers to as the Gann 50% line is merely the 4/8 th's (4 x 19 cents = 78 cents) bMML.

Since the 19 cent, 38 cent, and Gann 50% lines, are simply 1/8 th, 2/8 th's, and 4/8 th's lines, one can assign the appropriate support and resistance properties to these lines. One may then use these lines to evaluate price behavior just as one would use any other 1/8 th, 2/8 th's or 4/8 th's line.

If one were to create a square in time for an entity with a scale factor (SR) other than 100 (e.g. 1000), one would apply the same logic to the bMML's. In this case the 1/8th bMML would be 1.953125, the 2/8 th's would be 3.90625 and the 4/8 th's line (Gann minor 50% line) would be 7.8125.

Time

The term "square in time" has been used liberally throughout the prior discussions without any specific statements regarding time. All that has been addressed so far is the vertical price dimension of the square in time. This is justified since the process of identifying the MML's and MMI's requires a little more effort than the divisions of time.

The fact that less discussion has been devoted to the time dimension should not be interpreted to mean that the time dimension is any less important than the price dimension. Time and price are equally important.

Time is divided up in a very reasonable (and practical manner). The year is broken into quarters of 64 trading days each. Note that 64 is a power of 2 (i.e. (2 x 2 x 2) x (2 x 2 x 2) = 8 x 8 = 64). An interval of 64 can easily be subdivided into half intervals. Note that 8 (the number of vertical intervals in the square in time) is also a power of 2 (i.e. (2 x 2 x 2) = 8). Thus, the square in time can easily be scaled in both the price (vertical) and the time (horizontal) dimensions simply by multiplying or dividing by 2 (very clever). Consider also that a year consists of four quarters. Four is also a power of 2. So, a square in time based upon a year long scale can also easily be subdivided.

The ability to subdivide the square in time gives the square in time the ability to evolve as an entity trades through time. The square in time acts as a reference frame (coordinate system) that can adjust itself as needed. As an entity reaches new high or low prices, the reference frame can be expanded by doubling the square in both the price and time dimensions. Alternatively, if one wishes to look at the price of an entity during some short time frame one can simply halve the square in both the price and time dimensions (resulting in a quarter square). This halving and doubling may be carried out to whatever degree is practical (i.e. Practical within the limits of how much price and time data may be subdivided. A daily chart can't be subdivided into intraday prices or time). Refer back to the description of the rectangular fractal at the beginning of this paper.

The argument for breaking the year into quarters intuitively makes sense. The business world (including mutual fund managers) is measured on a quarterly basis. Each of the four quarters roughly correspond to the four seasons of the year which drive weather and agriculture (as well as commodity contracts). Clearly humans are geared to a quarterly cycle.

Murrey resets the time = 0 point on an annual basis. This is done the first week of October and corresponds to the day of the U.S. Treasury's monthly and quarterly bond auctions (This year 10/8/97). Once the time = 0 point is set one may simply count off daily increments of 4, 8, 16, 32, or 64 days relative to the time = 0 point to set the desired square in time (or 256 days if one wants an annual chart).

At this point one should realize that specifying a time interval is critical to setting up the square in time. In the above examples that were used to illustrate the selection of MML's and MMI's the time frame was implied. All that was specified in the examples was the price range that the entity traded at. Naturally, one has to ask the question, "The price range it traded at during what time frame?". One will probably want to set up the square in time for annual and quarterly time frames. The quarterly square in time will probably be subdivided into a 16 day time frame for intermediate term trading.

One would need intraday data to set up an intraday square in time. The time coordinate of an intraday chart is simply divided into 4 or 8 uniform intervals. The intraday MML's and MMI's are then set up using the intraday trading range. If one is looking at a weekly chart then a quarter should consist of 13 weeks.

Another key use of the time dimension is estimating when a trend in price will reverse itself. The horizontal MML's of a square in time represent points of support and resistance in the price dimension. The vertical lines that divide the square in the time dimension represent likely trend reversal points. My own personal studies, done on the DJIA, showed that on average the DJIA has a turning point every 2.5 days. Since we know that the market does not move in a straight line we would expect to see frequent trend reversals. Murrey uses the vertical time lines (1/8 th lines) in the square to signal trend reversals.

Circles of Conflict

The circles of conflict are a by product of the properties of the horizontal MML's that divide price and vertical time lines (VTL's) that divide time. MML's represent points of support and resistance. VTL's represent reversal points. Put it all together and the result is the "circles of conflict".

Consider a square in time divided into eight price intervals and eight time intervals. The five circles of conflict are centered on the 2/8 th's, 4/8 th's, and the 6/8 th's MML's and the 2/8 th's, 4/8 th's, and 6/8 th's VTL's. Recall that prices spend 40% of their time between the 3/8 th's and 5/8 th's MML's. Recall also that the 2/8 th's, 4/8 th's, and 6/8 th's MML's represent strong points of support and resistance. If we can assume that the 2/8 th's, 4/8 th's, and 6/8 th's VTL's represent strong points of reversal, we can expect that in slow trendless markets that prices will be deflected around the circles of conflict. In a fast up or down market prices will move through the circles quickly since the price momentum exists to penetrate support and resistance lines.

The circles of conflict are an example of the value of a standard reference frame (square in time) in divining market action. This reference frame and its associated geometry and rules can be applied to all price-time scales in all markets.

The Square in Time

Just a few more comments regarding the square in time. As has been stated the square in time is a scalable reference frame that can be applied to all price-time scales in all markets. At the beginning of this paper the price-time charts that describe the trading history of an entity were described as fractals (self similar geometry). It was stated that if one had a collection of charts of entities from different markets and different time frames one could not distinguish one chart from the other without the charts being labeled.

The square in time makes the labels on charts unnecessary. Rather than thinking of charts as representing dollars (or points) vs. days (or weeks, minutes, etc.) one can now think of charts as representing 1/8 th's of price vs. 1/8 th's of time. All of the rules associated with the MML's and VTL's and all of the associated trendlines are carried right along with the square in time. One may use this scalable reference frame (square in time) to construct any of Gann's trendlines. Since the trend lines are tied to the square in time geometry so are any of the rules that are associated with the trend lines.

Gann used various lines for characterizing price-time behavior. These lines may be summarized in TABLE 4 and FIGURE 4.

The various momentum lines are summarized in TABLE 5 and FIGURE 4.

The column labeled Line Trend specifies whether the line slopes upwards (+) or downwards (-) (moving left to right in time).

The column labeled Line Slope measures the rate of change of the line (# of 8th's in price):(# of 8th's in time).

TABLE 4: TRENDLINES

Line Trend	Line Slope	Points Forming the Line: Point 1	Point 2
+	8:8	O	X
+	8:7	O	G'
+	8:6	O	F'
+	8:5	O	E'
+	8:4	O	D'
+	8:3	O	C'
+	8:2	O	B'
+	8:1	O	A'
+	1:8	O	Q
+	2:8	O	R
+	3:8	O	S
+	4:8	O	T
+	5:8	O	U
+	6:8	O	V
+	7:8	O	W
-	8:8	O'	P
-	8:7	O'	G
-	8:6	O'	F
-	8:5	O'	E
-	8:4	O'	D
-	8:3	O'	C
-	8:2	O'	B
-	8:1	O'	A
-	1:8	O'	W
-	2:8	O'	V
-	3:8	O'	U
-	4:8	O'	T
-	5:8	O'	S
-	6:8	O'	R
-	7:8	O'	Q

TABLE 5: MOMENTUM LINES

Line Trend	Line Slope	Points Forming the Line: Point 1	Point 2
+	1:1	G	Q
+	2:2	F	R
+	3:3	E	S
+	4:4	D	T
+	5:5	C	U
+	6:6	B	V
+	7:7	A	W
+	8:8	O	X
+	7:7	G'	Q'
+	6:6	F'	R'
+	5:5	E'	S'
+	4:4	D'	T'
+	3:3	C'	U'
+	2:2	B'	V'
+	1:1	A'	W'
-	1:1	G'	W
-	2:2	F'	V

-	3:3	E'	U
-	4:4	D'	T
-	5:5	C'	S
-	6:6	B'	R
-	7:7	A'	Q
-	8:8	O'	P
-	7:7	G	W'
-	6:6	F	V'
-	5:5	E	U'
-	4:4	D	T'
-	3:3	C	S'
-	2:2	B	R'
-	1:1	A	Q'

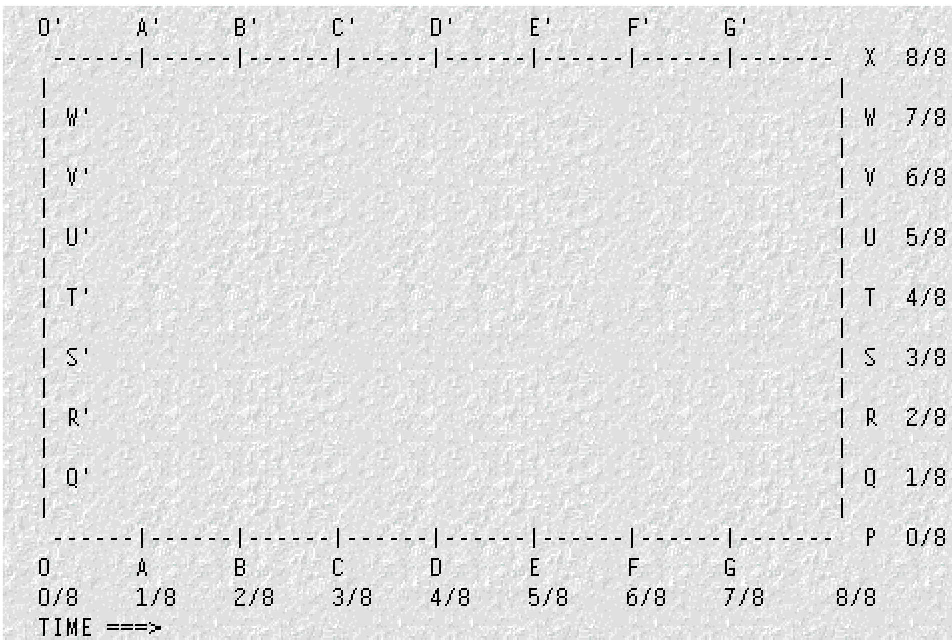

FIGURE 4

No One Ever Went Broke Taking a Profit

As we all know, traded markets do not move in a straight line. The prices zig and zag. A fast large movement in one direction is usually followed by a reversal as traders take profit from that movement.

Murrey provides tables that list the probability of certain price movements for stocks in terms of square in time MMI's. For example, one table is listed for stocks trading over 50 and less than 100. (This is for price movements over a short time span (i.e. the MMI for the square in time is the 1.5625 mMMI). The table is listed here:

1/8 th + .78 cents 50% of the time = 2.34
2/8 ths (3.125) 75% of the time = 3.12
3/8 ths (4.68) 85% of the time = 4.68
4/8 ths (6.25) 90% of the time = 6.25
5/8 ths (7.81) 95% of the time = 7.81

The way to read an entry in this table is as follows (row 3): If a stock moves up or down in price (within the square in time) by 4.68 then the probability that it will reverse direction is 85%.

Another way to look at it is:
If a stock moves up or down in price (within the square in time) by 4.68 then the probability that it will continue to move in the same direction is 15% (100% - 85%).

This table could also be re-written in terms of MMI's: (This assumes that the scale factor (SR) for the square in time is 100)

If Price Moves By:	The probability of reversal is:
(1 x mMMI) + (4 x bMMI)	50%
(2 x mMMI)	75%
(3 x mMMI)	85%
(4 x mMMI)	90%
(5 x mMMI)	95%

The message here is that large fast price movements are short lived. Take profit and move on to the next trade.

Murrey Math Reversal Percentage Moves

The following notes are observations regarding the Murrey Math Price Percentage Moves (MMRPM). The MMRPM statistics are a key Murrey Math factor to consider when evaluating a trade. The MMRPM statistics are also key in understanding the importance and function of the Square in Time.

Recall the definition of the MMRPM. The MMRPM statistics specify the probability that a price movement, of some magnitude (X), occurring during some time interval (t), will reverse itself. For example, in Reference Sheet U of the Murrey Math Book, a listing is given for:

Price Percentage Moves for Indexes over 500 but under 1000.
(Intraday Basis) (Slow Day).

One of the entries is this listing is:

6/8 ths 85% of the time 1.4648

This entry is specifying the following. The Murrey Math Square in Time that is being considered is based upon the perfect square of 1000. The height of the square in time consists of 8 Murrey Math Intervals with each Murrey Math Interval (MMI) being given by:
((((1000/8) /8) /8) /8) = 1000/4096 = 0.244140625

Since each 1/8'th = 0.244 then 6/8'ths = (6 x 0.244) = 1.4648. So, if price moves either up or down by 1.4648 then the probability that the price movement will reverse direction is

0.85 or 85%. This statement of probability assumes that the price movement of 6/8'ths has occurred on an intraday basis in a slow market.

Not being a Murrey-like genius I found the descriptions of time in the MMRPM tables of the Murrey Math Book to be somewhat subjective. I personally have difficulty deciding when a market is long term, short term, fast, slow etc. (just my own personal weakness).

Since the MMRPM statistic is an important part of Murrey Math and we have the Square in Time at our disposal one may wish to generalize the MMRPM tables for any Square in Time. Having one MMRPM table for any given Square in Time has a certain appeal. First of all, the analysis of the price movement of any traded entity is simplified and made more objective. Secondly, having one MMRPM table for all squares has a certain aesthetic appeal. After all, the Square in Time is a fractal that acts as an adjustable reference frame. In the purest sense of Murrey Math only one MMRPM table should be necessary for any Square in Time.

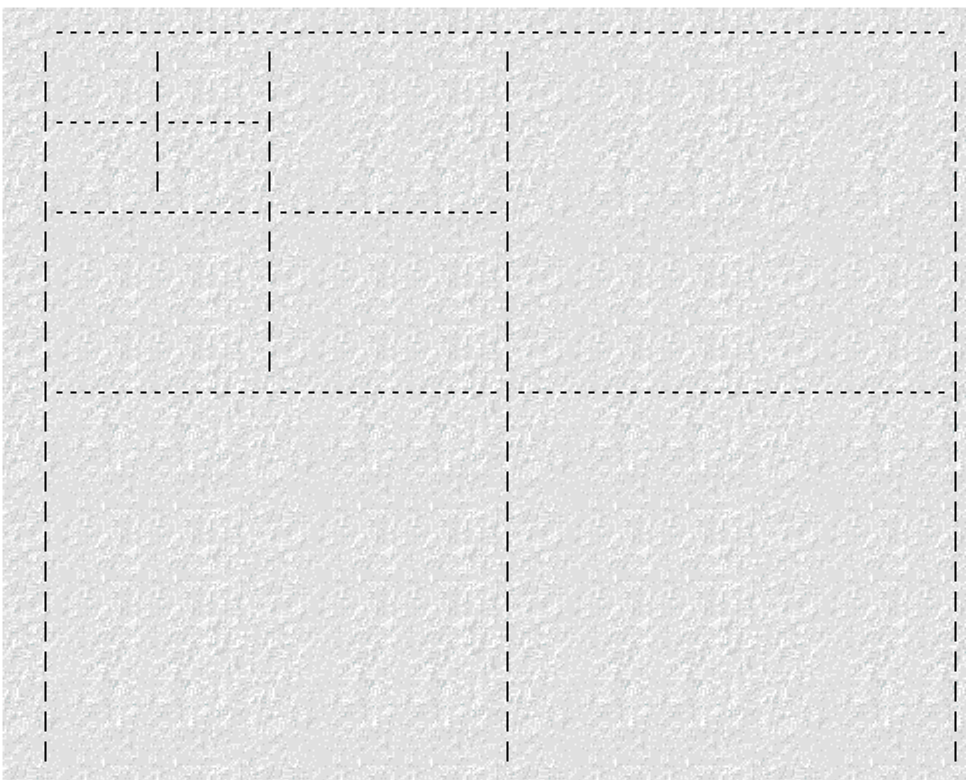

FIGURE 1

Fractals

To understand the approach that will be used here, certain concepts must be explained. First one must review the definition of a fractal.

The sizes (scale) of basic geometric shapes are characterized by one or two parameters. The scale of a circle is specified by its diameter, the scale of a square is given by the length of one of its sides, and the scale of a triangle is specified by the length of its three sides. In contrast, a fractal is a self similar shape that is independent of scale or scaling.

Fractals are constructed by repeating a process over and over. Consider the fractal shown in FIGURE 1.

A rectangle, may be subdivided into four equal sub-rectangles as shown in FIGURE 1. Each sub-rectangle can be divided, likewise, into a set of four smaller sub-rectangles. This process may be carried out ad infinitum (ad nauseum). Each resulting rectangle, no matter how large or small it may be has the exact same ratio of height to width. This property is called self similarity.

The zig-zagging pattern on a chart of price vs. time for a market or traded equity may also be regarded as a fractal. The definition of this type of zig-zagging fractal is not as simple as the definition given above for the rectangle. The price-time behavior of a market or traded equity may be regarded as a STATISTICALLY self similar fractal (if price and time are scaled correctly).

Fractional Brownian Motion

Statistical self similarity implies that if we look at the zig-zagging price-time pattern under different time scales (e.g. intraday, daily, weekly, etc.) the statistics that characterize the zig-zagging pattern are the same. Fortunately, a relatively simple statistical model exists for describing the zig-zagging price-time behavior of markets. That model is known as fractional brownian motion (FBM) and is specified quite simply in EQUATION 1 (EQ 1).

EQ 1: < (X(t2) - X(t1)) ^ 2 > = k*((t2 - t1) ^ (2*H))

While EQ 1 may appear complicated it really is not. Let's break it down.

X(t1) is the price of an entity at some initial time t1 (e.g. the price of gold at 2:21 PM on an intraday chart). Let X(2:21) = $320 an ounce.

X(t2) is the price of an entity at some later time t2 (e.g. the price of gold at 3:09 PM on the same intraday chart). Let X(3:09) = $323 an ounce.

^ 2 symbolizes that the preceeding number enclosed in parentheses is raised to the power of 2 (i.e. square the difference of X(t2) - X(t1)). So, $323 - $320 = $3 ($3 ^ 2) = ($3 * $3) = $9 Where * is used to symbolize multiplication.

< > These brackets symbolize the average of the enclosed number over many samples. So the number < (X(t2) - X(t1)) ^ 2 > is the result of looking at many sampled pairs of gold prices at 48 minute intervals. One could imagine a spread sheet with the following information:

	A	B	C	D
1	X(9:33)	X(10:21)	COL_B - COL_A	COL_C ^2
2	X(9:34)	X(10:22)	COL_B - COL_A	COL_C ^2
3	X(9:35)	X(10:23)	COL_B - COL_A	COL_C ^2
.				
.				
.				
R	X(2:21)	X(3:09)	COL_B - COL_A	COL_C ^2

So < (X(t2) - X(t1)) ^ 2 > would be the sum of all the numbers in Column D divided by the number of samples (R). Where COL_A, COL_B, and COL_C denote the numbers in Column A, Column B, and Column C respectively.

k is simply an undefined proportionality constant (i.e. just some number we don't know yet). The character * is used to symbolize multiplication.

t2-t1 is simply the time interval. In this case 48 minutes.

^(2*H) symbolizes that the preceeding number enclosed in parentheses is raised to the power of 2*H. The character * is used to symbolize multiplication. The exact value of H is also unknown, however, the FBM model states that H will have a value between 0 and 1.

What does EQ 1 tell us? For simplicity, let H = 1.0. In this case, EQ1 is saying that on average, the price range of some entity over any given time interval is proportional to that time interval. The key phrase here is "on average". One would look at the spread sheet of gold prices and find that the value in each row of Column D is different. But, when averaged together they will be proportional to the time interval (in this case 48 minutes).

If, in fact, gold prices behaved according to the FBM model (with H set equal to 1.0) then one would observe this same relationship for all time intervals. So, if one built a second spreadsheet looking at the range of gold prices over many 96 minute time intervals (96 = 2 x 48) one would find that the range of gold prices would be twice as large as the range of gold prices observed over 48 minute time intervals.

For example, if the average range of gold prices observed over many 48 minute time intervals was $3, then the average range of gold prices observed over many 96 (2 x 48) minute time intervals would be $6 (i.e. $6 = 2 x $3).

Statistical Nature of Price Changes

The next part of the FBM model to understand is the statistical nature of price changes. Let's define a price change that occurs over some time interval as:
| X(t2) - X(t1) |

Where the | | symbol means to take the absolute value of the number inside the vertical brackets. This just means that if X(t2) - X(t1) happens to be a negative number, then ignore the minus sign. Treat the number as if it was positive.

Let's define the symbol X21, where X21 = | X(t2) - X(t1) |.

This next statement is abhorrent and anathema to anyone wanting to trade the markets (forgive me my sin). Are you ready?

Assume that X21 is a random number that is normally distributed. Being "normally distributed" simply means that the probability distribution that describes a collection of X21 values is the good old bell shaped curve that our teachers used to grade us in school.

Here is a quick refresher for those who do not remember the properties of the bell curve (formally known as the Gaussian distribution). Refer to FIGURES 2A and 2B.

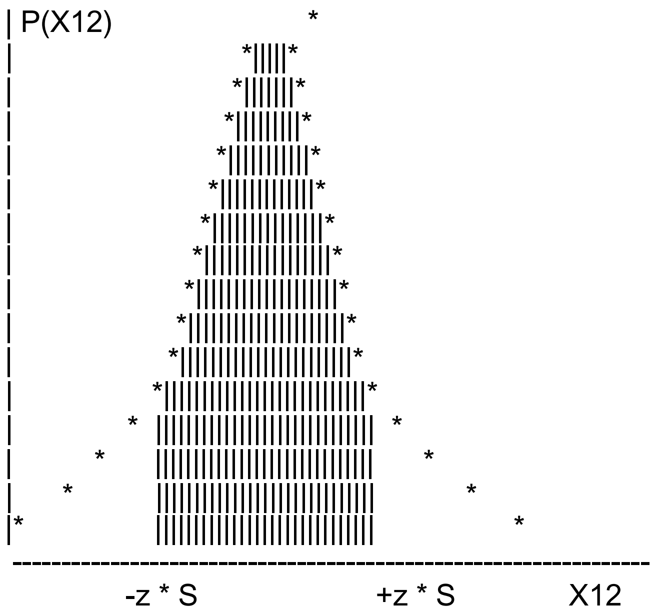

FIGURE 2A

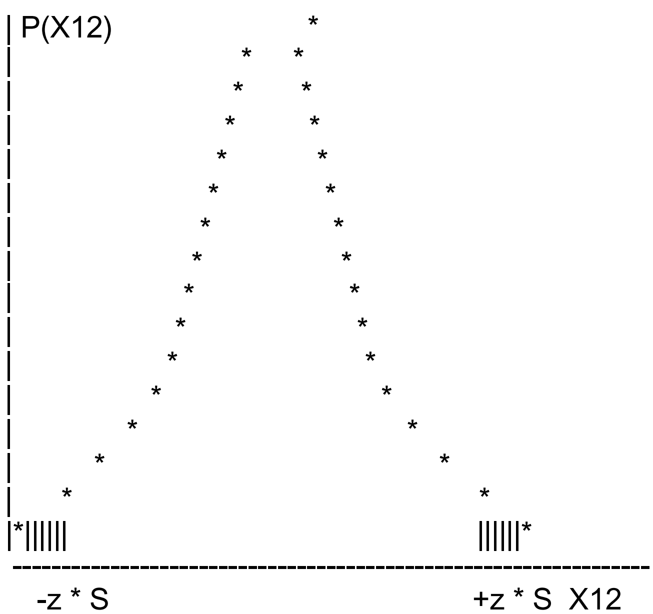

FIGURE 2B

In our case the quantity of interest is the price range (X12) that our entity will trade in during the next time interval (t2 - t1). The Gaussian distribution has the nice property that it considers all possible values of X12 (i.e. X12 can take on any value ranging from minus infinity to plus infinity).

The vertical axis in Figures 2A and 2B represents P(X12). P(X12) is the probability that X12 (shown on the horizontal axis) will take on some specific value X (inside an infinitely narrow range).

FIGURE 2A may be interpreted as follows. The shaded area specifies the probability that X12 will lie in a range between (-z * S) and (z * S) (i.e. (-z * S) <= X12 <= (z * S)). The total area under the Gaussian distribution curve (from minus infinity to plus infinity) is 1.0. So, in the extreme case that (-z * S) = minus infinity and (z * S) = plus infinity then the entire area under the Gaussian curve would be shaded and the probability would be 1.0 that X12 will have some value at the end of the next time interval (t2 - t1). We wouldn't know what that value is, but we are guaranteed with 100% certainty that it would be something. In practical terms, one would feel 100% confident making the prediction that the price of gold will change by some amount in the next 48 minutes (where some amount is any number from minus infinity to plus infinity).

Consider a practical example. One would find credible the prediction that in the next 48 minutes the price of gold would increase by $1 per ounce or less, or that the price of gold would decrease by $1 per ounce or less. This scenario is depicted in FIGURE 2A with (-z * S) = -$1 and (z * S) = +$1. In this case more than half of the area under the Gaussian distribution is shaded. Hence, based upon history, the prediction of a $1 per ounce (or less) swing in the price of gold over the next 48 minutes has a better than 50% chance of being correct.

Consider another example. If someone came up to you and told you that in the next 48 minutes the price of gold would go up $2000 or more per ounce, or that in the next 48 minutes gold would become so devalued that people would pay you $2000 or more per ounce just to take it off their hands, you would not be likely to make that trade. This is because history has shown that the probability of either of those events occurring is so small that you would be better off buying a lottery ticket. This scenario is depicted in FIGURE 2B. In this case (-z * S) = -$2000 and (z * S) = +$2000. Notice that the shaded area under the Gaussian distribution is at the tails of the distribution. Most of the area under the Gaussian is at the center. Very little area lies under the right and left tails of the distribution. Since the shaded area is very small when compared to 1.0 then we can see that the chances (probability) of gold making a $2000 per ounce price swing are very small.

The shaded area in FIGURE 2A can also be thought of in another way. The shaded area is the probability that prices will reverse after moving out to (z * S) or (-z * S). This is because the probability of moving further out into the tails of the Gaussian distribution is given by the unshaded area under the tails (FIGURE 2A). So, if the the price of gold happened to move far enough in the next 48 minutes so that 90% of the area under the Gaussian was shaded then only 10% of the Gaussian would be unshaded. Thus gold would only have a 10% chance of moving further. Therefore, the chance of reversal is 90%.

Let's repeat the prior point more symbolically. Refer again to FIGURE 2A. Let the current time be t1 and the price of the traded entity (e.g. gold) be specified by X(t1). Let the future time be t2 and the price of the traded entity be specified by X(t2).

X12 = X(t2) - X(t1)

The shaded area in FIGURE 2A specifies the probability that gold will increase in price by an amount of X12 or less or decrease in price by an amount of X12 or less during the future time interval t2 - t1. The probability that gold will increase in price by an amount greater than X12 or decrease by an amount greater than X12 is specified by the unshaded area in FIGURE 2A. Recall that the total area under the Gaussian distribution is 1.0

1.0 - Shaded Area = Unshaded Area

The shaded area is specifying the probability that a price swing of X12 (occurring during the future time interval t2 - t1) will be reversed. This is exactly the definition of the Murrey Math MMRPM's.

The above examples illustrate the fact that the behavior of the Gaussian distribution is consistent with the expected price behavior of traded markets. That is to say, within a given future time interval (t2 - t1), small to moderate price swings around the current price are more likely (more probable) than very large price swings. All of this discussion assumes that one is using the correct Gaussian distribution.

The shape of the Gaussian distribution is controlled by the parameter S. The parameter S is called the standard deviation. The parameter z is just some number that allows X12 to be expressed in units of standard deviations (i.e. X12 = (z * S)). The larger the value of S, the shorter and wider (more spread out) the bell shaped curve becomes. As S becomes smaller the bell shaped curve becomes more narrow and tends to look more like a spike than a bell. The larger the value of S the greater the price volatility over the time interval of interest.

In the above examples of gold, price swings were considered over the future time interval (t2 - t1) of 48 minutes. If one wished to consider a different time interval (e.g. 96 minutes) then one would need to have a new value of S to describe a new Gaussian distribution. One would need a Gaussian distribution for each future time interval (i.e. for our purposes, the standard deviation S is a mathematical function of time S = S(t)).

If one knows the value of S for all desired time intervals (i.e. if one knows the function S(t)) then one can refer to tables to determine the probability that price swings will reverse after reaching some particular value X12.

Fortunately, based upon how the Gaussian distribution is defined, the following relationship is true:

$$(S \wedge 2) = < (X(t2) - X(t1)) \wedge 2 > = k*((t2 - t1) \wedge (2*H))$$

Hence we now know S as a function of time. A new problem arises in that the values of k and H are not known for gold or any other market. We do, however, have Murrey Math and the Square in Time. Given the assumptions made by Murrey Math, and by making some additional assumptions, one can arrive at the final goal of specifying the MMRPM's for all markets.

Let's stop for a moment and consider the key assumptions that must be made to achieve the desired result.

1) The zig-zagging price-time behavior of markets is described by the model known as fractional brownian motion (FBM) (Eq 1).
EQ 1: $< (X(t2) - X(t1)) \wedge 2 > = k*((t2 - t1) \wedge (2*H))$

2) The values of X(t2) - X(t1) (i.e. X12) are random numbers that are normally distributed (the Gaussian distribution). This imples that $< (X(t2) - X(t1)) \wedge 2 > = (S \wedge 2)$ where S is the standard deviation of the Gaussian distribution.
Assumptions 1 and 2 are pretty good assumptions. Together, these two assumptions make up the random walk model of markets (When H = 1/2). Some have questioned

whether or not $(X(t2) - X(t1))$ is normally distributed. In general, however, the normal distribution is considered to be a good approximation.

3) All markets exhibit the same statistical behavior specified in assumptions (1) and (2).
This assumption is the basis of Murrey Math. Rejecting this assumption would require the rejection of Murrey Math.

4) The Square in Time scales the price-time action of markets so that the parameter H from EQ1 is equal to 1.0 (i.e. $H = 1.0$).
This is a big assumption, but an argument may be made in favor of it. The Square in Time is a fractal. The rules for changing the scale of this fractal are to simply multiply the height and width of the square by 2 or by 1/2. This is a linear scaling. This can only be valid if $H = 1.0$. H relates the typical change in price $< (X(t2) - X(t1)) >$ to the time interval $(t2 - t1)$ i.e.

$< (X(t2) - X(t1)) >$ is proportional to $((t2 - t1) ^ H)$

The same statistical properties should be observed in a larger Square in Time as well as in a smaller Square in Time. This is the statistical self similarity property of price-time behavior. If we wished to consider price action over a longer time frame then we would multiply the time interval by 2.0 (this is how we scale the fractal). Lets do that:

$$((2 * (t2 - t1)) ^ H) = (2 ^ H) * ((t2 - t1) ^ H)$$

Note the term $(2 ^ H)$. This term shows that if the time interval is doubled, then one would have to multiply the price range by $(2 ^ H)$. If the scaling rule of the Square in Time is valid then H must be 1.0. Otherwise, we could not simply double price and double time when scaling the Square in Time.

5) The proportionality constant (from Eq 1) $k = 1.0$.
I have no argument for this assumption other than convenience and wishful thinking. One has to start somewhere. This assumption may be valid based upon the way the Square in Time is defined. There may be a theoretical observation that could be used to prove $k = 1.0$ as was done for assumption (4) showing that $H = 1.0$. Algorithms are available for identifying the value of k. This would, however, require some computer programming that I do not have the time to perform currently. So, for now, $k = 1.0$.

Recall that when the price-time behavior of a market has been scaled inside a Square in Time the actual price-time units of dollars vs. days or points vs. minutes are replaced by 1/8'ths of price vs. 1/8'ths of time. Each Square in Time extends 8/8'ths in height and 8/8'ths in time.

Once the price-time behavior of a market has been scaled inside a Square in Time the following formula may be applied:

$$(S ^ 2) = < (X(t2) - X(t1)) ^ 2 > = k*((t2 - t1) ^ (2*H))$$

Setting $H = 1.0$ and $k = 1.0$ yields:

$$(S ^ 2) = < (X(t2) - X(t1)) ^ 2 > = ((t2 - t1) ^ 2)$$

or

$$S = t2 - t1$$

with changes in X and t (price and time) expressed in units of 1/8'ths. Let's represent a change in X (price) using M/8 and let's represent a change in t (time) using N/8, where

M = 1, 2, 3, 4, 5, 6, 7, or 8
N = 1, 2, 3, 4, 5, 6, 7, or 8

Refer back to FIGURE 2A and the discussion about the Gaussian distribution. Recall the statement that X12 = (z * S).

Solving for z yields z = X12/S = |X(t2) - X(t1)|/(t2 - t1) where the | | brackets symbolize the absolute value of (X(t2) - X(t1)). If changes in price and time are expressed in 1/8'ths then z = (M/8)/(N/8) = M/N

Given z, one can simply go to any statistics handbook and look up the probability that price will reverse after moving M/8'ths in N/8'ths of time. In other words, a general table of MMRPM values for any square in time (given the fact that the above assumptions are true). Refer to TABLE 1 (A Square of 64).

PRICE M \ TIME N	1	2	3	4	5	6	7	8
8	.999	.999	.992	.954	.890	.816	.746	.683
7	.999	.999	.980	.920	.838	.757	.683	.621
6	.999	.997	.954	.866	.770	.683	.610	.547
5	.999	.988	.905	.789	.683	.593	.522	.471
4	.999	.954	.816	.683	.576	.497	.431	.383
3	.997	.866	.683	.547	.451	.383	.332	.296
2	.954	.683	.497	.383	.311	.259	.228	.197
1	.683	.383	.259	.197	.159	.135	.111	.103

TABLE 1
(A SQUARE OF 64)

TABLE 1 may only be used in the context of the Square in Time. To use TABLE 1, set the price-time action into the appropriate Murrey Math Square in Time. Once the Square in Time has been defined, changes in price are expressed in 1/8'ths of the square's height. Changes in time are expressed in 1/8'ths of the square's time width. One can then look at the most recent price movement within the square as M/8'ths of price over N/8'ths of time (the table is the same for price increases and price decreases). The entry in the M'th row and N'th column specify the probability that the price movement will reverse itself.

General Discussion

The validity of the results shown in TABLE 1 are of course dependent upon the correctness of the assumptions used to derive them. The most questionable assumption is k = 1.0. If the value of k is something other than 1.0, the qualitative nature of the results would still be the same. The term "qualitative nature" meaning that the probabilities of price reversal would still be a function of the ratio M/N. A different value for k would change the magnitude of the probabilities but not their general pattern within the square.

A point worth noting is the fact that M/N is the slope of a line drawn within the Square in Time. The slope of any line is simply rise/run. Within the Square in Time rise/run is:
(change in price)/(change in time) = M/N

This implies that all trendlines within the Square in Time are lines of constant price reversal probabilities. One could think of trendlines as iso-MMRPM lines (just as lines of constant temperature on a weather map are called iso-therms). If prices were to move exactly along a trendline then the probability of price reversal would be constant at any point along the trendline.

Having a Square in Time that is correctly constructed is obviously crucial to using the MMRPM. The current square must be immediately re-drawn when prices move beyond its boundaries.

The reversal probabilities shown in TABLE 1 are in general agreement with the MMRPM numbers presented by Murrey in the Murrey Math Book. Certainly the qualitative behavior of the probabilities in TABLE 1 agree with one's expectations. Large price movements that occur over short time intervals are more likely to reverse than smaller price movements occurring over longer periods of time.

Understanding the source of the MMRPM probabilities helps to put Murrey Math in perspective. Points that Mr. Murrey makes in his book take on a greater clarity (at least for me) after seeing where the MMRPM probabilities seem to come from. While trading cannot be based solely upon MMRPM, they are a valuable part of Murrey Math. Understanding the MMRPM helps to build confidence in the Murrey Math system and confidence in trading.

http://www.webspace4me.net/~blhill/pages.aux/murrey/TKnotes.1.html
http://www.webspace4me.net/~blhill/pages.aux/murrey/TKnotes.2.html