The Guide to
Fractal Finance

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Fractal Finance®

For TradeStation

Guide Book
Version 3.0

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Preface

Thank you for purchasing Fractal Finance. As the world leader in fractal analysis software, Tetrahex is sure that Fractal Finance will be a valuable addition to your trading arsenal. Tetrahex has designed this analytical program with simplicity in mind. You don't need a trading background to use Fractal Finance. Our clear instructions will get you up and running quickly. Although Fractal Finance is designed to work right out of the box, we have added features that allow experimenters to design custom indicators or trading systems. With the introduction of formula mnemonics, Tetrahex has made it easy for the experimenter to integrate Fractal Finance algorithms with other formulas. This combination allows you to work on the cutting edge of Chaos research.

The Fractal Finance Guide is both an introduction to Chaos theory and the manual for program. You will be introduced to fractals and their application to financial markets. Each of the indicators in Fractal Finance is described, including operational theory and integration. A quick users guide is included at the end of this book along with a glossary. With The Fractal Finance Guide, you will learn how to find which markets to trade, how to trade them, and how to customize the program. Fractal Finance promises to make your trading experience that much more pleasurable. Enjoy!

Fractal Finance 3.0 Installation

System requirements: TradeStation 6.0 or higher. TradeStation must be installed on your system before installing Fractal Finance. .

NEW USERS

If TradeStation is currently running, close it. Then, run Fractal Finance 3_0 Installer.exe. When Fractal Finance is installing, you will be asked for a registration code. Your registration code will be e-mailed upon ordering. After entering your registration code, Fractal Finance will self-install into TradeStation. When download is complete, TradeStation will have these new items:

TFF_Vstatistic, TFF_Rhythm,TFF_MACD, TFF_FDI_Price, TFF_Consensus, TFF_Commentary
ShowMe(s): TFF_MACD-BS
PaintBar(s): TFF_Rhythm-BS
Strategies: TFF_BearStop, TFF_BullStop, TFF_Consensus LE, TFF_Consensus SE, TFF_Fractal Buy, TFF_Fractal Sell, TFF_Sell, TFF_Strong Buy, TFF_Strong Sell, TFF_Go Natural, TFF_Fractal Buy, TFF_Fractal Sell
ActivityBar: N/A
ProbabilityMaps: N/A
Functions: TFF_VStatistic, TFF_TVR, TFF_SS, TFF_SB, TFF_Rhythm, TFF_NFS, TFF_NFL, TFF_MFS, TFF_MFB, MACD, TFF_FDI_Price, TFF_FDI, TFF_Consensus, TFF_BullStop, TFF_BearStop

Be sure to keep your Personal Registration Code in a safe place in case Fractal Finance needs to be re-installed in the future.

If you have any questions, please email **support@fractalfinance.com.**

UNINSTALL INSTRUCTIONS

The process is very simple:

1. Find Fractal Finance for TradeStation in the programs menu of your Start menu.

2. Bring the pointer to the uninstall icon in the Fractal Finance for TradeStation menu.

3. Double click on uninstall

4. Fractal Finance for TradeStation will now guide you through the uninstall process.

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An Introduction to Chaos Theory and Fractals

Welcome to the wonderful world of Chaos. What is Chaos? Chaos is lightening, weather patterns, earthquakes, and financial markets. In short, Chaos is a nonlinear dynamic system that appears to be random when in effect is a higher form of order.

Technically, Chaos refers to a state of unpredictable, nonlinear, dynamics. However, the term is often used interchangeably with Complexity.

Complexity is the point where the transition to Chaos takes place and is really what we are interested in when studying markets. Order and randomness exist simultaneously, allowing a degree of predictability. Both social and natural systems including private, governmental, and financial institutions fall within this category. People design these complex systems and then find that they take on a life of their own. Each of these networks is sustained by complex feedback loops, re-entering the system at unpredictable points in their cycles. Because of this little understood abstraction, people go about their business bewildered by the very systems they helped to create.

It is not surprising that modern Western culture has had such a difficult time with the concept of Chaos. Early in European history, specifically in Greece, Plato educated his students in a form of rationalism that suggested that the real world is a construct of pure, symmetric, smooth forms. This world could only be understood through the mind and was considered the polar opposite of the world we live in.

Our world was considered to be a fragmented mess of asymmetric, rough objects, subject to decay. Euclid continued to propagate this philosophy through the development of Euclidean geometry. This symmetrical form of mathematics maintained that geometry could explain the real world, but not our world because of its complex

chaotic nature. Although great strides in civilization have been made using Euclidean mathematics, some introspection allows us to comprehend its limitations.
To understand why financial markets are nonlinear, we must examine their source. Markets are a construct of the human mind and social system. The actions of the markets are shaped by the subjective ideas that form in the human brain. The mammalian brain, lungs, arterial system, and most other human systems are nonlinear by nature. If the markets are formed by the combined interpretations of the human brain, it's reasonable to deduce that the market will in turn act nonlinearly.

Chaos is the realm of the nonlinear and therefore important to us as investors. Because financial markets are chaotic, we should use nonlinear tools to forecast market dynamics. Linear tools are doomed to failure because they are equivalent to describing objects in our world as cones, spheres, and squares.

Regardless of the type of technical analysis tool used, linear mathematics does not offer a description accurate enough to create reliable trading forecasts. What we need are tools that identify the hidden order in an apparently random process (i.e., the markets.) The first step toward that goal is identifying what underlies a nonlinear, chaotic system.

In order for a system to be deemed chaotic it must have a fractal dimension. A fractal is an object in which individual parts are similar to the whole. In effect, fractals are self-similar. The term fractal was first coined by the famous mathematician Benoit Mandelbrot:

> *Why is geometry often described as cold and dry? One reason lies in its inability to describe the shape of a cloud, a mountain, a coastline, a tree. Clouds are not spheres, mountains are not cones, coastlines are not circles, and bark is not smooth, nor does lightning travel in a straight line…Nature exhibits not simply a higher degree but an altogether different level of complexity. The number of distinct scales of length of patterns is for all purposes infinite. The existence of these patterns challenges us to study these forms that Euclid leaves aside as*

being formless, to investigate the morphology of the morphous. Mathematicians have disdained this challenge , however, and have increasingly chosen to flee from nature by devising theories unrelated to anything we can see or feel.

A fractal dimension is the measurement of the imperfect world in which we live. The manifestations of our world are not simple Euclidean objects with perfect symmetry. On the contrary, objects in our space are infinitely complex. If you examine any object with a microscope, more detail is revealed as the scale changes. In addition to various levels of detail, most objects in nature demonstrate self-similarity. Self-similarity is the organizing principle of fractals. Because of this, fractals will maintain their same dimension regardless of the scale used.

Regularity in irregularity is important as each time frame will have the same fractal pattern. This also tells us that markets are natural phenomena rather than mechanical processes. The significance of this is high since most that use technical analysis lose money consistently. Why? These traders are applying linear mathematical principles to a nonlinear natural system. When we apply fractal geometry to the markets, we use the right tool to forecast price movement more accurately. *These are the principles that form the groundwork for Fractal Finance.*

To further describe fractal geometry, one must have a clear understanding of dimensionality. According to Euclidean geometry, only solid objects are truly three-dimensional. We can see the limitations this imposes by looking at various objects in our three dimensional space. In your living room alone you are likely to have objects that do not conform to Euclidean geometry.

Two examples commonly used to impress this idea into the minds of students are the wiffle ball and islands. The wiffle ball resides in three dimensional space, but because of the holes in its surface it is not differentiable and therefore not a three-dimensional object. The true dimension is somewhere between two and

three dimensions. This translates to a fraction of a dimension so that the wiffle ball must be measured using a fractal dimension.
An island is another example of the power of fractal scaling and measurement. If you try to measure the perimeter of an island, England, for example, you encounter various dilemmas. The first problem is the unit of measurement. If the coast is measured with a foot long ruler, the scale and length will be different than if it is measured with a one-inch ruler.

What is interesting about this is that in theory the scales will continue into infinity. This becomes a problem because the Euclidean measuring device does not offer an accurate measurement of the island. Were the perimeter of the island symmetrical, the length of the coastline would have an absolute value. Because almost all natural shapes are irregular, standard geometry is not an efficient tool to measure them.

The island problem led to a fantastic discovery when Mandelbrot invented a method to measure natural, irregular objects. Mandelbrot labeled his invention the *fractional dimension*.

After various experiments, Mandelbrot applied his technique to the cotton market. It became apparent that the cotton market is a natural system similar to that of a river. This was a significant discovery because it meant that linear trading techniques are not appropriate for that market.

The second discovery Mandelbrot made was that the fractional dimension remains constant over various degrees of magnification. Once the fractional dimension for a market is discovered it can be applied to multiple time frames. This is information we are interested in as traders.

Although there has been no formal mathematical correlation between fractals and chaos, you can easily see the connection by watching a bifurcation program

in action. Bifurcation is the process that takes place when one answer splits between two potential answers in a system.
This process can continue for many generations. As the number of generations increases, the system moves closer to a point of complete chaos.

Figure 1 is a bifurcation diagram of the Logistic Equation. Notice the complexity as (a) approaches 1. After 0.9 the bifurcation region becomes chaotic. In this chaotic region there is still an inherent order to the system. The ridges represent areas of higher probability. The white areas represent areas where order returns to the system. Within these white areas are miniature bifurcation diagrams. These continue indefinitely at smaller and smaller scales. Because the chaotic area is composed of fractals, we know that there is a direct link between fractals and nonlinear systems.

Any discussion of fractals would be incomplete without an in-depth examination of *fractal time*. In fractal time randomness and determinism coexist. The human lung is an example. The lung has global structure and local randomness. If you view any number of healthy lungs, they all have a similar global structure that identifies them as lungs. Although the lungs resemble each other, they also have local randomness or subtle qualities that make each one different.

The same randomness and determinism apply to the way we view time. Random events are perceived as unpredictable and deterministic events as predictable. In reality, the majority of events are actually a combination of these extremes. Natural systems appear to prefer coexisting randomness and determinism because it forms the basis of efficient evolution. This blend of extremes applies to the financial markets just as it does to other natural systems.

To better understand the concept of simultaneous randomness and determinism, consider the *Chaos Game*. To play, start with three points that outline a triangle. Label the points (1,2), (3,4), (5,6). This is the playing board for the game and is

shown in Figure 2. Now, pick a point at random. This point can be within or outside of the triangle outline. Label the point "P." Roll a die. Proceed halfway from point "P" to the point labeled with the rolled number, and plot a new point. If you roll a 6, move halfway from "P" to the angle labeled C(5,6) and plot a new point (Figure 3).

Repeat these steps 10,000 times and throw out the first 50 points as transients. You now end up with the Sierpinski triangle in Figure 4. This triangle is an infinite number of triangles contained within the larger triangle. If the resolution is increased, you will see even more triangles. This self-similarity is an important characteristic of fractals (*Fractal Market Analysis, 1994, p. 10).*

The Sierpinski triangle is important because it demonstrates that a random process (the die roll and the starting point) coupled with global determinism (the triangle and the rules) can create a stable natural system with self-similarity. The model you have created through this game is a fractal: the position of the next point is dependent on the current point.

Predicting the actual sequence of points is impossible, but the odds of plotting each point are not equal. The empty spaces have a zero chance of being plotted while the edges of the triangles have a higher chance of occurring. Local randomness does not equal the probability of all possible solutions or equal independence. This example provides a basic understanding of Fractal versus Gaussian statistics. Read the section on the Chaos Game again if this is unclear. The underlying theory reappears later in this guide.

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Why Chaos Theory Is Useful

Chaos theory is a marvel to the modern day world because it offers a tool to analyze the dynamics of uncertainty and to locate order. This is the true science of the twenty-first century that accidentally began in the late twentieth century.

Although the origin of Chaos theory dates back to the work of Henri Poincare in the late nineteenth century, it proved impractical due to limits in number crunching. With advanced computer technology, researchers finally had the means to investigate this aspect of nature that permeates everything around us. We hear much talk today about Chaos and its application to economics, but we are really dealing with an enigma that influences our lives in all aspects of science, technology, and humanity.

Chaos is the study of turbulence. It presents challenges for us in long-term prediction. Because we are dealing with a nonlinear system, feedback is constantly introduced into and alters the same system.

This transformation continues indefinitely, each time creating a slightly different cycle. With the exponential growth of this system, a point will eventually be reached that appears completely random. This randomness is due in part to the fact that a small change in initial conditions is overlooked. The system continues with the feedback process generated from those initial conditions, and eventually seems out of control. This is why many researchers believe that long-term prediction is an impossible task.

Refer back to the bifurcation diagram or the Sierpinski triangle and you will see a graphic example of this. What does this mean to us from an economic point of view? It

tells us that markets are not truly efficient, and possibly not predictable in the long run. Does this mean we can use Chaos theory to make us better traders? *Absolutely.*

To better understand how Chaos theory can be used in trading financial markets, we need an understanding of *attractors*. Attractor refers to a region where a systems solution lies. The attractors are point attractors, limit cycles, and strange or fractal attractors.

Point attractors are the simplest form of attractors and are often explained through the pendulum. If you swing a pendulum, it will move in the direction swung until friction slows it down. Eventually the pendulum will stop at one point as in Figure 5.

Now imagine that friction is eliminated somehow, and you swing the pendulum. The pendulum takes on a circular pattern and continues to revolve undisturbed indefinitely. This pendulum is now an example of a *limit cycle attractor*. The limit of the cycle is the circle that the pendulum transverses see Figure 6.

Classic economics discusses systems in terms of point attractors or limit cycles. An easy way to understand this is to consider the equilibrium point in a standard supply/demand market as the point attractor: any periodic variation around the equilibrium point would be the market's limit cycle.

Finally, take the same pendulum and swing it with various degrees of strength. The energy of the pendulum will vary based on the strength of each swing. You will see that the position of the pendulum varies for each swing. So the pendulum will never complete a cycle and never duplicate an orbit. It appears to act randomly and chaotically, but falls within a certain range and always orbits clockwise. The pendulum is now acting as a chaotic or fractal attractor (Figure 7).

Chaotic attractors are fractal, and have individual fractal dimensions. The confined space or range that the chaotic attractor falls within is known as *phase space*. It doesn't

matter what initial value is used for the pendulum swing, the phase space will remain the same. This area is analogous to the perimeter of the Sierpinski triangle.

The stock market is easily identified as a chaotic attractor when one considers the conditions that form one. The periodic input of energy could be any time frame: minutes, days, or weeks. The amount of energy is based on the level of buying and selling in each market. Each equity will have its own phase space and move in a non-periodic cycle. Each equity will also have an individual fractal dimension regardless of time frame.

When fractals are used to forecast a financial market, we must take into account degrees of iteration and time scales. The reason is that chaotic systems have a sensitive dependence on initial conditions. A simple example is an inflated balloon. Let it go and it flies all over the room. If you try to catch it, chances are you won't. It's a classic illustration of sensitive dependence on initial conditions. Minor changes in the release of the balloon amplify into radical changes in flight direction. But is it impossible to predict the flight of the balloon?

An attempt to solve the equations for the balloon would reveal that the flight path is nonlinear and almost unpredictable. But if you watched the balloon 1000 times you would detect a theory of its flight pattern. The theory would not be perfect, but it would allow you to catch the balloon much more than randomly. You would also catch the balloon more often if you reached for it early in its flight.

Small errors in initial forecasting will lead to large errors over extended periods. This is why *our* forecasting will be limited to immediate time frames and a low number of scales. Limiting forecasts to the next immediate time period helps avoid errors caused by initial conditions. By applying the principles of Chaos theory to the markets in a way that capitalizes on current computing power, we can create a powerful forecasting tool.

The Application of Chaos to the Markets

Now that you have a basic understanding of Chaos and Complexity theory, let's focus our attention on the practical application of the theory to the markets. To begin with, consider the concept of liquidity, volume, and time.

Liquidity is not the same as volume. There have been many instances of the market moving quickly in either direction when liquidity was low and volume is high.

Although the majority of economists disregard liquidity in equilibrium theory, it still is an essential ingredient in moving markets. Conventional economic wisdom professes the fair price of a security to be the meeting point of supply and demand. The fair price is the current price, otherwise it would not remain at the current price.

According to Efficient Market Hypothesis current prices reflect all public information. Therefore, one market participant cannot have an advantage over another. The exception to this rule is the trader with information unavailable to others. Even this concept has been questioned by economists who insist that private information is discounted as the players in the "know" begin to influence the price.

The error with efficient markets is making the assumption that efficient markets and stable markets are one and the same. Liquidity is necessary for a market to remain stable, and when it is stable, the fair price and actual price may very well

be close to the same. Fortunately for us, the markets often slip away from a state of equilibrium when liquidity is low and volume is high. *These circumstances present trading opportunities.*
Market liquidity is created by different investors with different perceptions of fair price. This perception depends on the time frame the investor is trading within. A daily investor and a monthly investor do not normally view the price of a security in the same light. A daily investor might consider a sharp move down as a warning and attempt to sell, thus saving capital reserves for another trade.

The monthly investor could look at the same market and consider this a buying opportunity. The difference is that the monthly investor has a longer time range to consider. This is a great example of how value is perceived differently. Two investors are both looking at the same market, but because of the time frame, they have completely different perceptions of fair price. The different perceptions are important to maintain the market stability.

The market destabilizes when all time frames are in unison. This means that long, medium, and short-term investors are in agreement of market direction. In this case volume will increase and liquidity will decrease. An example is when long-term investors lose faith in longer-term information because of an unpredictable event. The short and long- term investors act the same way, so no one can provide liquidity and bring the market back to stability.

Because volume and money flow are integral components of the market, Fractal Finance monitors them when creating an analysis. Although the market is a natural system, money is the underlying energy of this system and is consequently important to financial forecasts.

Think of the markets as a river. Imagine the water is the money in the market and the change in turbulent water levels is the natural system. As Fractal Finance users, we take full advantage of the energy measured in the markets.

Fractal Finance measures money flow through volume and daily price movement. The open and closing price of each bar in a bar chart is noted and compared against the high and low of the day. This is further measured against the volume of each price plot. A direction is established for the money flow and its strength is established.

By identifying the bar's high and low, we know the highest level the bulls could move the security before the bears overtake them and the price moves back down. This is also true in reverse. The opening and closing prices identify who is in control of the market in the beginning and who is in control at the end of the bar's time period. With this information the current direction of the market and money flow can be determined.

Another application for the bars and price data is to determine the immediate trend. Take the midpoint of the current bar and compare it to the previous bars. This method provides a quick estimate of the market trend.

By comparing the immediate trend with the direction of price and money flow, a good indicator is created for forecasting short-term price movement. Although this is not a fractal indicator, it works well with them. It can be used in unison with all of the other indicators in Fractal Finance to trigger a buy/sell Alert.

An important component of Fractal Finance is the Fractal *pivot points* included in the systems analysis. They comprise two types: the Fractal Interim Trend and the Fractal Set Trend. They are principally used to identify the points where a market trend is about to change directions or begin.

The Fractal Interim Trend is essentially the fractal of the Fractal Set Trend. It identifies potential market movement with less data and is useful for small data sets.

The Fractal Set Trend uses more data to identify a market fractal and is oriented toward a longer range forecast. Over the last several years, Tetrahex has been studying

market behavior and the application of Chaos theory to market forecasting. With the aid of computer modeling, Tetrahex was able to identify fractals or fractal characteristics that occurred before price direction changed.
What Tetrahex found is that two types of initiating fractals are consistent in almost all markets. Variations of these fractals are common, but they all have similarities. Using pattern recognition, Fractal Finance searches through the data in the chart and detects the common denominators of the fractal pivot points. Once the characteristics are verified, Fractal Finance notifies the user with an Alert and a Commentary Window.

It is not unusual for both fractal indicators to disagree. This may take place when the interim trend doesn't provide a clear signal or vice-versa. Usually the interim trend will signal a change first as it uses less data.

Tetrahex believes that you may find the Fractal Interim Trend useful as a sole indicator when the trading range is more volatile or choppy. In other words, if you prefer to trade a security in a tight range, the Fractal Interim Trend may help you get in and out before the price reverses. While we recommend using both trading indicators together, experimentation is also encouraged.

The Fractal Dimension Index

Another indicator that was first introduced in Version 3.0 is the *Fractal Dimension Index* or FDI. It allows you to truly experiment and trade on the cutting edge of Chaos and Fractal theory.

This specialized indicator identifies the Fractal Dimension of the market by using re-scaled range analysis and an estimated Hurst exponent (see the Glossary and the discussion in the next section). FDI uses all data displayed on the chart to determine the volatility or trendiness of a market.

FDI is the same type of tool used by Mandelbrot, Hurst, and Peters in their examination of time series analysis. With FDI you can determine the persistence or anti-persistence of any equity or commodity that you display in MetaStock. Essentially, FDI will tell you whether a market is a random, independent system or a fractal dimension.

A persistent time series will result in a chart that is less jagged or closer to a line. An anti-persistent time series will result in a chart that is more jagged and subject to more reversals. This information is important when combined with the other Fractal Finance tools. Possible applications include new System Tests, Explorers, and Custom Indicators.

To better understand FDI, begin with its history. The history of FDI starts with a British Dam builder and hydrologist H. E. Hurst (1900-1978). He worked on the Nile River Dam Project in the early 20th century. Hurst searched for patterns in the Nile delta in an attempt to solve a hydrology problem.

The problem involved the storage capacity of the Dam reservoir. This is important to hydrologists because if the Dam is too high, resources are wasted. If the Dam is too low, it won't work. To solve this problem, Hurst considered the relationship between annual rainfall, the extremes of high/low water, and the reservoir's level.

Most hydrologists assumed that water inflow was a random process with no underlying order. Hurst, however, came to a very different conclusion after studying almost a millennium of Nile overflows. He found that large overflows tend to be followed by more large overflows. There appeared to be cycles, but their lengths were non-periodic. Standard statistical analysis revealed no patterns between observations.

So, Hurst then developed his own analytical method. To identify a non-random process, he tested the Nile using Einstein's work on *Brownian motion*. Brownian motion is a widely accepted model for a *random walk* (see the Glossary). Einstein found that the distance a random particle travels increases with the square root of the time used to measure it. This is called the *T to the one-half rule* and is commonly used in finance and economics.

Hurst divided the Nile data into segments and examined the logarithmic range and scale of each segment in comparison to the number of total segments. This process is called *re-scaled range analysis*. It's re-scaled because it has a zero mean and is expressed in terms of local standard deviation.

The re-scaled range value scales with an increase in the time increment, by a power-law value equal to *H*. H is referred to as the Hurst exponent. Using re-scaled range analysis, Hurst showed that the water overflows tended to repeat, meaning that the natural overflows were partially predictable.

Mandelbrot used the Hurst exponent to experiment with time series found in nature, including cotton prices. Through his experiments, Mandelbrot developed a method to

measure irregular natural objects. He named this measurement the *Fractal Dimension*. FDI is based on the work of Mandelbrot and Hurst.

FDI has many applications and is a valuable tool for experimenting with fractals and investment strategies. FDI may be inserted above a chart and used to identify the fractal dimension of the market.

If the indicator is close to two, the market is highly fractal with more jagged edges and reversals. If FDI is close to one, the market is closer to a line with less volatility. Bear in mind that FDI is determining the amount of dimension a market has. Two indicates a plane and one indicates a straight line. One and one-half indicates a random walk, meaning that the market is unpredictable. It's a product of the law of Brownian motion. You may want to avoid this market.

The second FDI is calculated with closing price data. Experimenters may wish to compare the two FDI over various time frames and securities when using them to create new trading systems.

When experimenting with FDI, remember that a Hurst estimate is used. This may produce strange results if not enough data is included. How much data is enough is speculative at best and is still debated among chaoticians and analysts. Feder believes any data with less than 2,500 observations is questionable.

Another postulate is the length of time necessary for each data period (periodicity). Some researchers believe that smaller time periods such as daily data are subject to more noise from random information. If this is the case, FDI is less accurate with finer slices of sequential data. The individual length of each period will come into play as noise is filtered.

The fractal dimension is helpful because it determines the amount of market volatility. The easiest way to use this indicator is to understand that a value of 1.5 suggests that

the market is acting in a completely random fashion. As the market deviates from 1.5, the opportunity for profit earning is increased in proportion to the amount of deviation.

The entire scale is based on a range of one to two suggesting extreme linearity to extreme volatility. An example of this scale is its use in geography. If you examine an island and plot the fractal dimension, you will be able to determine how jagged the edges of the island are for a particular measurement scale. An island with a 1.7 fractal dimension is highly jagged with many peaks and troughs on the periphery. An island with a fractal dimension of 1.3 is much more linear, approaching a single dimension or a straight line. If you examine this island on a map, the coastline will be straighter.

Applying FDI to the market is similar to studying an island on a map. The price plot is analogous to the periphery of the island. The FDI indicator then determines how close the price plot is to two dimensions (a plane) or one dimension (a line).

Because the price plot will never be one extreme or the other, we need to measure the "fraction" of the dimension. This is why we call the FDI number a fractal dimension. The further away this dimension is from 1.5, the more confident we can be that the market is not random.

When a market is not random it is more predictable. The best direction for trading is still a matter of debate, but with a highly sensitive tool like Fractal Finance, an FDI closer to two may provide substantial opportunities because of the high volatility and changes in market movement. An FDI closer to one signals a trending market that is moving in one direction. To alleviate any confusion, the new Fractal Finance System Tests use an optimized FDI to determine the best number for trading a particular market.

Another indicator under the Fractal Dimension Index heading: the *V-Statistic*. This ratio demonstrates a clear peak when re-scale range statistics stop scaling at a faster rate than the square root of time. When the V-Statistic peaks, it is often caused by a non-periodic or periodic cycle.

With FDI and V-Statistic, you now may experiment on the cutting edge of Fractal Analysis and Chaos Theory. If you just want to apply FDI as easily as possible to your trading strategies, simply follow the above directions and use the included tools.

The Fractal Finance MACD and Rhythm Indicator

Fractal Finance also includes a specialized Moving Average Convergence Divergence (MACD, see the Glossary). Tetrahex created this MACD with a unique oscillator and signal line. MACD is not a fractal indicator, but we find it useful for a number of reasons.

The primary application of MACD is as a leading indicator of momentum. Recall the earlier discussion of money flow: momentum is the amount of energy or money entering a market in a certain time period. Identifying this momentum in advance is a precursor to a good trade. MACD will identify where changes in the immediate momentum are occurring before it is obvious to you or competing traders.

MACD is also a useful tool for *Elliot wave counters*. The Elliot wave is interesting for those studying fractal market analysis because it shares certain similarities with the fractal.

One similarity is *iteration*. Iteration is the tendency of an object to repeat itself in a self-similar manner. Elliot waves do this because when making counts, one Elliot wave is used to find the end of a count in a higher Elliot wave as shown in Figure 8. This scaling principle is the second similarity that Elliot waves have with fractals.

Another property of Elliot waves is that they all tend to have a fractal dimension that lies within a specific range. This consistency allows us to draw parallels between various markets to which the Elliot wave is applied.

The problem many Ellioticians have is keeping an accurate count. This is where the MACD comes into play. When estimating a wave three in a count, look for an increasing MACD signal. Fractal Finance identifies an increasing MACD with a green dot when the ShowMe is inserted.

At the end of a wave three count the market will hypothetically move toward a wave four. This will also be accompanied with a change in momentum. Then we will look for the MACD to turn bearish (see Figure 9). Fractal Finance identifies a decreasing MACD with a red dot when the ShowMe is inserted. You don't need to understand Elliot waves to use Fractal Finance. The example is included to show you how MACD can be used with a number of different trading tools. Soon you will see how we use it in conjunction with fractals and the other money flow indicators.

Fractal Finance measures the natural rhythm of the market by comparing the current market direction to its medium and long-term directions. Because the market is a natural system, we want to be sure that our trades do not buck the trend. To do this we look at the Rhythm Indicator on the Fractal Finance chart. The indicator is symbolized by the color of the price bar when the PaintBar is inserted.

A red bar indicates a declining trend as the short-term price movement relates to the medium and long-terms. A blue bar indicates a neutral trend (or no trend) as the short-term relates to the medium and long-terms. A green bar indicates an increasing trend as the short-term relates to the medium and long-terms.

When this Rhythm Indicator is in agreement with MACD, you know that new money is flowing into a market that has maintained constant money flow for some time. This is strong evidence that the current trend will continue.

When changes start to take place between MACD and the market rhythm, it is important to examine the fractal pivot points and look for potential shifts in market direction. While you can use your own judgment, Fractal Finance will signal Alerts when these conditions begin to develop. These Alerts eliminate the ambiguity from buy/sell decisions.

Identifying Markets with Trading Potential

Part of using a trading system or tool is selecting a market that is ripe with opportunity. There are many ways to approach this, but the most effective are those that monitor price movement, volatility, and volume. They are effective because market makers and specialists act repeatedly in similar ways to reflect changes in supply and demand. If we can find securities likely to have strength, we can then apply fractal analysis to determine if the market is good to trade.

Because Fractal Finance users don't use other technical indicators, they don't even need to consider them. The only indicators Tetrahex believes you should be familiar with are relative strength and trends. One way to search for strength is to identify strong groups of securities and compare them with a measure of the market.

An example is to take an index of securities that represent one segment of the market and compare it with your measurement device. If you are interested in technical stocks, you could take the CBOE technology index and compare the strength of it to the NASDAQ. If the CBOE technology index has moved up a higher percentage than the NASDAQ, you know that the CBOE index is outperforming the NASDAQ.

In this case the CBOE technology index is a good place to search for technology securities to trade. After all, a security will not make money if it doesn't move or have follow-through. This practice of comparing the two indices is known as relative strength.

Relative strength is not limited to comparing an index to the broader market. You can use this technique just as easily with an individual security and an index of a sector. In the above example the CBOE technology index was compared with the NASDAQ, but

you could just as easily have compared one stock in that index with the index itself or the broader market in general.

This may sound confusing, but it really isn't. If, for instance, MSFT was trading at 50 and is now trading at 55, MSFT is up 10%. If during the same time period the NASDAQ was at 2000 and is now 2100, we know that the NASDAQ is only up 5%. By this reasoning, MSFT is twice as strong as the broader market. This translates to good strength. Considering that MSFT is moving and there is active interest in it, now would be a good time to run a fractal analysis of MSFT and look for a buy signal.

When searching for a good trading candidate, consider volume in addition to relative strength. If volume is higher than normal and relative strength is also high, demand is usually increasing.

Tetrahex has identified this market phenomenon and has determined certain of its characteristics. Stocks trading two to four times average volume and up (down) five to ten percent will continue to go up (down) and follow-through. However, beware of stocks moving at abnormally fast rates. These equities tend to attract attention in the news and correspondingly attract supply that makes the equity vulnerable to pullbacks. To give you an idea, stocks trading up 25% on 20 times average volume are inherently risky.

We identify potential opportunities by searching for securities that have moved between five to 25% and with a 50-day moving average of volume that lies between 50 to 2000%.

Using the logarithmic FDI of price change is also useful for finding good markets to trade. In conjunction with the other two indicators, it allows you to determine how close the security is to a random walk.

If the FDI is near 1.5, the security is in a highly difficult range to forecast price movement. We suggest first searching for securities with strong relative strength and average volume, and then finding those with an FDI as far away from 1.5 as possible.

Once you identify a security matching those criteria, pull up a chart and run the Fractal Finance Expert. Within seconds you will know if there is a buy or sell signal for the security. For a more in-depth analysis, run a Back Test to determine the best trading style for that particular market.

When entering trades, remember to determine when the buy/sell signal was first initiated. The reason is that you want to enter a trade at the beginning of a buy/sell signal to gain the most potential profit. If, however, you wish to see trends form before entering a trade, you can wait for a buy/sell signal and monitor the Commentary indicator. When all indicators are in one direction, and the FDI is decreasing rapidly, you will know you are in a trend.

Putting It All Together

Now that you have a good introduction to fractals, chaos, and Fractal Finance, let's put the program to work. Begin by identifying a security with volatility and volume. Use the techniques mentioned earlier.

After you have found a number of securities, look at each one on an individual chart.

Attach the Fractal Finance Expert and look for any buy/sell signals. Many Alerts are included with Fractal Finance, so be sure to read each one carefully. After identifying a security with a buy/sell signal, look at the commentary for more specific information. Determine how far into the Alert the security is trading and decide on your trading style.

You should decide if you want to enter a trade from the first buy/sell signal or after a trend is forming. Remember, buying into the trade may seem safer, but the potential for maximum profits will be reduced. When a trade is obvious to many people, there is a reason. So if all of the indicators in Fractal Finance are at or near the highest mark, and a strong buy signal has existed for several periods, chances are that many other traders are already on board.

To decide what type of trading strategy to employ, use Back Tests to run a comparison. Remember to examine multiple time frames. We recommend watching three consecutive time frames in unison. You should also experiment with tick charts instead of the typical man made time segment charts.

If you choose to trade directly from the Back Tests, remember that they will vary depending on the amount of price data loaded and the time frame analyzed. Tetrahex suggests that you use the Back Tests as a tool for selecting the markets with the most potential, not as a trading system itself.

The next step is to look at a chart of the next higher time frame and compare MACD and Fractal indicators of both charts. You will make a safer trade if you enter only when the MACD of the higher time frame is the same as the lower time frame.

The fractal indicator of the higher time frame is also important. It is acceptable to enter a trade when the higher time frame is showing a buy fractal signal with a buy MACD and the lower time frame is showing a neutral signal for the fractal signal and a buy for the MACD.

What is probably occurring in this case is a change in sentiment from the lower time frame that has not taken effect with the longer-term money. One way to execute this type of a trade is to watch both time frames closely and as soon as the fractals in the higher time frame correlate with the lower time frame you initiate the trade. Again, you may not catch the bottom of the new trend, but you will be entering a safer trade.

Quick Reference Guide

Below we have included a brief description of the various indicators and trading styles for easy reading.

USING FRACTAL FINANCE – OVERVIEW

Fractal Finance is easy to operate and read. For an accurate analysis, Fractal Finance requires a minimum of 100 periods loaded into your chart. Fractal Finance uses a series of analysis techniques, all of which are explained below.

Note: Fractal Finance analysis techniques are easily identified as they all begin with the prefix TFF_ in each category.

14 functions are available that allow you to create custom indicators while incorporating Fractal Finance. Here is each function:

1) Bear Stop – Resistance to the upside.
2) Bull Stop – Support to the downside.
3) Consensus - Summarizes MACD, Rhythm, Fractal Set Trend, and Fractal Interim Trend on a scale of 4 to –4. The number 4 is strongly bullish while –4 is strongly bearish. Any numbers between the two are variations of either effect. This is useful for initiating trades or anticipating trend reversals. This indicator is also suitable for measuring the strength of multiple time frames.
4) FDI - The Fractional Dimension Index that determines if a market is volatile, random or trending. This FDI is based on logarithmic change in price
5) FDI Price - The Fractional Dimension Index that determines if a market is volatile, random or trending. This FDI is based on closing price.
6) MACD - [Bullish, Bearish] - Moving average convergence/divergence. MACD primarily identifies the current momentum of the market. Our proprietary indicator is set to specific values that offer an early indication of a potential change in market direction. This is not a Fractal Indicator, but works well in conjunction with them. If using ShowMe techniques MACD is visible on the Fractal Finance chart as a green (bullish) or red (bearish) dot above the price plot.
7) MFB – MACD Fractal Buy. Fractal Finance does not signal a buy alert unless MACD agrees with Fractal Trends Combined.
8) MFS – MACD Fractal Sell. Fractal Finance does not signal a sell alert unless MACD agrees with Fractal Trends Combined.
9) NFL – Neutral From Long. A signal that gets the trader out of a long trade.

10) NFS – Neutral From Short. A signal that gets the trader out a short trade.
11) Rhythm - [Bullish, Neutral, Bearish] – Filter that compares market momentum over the long, medium, and short-term. This signal is the current disposition of the market in comparison to long and medium-term. It's useful in identifying current trends.
12) SB – Strong Buy. MACD, Rhythm and Fractal indicators are all in a buy mode.
13) SS – Strong Sell. MACD, Rhythm and Fractal indicators are all in a sell mode.
14) Vstatistic – Computes a ratio that demonstrates a clear peak when re-scale range statistics stop scaling at a faster rate than the square root of time. When the V-statistic peaks, it is often caused by a non-periodic or periodic cycle.

7 Indicators come ready to go with Fractal Finance. The indicators are based on the functions above.

1) Commentary - Important features of the Commentary Window are the Fractal Consensus, Fractal Set Trend, Fractal Interim Trend, Combined Fractal Sentiment, MACD, Rhythm, Bullish Support, and Bearish Resistance. Explanations are given in the commentary window.
2) Consensus
3) FDI
4) FDI Price
5) MACD
6) Rhythm
7) V-Statistic

1 Paint Bar can be attached that identifies the current market rhythm. A green bar is bullish, blue is neutral, and red is bearish.

1 Show Me places a dot on the chart with one of two colors. The Show Me identifies the current state of the MACD and is either green or red. Green is bullish, red is bearish.

11 Strategies. You can insert strategies into a template or a chart. Some of these have variable inputs to allow for experiments or optimization. The strategies are based on the functions of the same name. The list includes:

1) Bear Stop
2) Bull Stop
3) Buy
4) Consensus LE
5) Consensus SE
6) Fractal Buy
7) Fractal Sell

8) Go Neutral
9) Sell
10) Strong Buy
11) Strong Sell

These are all of the indicators in Fractal Finance. We recommend using them with multiple time frames in your analysis. If you have any questions about the operation of Fractal Finance, please feel free to e-mail support@fractalfinance.com.

Glossary

Anti-persistence A term used in re-scaled range analysis. An anti-persistent time series is reflected on a chart as a more jagged line. The fractal dimension of such a chart is closer to 2. If a market is highly anti-persistent, it is more likely that the price direction will change in the next time period.

Attractor The region where a systems solutions exists.

Bifurcation This is the point in a nonlinear system when the possible solutions double. The point where this occurs is the critical level. The transition from order to chaos occurs when the number of possible solutions begins doubling.

Chaos The particular state of a nonlinear dynamic system when it is unpredictable. This state appears to be random. A chaotic system has a fractal dimension and is sensitive to initial conditions.

Complexity theory When a large set of independent variables spontaneously organize themselves into a natural system.

Euclidean geometry The symmetrical form of mathematics developed by Euclid. He insisted that geometry could explain reality.

Fractal An object with self-similar individual parts.

Fractal Dimension A non-integer dimension that describes how an object takes up space.

Hurst exponent An indicator developed by H.E. Hurst to measure the bias in fractional Brownian motion. The Hurst exponent varies between 0 and 1.

Limit cycle A nonlinear attractor that has periodic cycles or orbits in phase space.

Liquidity The ability to buy or sell a security in a particular market. Not to be confused with the volume of a security.

MACD A Moving Average Convergence Divergence is calculated by subtracting a long term moving average from a medium term moving average. A short term moving average is plotted against the other two and used as a signal line. The MACD is primarily used to identify the current momentum of the market.

Nonlinear dynamic system A system in which randomness, initial conditions, and stimuli become the organizing principle rather than cause and effect.

Persistence A term used in re-scaled range analysis. A persistent time series is reflected on a chart as a straighter line. The fractal dimension of such a chart is closer to 1. If a market is highly persistent, it is more likely that the price direction will not change and continue to trend in the next time period.

Point attractors The simplest form of attractors, often explained with the example of a pendulum. If you take a pendulum and swing it, it will move in the direction swung until friction slows it down.

Random walk Explained in terms of Brownian motion as a change in the value of a variable that is unrelated to any past or future event.

Re-scaled Range (R/S) Analysis Developed by H.E. Hurst to determine long memory effects and fractional Brownian motion.

Strange attractor An attractor whose points complete a cycle in phase space and never duplicate an orbit. The orbits appear to be random and chaotic, but fall within a certain range of phase space. Strange attractors are non-periodic.

Sierpinski triangle A graphic example that demonstrates a random process coupled with global determinism can create a stable natural system with self-similarity.

V-Statistic A re-scale range plot that often peaks when a periodic or non-periodic cycle is complete.

Bifurcation Diagram

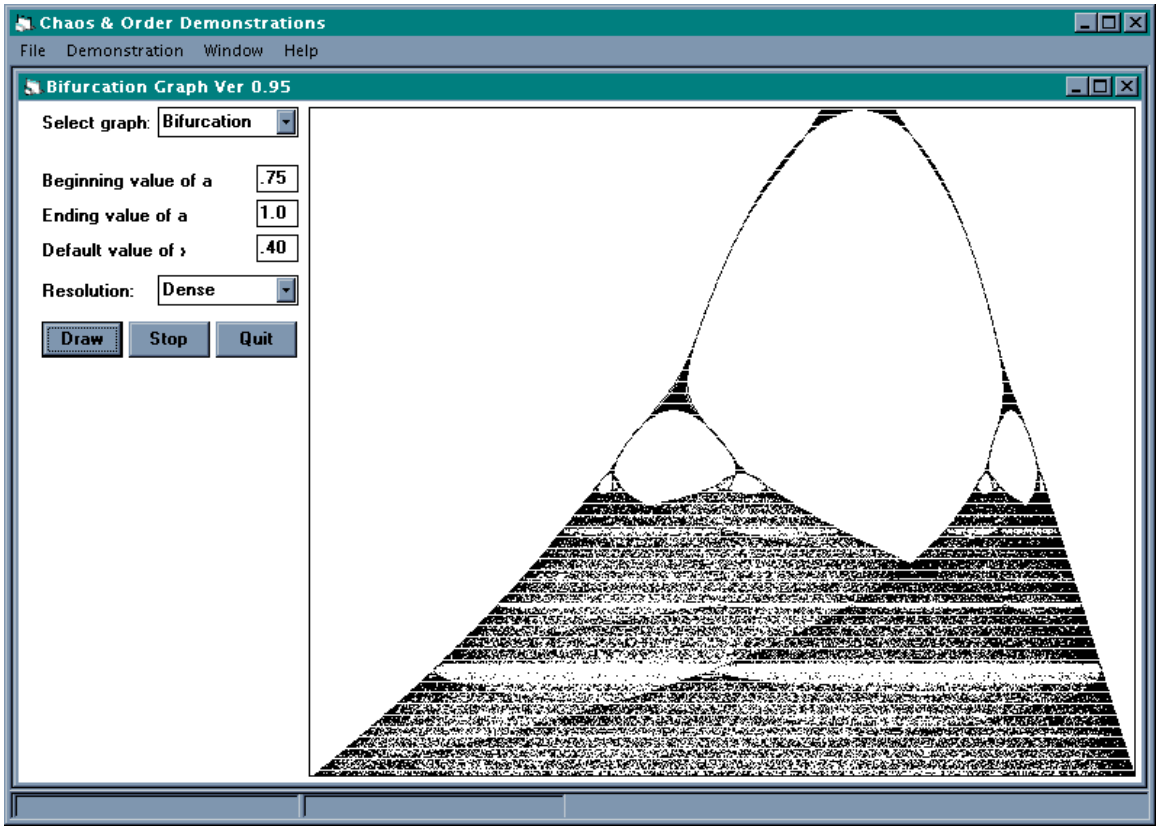

Figure 1

The Chaos Game

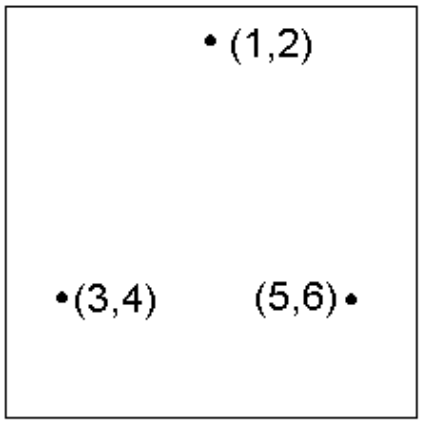

Figure 2

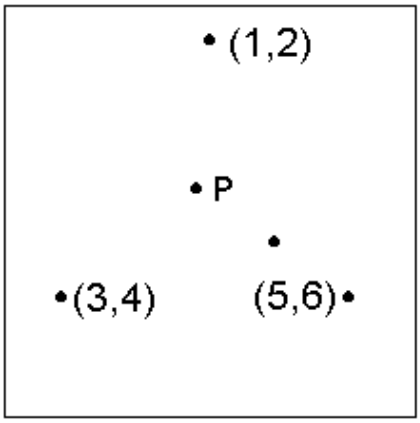

Figure 3

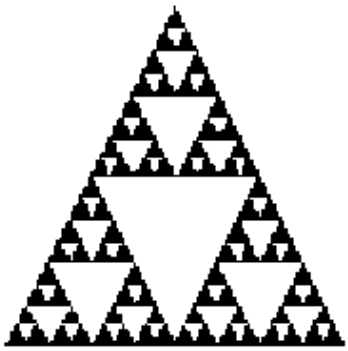

Figure 4

Attractors

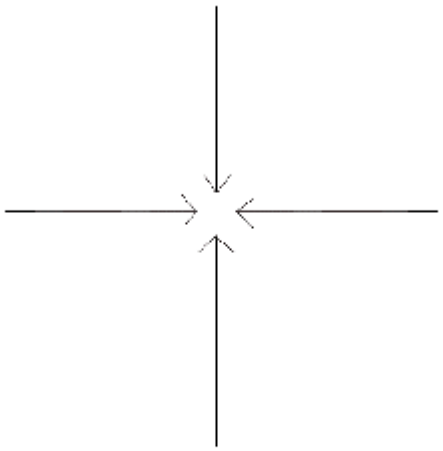

Figure 5

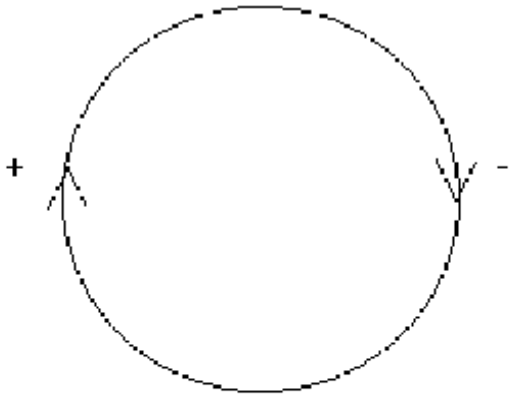

Figure 6

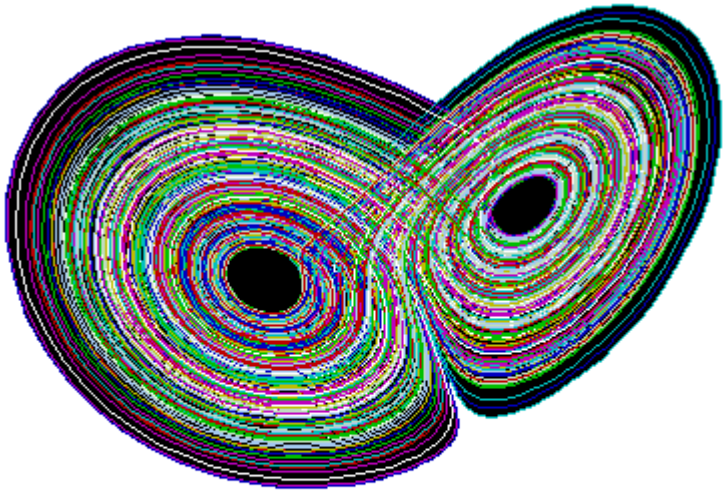

Figure 7

Subdividing Elliot Wave

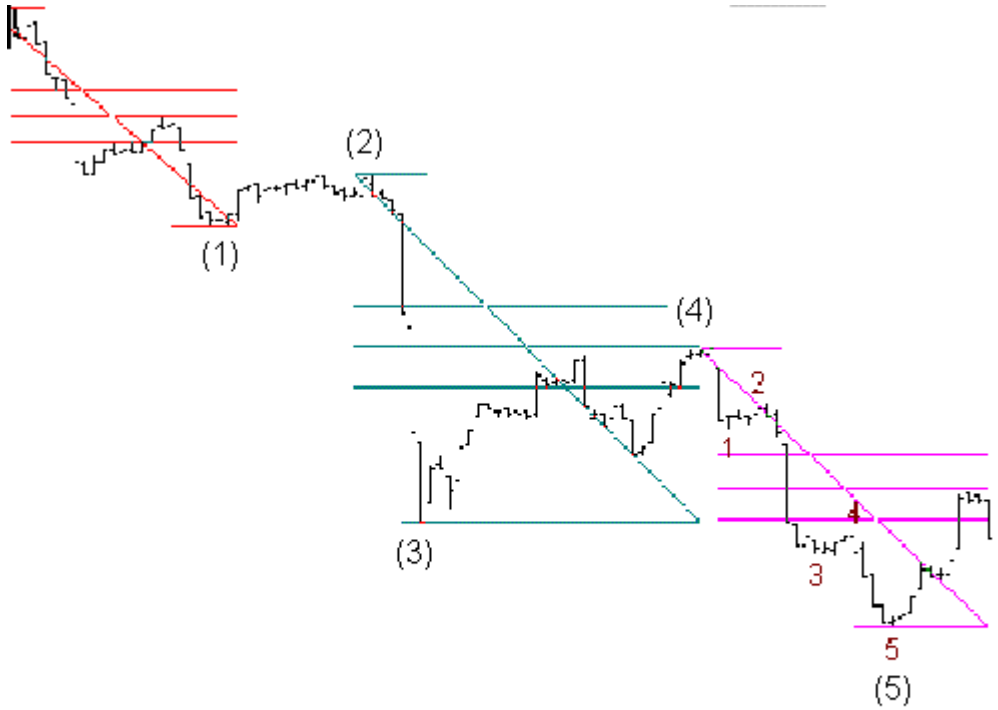

Figure 8

Fractal Finance Chart w/Bearish MACD

Figure 9