

# ID'ING WHEN TO BUY AND SELL USING THE STOCHASTIC OSCILLATOR

By Wayne A. Thorp

Stochastics work best with those securities that are currently trading within a particular range and may prove useful in identifying buying and selling points. But they can return false signals, especially during periods when stocks are in a strong uptrend or downtrend.

There is no such thing as a universal indicator. Rather, different conditions dictate the use of different indicators.

Oscillators, which are indicators that move between zero and 100, are useful in identifying conditions where a security may be overextended—overbought or oversold. In the May issue of the *AAll Journal*, we took a look at one popular oscillator, Wilder's relative strength index. This article focuses on another popular indicator, the stochastic oscillator.

## THE CALCULATION

The word stochastic is defined in general as a process involving a random variable. The stochastic oscillator was first introduced by George Lane in the 1970s. This indicator consists of two lines—the %K and %D lines—and compares the most recent closing price of a security to the price range in which it traded over a specified time period.

The following formula shows you how to calculate the latest point on the %K line:

$$\%K = [(Close - Lo) \div (Hi - Lo)] \times 100$$

Where:

Close = Last closing price

Hi = Highest intraday price over the designated period

Lo = Lowest intraday price over the designated period

Therefore, if you were calculating a five-day %K line, the first point would be calculated using the highest price over the last five trading days and the lowest price over the last five trading days as well as the closing price for day five (the last day of the five-day period).

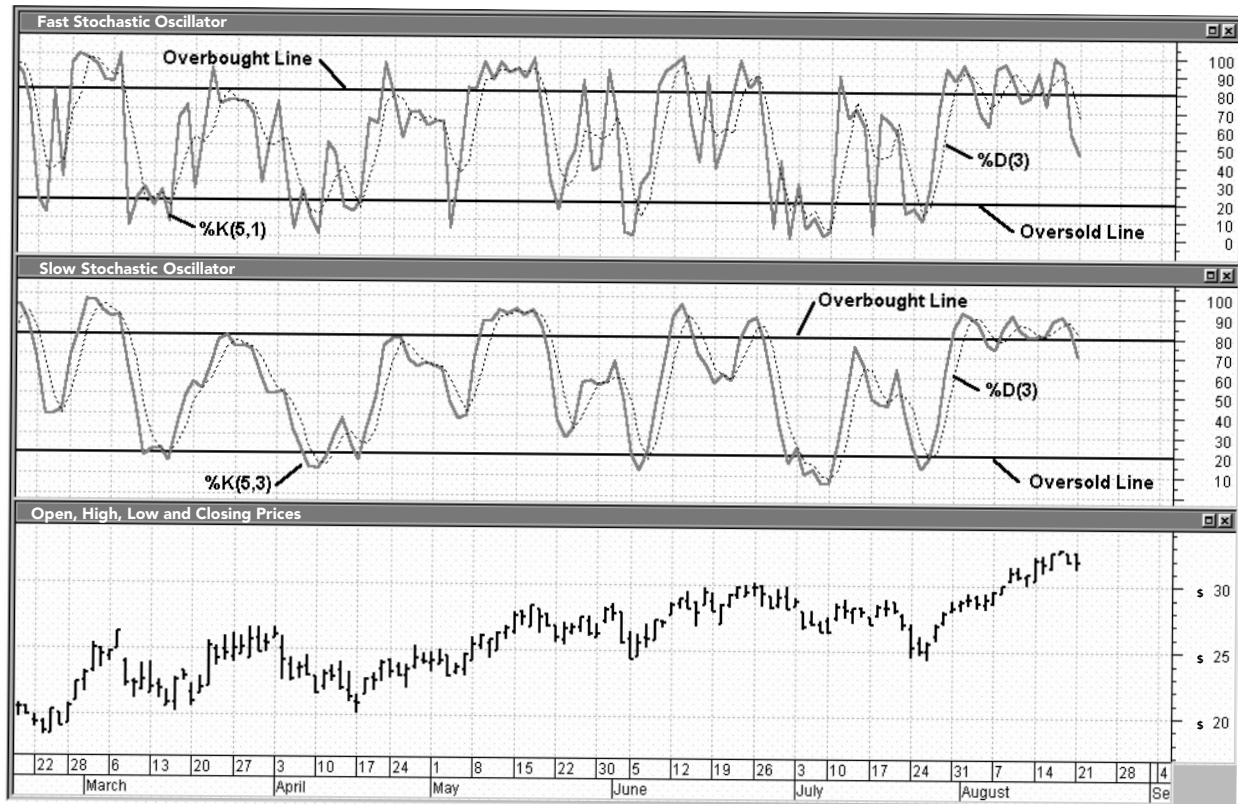
The %D line typically is a three-point moving average of the %K line, and serves as a "trigger" line for generating trading signals. In other words, you add together the last three %K values, divide this sum by three, and continue this over a rolling three-day period. You can use any type of moving average you wish when calculating the %D line, including simple, weighted, or exponential moving averages. [For more on how to use moving averages, see "An Intro to Moving Averages: Popular Technical Indicators," by Wayne A. Thorp in the August 1999 *AAll Journal*.]

Like virtually all technical indicators, you can calculate stochastics over any time period you wish, depending on your trading style. The shorter the time period used to establish the high-low comparison, the more responsive the indicator is to price changes which, in turn, will increase the number of signals the indicator generates. Alternatively, as you increase the time period used in calculating an indicator, you increase the time in which it takes to respond to current price movements. This lowers the number of signals the indicator generates. Also, keep in mind that you can use any time *increment* as well—minute, hour, day, week, month, etc. The same principles apply no matter the time period or increment you use.

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*The figures in this article were produced using MetaStock by Equis.*

**FIGURE 1. SLOW VS. FAST STOCHASTIC OSCILLATORS FOR GLOBAL MARINE**

## FAST VS. SLOW STOCHASTICS

The formula we provided on page 24 to calculate points on the %K line leads us to a stochastic oscillator that is extremely volatile and, therefore, is often referred to as a “fast” stochastic. Lane realized that due to the fast stochastic’s volatility, it was not very useful as a trading tool because it generated frequent and often inaccurate trading signals. In an attempt to create an indicator that was less volatile and, therefore, more useful, Lane created a “slow” stochastic by:

- Making the original %D line the new %K line—the stochastic is “smoothed” or slowed by averaging over three points. In other words, the new %K line is a three-point moving average of the fast %K line; and
- Using a three-point moving average of the original %D line as the slow stochastic’s %D line. Therefore, we

are taking the original %K line, smoothing or averaging it over three points, and then averaging this line over three points once more.

Figure 1 illustrates both the fast (upper window) and slow (middle window) stochastics for Global Marine. In both instances, the %K line is the solid line, and the %D line is the dotted line. In both stochastic windows, the two horizontal lines mark the overbought (indicator value above 80) and oversold areas (indicator value below 20) as defined by Lane. As we will see later, the movements of the %K and %D lines above and below these levels are useful when timing your buy and sell decisions.

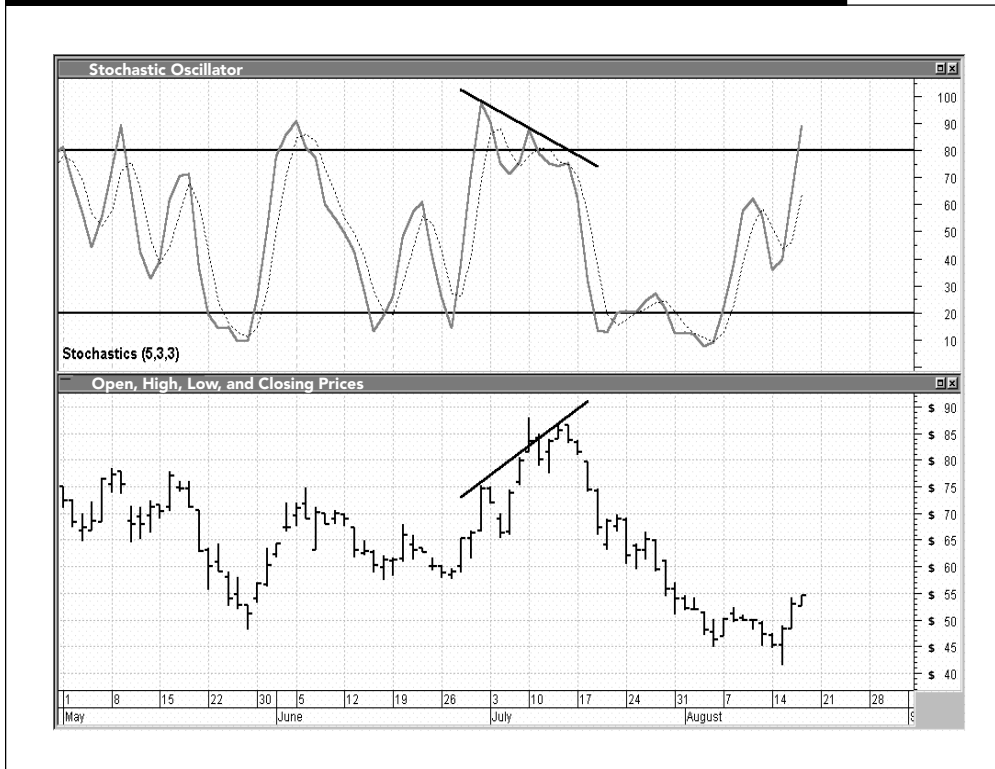
The numbers in parentheses on the chart indicate the number of points used in calculating the moving averages period used. Looking at the slow stochastic in the middle window, you see (5,3) after the %K

label. This indicates that the points on the %K line are calculated over five points and then “smoothed,” or averaged, over three points. The %D lines in Figure 1 are a three-point moving averages of their respective %K lines.

When comparing the slow and fast stochastics, you can immediately see that the slow stochastic is more rounded and less volatile than the fast stochastic. Note, also, that there are times when the fast stochastic lines either cross above 80 or below 20, while the slow stochastic lines do not. By slowing the lines, the slow stochastic generates fewer trading signals.

## INTERPRETATION

You can see in the figures that the stochastic oscillator fluctuates between zero and 100. A stochastic value of 50 indicates that the closing price is at the midpoint of the

**FIGURE 2. A BEARISH DIVERGENCE FOR PHOTON DYNAMICS**

trading range for the specified period. As values reach above 50, it indicates that the price is moving up into the higher trading-range for the period. The opposite is true when values fall below 50—the price is moving into the lower levels of the trading range for the period.

At the extreme, a value of 100 signals that the price closed at the absolute highest point for the period, while a value of zero means that the price closed at the lowest point for the period.

The three most common ways to use the stochastic oscillator are divergences, crossovers, and over-sold/overbought.

## DIVERGENCES

When Lane first introduced stochastics, he believed that the only valid signal occurred when a divergence developed between the price and the stochastic oscillator, more specifically the %D line. Divergences between price and an indicator occur when the behavior in the price is not mirrored by the

indicator.

A bearish divergence, for example, takes place when the prices are making higher highs while the stochastic is making new lows (preferably below 20), or is failing to also make new highs. This occurs because, while prices are reaching new intraperiod highs, the closing prices are falling. When you see this, you can reasonably expect the price to fall in line with the indicator—which means prices will reverse course and begin to fall.

Figure 2 provides an example of a bearish divergence between the daily price of Photon Dynamics and five-day stochastics (with three-day slowing). As you can see, prices moved in a generally upward direction (higher highs and higher lows) from late June through the middle of July—creating three successive peaks, each higher than the previous. At the same time, however, the stochastic oscillator was moving in the opposite direction, creating two successively lower peaks—both of which are above 80. Eventually, prices followed the

stochastic, reversed course, and fell from a high of \$85 to a low near \$45 in less than a month.

Bullish divergences occur when the price is making new lows while the oscillator is making new highs—or failing to make new lows—below the 20 line. Here you can expect prices to bottom out and begin to rise, matching the behavior of the indicator.

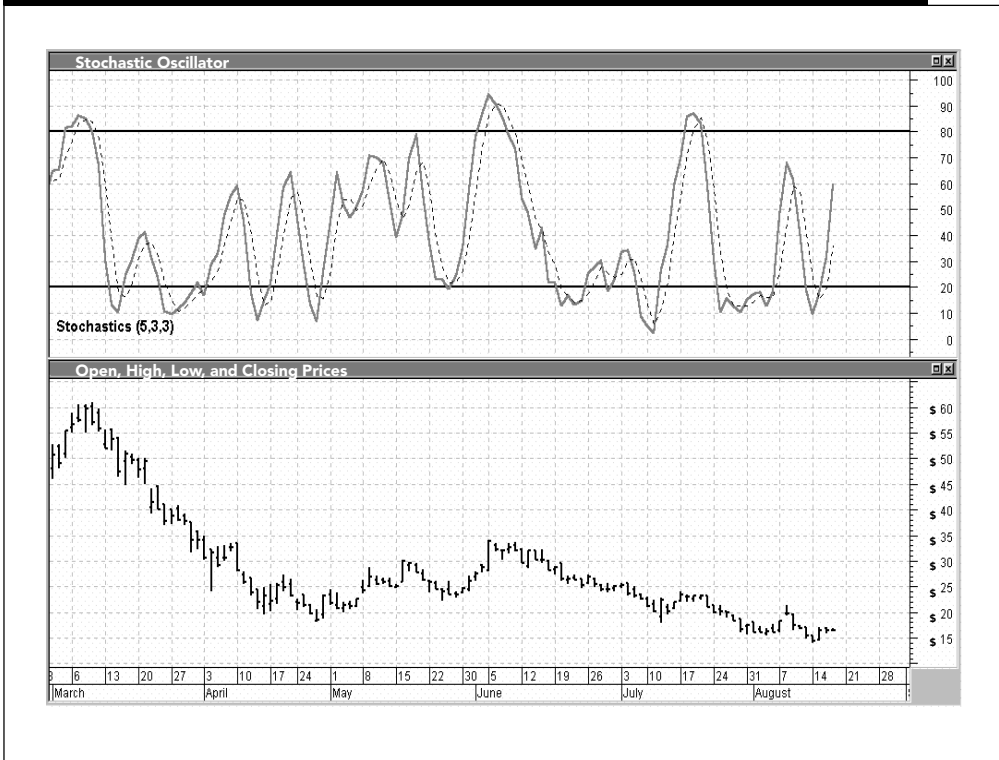
## OVERBOUGHT & OVERSOLD

The horizontal lines at 20 and 80 mark overbought and oversold areas for a given security. A security is considered *overbought* when the stochastic lines rise above 80 as closing prices near intraperiod highs. Likewise, it is viewed as *oversold* when

they cross below 20 indicating closing prices are near the intraperiod low. These levels represent points where one would expect prices to reverse—the extreme price levels are not sustainable over time. Note that either line—the %K line or %D—may be used, although most technicians consider the %D line to be more accurate.

There are several strategies that can be used based on overbought and oversold levels.

The strictest rule would be to sell when the %D line crosses above 80—in other words, when the stock becomes overbought—and buy when it crosses below 20 and becomes oversold. This strategy, however, has flaws. To begin with, there is no indication as to how long the security will remain at the price extremes, meaning that the security could become even more overbought or oversold. Therefore, if you sold when the %D line crossed above 80, you run the risk of missing further price gains, just as you run the risk of buying prematurely before the

**FIGURE 3. A STOCHASTIC OSCILLATOR "BREAKDOWN" FOR PSINET**

price bottoms if you buy when the line crosses below 20.

A more conservative approach is to allow the oscillator to cross either above 80 or below 20 and wait until it reverses itself—in other words, wait until it crosses back below 80 before selling and wait until it rises above 20 before buying. While you risk giving up some of your price gains or missing out on some or all of the upward movement, over time this strategy tends to perform better.

### CROSSOVERS

The stochastic oscillator is unique compared to other oscillators, such as Wilder's relative strength indicator, because it is composed of two lines instead of just one. Therefore, as with indicators such as multiple moving averages and the MACD (moving average convergence/divergence), potential trading signals arise when the %K line crosses the %D.

Generally speaking, a buy signal is generated whenever the %K line moves above the %D line. Likewise,

a sell or short signal occurs when the %K line crosses below the %D line.

For the most reliable signals, technicians typically wait to act on crossovers until the %K and %D lines are in the overbought or oversold zones—above 80 and below 20, respectively. Therefore, a stronger sell signal would be when the %K line crosses below the %D line when both are above 80, and a stronger buy signal would be when the %K rises above the %D line when both are below 20.

Further study has shown that the side of the %D line on which the crossover by the %K line takes place can also be a factor in how profitable the trade may be. "Right-side" crossings, which tend to be more profitable than "left-side" crossings, take place when the %K line crosses *after* the %D line has reached an extreme.

### BREAKDOWNS

Stochastics are most useful in identifying short(er)-term price

swings. In addition, the indicator is most reliable when used with a security whose price moves within a trading range. On the other hand, problems tend to arise when you attempt to use the stochastic oscillator in trending markets.

Oscillators in general perform poorly during strong, prolonged trends—either upward or downward. During strong uptrends, the stochastics tend to move into the overbought range (above 80) and can stay there for an extended period of time. Furthermore, during such trends, movements by the indicator below 80 tend not to be indicative of a reversal in the overall trend. The same is true for divergences that occur in trending markets, which also tend to

generate false signals.

One way to avoid trading on these false signals is to only trade on those signals that are in the direction of the overall trend. In other words, sell when the price is overbought only when there is a confirmed downtrend, and buy when the price is oversold only if the trend is up.

Figure 3 is an example of how the stochastic oscillator "breaks down" during a prolonged trend. Here, PsiNet experienced a steady decline from early March through late April. During this time, the stochastics fell from above the 80 line to below the 20 line. Subsequently, it rose above 20 four other times during this period. If you had purchased the stock on any of these crossovers above the 20 line, you would have seen three of the four trades lose money as the price fell from \$60 to below \$20, eventually staging a small rally.

### CONCLUSION

Stochastics, like any technical

indicator, can be a useful tool in implementing your trading strategy as long as you understand both its strengths and weaknesses.

Stochastics work best with those securities that are in a trading range or are non-trending. Under these conditions, the stochastic indicator may prove useful in identifying buying and selling points based on divergences between the indicator and the security's price, the interaction between the %K and %D lines that make up the oscillator, as well

as when a security may be overbought or oversold.

But stochastics can return false signals, especially during strong up- and downtrends. Using stochastics with other indicators can help reduce the risk of entering a trade against the overall trend. ♦

**RESOURCES**

Articles

Luisi, Joe "The Stochastic Oscillator," Technical Analysis of Stocks and Commodities, December 1997.

Evens, Stuart "Stochastics," Technical Analysis of Stocks and Commodities, September 1999.

"Indicator Insight: Stochastics," Active Trader Magazine, August 2000.

Web Sites

BigCharts, [www.bigcharts.com](http://www.bigcharts.com)

Meta Stock, [www.metastock.com](http://www.metastock.com)

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# ANALYZING SUPPLY AND DEMAND USING POINT AND FIGURE CHARTS

By Wayne A. Thorp

The usefulness of point and figure charts lies in their ability to filter out short-term price fluctuations that occur during longer, more established trends. They differ from the more conventional charts in that they are only affected by price movements.

One of the basic principles of economics is the law of supply and demand. It states that when there are more buyers than there are sellers of a given good, the price should rise. Likewise, when there are more sellers than buyers, the price should fall. In this technical analysis article, we focus on a type of chart that attempts to capture the battle between supply and demand: the point and figure chart.

Point and figure charts have been in use for over 100 years, yet they exist in relative obscurity compared to bar charts and candlesticks. Their usefulness lies in their ability to filter out market “noise”—short-term price fluctuations that occur during longer, more established trends. They differ from the more conventional charts in that they ignore the passage of time and do not take trading volume into account—they are only affected by price movements.

Figure 1 is an example of a point and figure chart for Cisco Systems, which covers daily price movements for the period from January 4, 1999, through April 31, 1999. Immediately, you should see some significant differences from other charts. First, the chart is made up of columns of X’s and O’s. X’s represent rising prices while O’s represent falling prices. Put another way, X’s represent demand and O’s supply. The movement from columns of X’s to O’s and back again creates patterns that you may use to make buy and sell decisions.

There are two key items you need to address before you can begin creating your own point and figure charts—the box size and reversal amount.

The box size is based on the scale you wish to use for a particular security or index and it represents the value given to each box (X or O) on the chart. It is the minimum price change needed to continue the trend—i.e., to add an X to the top of the column of X’s (or the minimum price decrease needed to add an O to the bottom of a column of O’s). The reason that this is even an issue is because a reversal of \$3 for a \$10 stock is more dramatic, on a different scale, than a \$3 reversal on a \$100 stock. Furthermore, since point and figure charts are used to filter out “noise” in the market, you will want to be sure that you are filtering out just enough to eliminate momentary price reversals, yet at the same time allow enough through so you can identify when a significant reversal is taking place.

As you use point and figure charts, you may find that different box sizes work better for your trading style or for a particular security. However, box sizes have traditionally been broken down into the following levels:

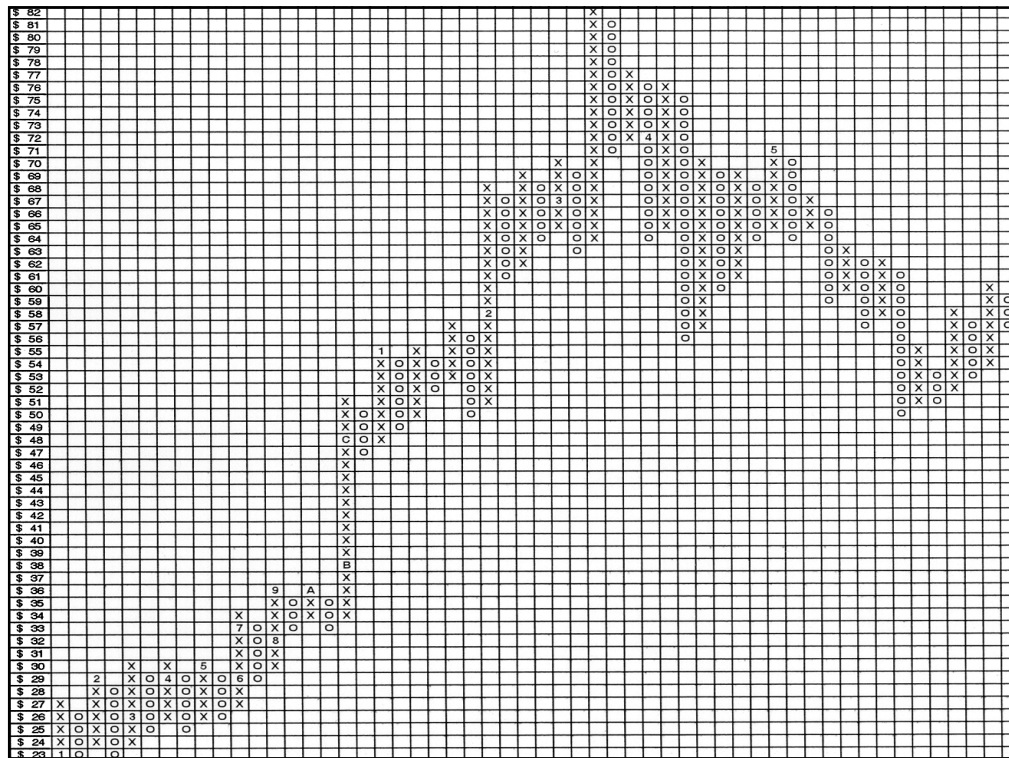
Share Price	Box Size
Below \$5	\$0.25
Between \$5 and \$20	\$0.50
Between \$20 and \$100	\$1.00
Over \$100	\$2.00

How you move from one column to another is key to your analysis of point and figure charts. The way in which you move to a new column is

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**FIGURE 1. POINT AND FIGURE CHART FOR CISCO SYSTEMS (1/4/99 TO 4/31/99)**



different results. You may wish to experiment to find the technique that works best for you.

A key concept to remember when creating point and figure charts is that you remain in the same column of X's or O's as long as prices continue to rise or fall, respectively. In other words, if the chart was in a column of X's and prices were rising, you would ask yourself each day whether the price rose one full box or more. You would find this out by looking at the high price for the

called the "reversal method." The reversal amount determines how many boxes the price must reverse course in order to move to a new column and switch from X's to O's or O's to X's. While this can be left to the individual creating the chart, the typical reversal is the "three box" reversal, because it is thought to eliminate spurious price fluctuations and focus on only "significant" price movements.

If a stock were trading below \$5, it would take a price move (up or down) of \$0.75 to generate a three-box reversal. Based on the table on page 25, the box size for such a stock is \$0.25; a three-box reversal would take three \$0.25 price moves to necessitate a shift to a new column of either X's or O's. The same principle applies no matter the box size.

Having established the parameters for the essential elements of a point and figure chart, you must last look at exactly which price(s) you will use to plot your point and figure chart. "Purists" typically use the

high and low prices for the period (day, week, month, etc.), while others may focus strictly on a single price such as the close. Depending on the price(s) you use, you may get

day—again we are only concerned with the high and low prices, not the open or close. If the price did rise at least one box, let's say from \$50 to \$51, you would add an X to

**FIGURE 2. CREATING A POINT AND FIGURE CHART**

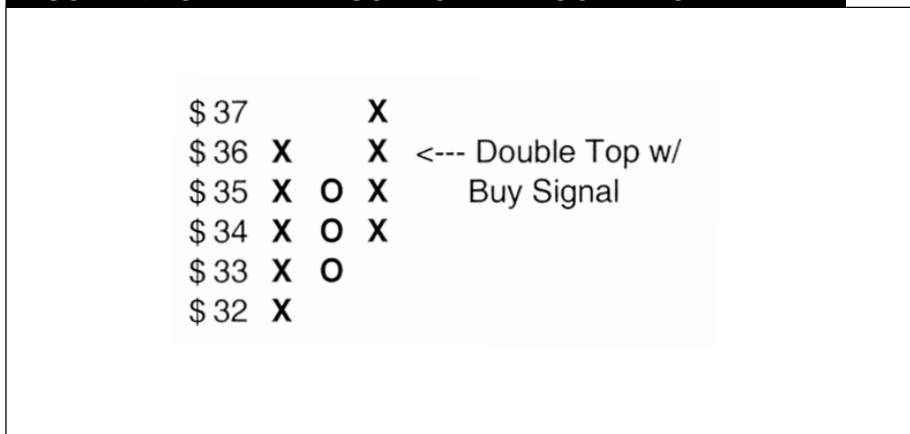
Date	High	Low
6/1/00	61.13	57.88
6/2/00	65.75	63.44
6/5/00	65.06	62.44
6/6/00	63.81	61.13
6/7/00	63.50	61.13
6/8/00	65.00	62.75
6/9/00	65.00	64.00
6/12/00	64.75	62.13
6/13/00	65.00	61.50
6/14/00	66.50	64.13
6/15/00	66.63	64.63
6/16/00	67.94	65.80
6/19/00	69.25	66.25
6/20/00	69.56	66.63
6/21/00	67.75	65.75
6/22/00	67.13	64.44
6/23/00	65.94	62.50
6/26/00	63.63	61.06
6/27/00	65.25	62.13

\$70					
\$69				X	
\$68				X	O
\$67				X	O
\$66				X	O
\$65	X	X	X	O	X
\$64	X	O	X	O	X
\$63	X	O	X	O	X
\$62	X	O	O	O	
\$61	X				
\$60	X				
\$59	X				
\$58	X				
\$57	O				





**FIGURE 4. POINT AND FIGURE CHART DOUBLE-TOP PATTERN**



X's was created as buyers bid up the price from \$32 to \$36, at which point demand dried up. The next move is to a column of O's, as sellers forced the price back down to \$33. Here the price had fallen enough to spur interest once again, providing support at this level. Finally, there is a move to another column of X's as buyers re-enter the market and again drive the price back to \$36. At this point, several things could happen. First, the price could again meet resistance and reverse course. Alternatively, buyers could continue bidding up the price, pushing the price past \$36. As the figure shows, if the price rises above \$36, this is viewed as a bullish signal and a potential buy.

right of this wall, you can begin constructing the bullish resistance line by placing a "+" at the top of the column of X's, then moving up and over one box, adding another "+" and repeating. The bullish support and resistance lines serve to form a trading channel.

Bearish resistance lines are the reciprocal of bullish support lines. In Figure 3, you can see that you begin drawing the bearish resistance line in the column of X's prior to the column of O's that penetrates the bullish support line. Connecting the boxes diagonally downward, you create a line that is parallel to the bullish support line. Stocks trading below the bearish resistance line are viewed as being in a bearish trend and you can expect prices to meet strong resistance as they near this boundary.

Lastly, the bearish support line is the reciprocal of the bullish resistance line. To begin drawing this line, look for the first "wall" of X's to the left of the bearish resistance line. The line that is formed by placing a "+" at the bottom of the column of X's and moving diagonally downward can be used as a guide, telling you where to expect downward moving prices to meet resistance. In other words, prices would receive support at or near this line. Similar to the bullish lines, the bearish support and bearish resistance lines form a trading channel

through which the stock can be expected to trade.

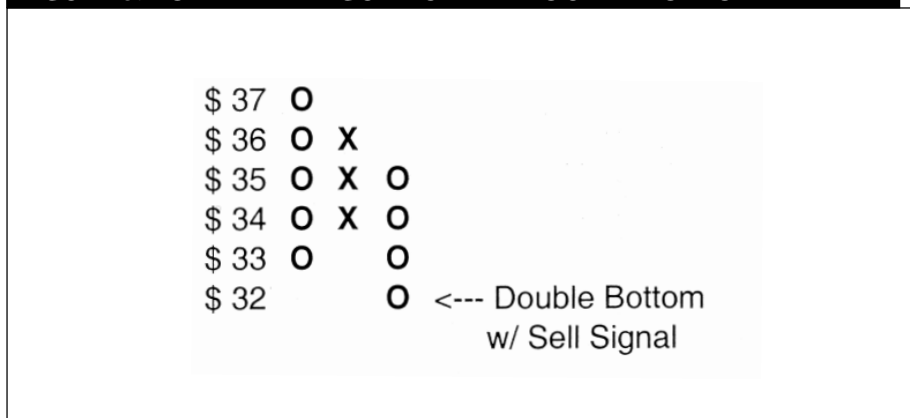
**TYPICAL PATTERNS**

One of the main objectives of technical and chart analysis is to identify trends in price and/or volume that may be used to predict future price movements. Some of the more popular and frequently occurring chart patterns are double tops and bottoms, as well as bullish and bearish triangles.

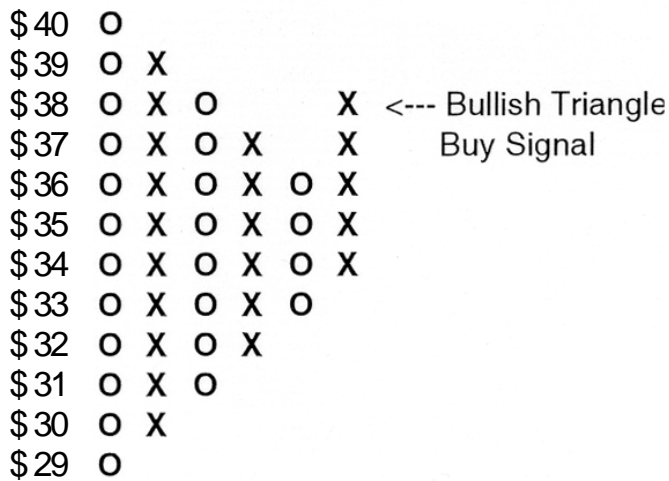
The double top and double bottom are two of the most common chart patterns that appear in most charts, especially point and figure. Figure 4 shows a double-top formation. Looking at the figure, you can see that this formation contains two columns of X's separated by a column of O's. The first column of

The double bottom is simply the double top turned upside down, and is shown in Figure 5. Here the formation is made up of two columns of O's separated by a single column of X's. In the first column of O's, there are more sellers than there are buyers and the price falls to the equilibrium point between buyers and sellers. Here, the price falls from \$37 to \$33, at which point the price finds support and reverses to a column of X's. In the column of X's, buyers bid up the price to \$36 until their demand was satisfied. The price meets resistance, forms a top, and falls once again. Once the price reaches \$33, again it can take one of two courses—it could either reverse or continue its

**FIGURE 5. POINT AND FIGURE CHART DOUBLE-BOTTOM PATTERN**



**FIGURE 6. POINT AND FIGURE BULLISH TRIANGLE PATTERN**



downward trek. If the price falls below \$33, this would be a bearish sell signal.

Another typical point and figure pattern is triangles, both bearish and bullish. The hallmark of any triangle pattern is that, as prices fluctuate, higher lows and lower highs are created. Figure 6 illustrates a bullish triangle pattern. As you can see, as you move to the right, the highs become lower and the lows higher as the height of each column gets smaller and smaller. At this point, you have no idea which way the price may go if it were to break out of the formation, meaning you must wait for the pattern to be confirmed before entering your trade. As it plays out in Figure 6, the bullish triangle forms a double top at \$36 and generates a buy signal when the price crosses above \$36 and breaks out of the triangle pattern. If the price were to reverse itself, however,

you should still pay close attention, because there is the possibility of a double bottom forming—a potential sell signal.

Figure 7 shows a bearish triangle, which looks the same as a bullish triangle except for the fact that the price breaks out to the downside. Here, it is the formation of the double bottom at \$34 that signals the potential formation of a bearish triangle. The signal is confirmed

when the price falls below \$33.

Of course, there are many variations on the patterns shown here.

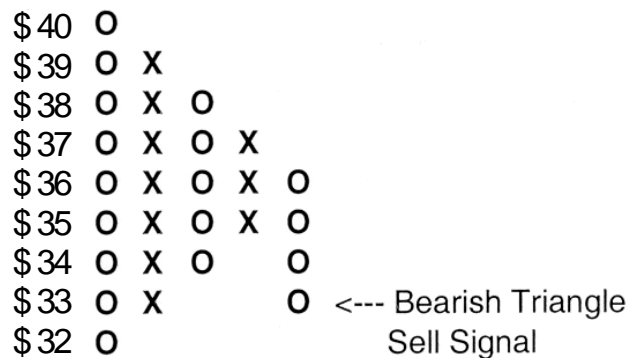
Overall, the formation of a triangle, with its series of lower lows and higher highs, signals the potential that prices will ‘break out.’ The formation of a double top or double bottom gives an indication of the direction of the breakout.

**CONCLUSION**

Point and figure charts are an interesting way of examining the basic economic principle of supply and demand. By eliminating the time element from the chart, you are left to focus strictly on price movements. By using reversal methods such as the three-point reversal, you are also able to filter out the market noise that can sometimes generate false information regarding trend reversals.

Taking point and figure analysis one step further, some relatively basic principles, such as trendlines as well as pattern formations such as tops, bottoms, and triangles, can be helpful in gauging buy and sell decisions. F

**FIGURE 7. POINT AND FIGURE BEARISH TRIANGLE PATTERN**



# MEASURING INTERNAL STRENGTH: WILDER'S RSI INDICATOR

By Wayne A. Thorp

Wilder's relative strength index measures a stock's price relative to itself over time. Its popularity lies in its versatility in identifying market extremes and illustrating points of divergence that may indicate an approaching reversal of price trend.

In his 1978 book, "New Concepts in Technical Trading Systems," J. Welles Wilder (Trade Research) introduced the relative strength index (RSI). This indicator, which has gone on to become one of the most widely used technical indicators, is a momentum indicator that belongs to a family of indicators called oscillators. An oscillator gets its name from the fact that it moves or oscillates between two fixed values based on the price movement of a security or index.

Wilder's RSI should not be confused with relative strength figures that appear in publications such as the Investor's Business Daily and AAI's *Stock Investor* program. Those relative strength calculations compare the price movement of a security or index against the price movement of some broad market measure such as the S&P 500. In other words, they show how well a particular index or security has done relative to the *broader market*. Perhaps a better name for the Wilder RSI would be the *internal* strength index—the RSI compares the price relative to *itself*.

The RSI has been found to have the most favorable results when used in the futures and commodities markets. Furthermore, the RSI is most used over a short trading period—both of which make the RSI best-suited for active trading or short-term investors. However, it is also used with equities, mutual funds, and indexes. The reason for its popularity lies in its versatility, mainly in identifying market extremes and illustrating points of divergence that may indicate an approaching reversal of the price trend. Furthermore, research indicates that for shorter periods, RSIs are leading indicators, meaning that they signal price tops and bottoms before they actually occur.

This article focuses on two of the more popular uses of the RSIs—identifying market extremes and divergences.

## CALCULATING RSI

Before you begin using the RSI in your trading, you need to decide on the period length you wish to use. When Wilder developed the relative strength index, he based it on 14 periods. A period can be a day, week, month, etc.; therefore, using a 14-period relative strength index would give you a 14-day, 14-week, or 14-month calculation. While 14 periods is the default value for most technical analysis software programs and Web sites, nine- and 25-period relative strength indexes are also gaining in popularity.

The Wilder RSI is a ratio of the average points gained during "up" periods over the past  $n$  periods divided by the average points lost during "down" periods over the same period. Most technical analysis software programs will perform this calculation for you. However, the formula is:

$$RS = \text{Avg. price change on up days} \div \text{Avg. price change on down days}$$

The RS value is then entered into this formula to give you the relative strength index:

$$RSI = 100 - [100 \div (1 + RS)]$$

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*Wayne A. Thorp is assistant financial analyst of AAI. The figures in this article were produced using MetaStock by Equis.*

**FIGURE 1. WALT DISNEY 14-DAY RSI**



The resulting value will range, or oscillate, between zero and 100. As you will see, the RSI spends most of its time fluctuating between 30 and 70, unless strong price movements force the RSI outside of this range.

In Figure 1, you can see the 14-day RSI plotted for Walt Disney Co. When looking at an RSI graph, you should note several items. First of all, horizontal lines at the 30 and 70 levels indicate the predetermined oversold and overbought levels. It is important to note that the vast majority of the movement is *between* the 30 and 70 levels. The crossing of these lines indicates that a security or index may be oversold or overbought. Secondly, there is the RSI line itself, which has experienced a wide range of movement over this three-year period.

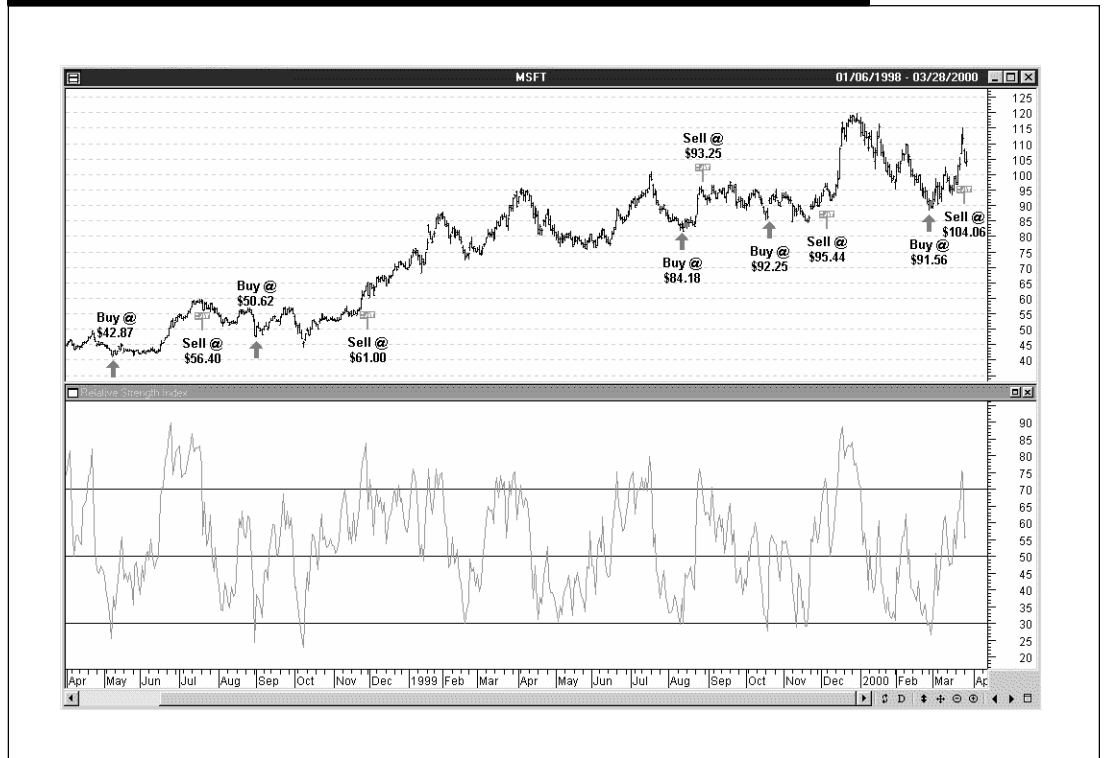
**TOPS AND BOTTOMS**

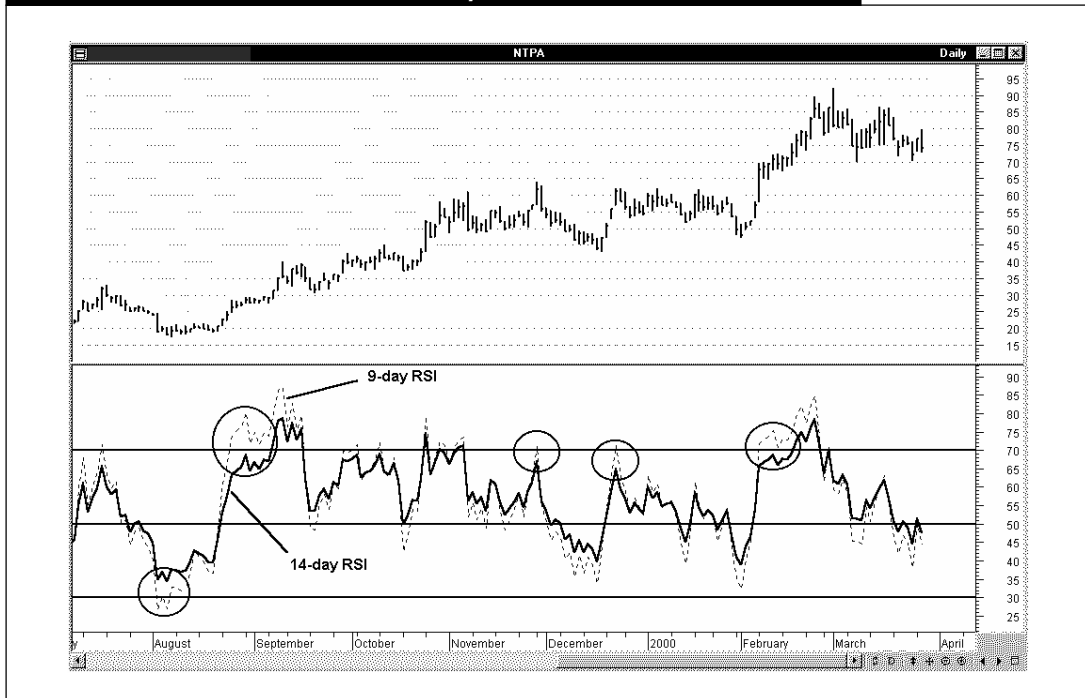
Historically, levels above 70 have been considered overbought—where continued buy interest is overex-

tended—and levels below 30 are oversold, where selling pressure has reached its maximum. Today, 80–20 is becoming more prevalent as regions of overbought and oversold, especially with the increased use of the nine-day RSI. The nine-day RSI tends to be more volatile as compared to RSIs of longer time periods. Furthermore, today's markets are more volatile, which may cause the RSI to exhibit wider fluctuations.

For the sake of continuity, this article will use the 70–30 levels throughout. When the RSI crosses above 70, the possibility of a reversal of the upward trend greatly increases. Likewise, when the RSI crosses

**FIGURE 2. MICROSOFT: TRADING ON RSI CROSSOVER SIGNALS**



**FIGURE 3. NETOPIA PRICE CHART, NINE-DAY RSI & 14-DAY RSI**

below 30, the possibility of the downtrend reversing also increases. Be aware, however, that these levels are by no means fixed. It may be beneficial to view RSI behavior for a security or index over time to gauge where the extremes exist. In doing so, you will find that different securities have varying overbought and oversold levels. Furthermore, just because the RSI enters into these extreme levels, it does not mean you necessarily need to buy or sell, depending on the RSI level. At a minimum, such movements should alert you to the possibility that a trend reversal is imminent.

There are several ways to trade the RSI based on its movement above 70 and below 30. First of all, you could buy when the RSI falls below 30 or sell once it crosses above 70. The main drawback to this approach, however, is that you may be entering into a trade before the trend has run its course. Often, the price will continue to rise even after the RSI crosses above 70, meaning you will miss out on some profits. Furthermore, you may have to carry a loss for an uncertain

amount of time if you buy when the RSI crosses below 30 and the price continues to fall.

You could also sell when the RSI crosses below 70 and buy when it crosses above 30. This also happens to be a popular trading strategy when using the nine-day RSI. Figure 2 illustrates this approach for Microsoft. From March 30, 1998, to March 28, 2000, this system generated five round-trip trades. These five trades returned a 106.5% profit over this two-year period. Be aware, however, that selling when the RSI crosses below 70 and buying when it crosses above 30 will have you entering trades once the uptrend has already begun and exiting after a downtrend has taken form.

Taking a more centrist approach, you can sell when you see the RSI begin to turn downward above 70 and buy when the RSI begins bottoming out below 30. Depending on the trading behavior of a particular security, however, this strategy may also be less than optimal. During strong price trends, the RSI tends to move to the extremes and then may give off false signals that

could have you entering or exiting trades prematurely (as we will see later).

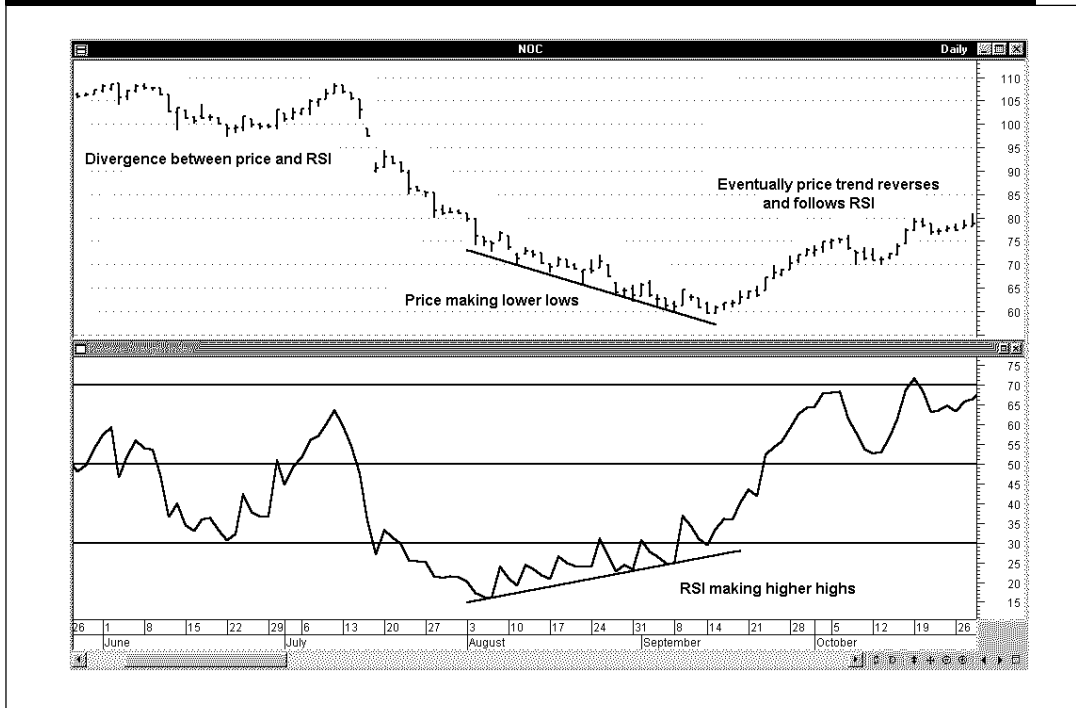
There may be times, however, when there is not sufficient price volatility to move the RSI into these extreme ranges. In this case, you may wish to increase the amplitude (wideness) of the RSI by shortening the time period to the extent that the index moves above 70 or below 30. Shortening the time period increases the sensitivity of the indicator to price

movements, thus increasing its volatility.

Likewise, in a market where there is a lot of volatility, the RSI will tend to make numerous moves outside of these boundaries. Such activity makes the signals that such movement generates less useful. Here it may be necessary to lengthen the time period. Lengthening the time period slows reaction to price changes, thereby making the signals less frequent, and more meaningful.

Figure 3 shows the daily price plots for Netopia as well as two RSI plots—a nine-day and a 14-day. From this chart, you can see that the nine-day RSI is more volatile. There are several times when the 14-day relative strength index does not venture outside of the 70–30 boundaries, while the nine-day does (the circled areas on the chart). Using the nine-day RSI for Netopia, therefore, would yield more buy and sell signals than would the 14-day. By altering the number of periods used in the calculation, you may develop a better sense of what works best, given your particular trading style.

**FIGURE 4. NORTHRUP GRUMMAN: TRADING ON RSI DIVERGENCE SIGNALS**



that negative divergence is taking place.

On the flip side, divergence takes place when prices are making successively lower lows as the RSI, which is below 30, makes a double-top or a series of higher highs. Again this should serve as an alert that prices may begin an upward track.

This is the case in Figure 4, where Northrup Grumman's price is in a steady downward trend while its 14-day RSI is making a series of higher highs below 30. After several weeks of this diver-

**DIVERGENCE**

When you compare the pattern of a price chart and the RSI, you would expect that the two for the most part would move in the same direction. There are times, however, when the RSI and price will move in opposite directions—in other words, the two values diverge. Some of the most powerful signals the RSI will generate are when there is a divergence between the indicator and price. When this occurs, the price eventually will reverse and again “follow” the RSI.

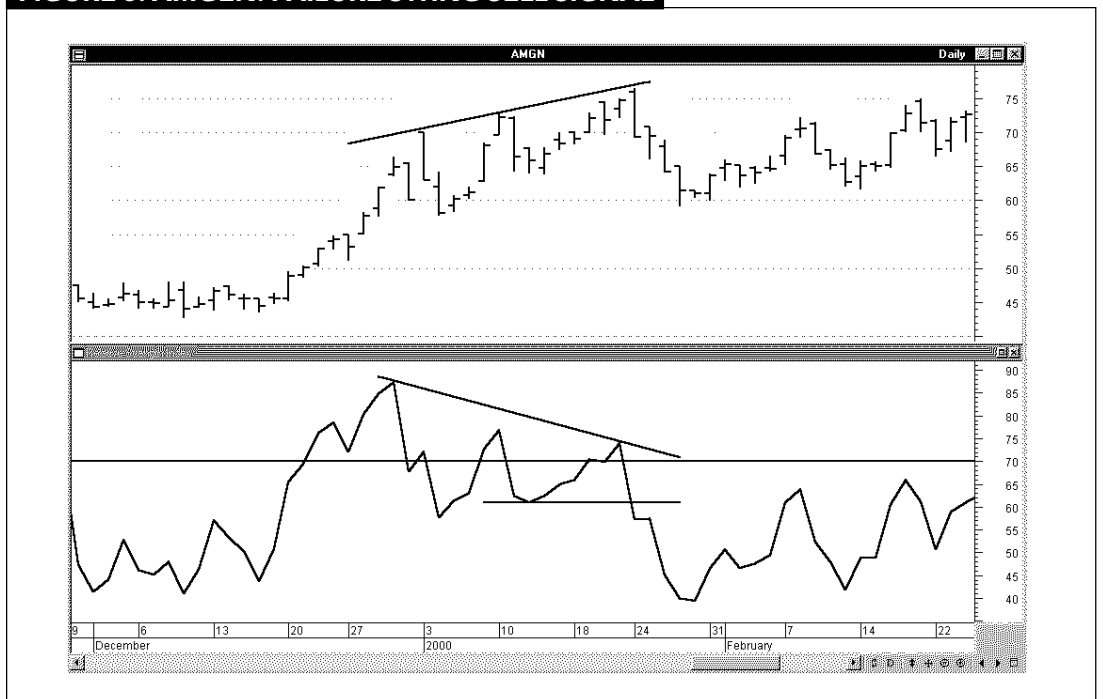
One way in which divergence takes place is when the price hits a new high while the RSI is above 70. After a pullback, the price goes to a new high. However, the RSI—while still above 70—

fails to rise above its prior peak. The creation of a double-top by the RSI (two peaks at roughly the same level) or a series of descending peaks while the price is reaching new highs should serve as a warning

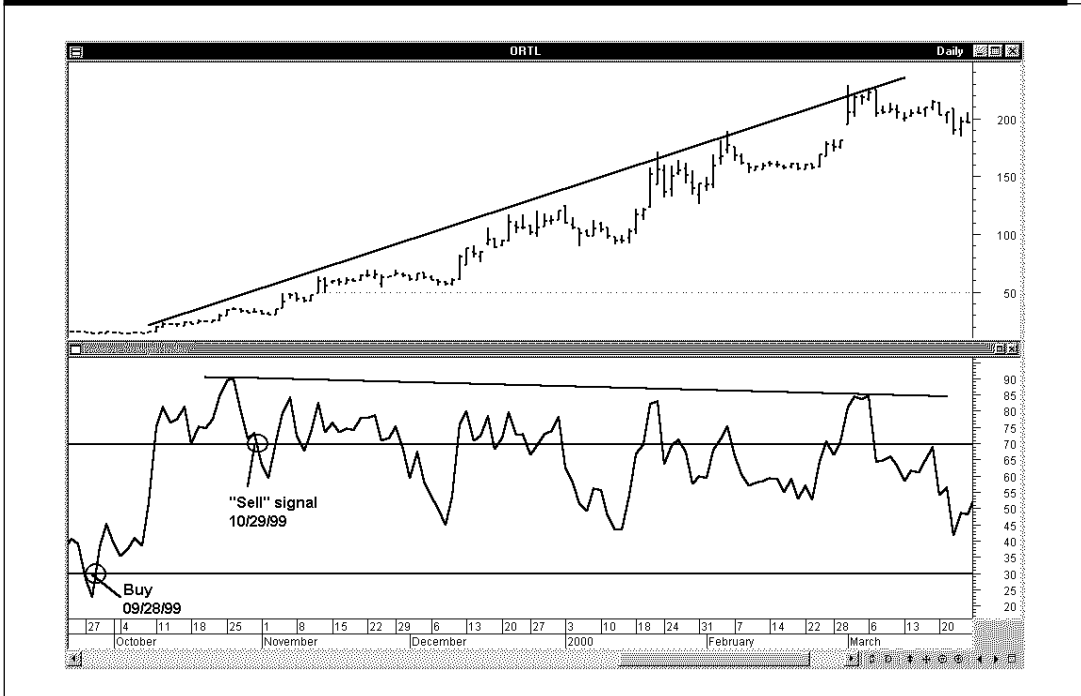
the price reverses in an upward direction.

Often when negative divergence is developing, the confirming signal comes in the form of a “failure swing.” After establishing two peaks

**FIGURE 5. AMGEN: FAILURE SWING SELL SIGNAL**



**FIGURE 6. ORTEL CORP. PRICE & 14-DAY RSI IN SUSTAINED UPTRENDING MARKET**



sell signal. For the next five months the RSI drifted around the 70 level—never generating a buy signal. Meanwhile, Ortel’s price appreciated almost 480% after the sell signal. The most you could take away from the extreme rise in RSI is that the price was probably entering a trending period.

For this reason, the RSI should not be viewed in isolation. Using it in tandem with other indicators such as moving averages may help eliminate such false signals.

above 70 while the price continues to rise, the RSI then falls below the trough formed between these two peaks. When this occurs, a potential sell signal is given—irrespective of the fact that the price may still be rising.

Such is the case in Figure 5. Here we have the daily price plots for Amgen and a nine-day RSI. From the chart, you can see that, over the period January 3, 2000, to January 24, Amgen was in a steady uptrend with three successive higher highs. However, during this same period, the RSI was showing ever lower lows—a distinctive sign of negative divergence. On January 10 and 21, the RSI formed a double-top near 75. After forming the second peak of the double-top, the RSI began to fall and continued down past the level of the trough formed between the two peaks. This failure swing would indicate a signal to sell. Shortly thereafter, Amgen’s price began to fall, from a high of \$76.50 on January 24 to a low of \$59.13 on January 27.

At the bottom, circumstances are reversed. The RSI forms a double

bottom below 30, at which point the RSI goes above the previous peak—generating a buy signal.

**LIMITATIONS**

As is the case with all types of technical indicators, the RSI does have some limitations. Perhaps the greatest handicap it has is that it is not overly useful in *trending* markets. In other words, its usefulness breaks down when prices are in a sustained up- or downtrend. This is because, during persistent trends, the RSI moves to extreme levels and can remain there for weeks or even months, at which point it cannot be looked upon to generate useable signals.

As an example, Figure 6 shows the price and 14-day RSI for Ortel Corporation. On September 28, 1999, the RSI signalled a buy as it rose above 30. For the next couple of weeks, the RSI rose sharply while the price was all but flat. In mid-October, Ortel began to rise, driving the RSI to a peak of almost 90. While the price continued to rise, the RSI fell below 70 on October 29—a

**CONCLUSION**

The Wilder RSI may be helpful in identifying potential reversals in an existing trend, assuming you are in a trading market and are a trader. While the signals it generates for such market behavior may be helpful, it is also clear that the RSI breaks down during strong trends.

Like all technical indicators, the RSI is not intended to be *the* indicator. By using it in conjunction with other indicators, you may be able to develop a system that functions in all types of markets. Web sites that offer the RSI in their charting capabilities include BigCharts ([www.bigcharts.com](http://www.bigcharts.com)) and MetaStock Online ([www.metastock.com](http://www.metastock.com)).

This article has presented several ways in which you can use the RSI as part of a systematic trading approach, but it also serves as an introductory base from which you can begin to formulate your own strategies. Only through time, effort, and trial and error will you find a system that best suits your needs. ♦

# POINT & FIGURE CHARTS REVISITED

By Wayne A. Thorp

In the August 2000 issue of the *AII Journal*, we introduced the seemingly forgotten art of point and figure charting. These charts illustrate the underlying supply and demand for a security while ignoring the passage of time. You can find this article at the AII Web site ([www.aaii.com](http://www.aaii.com)) using the search tool. Member feedback prompts us to offer this supplement to the article, correcting a few mistakes and more explicitly laying out how the sample point and figure chart was plotted.

## CORRECTION

The time period for Figure 1 in the August article is mislabeled. The chart for Cisco is stated as covering the period January 4, 1999, through April 31, 1999. This chart, reproduced here in Figure 1, actually covers the time period January 4, 1999, through May 31, 2000.

The high/low price table in Figure 2 in the August article shows italicized dates corresponding to those dates where a shift in column takes place from X's to O's or O's to X's. June 5 is incorrectly italicized when, instead, June 6 was the date to shift from a column of X's to a column of O's. The explanation below walks you through this shift. One final note on the August article: Figure 6 shows a double-top formation at \$37, which we failed to label.

## POINT & FIGURE STEP-BY-STEP

To walk through the construction of a point and figure chart, look at Figure 2 here. The table on the left shows high and low prices for Cisco for the period May 31, 2000, through June 27, 2000. On the right side is the point and figure chart

constructed using this data, which is a continuation of the chart in Figure 1.

When creating a point and figure chart, it is helpful to determine the "action points" for each day. If a chart is in a column of O's, as was the case at the end of May (the last column in Figure 1), the first action point is the price that is one box lower than the last. If the price falls to this point, we add another O to the existing column. The second action point would be the price at which a three-box reversal occurs. This point is three boxes above the last O. If this point is reached, we would then switch to a new column of X's.

When you are in a column of X's, the first action point is at the price one box above the last X. The point where a three-box reversal takes place is where the price is three boxes below the last X. When this level is reached, we switch to a new column of O's.

In Figure 1, the last box closed in May at 57. Since we are in a column of O's, the first action point is 56, one box below 57. The other action point is 60, which is three boxes above our last box of 57.

Now, let's walk through the plotting of the next several days of data using Figure 2.

**June 1:** Since we ended May in a column of O's, we must first see if the price fell. Look at the low price for the day: 57.875. When plotting point and figure, it is easier to deal in whole numbers, so the high and low prices for a given day are rounded upward or downward depending on whether you are in a column of X's or O's. When you are in a column of O's, you round the low price up to the next whole number, in this case 58. Since 58 is

above our first action point of 56, we do not add another O to our column. We then look at the high price for the day to see if a three-box reversal has taken place. The high of 61.125 must also be rounded, but when dealing with high prices we round down to the next whole number. Comparing 61 to the second action point of 60, we see that a three-box reversal has occurred since the high price is above the second action point. We therefore shift to a new column of X's that begins at 58, one box above the lowest O, and goes up to 61.

**June 2:** Begin by determining the action points. Since on the prior day we recorded X's up to 61, our first action point—where we would add another X—is 62. The other action point, for a three-box reversal, is at 58 (61 - 3). The high for the day is 65.750, which we round down to 65. Since this is higher than the first action point, we stay in the column of X's and record them up to 65.

**June 5:** The action points are 66 (one box above the last X at 65) and 62 (three boxes below 65). The high for the day is 65, so we do not plot another X. The low for the day is 63 (62.438 rounded up), not enough for us to move to a new column of O's. Therefore we make no marks for the day.

**June 6:** Since we did not record anything the prior day, the action points remain at 66 and 62. The high for the day of 63 is below the first action point, so we do not record any additional X's. The low for the day of 62 matches the second action point. Therefore, a three-box reversal has taken place and we shift to a column of O's that begins one box below the highest X in the previous column and continues down to 62.

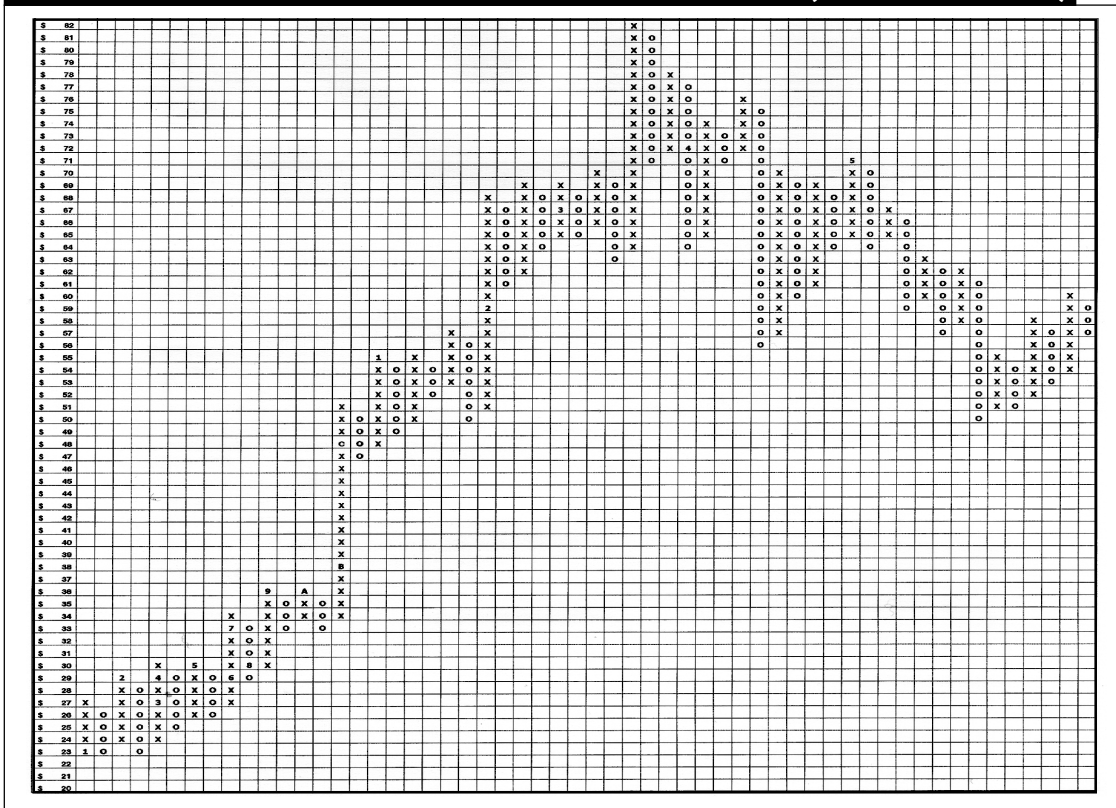
**June 7:** The action points for today are 61 and 65. Looking first at the low of 62, we do not add another O

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Wayne A. Thorp is assistant financial analyst of AAI.



**FIGURE 1. POINT AND FIGURE CHART FOR CISCO SYSTEMS (1/4/99 TO 5/31/00)**



high enough for a new X, but the low of 62 is low enough for a three-box reversal. Our new column of O's begins at 64 (one box below the highest X of the previous column) and goes down to 62.

**June 14:** The new action points are 61 (62 - 1) and 65 (62 + 3). The low for the day of 65 is not low enough to add another O. The high for the day—66—is enough for a three-box reversal, so we shift to a new column of X's that begins at 63 and goes up to 66.

**June 15:** The action points are 67 and 63. The high for the day of 66 is not high enough for another X and the low of 65 is not low enough for a three-box reversal. Nothing is recorded for the

to the column because it is not low enough to record an O at 61. The high for the day of 63 is not high enough for a three-box reversal. Therefore, nothing is recorded for the day.

**June 8:** The action points remain the same—61 and 65. The low for the day is 63, so we do not record any O's. The high for the day is 65, which is high enough to result in a three-box reversal. We therefore move to a new column of X's that begins at 63 (one box above the lowest O of the previous column) and goes up to 65.

**June 9:** The action points for the day are 66 and 62. Looking at the high first (since we are now in a column of X's), we see that it is not high enough to record an X at 66. The low for the day—64—is not at or below the point needed for a three-box reversal, so we make no mark for the day.

**June 12:** The action points are still 66 and 62. The high of 65 is not high enough for a new X, and the

low of 63 is not low enough for a three-box reversal. For the second straight day we record nothing.

**June 13:** Again the action points are 66 and 62. The high of 65 is not

action points are 67 and 63. The high for the day of 66 is not high enough for another X and the low of 65 is not low enough for a three-box reversal. Nothing is recorded for the

**FIGURE 2. CREATING A POINT AND FIGURE CHART**

Date	Price		First Action Point	Second Action Point
	High	Low		
5/31/00	60.250	56.375		
<b>6/1/00</b>	<b>61.125</b>	<b>57.875</b>	56	60
6/2/00	65.750	63.438	62	58
6/5/00	65.063	62.438	66	62
<b>6/6/00</b>	<b>63.813</b>	<b>61.125</b>	66	62
6/7/00	63.500	61.125	61	65
<b>6/8/00</b>	<b>65.000</b>	<b>62.750</b>	61	65
6/9/00	65.000	64.000	66	62
6/12/00	64.750	62.125	66	62
<b>6/13/00</b>	<b>65.000</b>	<b>61.500</b>	66	62
<b>6/14/00</b>	<b>66.500</b>	<b>64.125</b>	61	65
6/15/00	66.625	64.625	67	63
6/16/00	67.938	65.797	67	63
6/19/00	69.250	66.250	68	64
6/20/00	69.563	66.625	70	66
<b>6/21/00</b>	<b>67.750</b>	<b>65.750</b>	70	66
6/22/00	67.125	64.438	65	69
6/23/00	65.938	62.500	64	68
6/26/00	63.625	61.063	62	66
<b>6/27/00</b>	<b>65.250</b>	<b>62.125</b>	61	65

\$69				X		
\$68				X	O	
\$67				X	O	
\$66				X	O	
\$65	X		X	X	O	X
\$64	X	O	X	O	X	O
\$63	X	O	X	O	X	O
\$62	X	O		O		O
\$61	X					
\$60	X					
\$59	X					
\$58	X					

day.

**June 16:** The action points are again 67 and 63. The high is 67, which means we add another X to our column at 67.

**June 19:** The action points are now 68 and 64. The high of 69 means that we again add X's to the column at 68 and 69.

**June 20:** The action points are 70 and 66. The high of 69 is not enough to add another X. The low of 67 is not low enough for a three-box reversal. Nothing is recorded for the day.

**June 21:** The action points remain at 70 and 66. The high for the day

is 67, which is not enough to add another X to the column. The low of 66, however, is enough for a three-box reversal, so we shift to a new column of O's that begins at 68 (one box below the highest X from the previous column) and goes down to 66.

**June 22:** Our action points for the day are 65 and 69. The low for the day of 65 is below our first action point, so we add another O at 65.

**June 23:** The action points for the day are 64 and 68. The low for the day is 63, meaning we add another two O's to the column at 64 and 63.

**June 26:** The action points for the

day are 62 and 66. The low for the day—62—matches our first action point, so we record an O at 62.

**June 27:** The action points for the day are 61 and 65. The low for the day is 63, which means we do not record any O's for the day. The high is 65, which matches the second action point. Therefore, we shift to a new column of X's that begins at 63 and goes up to 65.

If you wish to learn more, you may check out the Dorsey Wright Web site—one of the few point and figure sites around ([www.dorseywright.com](http://www.dorseywright.com)). ♦

## AUGUST ARTICLE CORRECTION

### SOCIAL SECURITY BENEFITS AT AGE 65: DELAY, OR TAKE THE MONEY AND RUN?

The number of years to breakeven in Table 6 in the article on Social Security benefits was incorrect. The article, which appeared in the August 2000 issue, discussed whether individuals were better off taking Social Security benefits starting at age 65 or delaying them to age 70 to receive higher payments via the delayed retirement credit. In the table, the number of years to breakeven should have been added to age 70, rather than to age 65 as it appeared in the article. The corrected table is printed

below.

In the table, breakeven occurs when the total payments from the higher delayed benefits are equal to the total payments that would have been received if Social Security was taken earlier. The assumption in Table 6 is that if benefits begin at age 65, one-third of the monthly benefit will go to income taxes, and the remainder will be invested each month for a term of five years. Thereafter, an amount will be withdrawn from the accumulated fund each month such that, combined with the regular benefit, the total will equal the monthly benefit

that would be received had one delayed benefits to age 70. It assumes annual inflation adjustments of 2.4%. Under this scenario, Table 6 shows that the breakeven age is essentially the same as the breakeven age when the benefit is taken at age 65 and spent (scenario one in the article). The risk of delaying the benefit is the same as the risk all workers faced under prior law by not retiring before age 70. Given that risk, and the probability of reaching the breakeven age, one could argue that delaying the benefit could be a viable option.

**TABLE 6. BREAKEVEN AGES FOR DELAYED RETIREMENT BENEFITS: FIVE-YEAR WITHDRAWALS**

	Net Return on Investments					
	5%	6%	7%	8%	9%	9.29%
Accumulated Fund	\$67,813	\$69,454	\$71,131	\$72,847	\$74,600	\$75,110
Years to Breakeven	10.5	11.4	12.6	14.1	16.1	16.9
Breakeven Age From Age 70	80.5	81.5	82.6	84.1	86.1	86.9
Survival Probability From Age 70	63%	57%	52%	45%	37%	32%

# A LOOK AT MOMENTUM INVESTING: SCREENING FOR STOCKS ON A ROLL

By Wayne A. Thorp

Momentum investors purchase stocks that are rapidly rising in price in the belief that the rising price will attract other investors, who will drive up the price even more. One key is recognizing when the momentum is beginning to fade.

Envision a snowball rolling down a hill: As it rolls along, it picks up more snow, which causes it to move faster, which causes it to pick up even more snow and move even faster.

That's the basic strategy behind momentum investing—purchasing stocks that are rapidly rising in price in the belief that the rising price will attract other investors, who will drive up the price even more.

Richard Driehaus is one of the champions of momentum investing, favoring companies that are exhibiting strong growth in earnings and stock price. He is not a household name, but his firm, Driehaus Capital Management in Chicago, rates as one of the top small- to mid-cap money managers, and his success has landed him a spot on Barron's All-Century Team—a group of 25 fund managers that includes such investment luminaries as Peter Lynch and John Templeton.

This article focuses on Driehaus' momentum strategy, which is discussed in the book "Investment Gurus" by Peter J. Tanous (New York Institute of Finance, \$24.95), and serves as the basis for this article.

## THE MOMENTUM APPROACH

Driehaus emphasizes a disciplined approach that focuses on small- to mid-cap companies with strong, sustained earnings growth that have had "significant" earnings surprises. If a company's earnings are slipping, it is eliminated. Ideally, you would like to see improving earnings growth rates.

Driehaus uses positive earnings surprises as a "catalyst." An earnings surprise takes place when a company announces earnings different from what has been estimated by analysts for that period. When the actual earnings are above the consensus estimates, this is a positive earnings surprise; a negative earnings surprise occurs when announced earnings are below consensus estimates. Another factor is the range of earnings estimates—a surprise for a company with a narrower range of estimates tends to have a greater impact than a surprise for a company whose estimates have a greater dispersion. In general, positive earnings surprises tend to have a positive impact on stock prices.

Another key to momentum investing is to recognize when the momentum is beginning to fade, when sellers begin to outnumber buyers. Thus, investors need to closely monitor the company itself, as well as the market, and it therefore is a strategy that makes sense only for those willing to keep their fingers constantly on the pulse of the stock.

Driehaus cautions investors to be mindful of events such as earnings announcement or warnings and earnings estimate revisions—anything that could either signal the slowing of the upward trend or propel the price even higher. In addition, investors should gauge the direction of both the industry in which the company operates as well as the broader market environment, both of which could affect the individual holdings.

## EARNINGS GROWTH SCREENS

Table 1 presents a list of the companies that passed a screen of filters based on the Driehaus momentum investing approach and applied to AAI's *Stock*

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*Wayne A. Thorp is assistant financial analyst of AAI.*

*Investor Pro* database.

The heart of the Driehaus method is to identify those companies with improving earnings growth rates. To find those stocks that are exhibiting sustained or increasing growth rates in earnings per share, the screen first filters for stocks whose year-to-year earnings growth rate is increasing. The screen examines the growth rates in earnings from continuing operations from year 4 to year 3, year 3 to year 2, year 2 to year 1, and from year 1 to the trailing 12 months, and requires an earnings growth rate increase each period over the rate that preceded it. [The box below shows how these growth rates are calculated.]

Growth over each of the last three years is used for two reasons—first, a longer period would exclude companies not in existence for more than three years; second, it is long enough to see if a pattern of sustained or increased earnings has developed.

Another screen stipulates that, at a minimum, a company has experienced positive earnings growth over the trailing 12 months compared to the earnings in the preceding 12 months. Many of the companies that pass the earnings growth rate screen are not yet profitable—they do not necessarily have positive earnings.

Applying the four earnings growth rate criteria narrows the *Stock Investor* database down to 220 companies (out of 9,269 companies tracked by the program).

Table 1 shows selected earnings growth rates in continuing operations for the companies that ultimately passed all of the criteria: The median growth rates over the last four quarters compared to the preceding four quarters (the 12-month growth rate), from fiscal year 2 to year 1 (the one-year growth rate), and from fiscal year 3 to year 2 are 68.4%, 4.5%, and -21.9%, respectively.

As these numbers show, the growth in earnings over the last four quarters as compared to the previous four quarters has taken off, particularly when compared to the median increase of 8.5% for all the stocks in

the database. Exchange Applications (EXAP) has seen earnings growth of almost 126% during this period. The “laggard” of this group, Microcell Telecommunications (MICT), has seen growth of 9.3%, which is only slightly above the median growth rate for all stocks.

Looking at the prior periods provides some insight into where many of these companies are coming from. Three of the eight companies that passed this screen actually saw earnings fall from fiscal year 2 to fiscal year 1, while all but two had declining earnings from fiscal year 3 to fiscal year 2. However, companies that experience negative earnings growth from period to period, as long as the negatives are getting smaller, do not scare off Driehaus. He terms these time periods the flexion points—where negative earnings are declining, and ultimately shifting to positive earnings figures. For example, Terayon Communication Systems (TERN) saw its earnings fall over 99% from year 3 to year 2, yet it saw positive growth of 0.2% in earnings from year 2 to year 1. This is the kind of turnaround

Driehaus is looking for.

One last point to keep in mind about earnings growth concerns the base earnings level used to calculate earnings growth. For instance, two companies with 100% growth in earnings from year 2 to year 1 would be considered on an equal footing at first glance. However, upon closer examination it turns out that Company A's earnings have gone from \$0.01 to \$0.02, while Company B's earnings have risen from \$0.50 to \$1.00—telling a much different story. Therefore, when you see an extremely high growth rate for a company, you may wish to check where the company started. Growth rates are very helpful in identifying interesting stocks, but you should look at the underlying figures to gauge the true significance of these changes.

## EARNINGS SURPRISES

Once companies with improving historical earnings growth rates have been identified, the next step is to select those most likely to continue the trend. One event Driehaus sug-

### DETERMINING THE GROWTH RATE

#### Earnings per Share (from Continuing Operations) for Intel (INTC)

Quarterly:			Annual:		
Q1	25-Sep-99	\$0.44	Y1	26-Dec-98	\$1.82
Q2	26-Jun-99	\$0.53	Y2	27-Dec-97	\$2.12
Q3	27-Mar-99	\$0.60	Y3	28-Dec-96	\$1.57
Q4	26-Dec-98	\$0.62	Y4	30-Dec-95	\$1.08
Q5	26-Sep-98	\$0.47			
Q6	27-Jun-98	\$0.35			
Q7	28-Mar-98	\$0.39			
Q8	27-Dec-97	\$0.53			

#### 12-Month Growth Rate:

$$\begin{aligned} \text{Formula: } & [(Q1 + Q2 + Q3 + Q4) \div (Q5 + Q6 + Q7 + Q8)] - 1 \\ & [(0.44 + 0.53 + 0.60 + 0.62) \div (0.47 + 0.35 + 0.39 + 0.53)] - 1 \\ & = 0.259 \text{ or } 25.9\% \end{aligned}$$

#### One-Year Growth Rate (Y2 to Y1):

$$\begin{aligned} \text{Formula: } & (Y1 \div Y2) - 1 \\ & (1.82 \div 2.12) - 1 \\ & = -0.142 \text{ or } -14.2\% \end{aligned}$$

gests seeking is a “significant” positive earnings surprise, where the company’s actual announced earnings beat the median consensus analyst estimates. Earnings estimates are based on expectations of the future performance of a company; surprises signal that the market has underestimated the company’s future prospects in its forecast.

Driehaus does not specify what he considers to be a “significant” earnings surprise. Recent studies have shown that analysts tend to be pessimistic when it comes to their quarterly earnings estimates. Therefore, it is more likely that a company will beat its quarterly earnings estimates than fail to meet them. Using data on 498 of the S&P 500 companies from the third quarter of 1999, one analyst estimate service, First Call, found that earnings came in, on average, 3% above analysts’ estimates. On our own *Stock Investor* program with data as of January 28, 2000, the median earnings surprise for the 4,328 companies with earnings surprise data was 2.4%. Therefore, ideally, an earnings surprise screen would take into account this apparent downward bias in analysts’ estimates.

Only 4,328 companies in the *Stock*

*Investor* database have earnings surprises, so simply performing the screen automatically eliminates half of the companies. Requiring the earnings to be at least 5% above the estimates winnows the database down to 1,807 companies, while a 10% minimum requirement narrows the database to 1,340. Not wanting to be too restrictive, yet wanting to choose a level that was “significant,” we chose 10% for use in this screen. Applying this criterion to the list of companies that passed the earnings growth requirements narrows the list to 59 companies.

In Table 1, the median earnings surprise percentage for the companies that passed all of the screens is 26.4%, well above the 2.4% median percentage for the entire database. NetIQ (NTIQ) leads the pack, with an earnings surprise percentage of 300%. NorthEast Optic Network (NOPT) had the lowest earnings surprise percentage, 11.8%.

To provide perspective, the table also provides the announced earnings figure. NetIQ had announced earnings of \$0.08, which was 300% above the median expectation, meaning that the median earnings estimate was \$0.02 per share.

The earnings per share figures for the passing companies also illustrate that most of these companies, although moving up, are not yet profitable—only three of the final eight companies have positive quarterly earnings.

The number of analysts tracking a company is an important factor. Coverage of a company by only one analyst limits the usefulness of an estimate; as the number of analysts covering a company increases, the consensus estimates become more credible. Of course, requiring more analyst coverage reduces the number of stocks with the required estimates; in the *Stock Investor* database, only 2,741 companies have at least three analyst estimates, and only 1,737 firms have at least five. For this screen, we required at least three analysts, which provides a high, a middle, and a low estimate for a given company. Adding this requirement reduced the number of passing companies from 59 to 40 companies.

## MOMENTUM

Like most investors, Driehaus remains invested in a stock until he sees a change in the overall market, in

**TABLE 1. MOMENTUM COMPANIES: FIRMS PASSING ALL SCREENS**

Company (Exchange*: Ticker)	EPS Continuing Grth			Earnings Surprise	Announc'd Qtrly EPS	4-Wk. Price Change	26-Week		Mrkt Cap.	Description
	Last 12 Mos.	Y2 to Y1	Y3 to Y2				Relative Strength Firm	Relative Strength Industry		
Celgene Corp. (M: CELG)	23.5	8.8	1.8	23.8	-0.16	5	354	41	1,258.5	Pharmac'ls & agrochemical
Exchange Applications (M: EXAP)	125.7	73.5	-63.3	20.0	0.06	67	158	64	1,092.4	Customer optimiz'n software
Geoworks Corp. (M: GWRX)	47.1	-2.1	-6.7	27.3	-0.08	96	1,218	30	582.6	Mobile E-commerce & info
Heartport, Inc. (M: HPRT)	65.1	-4.4	-8.5	26.1	-0.17	47	177	3	178.2	Systems for heart surgeries
Microcell Telecom. (M: MICT)	9.3	-20.2	-96.3	26.6	-1.82	25	277	30	2,214.8	Communication servs
NetIQ Corporation (M: NTIQ)	80.2	64.9	17.3	300.0	0.08	17	256	64	1,030.0	Application mgmt software
NorthEast Optic Network (M: NOPT)	71.6	49.6	-35.3	11.8	-0.45	49	151	30	1,513.4	Fiber optic transmission
Terayon Comm. Sys. (M: TERN)	74.7	0.2	-99.2	116.7	0.12	67	163	72	2,293.5	Cable modem systems
<b>Median for passing companies</b>	<b>68.4</b>	<b>4.5</b>	<b>-21.9</b>	<b>26.4</b>	<b>-</b>	<b>48</b>	<b>216</b>	<b>-</b>	<b>1,175.5</b>	
<b>Median for all companies</b>	<b>8.5</b>	<b>5.2</b>	<b>11.4</b>	<b>2.4</b>	<b>-</b>	<b>1</b>	<b>-8</b>	<b>-</b>	<b>109.5</b>	

Source: AAll Stock Investor 3.5 Pro (currently in beta testing), Market Guide, I/B/E/S Data as of 01/28/00

\*M = Nasdaq

the sector, or in the individual company. He has no qualms with buying a stock that has already seen a rapid rise in price if he believes that trend will continue.

Aside from strong, sustained earnings growth and positive earnings surprises, there are several other characteristics that Driehaus looks for to identify stocks that will continue their upward trend. These characteristics primarily concern momentum.

The first momentum screen looks for those companies whose stock price has experienced a positive increase over the last four weeks; the larger the required price increase, the more strict the momentum screen. As a stand-alone criteria, 4,618 companies in the *Stock Investor* database had a positive percentage change in price over the last four weeks. Adding this requirement to our other Driehaus screens winnows the list of passing companies down to 16.

Among all companies that passed the full screen in Table 1, the winner in this category is Geoworks Corporation (GWRX), with a four-week price increase of 96%. This is even more

impressive when compared to the median price increase for all stocks in the database, which is only 1%. At the other end of the scale in the list of passing stocks, Celgene Corp. (CELG) has seen a price increase of only 5%, which is still above the median four-week price change for the entire database. The median for the eight stocks that passed all the criteria is 48%, a definite illustration of the underlying price strength of these companies.

The second momentum screen focuses on relative strength. Relative strength communicates how well a stock has performed compared to some benchmark—usually a market or industry index—over a given time period. A positive relative strength means that the stock or industry outperformed the S&P 500 for the period, while a negative relative strength means it underperformed the S&P 500 for the period.

The relative strength screens here provide two measures—the firm relative to the S&P 500 and the company's industry relative to the S&P 500.

The first relative strength screen seeks companies that over the past 26 weeks have had stock performance better than that of the S&P 500. The 26-week time period allows for patterns to develop for both the industry and the company. Shorter time periods tend to produce false signals, while longer time periods may signal a trend that has already ended. The 26-week period provides a solid middle ground. In the *Stock Investor* database, there are 4,447 companies with a 26-week relative strength that is greater than zero—meaning the price has outperformed the S&P 500 over the last 26 weeks. Applying this criteria to the other Driehaus screens knocks out three companies, bringing the grand total thus far to 13.

In this relative strength screen, Geoworks again leads the way, towering above the market with a relative strength figure of 1,218%. The median for the companies that passed all the criteria is almost 217%, compared to the entire database, which has underperformed the S&P 500 by 8%.

The last relative strength measure

### Definitions of Terms

The following is a short description of the screens and terms used in Table 1.

**EPS Continuing Grth—Last 12 Mos.:** The percentage change in earnings per share from continuing operations between the last four fiscal quarters and the preceding four fiscal quarters.

**EPS Continuing Grth—Y2 to Y1:** The percentage change in earnings per share from continuing operations from fiscal year two to fiscal year one.

**EPS Continuing Grth—Y3 to Y2:** The percentage change in earnings per share from continuing operations from fiscal year three to fiscal year two.

**Earnings Surprise:** The percentage by which announced earnings exceeded or fell short of the median analysts' estimate for the latest fiscal quarter. Positive earnings surprises tend to have a positive impact on stock price.

**Announc'd Qtrly EPS:** The earnings per share figure announced by a company for the latest fiscal quarter, but which has not been filed with the SEC.

**4-Wk. Price Change:** The percentage change in stock price over the last four weeks.

**26-Week Relative Strength—Firm:** The percentage by which the stock price of a company has either outperformed or underperformed the S&P 500 over the last 26 weeks.

**26-Week Relative Strength—Industry:** The median 26-week relative strength figure for all companies in a given industry.

**Mkrt Cap.:** Market capitalization in millions of dollars. Number of common stock shares outstanding times share price. Provides a measure of firm size.

compares the prospective company's industry and how it has performed relative to the S&P 500. Driehaus would rather buy a stock in a strong industry group even if its earnings growth is weaker rather than a stock with stronger earnings growth but in a weak industry. This is because strength or weakness in an industry as a whole can have a strong impact on the performance of an individual company. While this step cannot be automated with *Stock Investor*, the industry relative strength data can be looked up and companies failing to meet the criteria can be manually removed. Applying this process to the other Driehaus criteria eliminated one company whose industry has underperformed the S&P 500 over the last 26 weeks, bringing the number of passing companies down to 12.

For the most part, the companies that passed all of the screens are in very strong industries, with most outperforming the S&P 500 by at least 30% over the last 26 weeks. The communications equipment industry, represented by Terayon Communication Systems, has performed best, outperforming the S&P 500 by 72%. The lone exception is the Medical Equipment & Supplies industry, represented by Heartport, which has outperformed the S&P by only 3%. While this stock has performed very well when compared to the market, its industry's weakness could begin to weigh on its price performance.

## THE UNIVERSE

Richard Driehaus focuses most of his energies on small- to mid-cap stocks. Historically, small-cap stocks have done better than larger stocks, with the trade-off being higher risk and volatility. By focusing on smaller companies with strong earnings growth rates, he hopes to identify the market giants of tomorrow.

There are differing definitions of the market capitalization categories, but for the screen here, we defined small- and mid-size stocks as ranging

from \$50 million to \$3 billion in market capitalization; 4,933 companies in the *Stock Investor* database fit into this range. Adding this requirement to the other Driehaus screens reduces the number of passing companies to nine.

In the list of companies passing all of the criteria, the median market capitalization is \$1.176 billion—10 times larger than the median market cap of the entire database of \$109.5 million. The largest company in the list of passing stocks is Terayon Communication Systems. (TERN), with a market capitalization of \$2.29 billion; the smallest company is Heartport, Inc., weighing in at \$178.2 million.

Driehaus also prefers to deal with domestic firms, so the screen here eliminates American depositary receipt firms (ADRs), which are foreign companies that are traded on U.S. exchanges. Adding this requirement to the prior screens reduces the overall total to eight.

## TRADING VOLUME

One difficulty that can arise when attempting to invest in small-cap stocks is that they may lack liquidity, meaning that they have relatively low daily trading volume. This may not be an overriding concern for a buy-and-hold investor, but fast-paced momentum investors need sufficient volume and float (number of shares freely tradeable) to buy and, more importantly, to sell shares with ease.

Once again, the rules are subjective. A key factor is how many shares will be bought and sold during each trade; the more shares you will be buying and selling, the higher the daily volume that should be required. Buying 1,000 shares of company that typically trades on volume of 10,000 shares a day will most likely be more difficult than buying 100 shares of that same company.

The median daily volume for the 4,933 companies that fall into the

small- and mid-cap category in the *Stock Investor* database is 97,000, while the average is almost 288,000 shares traded. For the entire *Stock Investor* database, the median daily trading volume is 57,000 and the average is 387,000. Our screen uses the percent rank function in *Stock Investor*, which breaks down the entire database in percentiles for a given data field. We required companies to have a daily trading volume that falls in the top 50% of the database. As it turns out, this criterion did not change the number of passing companies.

The final tally of companies passing all of the screens is eight. Not surprisingly, all eight companies operate in businesses that have been performing well recently—telecommunications, biotechnology, and computers. The results of any type of momentum screen will mirror the current sentiment of the market—companies in the “hot” industries will be favored over less popular industries.

## CONCLUSION

The momentum approach to stock selection used by Richard Driehaus identifies companies that have strong-sustained earnings growth, accompanied by earnings announcements that exceed analysts' estimates and upward-moving prices. The approach seeks the “home run” that will provide above-normal returns. The key is to have a system in place that gets you out of a trade with only a minimal loss, while allowing the winners to run until the momentum dies.

By implementing a strategy built on discipline and careful examination of a company, its industry, and the market, momentum may be on your side. However, remember that screening is just a first step. There are qualitative elements to examine that cannot be captured by a computer-generated list. Further fundamental analysis is necessary for successful investing. ♦

# HOW TO TEST AND INTERPRET TRADING SYSTEM PERFORMANCE

By Wayne A. Thorp

Many forces are at work when you trade a system—commissions, slippage, protective stops, idle interest, margin, and short trading can all significantly influence a trading system's performance results.

Pick up any technical analysis trade magazine, and inevitably you will run across companies and practitioners marketing technical analysis trading systems. Like any other type of investment strategy or methodology, a popular way to determine how one system stacks up against another is by comparing annual returns. While these numbers are helpful in separating the winners from the losers, it is important to keep in mind that a multitude of factors impacts the performance of any trading system.

When judging the efficacy of a system's reported performance or the performance of a system you create, keep in mind several issues:

- Are the performance figures based on backtesting or actual trading?
- Is the system optimized and, if so, how does it perform over "hold-out" periods?
- How does it handle income reinvestment?
- Are there any tax implications?
- What are the assumptions inherent to the system itself—commissions, slippage, and money and risk management stops?

This article will walk you through a general discussion of how these elements can impact the financial performance of a trading system.

## ACTUAL TRADING RESULTS?

When confronted with the results of a trading system, your first thought should be: How were these results generated? If a system claims returns of 25% a year, is this based on actual trading or historical backtesting?

Backtesting involves testing a system using a set of historical data. Results based on actual trading have a greater degree of credibility because returns are generated over actual trading conditions *as they happen*. Secondly, results based on backtesting are more easily manipulated to generate the highest possible return (the practice is called optimizing).

## GAUGING PERFORMANCE

However, backtesting using historical data is the most efficient manner to derive system performance statistics. Backtesting is the fastest and most popular way to gauge the *potential* profitability of a trading system. The process of backtesting involves running a system over historical data. The end result is system performance statistics that show how the system *would have* performed had it actually been used over that time period. In order to backtest a system, all you need is the historical database.

Ideally, whenever you backtest a system, you want to use a "significant" amount of data in order to capture as many different market phases as possible. The amount of data you will require depends, in part, on the system you are testing—real-time, tick-by-tick systems require several days or weeks of tick data while end-of-day systems will need at least several years of daily data. The bottom line, however, is that the more data you have, the more complete the picture you can draw from your backtesting results.

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A drawback to historical backtesting is that results are based upon events that have taken place in the past. Therefore, the most you can hope to learn from backtesting is how a system *may* perform. There is no guarantee that what has happened in the past will repeat itself going forward. The usefulness of backtesting lies in its ability to provide insight into how a system may react in various market conditions. Backtesting can often show you if a system works better during trending markets compared to trading (sideways) markets, or vice versa.

You should also keep in mind the period over which a system is backtested. If backtested results cover “odd” periods, this should serve as a red flag for possible manipulation. Companies sometimes only report results for the periods in which the system performed best. If the results are for the period 1992 through 1999, you should ask yourself how the system did during the market downturns of 1991 and 2000. Often, the performance of the system outside the reporting period will have an adverse affect on the overall performance. Ideally, you would like to have system results that cover several market cycles—both good and bad.

A final thought to consider is how a system performed in comparison to a “buy and hold” strategy. The whole idea behind trading a given strategy is to garner greater returns than if you simply bought the stock and held it over the period. If you cannot outperform such a strategy, you need to go back to the drawing board and try again.

## SYSTEM OPTIMIZATION

Optimizing is the process of “fitting” a trading system to a specific set of data. For example, suppose you are using a simple moving average system that generates buy signals when the closing price moves above the moving average and sell signals when the

closing price moves below the moving average line. Optimizing would run the system over the data, testing varying moving average lengths to find the period that netted the largest gain or the smallest loss.

The problem with optimizing is that you are finding the best set of parameters for a fixed period in the past. However, there is no guarantee that the past will repeat itself. While optimizing isn’t necessarily a bad thing, it is easy to fall into the trap of over-optimizing. In the end, you may have a system that performs spectacularly in the optimization period, but falls apart when tested over any other period.

One way to validate or disprove the effectiveness of optimizing is through the use of a “hold-out” period—a set of data over which the system is not optimized. Returning to our earlier example, let us assume you have 20 years of historical data for backtesting. A hold-out technique to follow would be to optimize the system over one half of the data (10 years) to arrive at the optimal moving average period length. From there, you would then test the optimized system over the second half of data. If the results from the two 10-year periods are comparable, you can be more confident that the system will perform in a similar manner over other periods and, most importantly, going forward. If, on the other hand, the results over the last 10 years differ dramatically from the first 10 years, you should begin to question the viability of the system.

## OTHER FACTORS

You should be aware of a few factors that, while today’s software does not take them into account, can affect the overall performance of a trading system.

The receipt or reinvestment of dividends is an issue that is not handled by most technical analysis programs. However, it can have a significant bearing on a system’s performance. If you trade stocks that

pay dividends, the dividend income received will have a positive impact on performance.

Another issue that few, if any, trading system packages explicitly account for is taxes. Depending on your holding period—short-term or long-term—the marginal tax rate on your gains will differ. Those holding an investment for over one year are subject to the long-term capital gains rate of 20%. If you hold an investment for less than a year, gains are viewed as income, which is taxed at your marginal income tax rate. Depending on your income tax bracket, therefore, you would need to generate a higher rate of return to overcome the tax effects as compared to someone holding their investment(s) for more than one year.

## SYSTEM ASSUMPTIONS

When you construct a trading system, the assumptions you make (or fail to make) play a role in how well your system may perform.

These assumptions involve initial equity position, trading on margin, the handling of short trades, commissions, time and price slippage, risk and money management stops, and interest earned on idle balances.

### Initial Equity

The initial equity amount is the amount of money you have in your account before you begin trading. By beginning with a sizable amount of equity, you gain greater flexibility in the form of entering a larger position, which, in turn, can generate larger total dollar gains (or losses).

Typically, by entering with more money, you can stay in the game longer. This is especially true if you plan to short stocks. Short sellers hope to profit from stock price declines by borrowing stock and selling it first, then buying the stock later at a lower price and returning the borrowed shares. When a stock is sold short, your potential loss extends well beyond your initial investment. Depending on who you

ask, you will probably receive different answers regarding the “ideal” equity balance. Ultimately, it is up to you, just be sure you can afford to lose it!

### Short, Long, or Both?

One critical issue involves how to deal with sell orders. When a sell is triggered, you could sell your long position and go to cash, or you can elect to be more aggressive and “double down.” This involves selling your long position and establishing a short position in which you profit if the security decreases in value, but you lose money if the security goes up in value.

### Margin

Margin investing is a delicate topic that investors should understand before attempting. Margin is money you borrow from a broker, similar to a loan, that you then use to buy stocks. You cannot buy all stocks on margin: Those priced below \$5, certain other Nasdaq stocks, and IPOs within a certain period of their introduction are excluded.

Brokers are regulated by the Federal Reserve as to how much credit they can extend to their clients. Currently, you can initially borrow up to 50% of the value of your marginable securities for stocks. For example, assume you have \$10,000 in a margin-approved brokerage account. This means you can purchase up to \$20,000 of marginable securities, with 50% coming from you and 50% from the brokerage. Another way to word it is that you have \$20,000 of “buying power.”

The amount you are able to borrow on margin fluctuates on a daily basis as the prices of the marginable securities rise and fall. If the prices increase, so too does the amount you can borrow. The opposite holds true as well: As prices fall, the value of the marginable securities—your collateral—falls as well. If the value of your margined securities falls below a predetermined minimum level, you will receive a “margin call” from your broker. At

this juncture, you are required to either liquidate part of your existing position or send in more money to bring the value of your account back above the predetermined level; or your broker can sell your securities without calling.

Investing on margin carries with it risks and rewards—it magnifies the effects of gains and losses. Returning to our \$10,000 margin account example, let us assume you buy 1,000 shares of stock priced at \$20. You pay for this transaction by borrowing \$10,000 from your broker and using your \$10,000 from your account. If, in a year, the price rises to \$40 a share, the value of your investment has risen from \$20,000 to \$40,000. If you sell the shares and pay back the \$10,000 you borrowed from your broker (including margin interest—interest charged by the broker for the privilege of using their money), you would have roughly \$30,000 remaining—\$20,000 of which is profit to you.

On the other hand, if you simply use your \$10,000 to buy 500 shares of the \$20 stock, your profit would be roughly \$10,000. In the first example, you would have made \$20,000 on a \$10,000 investment, while in the second you would have made \$10,000 on that same \$10,000 investment.

Just as margin can improve your profit, it can also worsen your losses. If the \$20 stock you initially bought on margin falls to \$15 a share, the investment value falls from \$20,000 to \$15,000. After paying back the \$10,000 you borrowed from the broker, you are left with \$5,000 of your original \$10,000. Without margin, the 500 shares you bought at \$20 would now be worth a total of \$7,500. With margin, you lose \$2,500 more than you would have using only your own money. Be aware, too, that in our examples we did not account for commissions, margin interest, or capital gains taxes, which, as we have discussed, will impact the bottom line.

### Commissions

People tend to forget what a dramatic impact commissions—the fees paid for buying and selling securities through a broker—can have on the overall success of a trading system.

To get a more accurate picture of a system’s profitability, it is important to figure in the commission costs. This is especially important for a system that generates numerous buy and sell signals, which will dramatically lower the profits or increase the losses of a system. Commissions can vary greatly depending on the type of security you are trading and whether you are using a deep-discount broker or a full-service one.

### Slippage

Another element that many traders lose sight of is the fact that you will rarely be able to enter or exit a trade at exactly the same price at which the trading signal was generated. If your system is based on end-of-day data, a buy or sell signal will be generated after the market close. Realistically, your first opportunity to act on the signal is at the open the next day. The difference between the price at which the signal was generated and the price at which your order is actually filled is called slippage. When testing a trading system, it is important to account for slippage; otherwise the trading results are overstated. Some software programs allow you to specify slippage in dollar or percentage terms, while others allow you to build in a time delay between the signal and order execution.

### Stops

Perhaps the most useful tool in developing a trading system is a stop. Compared to commissions and slippage, which are costs associated with a system, stops are more of a system “tweaking” mechanism. Stops are user-defined points where a position is closed out. When a stop is triggered, the position is closed regardless of the current

status of your trading rules. Stops allow you to limit your losses should a trade go against you. The stops you specify in a trading system are similar to stop-loss orders you can place when executing a trade. As the name suggests, a stop-loss order is designed to stop a loss. If you purchase a stock for \$30, you can protect yourself against the possibility of it falling in price by placing a stop-loss sell at \$30. A market order to sell the stock is placed if the stock falls below \$30.

There are several strategies using stops when creating a trading system, the most popular being breakeven, inactivity, maximum loss, profit target, and trailing stops.

**Breakeven stops** close open positions when the closed-out value of the position equals the amount at which the current trade was opened. The stop is placed at the price where the trade could be closed and the proceeds generated would equal the equity value when the trade was opened.

**Inactivity stops** will close an open position when the security's price does not generate a minimum percent or price change within a specified time period. If you specify 1% as the minimum change and 20 as the number of periods, the system would automatically close any long (short) positions where the security's price has not increased (decreased) by at least 1% within any 20-period time frame.

**Maximum loss (max loss) stops** are useful as a risk management strategy, because you can specify the exact percentage or dollar amount of your total equity you wish to risk on a given position. These stops close an open position when the losses resulting from the trade exceed the specified maximum loss amount.

**Profit target stops** exit a trade once it reaches a predetermined profit level. Therefore, if you specify 10% as the profit target, open positions will be closed when they generate a 10% profit (after commissions).

Lastly, **trailing stops** close open

positions when a specified amount of the current open position's profits is lost. Each time a position's profits reach a new high, the trailing stop is moved to a level that allows a specified portion of the position's profits to be lost.

You are also able to specify the number of periods to ignore in trailing stops. For example, if you instruct the system to ignore three periods, the trailing stop will lag by three periods. Therefore, the last three periods' profits or losses will be ignored when determining the current stop level. Such lags are useful in filtering out price swings. However, you need to exercise caution when using trailing stops. They are not designed to limit losses, but to lock in profits.

### Idle Interest

Depending on the type of system you are using, there may be times when you are not in a trade. This means that all long trades have been closed and short trades covered. Ideally, you will be earning some interest on this "idle balance." The interest you might earn is influenced by several factors, including the brokerage firm you use to execute your trades, the cash accounts available, and the size of your account.

### HOW IT WORKS: AN EXAMPLE

Now that you know what to consider when testing a trading system and examining the results in general terms, let's take a look at an example of how these factors can impact the performance of an actual system using historical data. For this article, we used MetaStock 7.0 by Equis International.

Before you can begin testing a system, you obviously need to have a system to test. A trading system can be as simple or as complex as you can imagine—from a moving average crossover system to one consisting of several highly evolved indicators. For our example here, we use a 50-day exponential moving

average (EMA). The exponential, or exponentially weighted, moving average is calculated by taking a percentage of today's closing price and applying it to yesterday's moving average, with greater emphasis placed on the newest price. (To learn about exponential moving averages, refer to the August 1999 *AAll Journal* article, "An Intro to Moving Averages: Popular Technical Indicators" on our web site.)

With our system, buy signals are generated (and short positions covered) when the closing price moves above the 50-day exponential moving average. Likewise, long positions are closed and short positions are entered when the closing price falls below the 50-day exponential moving average. This system may seem overly simplistic, but it illustrates the elements we have been discussing when evaluating, testing, and optimizing a trading system.

To show how the factors such as commission, slippage, and stops can impact the overall performance of a trading system, we must have a benchmark against which to compare their impacts. Therefore, we begin by presenting a system that, in effect, ignores many of these issues.

Using Walt Disney, we ran our initial test over the 20-year period from November 3, 1980, to October 31, 2000. The only assumptions we made for this test are that we handle both long and short trades and that we begin with a non-margin account balance of \$10,000. We do not account for commissions, slippage, stops, or interest on idle balances.

Running this "sterile" system resulted in a net profit of \$20,603.32 over the period. While the system made money, it fell well short of the return netted by a buy-and-hold strategy. If you had bought \$10,000 of Disney stock at the beginning of the period and sold it at the end, you would have earned \$384,480.56! At this point, it is evident that this system needs some improving before it is ready to be traded in the real world.

Next, we apply our assumptions to the system, individually first and then in combination. We begin by testing our system assuming that we borrowed 20% of our equity on margin. Although federal regulations allow you to borrow up to 50%, we recommend this only for experienced traders who are well-versed in the implications of trading on margin. Trading on margin had a slightly negative effect on this system—we netted \$20,461.44, or \$141.88 less than what we would have earned had we not traded on margin. However, if we had followed a buy and hold strategy using margin, we would have earned an extra \$97,000.

Then we tested the system assuming that we pay a \$15 commission for each trade generated by the system—\$15 for each buy and \$15 for each sell. The 807 buy and sell trades the system generated over the 20-year period cost us \$12,105 in commissions. However the true cost was \$14,101.46 since the money spent on commissions can not be spent on trades which may cost us on profitable trades or save us on losing trades. Obviously, depending on the price you pay for transactions and the number of trades you place, the amount you pay in commissions can vary significantly.

Accounting for slippage, we instructed the system to execute trades at the opening price the day after the signal was generated. This adds a greater degree of realism to the system since signals are not generated until after the close of trading for the day. This “delay” in execution had a tremendous impact on the overall performance of the system—a net loss of \$1,604.27, or \$22,207.59 less than the “sterile” system.

In a system such as this, which is fully invested, idle interest is not much of a consideration. In fact, the only interest we earned on our idle balance was during the first 50 days of the system. Since there was no 50-day exponential moving average during this period, we were not in any trades and we earned \$60.

Lastly, we entered in our protective stops for the system. The two we used were a trailing stop and max-loss stop. Our maximum-loss stop closes a trade if it loses 2% of our remaining equity. Therefore, in essence, we are risking 2% of our equity per trade. Remember, however, that because of slippage, we run the risk of losing more than 2% on a given trade. Our trailing stop risks 20% of our profit while ignoring one period to filter out random price swings. Implementing our stops into the system has a significant positive impact—it netted \$102,050.32, \$81,447 more than the sterile system.

Having discussed all of our factors in isolation and showed how they impact the performance of our system, it is time to see how they work in tandem with one another. Our last test combines all of the assumptions we have covered, and the end result stands in stark contrast to the result we first arrived at. In this case, our system exhausted all of the equity in our account, leaving us with a loss—an ending amount of \$9,999.46. Overall, the system generated 502 trades, which cost us \$7,530 in commissions. Furthermore, our idle balance earned \$268.96 over the 3,630 days the system was out of all trades, due in large part to a lack of liquidity to execute trades. Obviously, this system needs some work before it is ready for actual trading!

### USER ACTION REQUIRED

What sometimes gets lost in the

discussion of trading systems is the fact that, although they are mechanical in their generation of buy and sell *signals*, most programs are not capable of executing their orders for you. Therefore, the performance of your system is ultimately contingent on whether you execute each and every trade when you are supposed to. The most difficult thing for many traders is not creating, testing, or optimizing a system, it is actually following it in real-time.

Depending on the type of system you are trading, you may have to devote a significant amount of time to monitoring it and executing trades. Intraday systems, those based on real-time or intraday delayed data, may require your undivided attention through the course of a trading day. End-of-day systems, while not demanding the same attention, require daily examination. Therefore, time is another intangible cost associated with following a systematic trading strategy.

### CONCLUSION

It is clear from our discussion here that many forces are at work when you trade a system. Commissions, slippage, protective stops, idle interest, margin, and short trading all in their unique way influence a trading system's results.

Comparing the results of our initial test where we ignored many of these factors to the results generated when we integrated them shows how important it is take them *all* into consideration when evaluating or testing a trading system. ♦

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# THE MACD: A COMBO OF INDICATORS FOR THE BEST OF BOTH WORLDS

By Wayne A. Thorp

Moving averages are trend-following indicators that don't work well in choppy markets. Oscillators tend to be more responsive to that kind of trading behavior. The moving average convergence/divergence indicator combines those characteristics.

Moving averages are the easiest and most popular technical indicators. But they are trend-following indicators that work best in strong trending periods; in fact, moving average trading systems tend to lose money during periods of choppy trading.

Since markets and individual securities will, at some point, enter a period of sideways or choppy trading where prices move up and down without any sense of direction, you may want to turn to an indicator that is more sensitive and responsive to that kind of trading behavior. Oscillators fit this bill.

Technicians use oscillators in a variety of ways—to determine overbought and oversold conditions, to determine the momentum of a security or index, as well as to identify divergences between price and the indicator.

This article focuses on one indicator that combines the best of both worlds—the trend-following characteristics of moving averages, and oscillator characteristics that help indicate whether a security is overbought or oversold and that help pinpoint potential divergences. The indicator is called moving average convergence/divergence, more commonly known as MACD.

## CALCULATING THE MACD

The MACD is a trend-following momentum indicator developed by Gerald Appel that shows the relationship between two moving averages of price (normally the close). The MACD line is calculated by taking the difference between a longer-period and shorter-period exponential moving average. It is the interaction of these two moving averages that gives the indicator its name. Over time, the two moving averages are constantly converging and diverging. Exponential averages are used because they respond more quickly to changes in price, since more weight is placed on the most recent price compared to the earlier prices. [For a refresher on the calculation and uses of moving averages, see “An Intro to Moving Averages: Popular Technical Indicators” in the August 1999 *AALJ Journal*]. A “signal” or trigger line is also used, which is the nine-period exponential moving average of the MACD line.

Table 1 illustrates the MACD calculation used here. Two items, however, should be noted:

- First, you can use any length of period you wish when calculating the various exponential moving averages, although the 12-, 26-, and nine-period averages are most frequently used.
- Second, a period can be any length you choose—days, weeks, months, etc. In the examples used here, the MACD line is calculated using the 26- and 12-*week* moving averages, while the signal line is a nine-*week* moving average of the MACD.

## INTERPRETATION

To understand how the MACD can be used in trading, you first need to know how it works.

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**TABLE 1. CALCULATING THE MACD, EXPONENTIAL MOVING AVERAGE, AND SIGNAL LINE**

MACD = EMA1 - EMA2

Where:  
 MACD = Moving Average Convergence/Divergence Value  
 EMA1 = Current value of the first exponential moving average (using shorter period)  
 EMA2 = Current value of the second exponential moving average (using longer period)

Exponential Percentage Moving Averages:  
 A weighted moving average calculated by taking a percentage of today's price and applying it to the previous period's moving average. The percentage is determined by the investor:

EMA = (Today's close × Exp %) + [(Previous period EMA) × (1 - Exp %)]

Where:  
 Exp % = The chosen exponential percentage

Signal Line:  
 SL = Previous period MACD + Exp % (MACD - Previous period MACD)

Where:  
 Exp % = The chosen exponential percentage for the signal line

When the indicator is plotted on a chart, including the MACD line and the signal line, the most important aspect is the interaction between the two lines, as well as their positions relative to the equilibrium, or zero, line.

When the MACD is above the zero line, it indicates that the shorter-period moving average is above the longer-period moving average, which in turn indicates that the market is bullish on this security or index. More accurately, current expectations are more bullish than they were previously—demand is increasing.

When the MACD falls below the zero line, the shorter-

period moving average is less than the longer-period moving average, indicating that demand is more bearish than it was in the past.

Figure 1 shows the relationship between the two moving average lines and the MACD for Columbia Energy Group. The top part of the chart contains the weekly price plots for Columbia, as well as a 12- and 26-week exponential moving average. The bottom portion contains the MACD line, the signal line, and the equilibrium, or zero, line. Two things stand out from this chart. First, you can see that as the two moving averages move away from each other, the MACD line rises. Second, you can see that when the two moving averages cross, there is a corresponding crossing of the equilibrium line by the MACD line. The points at which this takes place are shown by the vertical lines on the chart. In the week ending January 22, 1999, the MACD line crossed below the equilibrium line; at the same time, the 12-week exponential moving average crossed below the 26-week average. During the week ending June 4, 1999, the 12-week moving average crossed above the 26-week; at the same time, the MACD line crossed above the equilibrium line.

**FIGURE 1. THE MACD IN RELATION TO ITS MOVING AVERAGES**



**FIGURE 2. BUY AND SELL SIGNALS  
GENERATED BY MACD CROSSOVERS**



## CROSSOVERS

In general, MACD indicators are used in one of three ways—crossovers, overbought/oversold conditions, or divergences.

Crossovers are probably the most popular use of MACDs: a sell signal is generated when the MACD crosses below the signal line, and a buy signal is generated when the MACD crosses above the signal line.

In addition, the locations of these crossovers in relation to the zero line are helpful in determining buy and sell points. Bullish signals are more significant when the crossing of the MACD line over the signal line takes place below the zero line. Confirmation takes place when both lines cross above the zero line.

Using the MACD in this way makes it a lagging indicator. Just like moving averages—which are also lagging indicators—the MACD works best in strong trending markets. Both the MACD and moving averages are intended to keep you on the “right” side of the market (on the long side during

uptrends and on the short side or out of the market altogether during downtrends), meaning you buy and sell late. While you may enter a trade after the beginning of a trend and exit before the trend comes to an end, these indicators are intended to reduce your risk.

Figure 2 shows the buy and sell signals generated for Texas Utilities Company by the crossovers of the MACD line and the signal line. Over the period from June 1997 to August 1999, this system generated five round-trip trades with an average gain of 3.75% per trade. [Note that this system, and all systems used in this article, deal only with long trades.]

The price behavior of Texas Utilities in Figure 2 highlights the strengths and shortcomings of using MACD crossovers in a trading system. First of all, the MACD works very well in strongly trending markets, because it is a trend-following indicator. The first round-trip trade generated a gain of 18.7% over an eight-month period. During this time, Texas Utilities experienced

an almost uninterrupted rise in its stock price, which is indicative of a strong uptrend. However the trades generated in July 1998 and again in June and July 1999 came during a period when Texas Utilities’ price was in a period of “choppy” trading. These three round-trip trades all resulted in losses, illustrating the shortcomings of the MACD in non-trending markets.

## OVERBOUGHT/ OVERSOLD

Another use for the MACD is to determine when a given security or index is either

overbought or oversold. An overbought condition may exist when the price has experienced a significant upward move. At some point you expect that the price might fall and return to some more “normal” level. Likewise, when the price has seen an extended downward movement, an oversold condition may exist. At some point the price may be expected to rise to some normal level.

A security or index may be overbought when you see the MACD rise significantly. During this period, the shorter moving average used in the MACD calculation is rising faster than the longer moving average. This is an indication that the price is overextending itself and, at some point, may reverse its course.

When using the MACD to identify periods when a security or index is overbought or oversold, the best buy signals come when the MACD line and the signal line are below the zero line—the security or index may be oversold. Sell signals are generated when the lines are above the

**FIGURE 3. THE MACD AS AN OVERBOUGHT/OVERSOLD INDICATOR**



indicator when trading on the crossovers, it is more of a leading indicator when it is used to highlight possible overbought or oversold conditions. A leading indicator is useful because it alerts you to what prices *may* do in the future. Leading indicators offer the potential of greater rewards—getting in on the ground floor—while exposing you to greater risk—the possibility of the expected move taking place farther off or never taking place at all. There is the assumption that when a security

zero, where they may indicate an overbought condition.

Unlike other oscillating indicators such as the RSI (relative strength index), there is no pre-determined overbought or oversold condition. High and low MACD

levels are relative, depending on the security or index you are examining. You may need to study the behavior of the MACD over time before you can determine when the price is overbought or oversold. Looking at the MACD behavior over an extended period of time, you may be able to discern patterns where the MACD may rise or fall to relatively similar levels, at which point the price will fall or rise, respectively—and with it the MACD lines. You should also be aware that over-

bought and oversold levels need not be symmetrical for a given security or index (in other words, oversold levels can be higher relative to overbought levels and vice versa).

Although the MACD is a lagging

appears to be oversold, its price will rise; conversely, there is the expectation that a price that is overextended or overbought will fall.

Figure 3 is a 10-year weekly chart for Cascade Natural Gas. Examining

**FIGURE 4. BEARISH DIVERGENCE IN THE MACD**





the behavior of the MACD over this period, you may be able to pick out some recurring patterns in the price and the MACD. The two darker horizontal lines in the MACD window mark the overbought and oversold regions for Cascade. At the top region (overbought) you can see where the stock price frequently experienced a fall shortly after the MACD penetrated this level. At the oversold level, the stock price often saw an increase shortly after this region was reached. Again, it is important to point out that these levels are subjective and will vary from security to security.

## DIVERGENCES

The third popular use of the MACD is to identify those times when it diverges from the security price. A divergence occurs when the trend of a security's or index's price does not agree with that of an indicator. In other words, an indicator trends in one direction while the price goes another, or does not go in the same direction. MACD divergences tend to preface a reversal in the current price trend of the security or index in question.

A bearish divergence occurs when the MACD is making new relative lows even though the price fails to make new lows. An even stronger warning is sounded in this case if the price makes a new relative high (the price peak is higher than the last price peak). This is the case in

Figure 4 for Allegheny Energy. During the period from September 1995 through February 1996, both the price and MACD rose steadily. After that point, however, a divergence developed between the price and the indicator. From February of that year until January of 1997, the MACD made a steady decline while Allegheny's price, for the most part, continued to make higher highs. The fall in the MACD is due to the coming together of the 12-week and 26-week exponential moving averages, which can also be seen in Figure 4. Eventually, the price reversed course and fell back in line with the MACD.

A bullish divergence takes place when the MACD is making new highs even though prices fail to reach new highs. Again, greater importance should be placed if the price makes a new relative low (a price trough is lower than the previous price trough) while this pattern develops. Furthermore, both signals carry greater significance if they occur at relative overbought or oversold levels.

## DAILY VS. WEEKLY

All of the MACD examples here are calculated using *weekly* prices. No matter which indicator you use, signals generated always carry more weight as the time period being used to calculate the indicator increases. Weekly signals are more significant than daily signals, just as monthly

signals carry more weight than weekly signals.

While weekly signals are of greater importance than daily signals, that is not to say you should write-off the usefulness of daily movements.

One technique used by technicians is to track the behavior of the MACD on a daily basis. However, instead of entering or exiting a trade based on a *daily* signal, they refer to the weekly chart to see where the MACD is. For example, if you receive a buy signal from the daily MACD and you see that on the weekly chart the MACD is in a bullish "condition," you may wish to enter a long position. However, if the weekly MACD is in an overbought condition, you will probably want to ignore the buy signal from the daily MACD.

Overall, you can use daily charts to determine entry and/or exit points or to identify early trend warnings; ideally after you refer to a weekly chart.

## TRADING COMPANION

The MACD takes the principle of moving averages and advances it one step further.

This indicator is useful when examining the interaction between two moving averages. In addition, it is helpful in identifying points when the indicator and price diverge.

However you may use it, the MACD could be a useful trading companion. ♦