Murrey Math Study Notes

(This has been taken from a study by Tim Kruzel)

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 overriding 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.

```
         P''     P'                P
 ------------------------------------------------------------------
|       |       |                 |                                |
|R''    |O''    |S''              |                                |
|-------|-------|                 |                                |
|       |       |                 |                                |
|R'     |Q''    |                 |S'                              |
|---------------|-----------------|                                |
|               |O'               |                                |
|               |                 |                                |
|               |                 |                                |
|               |                 |                                |
|R              |Q'               |O                               |S
|---------------------------------|--------------------------------|
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |                                |
|                                 |Q                               |
 ------------------------------------------------------------------
```

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.
- 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

- 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)
- 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.
- 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
- 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.

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.