Trading System Development:

Trading a System of Systems

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Abstract

The purpose of this project was to create three individually working trading systems that comprise one whole portfolio system. The three individual systems constructed for this project include one system based on trading price gaps in the stock market, one based on the pay-to-use service GorillaTrades.com, and one based on the opening range breakout strategy originally developed by Paul Woldt. All three systems were developed using the TradeStation software provided by our advisors. The resulting system of systems showed potential for long term profits and would benefit from further refinement.

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Introduction

Given the recent economic turmoil of past years there are many concerns for financial security. Many individuals are intimidated to invest capital because of the state of the economy. However, letting equity stay stagnant in a bank account is not the only option. People can grow their capital at a much greater rate than the miniscule interest rates of common banks. Using a well-structured trading system to move any stagnant capital into a system will encourage growth at a steady rate.

The purpose of this project was to develop a trading system that will consistently return profits on invested capital at a greater rate than a common interest rate. Using what we learned in Professor Radzicki and Professor Hakim's lectures we created a system of systems. These three systems are comprised of a Gap Trading System, Gorilla Swing System, and Paul Woldt's Opening Range System. Our strategies attempt to minimize losses by minimizing exposure to the market. By using three different systems we add additional security by diversifying our investment portfolio. If one system were to fail we would suffer minimal losses as the majority of our investment will be allocated in the other two systems.

This paper talks about our scientific process to obtain a working system of systems.

Background

The Different Asset Classes

Stocks

A stock in essence is a share of ownership in the company. As an owner of stock in a company, the investor has part in the company's equities and assets. Depending upon the growth or decline of the company the shareholders' investments may be worth more or less. They have the right to sell their shares to other investors who want part ownership in the company. This broad definition splits into two different types of stock, common and preferred. Common stock allows the owner to have a vote in the shareholders meetings and preferred stock does not allow voting rights. Preferred stock, however, has higher claims on assets and earnings than common stock. Stocks utilize exchanges all over the world where they can be bought and sold. This is the type of asset we chose to trade with our system. Specific reasons for this are explained later in the paper.

Bonds

Bonds are a type of debt security and work much like loans, but can easily be traded, making them more useful to those who need to be able to transfer debt easily. In essence, a bond is an agreement on a series of cash flows between two parties. There many ways in which the cash flows can be structured, but there are a few factors common among most bonds. A typical bond has some specified "par" or "face" value that it will reach once it has matured, which occurs after some specified time (also known as "time to maturity"). Like loans, bonds are subject to interest, which can be accumulated or be distributed periodically in the form of "coupons". When a bond pays out coupons, the amount of the coupon is determined by the par value and a specified "coupon rate". Finally, whoever buys the bond expects some sort of return on their investment, which is determined by the bond's yield rate. All of these factors along with the price of the bond and can be manipulated to customize the cash flows involved, making bonds very versatile assets.

While the previously mentioned typical bond elements are specified by the bond's contract, there is more involved in determining a bond's market value. As with any loan, there is always a risk that the party that issued the bond will not be able to make the payments. This risk and inflation are two more driving forces that affect what investors will

be willing to pay for bonds, making bonds susceptible to speculation and, therefore, interesting to traders.

Since bonds are so easily customized, bond issuers sell several different bonds with varying yield rates, maturity times, etc. This creates incredible variety within the market as a whole. With all of the volume in the bond market being spread across so many different assets, most bonds are scarcely traded (if at all). Such low volume has two major effects on bond trading, the first being the low liquidity of the bonds, which can make it take a long time for a seller to find a buyer and vice versa. Secondly, market values for bonds tend to move slowly. For these reasons, the bond market is not a popular choice for active traders.

Bonds were explored as an option to trade in our system of systems but were ultimately passed over for stocks due to their low liquidity.

Currency Pairs

While many trades in the world involve the exchange of some item (or items) for money or for another item of equal value, currency trading is basically exchanging money for money. Of course, that is an overly simplified way to describe it. More precisely, it is the exchange of some amount of one form of currency for an equally valued amount of another currency, as determined by foreign exchange rates. Since these rates are constantly fluctuating, currency traders can profit by exchanging some form of currency for one that they anticipate will rise in value relative to the one they traded for it.

The relationships between the values of different currencies are represented by currency pairs. A number is calculated for each currency pair, dictating the current relative value or price of one currency, called the "quote currency", in terms another, called the "base currency". The pairs are notated such that the base currency is on the left: "USD/EUR" represents the currency pair in which the US dollar is the base currency and the euro is the quote currency. The basic idea is that the quoted value for a currency pair is how many units of the quote currency it would cost to purchase one unit of the base currency. For example, a quote of 2 for USD/EUR indicates you would have to pay 2 euros in order to receive 1 dollar. Similarly, the quote for EUR/USD would be .5, meaning it would cost half of a dollar to purchase 1 euro.

Speculative trading in the currency market is not so different from speculative trading in the stock market. When purchasing a currency pair (taking a long position), the

trader is speculating that the base currency will increase in value relative to the quote currency, meaning an increase in the quoted value for the pair. Similarly, the trader would sell a pair (take a short position) if they anticipate a decrease in value. Although there are not as many different currency pairs as there are different stocks to trade, the same, broad spectrum of price behavior can be seen: some currencies are highly volatile while others are very stable, some newer currencies have high reward potential but at high risk, and some currencies have strong correlations with others. The major difference between a stock trader and a currency trader is that the currency trader is usually more concerned with macroeconomics while stock traders are usually more concerned with microeconomics.

Currency pairs were ruled out of our trading system because of the lack of variety compared to stocks.

Commodities

The type of asset that has been traded for probably the longest time is the commodity. Even in the earliest civilizations, people would cultivate certain goods and trade them in exchange for items or services. While the ancient civilizations did not trade on the same scale that we do today, farmers often grew large amounts of certain crops and trade what they didn't need to keep for themselves. Since then, commodity trading has continually developed and expanded.

In terms of financial instruments, commodities are generally raw materials or goods. While this is a loose definition, the essential distinction between commodities that are traded as financial instruments and other products is that such commodities are generally invariant in quality. For example, copper from one source is basically the same as copper from any other source, but the quality of the electronics made using copper and other materials are far more dependent on the manufacturer. However, there still are many goods that can vary in quality, particularly perishable goods that may spoil, which is why those that are traded through a commodity exchange must meet minimum standards known as a basis grade.

While commodities were originally traded to people who intended to physically use the goods, they are now often traded to people who simply make speculations on their prices and later resell them. The person purchasing the commodity never has to actually receive the physical items. Moreover, commodities are frequently traded using market

derivatives, such as futures contracts and options, which can be traded without any physical or hypothetical exchange of goods. These will be described in the next section.

There are a variety of commodities traded in the market with various price behaviors, not so different from what is seen in the stock market. While the stock market has more overall trading volume, certain commodities are traded just as much as popular stocks. A unique trait of commodities, however, is that certain events have direct impacts on particular commodities, such as natural disasters destroying farmlands. Furthermore, there are many commodities that are very highly correlated with others, such as soybeans and soybean oil. These characteristics of commodities add an extra element of predictability that stocks don't have seeing as how the market has proven time and again to move counter intuitively.

The commodities market was ruled out of our system of systems for lack of diversity in comparison to the stock market.

Market Derivatives

Forward Contracts and Futures Contracts

A forward contract is a contractual agreement to exchange an asset at a future date. When writing the contract, the involved parties agree upon the type of asset or commodity, the quantity to be exchanged, the strike price (the price that will be paid), and the logistics of the transaction (e.g. date, time, location). This allows investors to lock in a specific price on an asset or commodity that they wish to purchase in the future, protecting them against the risk that the price will rise before the transaction. This is particularly useful for businesses that require certain commodities as materials for production because it gives them solid numbers to use when accounting for their costs and also protects them against the risk that a catastrophic event causes the prices of the particular commodity to soar.

Futures contracts are essentially forward contracts that can be traded like stocks on an exchange. Since they are traded through exchanges, they are standardized and have specified delivery trades, locations, and procedures. While forward contracts are settled at the expiration of the contract (date and time of transaction), futures contracts are settled daily. This means the value of the contracts are continually recalculated and a price change means a loss for one party and a gain for the other at the end of the day. The determination

of which party owes which and how much is owed is called marking-to-market. As a result of the daily settlement, futures contracts are liquid, meaning an investor may enter or exit a position in a futures contract easily (at least in comparison to forward contracts).

Additionally, both buyers and sellers of futures contracts are required to post a performance bond with the broker to guarantee they will be able to cover a specified loss on a position. This deposit is known as the margin, and it accrues interest over the duration of the contract. When marking-to-market, the losses can either be paid directly or be taken out of the margin balance. If the balance drops below a certain level, the broker makes a margin call, requiring additional deposits into the balance. These practices protect the involved parties against credit risk (risk that the other party will fail to fulfill their obligation in the contract).

Forward and futures contracts were ruled out of our portfolio because the pricing of these assets is more complicated than with stocks, and we wanted to keep things simple.

Options

While forward and futures contracts require a transaction to take place at expiration, there are other types of contracts in which one party may choose not to go ahead with the transaction. These are known as options because the party that purchases the contract is given the *option* to either exercise the contract (complete the transaction) or simply allow the contract to expire without ever making an exchange. If the buyer chooses to exercise the option, the seller is obligated to make the transaction. Purchasing an option allows the buyer to put a limit on their potential losses at the cost of some of their potential profits.

There are two fundamental types of options: puts and calls. When purchasing a put, the buyer is given the option to sell the underlying asset at a future date. Similarly, purchasing a call gives the buyer the option to purchase the underlying asset. As with forward and futures contracts, the strike price (also known as exercise price) is determined when writing the contract along with the quantity and other logistics. However, some options can be exercised before the expiration of the contract. European-style options can only be exercised at expiration, American-style options can be exercised at any time during the life of the contract, and Bermudan-style options can only be exercised during certain specified time periods.

The use of options allows investors to share risk easily, making options very useful for hedging tactics. Purchasing an option is essentially paying a premium (cost of the option) in exchange for a share of the risk involved in the underlying asset. In fact, one investor may take on some risk by selling one option, and then offset that risk by purchasing another. By purchasing and/or selling multiple different options, investors are able to cater their potential profits and losses to exactly what they need. Options involving higher-risk assets require higher premiums.

Options, even more than forwards and futures, involve complications that stocks do not, so we chose to avoid the options market as well.

Investment Funds

Exchange Traded Funds

Exchange traded funds (ETFs) are securities whose prices follow an index, a commodity, or a basket of assets. What makes them unique is that they can be freely traded like a stock on an exchange. In practice, trading an ETF is no different from trading stocks, but due to the diversification of the funds, they are generally less volatile than the individual assets within the funds.

Mutual Funds

Mutual funds are collections of funds received from several investors that are pooled together and invested into various different assets and securities. All of the gains and losses by such a fund are “mutually” shared by each stakeholder proportionately, hence the name. They are operated by money managers, who invest the fund's capital. The detailed investment objectives for each fund are outlined in its prospectus. The managers of the fund structure the portfolio such that it matches these objectives. Shares of funds generally can be purchased or sold at the fund’s current net asset value. Typically, having a professionally managed, diversified portfolio requires substantial capital, but mutual funds can provide the same benefits to small investors.

Sources of Data (Exchanges and Indexes)

Dow Jones Industrial Average

The Dow Jones Industrial Average (DJIA) is an index created on May 26, 1896 by Wall Street Journal editor Charles Dow. Dow was born on a farm in Connecticut on November 6th, 1851. As soon as he was old enough he wanted to leave the rural life and become a journalist. At the age of 21 he left his farm and became a reporter, interviewing many capitalists, industrialists, and financiers, his interest in the business sector grew quickly. In 1882 Dow started a company with fellow reporter Edward Jones called Dow, Jones and Company. Each day Dow would write about financial news and movements of certain stocks. He wanted to provide a market average to show readers if the market was advancing or retreating. The average was developed by using the averages of the top 12 stocks in the market, and just like that the Dow Jones Industrial Average was born.

Currently the DJIA is made up of 30 major American companies and is a scaled moving average. Along with the Nasdaq Composite and the S&P 500, the Dow is among one of the most closely watched U.S. benchmark indices tracking market activity. Comparing stocks to the Dow average will show you if a company is doing well in terms of market activity or if the company is doing poorly in terms of market activity. The DJIA will also show how the market is trending. A bullish trend would be a market that is headed in the positive direction and shows that investors have optimism and confidence in current economic situations. A bearish market is characterized by low investor confidence and market securities falling. The Dow can provide the investor with a sense of how the market is performing and whether or not to invest.

NYSE

The New York Stock Exchange is an exchange based in New York City and is considered one of the largest equities based exchanges in the world. In the very beginning the NYSE comprised of 5 traded securities in New York City, including the Bank of New York. In 1817 the first constitution was born and it was named the New York Stock Exchange Board. "A Governing Committee reigned over the NYSE until 1938, when the exchange hired its first paid president and created a 33-member board of governors. Incorporated in 1971 as a not-for-profit corporation, the members voted to replace the

board of governors with a 25-member board of directors the next year. The board included 12 representatives, a chairman, and a CEO representing public interest, and 12 representatives from the securities industry." (BusinessNewsDaily). Often referred to as "The Big Board", the NYSE became a public entity in 2005 after the addition of electronic trading exchange Archipelago.

For many years the NYSE relied on the open outcry system (the trading pit), focusing on floor trading. In modern day trading at the NYSE, more than half of the trades made are made electronically although there are still floor traders that set prices on the different securities. For a company to be listed as an NYSE stock, there are many financial requirements. These requirements include having more than 2,200 shareholders with an average daily trading volume of at least 100,000 shares. The company also needs to have a total capitalization of $750 million or pretax earnings that total more than $10 million. In short, in order to be considered for the NYSE, the company needs to be large and quite profitable along with a profitable history.

NASDAQ

The NASDAQ was invented in 1971 to provide Americans a way to trade stocks over a speedy computer based network. The acronym originally stood for National Association of Securities Dealers Automated Quotations. This exchange was created because of the burdens of in-person trading, referring to the open outcry system of the NYSE at the time. It was made an alternative to the outcry system and cuts out the delay and inefficiency of in-person pit trading. Because the exchange is electronic it offers no physical trading floor. Brokers buy and sell stocks through a market and do not go through individual people. Although the NYSE is the largest exchange in the world, the NASDAQ has the highest trade volume in the world with approximately 1.8 billion trades per day.

The NASDAQ is currently comprised of around 3,200 publicly traded companies. These companies are from all different sectors such as financial, technology, healthcare, public utilities, and many more. However, this exchange is known primarily for its high tech stocks. The listing fees for a company in the NASDAQ is set at $150,000 allowing for smaller high growth stocks that are more volatile than other exchanges. To be listed in the NASDAQ exchange a company must meet certain financial criteria. "They must maintain a stock price of at least $1, and the value of outstanding stocks must total at least $1.1

million." (DailyBusinessNews) For small companies that cannot maintain these criteria the NASDAQ offers a small caps market.

Standard & Poor 500 Index

The S&P 500 is one of the most watched indices along with the Dow and the NASDAQ Composite. This index is made up of 500 stocks that are chosen because of their liquidity, size, and industry along with many other important factors. This index is made to reflect how the large cap U.S. equities are performing and show the characteristics of a large cap market. Most experts say that the S&P is a better reflection of how the market is performing than the Dow; some reference it as the sole definition of the market.

The S&P was first introduced as an index in 1923 as the S&P 90, as it only contained 90 stocks at the time. The index was introduced as value weighted on these first 90 stocks. The modern day index is made up of 500 stocks that are a mix of technology, industrial, value, and volatile. A committee is in charge of selecting any new companies that come into question of addition. The committee bases their decision to add these stocks on specific criteria. These various criteria include liquidity, market cap, volatility, and length of public trading. If the new company passes all these tests and is approved by the committee than it is added to the index.

Many ETF's and mutual funds try to mirror the S&P 500 index by buying the same stocks at the same volume. This allows investors to essentially buy and sell something very similar to the index that can be bought and sold intraday (within the day). Other ETF's offer funds that mirror the S&P up to two and three times leverage, meaning the fund will move two or three times as much as the index. This creates seemingly more risk if the market is less predictable and volatile but also an opportunity for more reward if it can be predicted.

Hang Seng Index

The Hang Seng Index is very similar to the S&P 500 except the stocks that comprise the index are traded on the Hong Kong Exchange. This index is widely noted as the benchmark for the economy of Hong Kong and is often referred to as such. This market capitalization-weighted index is based on 40 large stocks from the Hong Kong Exchange. The Hang Seng originated in 1969 and is maintained by a subsidiary of Hang Seng Bank. It covers a total of approximately 65% of the Hong Kong Exchange's market cap.

Nikkei 225 Index

The Nikkei index is short for Japan's Nikkei 225 Stock Average. This index is the leading benchmark for all Japanese traded stocks. It can be viewed as the behavior for the Japanese economy because the two often mirror each other. It is very similar to the S&P 500 of the U.S. and the Hang Seng of Hong Kong as all of these are viewed for the behavior of the market for each nation. The Nikkei is made up of 225 blue chip companies that are traded on the Tokyo Stock Exchange. The index has been calculated since 1950 and is based on criteria similar to the Hang Seng index.

The Hang Seng Index as was as the Nikkei were not used in our portfolio due to the fact that we wanted to focus on American markets.

Order Types

Market Orders

A market order is the simplest and most common order type. It is an order made through a broker to buy or sell the stock immediately, at the best available price. This gives market orders some distinct advantages. The nature of the order guarantees that it will be filled, which allows traders to be confident their purchases will go through. This reliability is useful when a trader needs to buy or sell quickly, and other factors are secondary.

These other factors, however, can be detrimental if market orders are used exclusively. Although the trader will have their order filled, it will be filled at the current buying or selling price, which may have changed from when the trader first saw the price. This can create imprecise trades, and lead to considerable slippage, which is when the price of an asset changes between the time an order is place and when it is filled. Because of this, market orders are not effective in markets that have high volatility or low liquidity, where prices can change wildly over short times.

Because of their popularity, market orders are often the default order type on many electronic brokers, including TradeStation.

Limit Orders

Unlike market orders, limit orders are not filled immediately. Instead, they instruct the broker to wait for the stock to reach a specified price, or better, before buying or

selling. This allows for more precise trades. This type of order is especially suited for attempting to improve market prices or to capitalize on pullbacks in price, since they try to force the market to meet their demands before they enter it.

Limit orders have some downsides, however. If a trader cannot find anyone to meet their price, this leaves them outside the market indefinitely. This can prevent traders from ever entering the market if their demands are unreasonable. Additionally, limit orders lose their effectiveness in liquid markets, where their limits can be undercut by a flood of cheaper orders. Limit orders are also slow; their precision requires them to wait before buying or selling, which can be risky in a volatile market.

Overall, limit orders are best suited to markets with a lower amount of shares that will be able to meet their requirements, and will not change so rapidly that the trader needs to constantly adjust their buy and sell prices.

Stop Orders

Stop orders are different from the previous order types in that they do not actually buy shares at market. They function as a type of trigger; once a certain price level has been reached (called the "stop level"), the order is converted into a market or limit order, which is specified before, and placed into the market. This gives two types of stop orders based on what it is converted into: stop-market orders and stop-limit orders.

Stop levels are opposites of limit orders; buy orders are placed above the markets level, and sell orders are placed below the market. Once this level has been reached, the stop order sends out the corresponding order to the market, and then the purchase functions as a market or limit order. This system allows traders to have confidence in their orders. If their trigger is met, it gives a trader an understanding of the trend of the market, and allows them to plan future purchases accordingly.

Stop orders are also major components in creating risk-management systems. By placing stop orders with sell prices below the price the trader purchased the stock, or above it in the case of short positions, it allows them to quickly exit the market in the case of a price drop, preventing any significant losses. This method, known as a stop-loss order, is a common exit strategy in many trading systems.

Trading Platforms

TradeStation

TradeStation is an online brokerage service that provides several tools for computer trading. It is designed for use with a variety of markets, and contains a set of general tools for analyzing them. These tools include a basic ordering interface for trading markets, a series of charts for different parameters (e.g. market price, volume, volatility), and scanners to search markets by these same parameters.

The software also includes tools for automated trading. The most important of these is the ability to create a strategy and apply it to a market, allowing a trader to trade according to well-defined rules. Strategies are created as scripts in EasyLanguage, a simple programming language exclusively used by TradeStation. These scripts can set various constraints, including time of day, comparison to a previous value (such as the floor and ceiling in an opening range strategy), and parameters for exit strategies. EasyLanguage may also be used to create indicators, which then can be run on a market like a strategy.

TradeStation was the primary platform used for the development of all the strategies discussed in this paper, and its application is described in greater detail in later sections.

MetaTrader

MetaTrader is an online trading platform that was developed specifically for foreign exchange (forex) trading. Like TradeStation, it provides traders with both an interface for placing orders, as well as a series of tools for analyzing markets.

Automated trading in MetaTrader is based on scripting rules and values for a strategy, and applying that to the forex market as a whole. MetaTrader's language is a modified version of the C programming language, which allows for MetaTrader to create more complex strategies than other platforms. It also allows C programs to interface with MetaTrader to create custom tools for viewing the forex market.

MetaTrader was considered as a platform for our system of systems, however, its focus on forex trading made it too difficult to implement a stock trading system.

Theories

CANSLIM

CANSLIM is a list of criteria that can be used to scan markets for potential stocks or businesses to invest in. It analyzes both qualitative and quantitative qualities of a business to determine its current health and potential for growth. The strategy can be verified by observations of successful businesses; many companies that experienced a large outbreak and a massive increase in stock price were found to match the CANSLIM criteria when they were smaller. As a result, these criteria have become a popular tool for weeding out potential markets to apply a formal strategy to.

CANSLIM is an acronym that details the seven qualities of a company it looks at. In order, these qualities are Current earnings, Annual earnings, new products or services, Supply and demand, Leader or Laggard, Institutional sponsorship, and Market direction.

Current earnings studies the earnings per share (EPS) of a company in a given quarter, which should be larger than their EPS for that same quarter of the previous year. The amount of growth should be substantial; a general rule is to check for at least 18-20% growth, although truly prodigious companies can have growth upwards of 50%.

Annual earnings, like current earnings, look at the EPS growth of a company. Here, it is used to determine if the company has grown over the year for the past five years. The general range is somewhat higher than it is for current earnings. For a company to pass these criteria, it should have an annual earnings growth somewhere in the range of 25-50%.

New products or services are a vaguer trait. Essentially, a good company should be expected to have either created or acquired a new item within recent history. This can be anything from a new marketing team to a buyout of another company to a new high stock price. Passing this criteria shows that a company is expanding and improving itself.

Supply and demand refers to the volume of shares being traded for a particular company. Smaller companies require less stock to be bought or sold to show gains compared to a larger one, and those with fewer stocks in the market generally have more impressive gains. This allows investors to trade a company without the risk of moving the price unfavorably.

Leader, or laggard, separates the market into two camps. The leaders are those in the industry that dominate the markets, providing the best gains to investors. The laggards are the groups that have mediocre returns on their stocks. The two are usually separated using the relative price strength of a stock, which ranks the stock on a scale of 1 to 99, with the numbers corresponding to what percent of stocks they outperform. For the purposes of CANSLIM, it is best to find stocks with a strength of at least 70 with 80-90 being preferred.

Institutional sponsorship requires looking at who else has invested into a company. If no big-name investors have looked into the stock, it generally means they have all viewed it as a poor investment, which means it is wise to follow suit. However, if too many institutions already have their hands in it, it may mean the company is over-owned, and the slightest shock could trigger a mass sell-off. It is advisable to find some medium between these two extremes.

Market direction simply refers to the trend of the market the company is in. It is important to see whether the market is bullish or bearish, and to plan any stock purchases around this trend.

Opening Range

The opening range is a powerful tool for predicting trends in a stock or market's price. The actual concept of the opening range is very simple: it is the stock's high and low price for the first N minutes of the trading day. Generally, N is 30 minutes, but it can be as low as 5 minutes depending on how the strategy is applied. This time frame captures the market at its most severe; the market here is most severe as a result of overnight trades all being handled very rapidly, creating rapid price changes over a short period of time. Investors are also making decisions based on their analysis of the previous day's performance and any overnight news they have found. This leads to emotionally charged decisions that indicate the world's general outlook for the day.

Looking at the opening range allows a trader to infer a great many things about the market. First of all, it can be used as a barometer of the stock's bias, or trend, for the day. For example, if the market is trending bullish during the 30-minute opening range, it can be expected to continue trending in the same direction for the rest of the trading day. The opening range also has the benefit of defining a floor and ceiling for the stock's price range. A smart investor can use this information to determine breakout points for the stocks. If a stock's price goes over towards the high of the opening range, it can be expected to keep

going up for some time, creating a good opportunity for a long trade. If the price dips under the low of the opening range, it is predicted to return to equilibrium after some time, which makes it a good time to short-sell. Using this information allows a trader to make a series of low-risk trades using solely the data from the opening range.

The opening range is an effective and incredibly versatile tool for developing trade systems. In his book "Trading the 10 O'Clock Bulls", Geoff Bysshe follows trends on the opening range over a series of days, and discovers that 35% of the time, the high and low of a stock for the day are set within the first 30 minutes of trading. This gives a consistent base for predicting market flow. As such, it is used as the basis of many trading strategies, often to great success.

Black-Scholes Model

The Black-Scholes model is one of the most well-known and widely used models in the world of options. Introduced in 1973 by Fischer Black, Myron Scholes, and Robert Merton, the model is a mathematical equation that approximates the price of a European option over the time from its sale to its expiration date.

The model operates based on several assumptions about the market: the most notable being:

- The options are using European exercise terms (i.e. the option can only be exercised at its predetermined expiration date).
- No dividends are given out during the option's lifetime.
- The markets are efficient, and so their movements cannot be predicted.
- No commissions are charged on the options.
- The options have a known and constant risk-free interest rate.
- The returns on the underlying stock are evenly (lognormally) distributed.

The formula, shown below, can be viewed as the difference of two separate components. The first term,$SN(d_1)$ is the expected profit from buying the underlying stock outright. It is the product of the change in the call premium with respect to the change in the underlying price. The second term $N(d_2)\ Ke^{-r(T-t)}$ is the current value of paying the

option price at its expiration date. The difference of these two parts yields the value of the option.

This model can also be modified to take dividends into account. This is commonly done by adding the ex-dividend date into the equation and subtracting the value of a future dividend from the stock price. This removes one of the more severe limitations on the Black-Scholes model.

$$C = SN(d_1) - N(d_2)\,Ke^{-r(T-t)}$$

$$d_1 = \frac{\ln(\frac{S}{K}) + (r + \frac{\sigma^2}{2})(t)}{\sigma\sqrt{t}}, d_2 = \frac{\ln(\frac{S}{K}) + (r - \frac{\sigma^2}{2})(t)}{\sigma\sqrt{t}}$$

C = Call premium S = Current stock price

t = Time to exercise date K = Strike price

r = risk − free interest rate σ = Volatility

In practice, the limitations imposed on the Black-Scholes model due to the assumptions listed above make it too disconnected from reality in order to accurately predict option values. For example, most companies do hand out dividends to shareholders, and by assuming the contrary the equation produces values that are consistently larger than what is true. This issue can be avoided by modifying the equation as described above, but the other assumptions cannot be avoided as easily. Nonetheless, it is frequently employed as a rough approximation of the price of an option, which is then further refined with the use of more sophisticated models. This method gives the Black-Scholes model considerable versatility and accounts for its popularity in options trading.

Gap Theory

As the name implies, Gap Theory strategies revolve around the concepts of gaps in stock prices. There are four basic types of gaps:

1. Full gap up – when the opening price of the stock is higher than the high of the previous day.

2. Full gap down – when the opening price of the stock is lower than the low of the previous day.

3. Partial gap up – when the opening price of the stock is higher than the close of the previous day, but lower than the previous day's high.

4. Partial gap down – when the opening price of the stock is below the previous day's close, but higher than its low.

Although these gaps are defined in terms of days, they can be scaled up or down as necessary, in order to work on intraday or weekly gaps.

Each of these four gaps has different strategies for making long and short trades on stocks. Consequently, there are eight strategies that can be applied to gap trading. These strategies and gaps all have different risks and gains. In general, the full gaps indicate a significant change in the market's attitude towards the stock. As a result, stocks that fully gap tend to trend in the corresponding direction for prolonged amounts of time. On the other hand, partially gapping stocks show a smaller demand, and their price stays within a more defined range, allowing for considerable gains over several trades.

The full trading strategies of gap trading are explored in greater detail later in this paper.

GorillaTrades

GorillaTrades refers to the trade website www.gorillatrades.com. The site is a pay-to-use service. Subscribers are given a series of recommendations every evening via email. These recommendations include both stocks to invest in long-term and stocks to sell short. These picks are based on a combination of recent news about the related markets, which is included as a brief commentary in the email, and a "black box" trading strategy that picks out distinct, but unknown to the subscriber, indicators in the stock market.

For every stock recommendation, the Gorilla (as the owner of the site is known by) gives two indicators at which subscribers are recommended to buy stock. The first, the "trigger price", is when the stock is included and tracked on the GorillaTrades portfolio. As the name implies, this is the price where the Gorilla believes the stock is on the verge of making a breakout, and interested traders should begin paying attention, or even buy the stock if they feel confident. The second indicator is a combination of an increase in price

from the trigger price and a specific volume level, called the "confirmation level". This is the point where the site recommends traders to buy in, and is the indicator that most users of the site wait for.

Once a subscriber purchases a stock, GorillaTrades provides them with several risk management systems to protect their investments. First and foremost is the risk rating for a stock, where the stock is rated on a scale from 1 to 5, with 1 being the safest and 5 having the most risk. This value is derived from several factors, including volume, liquidity, price, etc. In addition, for every confirmed stock, an exit strategy is also provided with stop loss levels to help mitigate losses while a trader is holding the stock. To complete the system, the Gorilla provides indicators for shorting stocks that unexpectedly decline, and encourages its users to diversify their investments to prevent severe losses.

GorillaTrades has become well known for its reliability and honesty in providing accurate picks for its subscribers. As a result, it has been included as one of the strategies used in this report's portfolio, and is described in greater detail later in the paper.

Swing Trading

At its simplest, swing trading is trading and holding positions for more than one day. Typically, this means trades are held anywhere from one day to a week. This creates a sort of middle ground between day trading (where positions are never held for more than a day) and trend trading (where positions can be held for weeks or even months). Swing trades are effective in markets that are slightly trending; this allows traders to make a decent profit off of several intraday trades. When swing trading, the position is often exited as close to the upper or lower boundary lines as possible. Weaker markets make timing this easier. Markets that are trending stronger in one direction, like bull and bear markets, are better suited to either day trades to short the market or long-term trend trades to ride the trend as long as possible.

Swing trading is used in our system of systems as part of the GorillaTrade system. Its use is described in further detail in the systems description.

Fundamental and Technical Analysis

Fundamental and Technical analysis are two basic and evidently different ways to analyze a stock. The two ways may arrive at the same answer but the journey to this

solution is extremely different. Fundamental analysts believe that the market price of a stock doesn't always match the true value of the given company. On the other hand, technical analysts believe that the fundamental elements of the stock are already included in the stock's price. They also believe prices move in trends and these trends tend to repeat over time.

Fundamental analysts rely on everything that can affect the company's value, including many macroeconomic factors. These areas also include the company's management and financial stability, as these are the attributes that can make or break a successful company. The overall state of the economy is a factor that fundamental analysts take into account when analyzing a stock. If the health of the market does not look reliable then the analysts will discount the value of the company and vice versa. Fundamental analysts also use market behavior to make predictions in the company. These analysts believe that the technical aspects of the stock are not what drives the company as a whole, and that these areas cannot be focused on when conducting research on a security.

Technical analysts rely on trend following and historical pricing data when evaluating a company. The price data consists of statistics and is generated by market activity. These analysts believe that the fundamental aspects of a company are included in the statistical trends of the stock. Therefore fundamental analysis of a stock becomes obsolete. Along with this type of analysis come the scientific tools that are used for company evaluation. These tools include indicators, channels, oscillators and many more. The tools used for analysis are relying on the fact that history tends to repeat itself and prices almost always move in trends.

Many experts see these two types of evaluation as complete opposites, and one would think that the combination of the two would be impossible. However, having both fundamental and technical aspects on one's side can provide the best case scenario for a trade.

Basic Strategies

While there are countless different strategies that can be employed in a trading system, there are a few basic strategies that are utilized in most successful systems. Each of the basic strategies is based on general ideas of how stock prices behave. For example, a

stock that is "trending" upward will likely continue to rise in price. While this certainly is not always true, traders can capitalize on situations where it is by buying stock and selling it in the future at a higher price. However, determining whether or not a stock is "trending" is not always straightforward and often requires observing several different factors. Furthermore, a successful trader needs to know how many shares to buy and when to sell, among other things. For these reasons, these basic strategies are really just general trading concepts and are too simple to be consistently successful on their own. Five of the most popular, basic strategies are described below.

Trend Following

Every trader has one core idea in mind: buy stocks that will rise in price and sell stocks that will drop in price. One way to determine if a stock's price will go up or down is by looking at its current trend (i.e. the direction in which it is currently moving). As mentioned earlier, a stock that is in an upward trend will likely continue to rise in price. Similarly, a downward trending stock will likely continue to drop. There are many different ways to determine a trend in a stock, but a general requirement is that the stock's short-term high and low prices (peaks and valleys on the stock's chart) are moving in the same, consistent direction. On a chart of an upward trending stock's prices, both the peaks and the valleys would be gradually getting higher and higher. Similarly, the chart of a downward trending stock would have peaks and valleys getting lower.

Trend following strategies assume that the price of a stock that is trending will continue in the same direction as the trend. This means the strategies will trigger buy orders on upward trending stocks and orders to sell short on downward trending stocks. Since the trend is only identified after the price has moved significantly in one direction, traders who follow trends trade by this philosophy: buy at high prices/sell at higher prices and sell short at low prices/buy to cover at lower prices. The idea of buying high and selling low makes some traders uneasy, and it results in many more losing trades than winning trades. However, a properly implemented trend following trading system will suffer only small losses on each losing trade while making very large profits on winning trades.

Since trend following systems make most of their profits in a small number of large trades, they are constantly in the market so that they are sure not to miss those big opportunities. Spending so much time in the market with a low win percentage can

sometimes result in long drawdown periods, meaning long periods of time where the trades incur net losses, which can be stressful. This will happen during periods when prices move up and down too rapidly for the strategy to react. However, trend following systems have the potential to yield incredible profits if they are able to catch big price movements at the right time.

Counter-Trending

While trend following strategies assumed that stocks that exhibit trends will continue those trends, counter-trending strategies assume that stocks will move up (or down) until reaching a certain high point (or low point), then will bounce back in the opposite direction. These high and low points are often referred to as ceilings and floors, respectively. Traders using a counter-trending strategy will look at a stock's history to try to determine a price range that it seldom breaks out of, and then set their ceiling at the maximum of the range and their floor at the minimum. Whenever the stock's price hits the floor, they place a buy order, and when it hits the ceiling, they place a sell order. This is considered a counter-trending strategy because it profits from stocks that move one way and then change direction instead of continuing like a trending stock would. In fact, many trend followers look for stocks that have recently broken through their floors or ceilings and continued because that can often be an indication of a trend.

The idea behind counter-trending strategies is that well-established stocks will rarely drop below or rise above certain prices due to strong support and resistance in the market. For this reason, counter trending systems are also referred to as support and resistance systems. In order for a stock to have strong enough support and resistance, it must prove to have historically stable prices over long periods. This means stocks that are relatively new to the market generally should not be traded using this strategy because there is too much uncertainty and volatility in their prices. While a stock has to move up and down between the floor and ceiling in order to make counter-trending profitable, too much volatility can be dangerous over long periods. Additionally, the stock should have relatively good liquidity (ease of buying and selling) or else trade orders may not be filled until the price has already bounced back.

Since counter-trending strategies trade stocks when their prices are about to change direction, they employ a "buy low/sell high" philosophy. This makes them emotionally easier to trade than trend-following strategies. They also have generally higher win

percentages. However, they generate relatively small profits on each winning trade, and they can suffer substantial losses when a stock breaks through its ceiling or floor and trends over a long period.

Stop-and-Reverse

While counter-trending strategies use historical data to predict when a stock's price is about to change direction, stop-and-reverse strategies focus on very recent data to identify when a stock's price has already changed direction. The idea behind stop-and-reverse strategies is that a stock that has recently changed its direction of price movement will continue in its new direction. A stop-and-reverse trader will buy a stock that has been rising in price, but once the trader decides that the price has (or is about to) change direction, they will immediately close their current position (sell all shares) and enter the opposite position (sell shares short). This sudden reversal of positions is why these are called "stop-and-reverse" strategies.

Systems using stop-and-reverse strategies have similarities to both trend following and counter-trending systems. Like trend following systems, they are constantly in the market, riding a stock for as long as it continues in the same direction. Like counter-trending systems, they closely monitor short-term price data in order to predict when the price is about to change direction. However, a system that uses a stop-and-reverse strategy alone will only take the most recent changes in price into consideration when determining the direction of a stock, ignoring any long-term trends or support/resistance that the stock may exhibit. For this reason (among others), the stop-and-reverse concept is typically utilized as a smaller part of a more complete trading system.

A system that trades solely based on a stop-and-reverse strategy is always in the market. It can have a very high win percentage as it is able to profit as long as the stock's price moves, even if it begins moving in the other direction. However, if the stock's price changes direction too frequently, the trader can accrue enough commission costs to erase any potential profits. It can be as profitable as a trend following system, but it has a significantly higher chance of losing money over time. As previously mentioned, the stop-and-reverse concept is more useful when combined with other strategies in complete trading systems.

Volatility Expansion

While the previously mentioned strategies spend a substantial amount of time in the market, volatility expansion strategies spend majority of the time out of the market. Volatility expansion strategies involve monitoring stocks with recently low volatility. When the volatility of one of these stocks suddenly jumps, it is an indication of market activity. If the stock has broken out of its range on the high side, the trader buys that stock; if it has broken out on the low side, the trader sells it short. The goal is to enter the market quickly while the stock's price is still moving, and then exit with a little profit once the market quiets down.

Since the volatility of a stock is determined by looking at how much the price changes, volatility expansion strategies only enter the market once a stock's price has already moved a significant amount. This generally results in relatively small profits per winning trade when compared to the other strategies, which attempt to get in the market before significant price movements occur. However, since volatility expansion strategies enter in the middle of price movements, they tend to have fairly high win percentages. It can be an exciting strategy to trade as it enters as the market is erupting, and then soon exits with a quick profit.

Specialized/Boutique

One final basic strategy that is worth noting is to specialize in a particular asset or group of assets, which is sometimes referred to as boutique trading. The idea behind this strategy is that certain entities in the world of trading (stocks, commodities, markets, industries, etc.) will exhibit repeated, recognizable patterns over time. This strategy is unique in that it can be executed using any one or combination of the strategies previously mentioned, assuming the asset(s) being traded has consistently proven to be profitable for each strategy used.

A trader who specializes in a particular asset will trade that asset exclusively because they are so familiar with that asset that they know how the price is most likely to behave at all times. Although they can't always predict future prices, specialists recognize patterns in the assets and can identify good times to trade as well as good times to stay out of the market. This also applies to traders who specialize in groups of multiple related assets such as particular industries or even sectors of the market, which also exhibit certain

patterns. However, this is not always the case with boutique firms, which often instead specialize in particular methods of investing in order to serve a particular niche of clients.

In order to be a successful specialized trader, a lot of time must be spent gaining an understanding of how the prices of the asset(s) tend to behave. This may involve rigorous research and testing, but absolutely requires substantial experience in the real-time trading of the asset(s). Furthermore, there are many assets that simply do not exhibit patterns consistently enough to be worth specializing in. For this reason, most successful specialists spent years professionally trading multiple different assets before recognizing truly consistent patterns in any particular one. However, those boutique traders who have reached that level of familiarity with their specialties are capable of making enormous profits while maintaining low levels of risk.

Manual vs. Automated Trading

The advent of the internet led to two major advances in the investment and trading business: remote access to real-time market data and the ability to place trade orders directly from a computer. After that, it was only a matter of time until people managed to program their computers to execute trades automatically. Now, traders have access to software that allows them to design, test, and execute trading strategies with relative ease. This poses a question of whether is better to use automated trading instead of trading manually.

Manual and automated trading each has its own advantages and disadvantages, resulting in a decision that is dependent on the trader and the trading system used. The obvious advantage is that having a computer do the trading can save both time and effort. By programming strategies into a computer and letting them run, a trader can spend time on other things while the computer handles all of the calculations and executes all of the trades. However, a smart trader will continue to monitor their trading activities because machines can make mistakes. Programming errors and hardware failures can be catastrophic if they go unnoticed. For this reason, automated trading systems should not be left unattended for extended periods of time, especially those that trade frequently. Still, trade automation can be very useful when a trader needs to step away from the computer momentarily, but does not want to miss potential trade opportunities.

It is also worth noting that many people find actively trading to be quite stressful, so having a computer do it for them can relieve some of that stress. Traders who allow stress and other emotions to get in their way may find themselves hesitating or making irrational decisions. Even a well-designed strategy can fail if it is not executed correctly. For this reason, traders who are confident in their strategies but not in their ability to execute them effectively can benefit from automated trading.

While automation can be helpful for many traders, there are some traders whose strategies require automation in order to be successful. Strategies that trade in very small time frames rely on computers to place trade orders as quickly as possible. The price of a highly volatile stock (or asset of some type) can change very quickly, so a manual trader would be much more likely to miss their desired price. There are, for example, traders who capitalize on price changes that occur within a matter of microseconds, which would be impossible for a human to do through manual trading.

In general, automation makes trading easier, but there are some factors that can be difficult to account for with a programmed strategy. For example, trend following traders may be profiting on stocks of a production company that are steadily increasing in price, but if that company is forced to issue a massive product recall, their stock value may plummet. While it is relatively easy to implement a trend following strategy that accurately identifies trends based on historical prices, it is far more difficult to identify events that occur in the world and react accordingly. A good trend following system will likely identify the sudden drop in stock price quickly, but not before suffering significant losses. There are several things that can significantly affect the price and price behavior of a stock. Many of these things are events that can be read in the news, which means a diligent manual trader will find out about them and react accordingly. There are professional traders who use highly complex programs that can read and interpret news and other sources of information, which allows them to implement strategies that utilize this information. Of course, this is incredibly difficult for the typical trader. That being said, those who use automated trading should keep an eye on the news and be prepared to disable trade automation if necessary.

Basic Tools

Trend Lines

Technical analysis of stocks is based on the fact that prices trend. Some stocks trend in a more definitive way than others and the job of analysts is to find the ones that trend the most. Trend lines are an important facet to technical analysis because they can lead to trend identification and confirmation. The trend line connects two or more price points with a straight line and serves as a line of support and resistance for the stock being analyzed. Trend lines can have a positive or negative slope depending upon the behavior of the company. These slopes are referred to as up-trending (positive) and down-trending (negative). A stock, or an entire market, is up-trending if it makes higher highs and higher lows and would be considered down-trending if it makes lower highs and lower lows. These analytic tools can help predict the direction a stock will go depending upon the trending patterns. Although trend lines can be very helpful in a trading system, they can also be used as false signals if used improperly. They are one aspect of technical analysis that we used in our system and helped us scan for trend following stocks.

Indicators

Technical indicators are a part of the all-encompassing term "technical stock analysis". This facet is used to examine the past performance of a company so that a future trend or pattern can be predicted. There are indicators for the price, volume, and many more aspects of a stock in order to give the trader signals for buying and selling. An indicator does not provide a flat out buy or sell signal, as the investor will need to interpret the signs to adapt them to his or her individualized trading system. Indicators can also be applied to general market conditions and can be used to predict how a market will perform short term. They are different from other tools because they do not evaluate any part of the fundamental business itself such as earnings and profit margins.

The key to using technical indicators is to choose those that will fit with the accepted trading strategy. No indicator is right all the time and this is an important fact for investors to remember. The deal breaker for successful technical analysis of a stock is the investor that can be right more frequently than they are wrong. A disciplined trading approach and set indicators will improve the rate of success; switching indicators in an already successful strategy can be the recipe for failure.

Channels

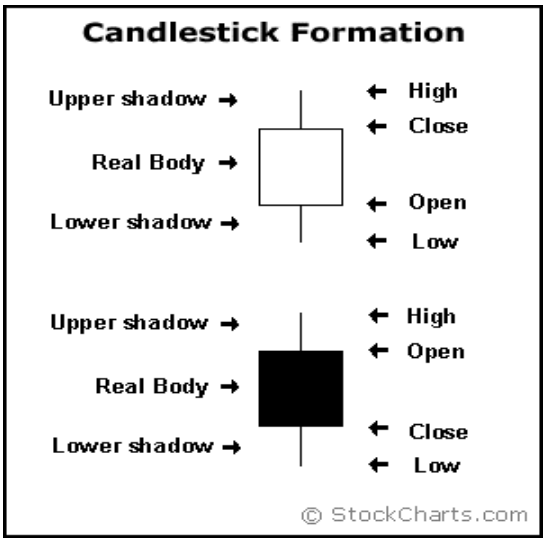
A price channel is a set of upper and lower trend lines that encompass a steadily moving pattern of a stock. The upper line marks the resistance and the lower line marks the support. The stock will bounce around within this channel and sometimes break through the floor or ceiling, alerting investors of a sudden change in behavior. The slopes of the channel determine if the channel is bearish or bullish. A bullish channel is one that has a positive slope; a channel with a negative slope is considered a bearish channel. Investors look to buy or sell a stock when it breaks through either the support or resistance. These strategies are known as "breakthrough strategies". The dotted centerline in a price channel is the midpoint between the support and resistance and is the neutral area for the channel. These channels can also be used to determine if a stock is overbought or oversold.

Japanese Candlestick Charts

Candlestick charts were first introduced by the Japanese in the 17th century when they began to use technical analysis on their rice trade. Charles Dow ended up adapting this technique in the early 1900's and applied it to his theory. This type of analysis that was introduced by the Japanese had strict principles that included: all known information is reflected in the price, markets fluctuate, and the actual price may not reflect the underlying value. This sense that the market was moved and influenced by the emotions of traders was a revolutionary one that served as the backbone for charting. These ideas have been modified and refined into the candlestick charts we see today on platforms such as MetaTrader and TradeStation.

The necessary data set for a candlestick chart includes an open, high, low and close values for the given security. The hollow or filled portion of the candlestick is called the body. The long thin lines on the ends of the candlesticks are referred to sometimes as the "wicks" and "tails" and encompass the high/low ranges. The body of the candlestick is hollow if the stock closes higher than its opening price and is filled if it closes lower than its opening price with the prices on either ends of the tails. See Figure 1.

Figure 1: Candlestick Formation



http://stockcharts.com/school/doku.php?id=chart_school:chart_analysis:introduction_to_candlesticks

Traders often prefer candlestick charts to normal bar charts because they are easier to read and perform further analysis on. Each candlestick holds information on price action and an investor can immediately decipher the relationship between the open and close of the stock. If a group of candlesticks appear filled, then the investor knows there is significant selling pressure and a bearish trend and vice versa if the opposite is seen. These charts are widely used by investors and continue to be modified.

Artificial Intelligence

Investors are now looking to a new concept of artificial intelligence and allowing computers to make investment decisions for them. This breakthrough shows that computers can learn from decisions by being programmed to quickly respond to the decision that has been made. These programmed computers can adapt and learn much faster than humans are able to which is why the shift is being made.

Originally, experts had the thought to strive towards a computer system that can mimic human intelligence. Over the years this theory has been modified to certain applications called AI techniques. These techniques are being used by many major companies such as Facebook and Google for marketing reasons. One major problem that

experts face when programming computers is the type of mistakes that computers make. Computers don't have common sense unless humans program them to understand the mistake that is being made. These changes are being made and AI is starting to become more and more effective in investment situations. Many investors and computer scientists believe that the future of trading will be artificial intelligence, but for now we are nowhere near that accomplishment.

Our Trading System - A Combination of Systems

Overall Objectives

The objectives of our system as a whole are fairly simple. We wanted to return a profit while minimizing market exposure. We want to have a diversified portfolio so that we can limit the risk involved in trading our system. Each individual system has its own particular set of objectives.

Choice of Financial Instrument

Our group was interested in the stock market mainly because of our actual previous trading experience. Stocks were also ideal for our system because of the high volume of trading that takes place. There is a diverse selection of financial securities to choose from in the stock market compared to other high volume markets. We chose not to trade market derivatives because of the additional complications that they entail.

Brief Overview

As previously mentioned, our system is comprised of three different systems that make up a complete portfolio. The systems include: Gap Trading System, Gorilla Swing System, and Paul Woldt's Opening Range System. The Gap Trading System and Paul Woldt's Opening Range System were specifically selected because of the minimal time commitment for trading since the majority of the trading is done within minutes of the market opening. The Gorilla Swing System was chosen because of previous experience with the GorillaTrades service. While the Paul Woldt and GorillaTrades systems were based on existing strategies we attempted to modify them to fit our system objectives.

Gap Trading System

System Objectives

We decided to include a gap trading system in our overall system primarily because such systems can be designed to require very limited time commitment. While earning a high rate of return is always our main objective, we are also interested in doing so without needing to constantly monitor the market for the right times to enter and exit. By using a gap trading strategy that only enters positions at the market open, we need to worry about entries for this system only during the first few minutes of the trading day. To make things even easier, we close all positions before the end of the day so that none are held overnight.

Due to the nature of gap trading strategies, we set a relatively high win percentage as an objective for this particular system. More specifically, we wanted to win roughly between 55 and 65 percent of our total trades. If our system were to hit too far below that target range, it could indicate that the stock being traded is not consistently closing its price gaps, which is important in order for the system to be successful. If we were to set our target above that range, we would likely miss some good trade opportunities, limiting our potential profits. More importantly, our advisor specifically warned us that systems trading too far above 65% are most likely too good to be true, with the exception of systems specifically designed to make frequent, small trades with exceptionally high chances of winning (upwards of 80%).

Since we designed our system for our own use, we allowed ourselves flexibility in terms of the maximum drawdown we would allow. When developing the gap trading system, we would have liked to keep the maximum drawdown under 2% of our initial capital, which was set to $100,000 for the purpose of back-testing the system. Of course, we were willing to exceed that if it would significantly increase our returns. That being said, we set a strict maximum at 4% of our capital.

Trading Time Frame

As previously mentioned, restricting entries to the first few minutes of the day and forcing all positions to close before the end of the day make this gap trading system rather convenient. However, there are several other reasons why the specific time frames for trading were chosen. Possibly the most significant reason is because many stocks will

receive overnight orders, which have to be included when the market makers at the exchanges calculate the opening prices in the morning. If either overnight sales or purchases of a stock exceed the other by enough, the stock's opening price will be significantly different from the previous day's closing price, which it will likely return to at some point during the day.

The next biggest reason for the chosen time frames is because stock prices are generally more volatile and have higher volume at the beginning and the end of the trading day. The high volatility in the morning makes it possible make significant profits shortly after entering the market and the high volume helps the orders get filled more quickly, reducing slippage. The high volatility at the end of the day can be dangerous if a position is still open, waiting for the stock's price to fill the gap from the morning. If a stock still hasn't closed its gap as the final 30 minutes of the day roll around and it hasn't yet triggered an exit with a loss, it is very uncertain what will happen as the trade volume picks up and the volatility increases. In this situation, there is little time to recover from any sudden losses since the day is coming to an end. Even more importantly, positions should not be held overnight since there could easily be another gap the next day, which could result in a lost opportunity or even a severe loss. For these reasons, we close any positions that are still open at 3:30pm (30 minutes before the end of the trading day), avoiding all of those risks.

Another reason why we chose to keep our trades for this system within the span of the trading day was so that we could monitor the system's performance on a daily basis. Trading this system with a few different stocks that frequently experience gaps overnight gives us at least a few trades a week and often one or more per day. This makes it much easier to identify flaws in our system or our programming before it becomes a problem. The high number of trades also allows us to accurately compare our results from trading after making edits to the system.

System Details

While our gap trading system is still far from perfect, it has reached a stage in development where we believe that it can be profitable in the long term. Although we would like to refine the system more in the future, we put development on hold for the sake

of this paper. This section describes the detailed components of our gap trading system in its current state.

Entry

Stock Choices

Deciding on which stocks we should trade using our gap trading system was a lengthy process and is detailed later in this paper. The following is a brief description of how we made our choice.

In order to maximize profits from a gap trading strategy, the stocks being traded have to meet three criteria: the stock's price frequently gaps overnight, those gaps are filled more often than they are not, and the stock is liquid enough to be traded effectively. Determining if a stock meets the first two criteria requires looking at a large amount of its historical price data. Since we couldn't do that for every single stock, we narrowed down our search based on simpler criteria using TradeStation's scanner. We determined that a stock with prices that frequently gap and return within the day should have regularly high volatility in single-day time frames. After scanning for stocks with high daily volatility, high average volume, and sufficient historical data, we used brute force testing to determine which stocks would be best for this strategy. As of now, we are only trading stocks in Advance Auto Parts, Inc. (AAP) and Wynn Resorts Ltd. (WYNN) using this system.

Set-Up Rules

The set-up rules for this system are fairly simple. First and foremost, entry orders may only be placed immediately following the first bar of the trading day (9:31am for AAP and 9:35am for WYNN). Secondly, there must be no currently open positions. However, assuming the system is being traded properly, there will never be positions held overnight. Finally, before the market opens, the trader must check to see if there is any major news for Advance Auto Parts or Wynn Resorts in the last day or two (or since the last day of trading). Depending on what the news is about, it may cause a significant shift in investors' opinions about the stock, especially if it entails the release of earnings reports. A significant change in investors' opinions will likely result in a price gap that is very unlikely to close within the day, making it a bad day to trade. If there is any major news of this sort for either stock, it is best to play it safe and not trade that stock for a day.

Trigger Rules

The rules for triggering an entry order generally follow the theory of the gap trading described earlier, except for a few modifications. Instead of identifying partial and full gaps by comparing the current day's opening price to the previous day's high, low, and closing prices, this strategy compares the current day's opening price to the high and low prices of the last bar of the previous day. This range of values gives a better understanding of investors' opinions at the end of the previous day than just the single last price of that day would. Additionally, this strategy looks at the closing price of the first bar of the current day to be sure that the gap has not already been filled by the time the entry order is triggered. The only reason for this is that when we tried to program the system to place intra-bar orders using TradeStation, we encountered several issues that distorted our results from back-testing the system on historical data.

The trigger rules for this system are designed to place orders when it has identified a partial gap and has made sure that it has not already closed. If the opening price exceeds the high price of the final bar of the previous day by at least **x**% and by no more than **y**%, then it is considered a partial gap up. If the opening price is lower than the low price of the final bar of the previous day by at least **x**% and by no more than **y**%, then it is considered a partial gap down. A partial gap up triggers a short sale and a partial gap down triggers a purchase, assuming the gap has not yet closed. The variables, **x** and **y**, are set to optimal values for each stock based on historical data.

Exits

Rules for Exiting with a Profit

All of the rules for exiting with a profit depend on the time of the day. After entering a position in the morning, our system will exit as soon as the price gap closes, unless a certain amount of time in the day has passed. There is often a lot of uncertainty and volatility in the stock prices in the morning, causing sharp price movements and rapid changes in direction. If the gap closes early and we stay in the market, the price could easily reverse direction and we could quickly lose our profits. So when the gap closes early in the day, we exit with a quick profit.

However, as the day goes on, price movements become more gradual. After a certain amount of time has gone by, the system will no longer make quit exits, but will begin monitoring the direction in which the price appears to be moving. For example, if the price

gaps down and the gap finally closes three hours later, the system will stay in the position if it determines that the price will likely continue upward. When this occurs, the position will be left open until the price no longer appears to be moving up.

The amount of time that must go by before switching exit strategies, which we will refer to as "waiting time", is set to an optimal value for each stock based on historical data. The direction in which the stock price is moving is determined by a custom indicator we designed, which we will refer to as our "direction indicator". The indicator looks at the change in current price compared to the prices at four different points in the past, which are each separated by an equal amount of time. In general, consistently positive price changes indicate an upward direction, and consistently negative price changes indicate a downward direction. Further details on this indicator and the calculations involved are discussed later in this section.

Rules for Exiting with a Loss

The only rule that is specifically intended for exiting with a loss is designed for risk management. For any particular trade, there is a maximum amount of money we are willing to lose. In order to avoid the risk of exceeding that maximum loss, we must immediately exit any position that hits that limit. Since the price may slip by the time the order is filled, we typically set our limit slightly below the maximum that we want to allow. This is effectively the same exit strategy as what is known as a stop-loss. This involves placing an exiting stop order at the same time as the entry order with the stop price set so that it will be filled when the loss on the trade reaches the maximum that the trader will allow. The only difference is that our strategy exclusively uses market orders, which is discussed later in this section.

Rules for Exiting, Regardless of Profit or Loss

There are three situations where the system will immediately exit a position, regardless of whether it is currently making a profit or taking a loss. First, any time when there is a major event in the news that would significantly affect investors' opinions, the trader must seriously consider an immediate exit. We do this for the same reason we don't enter any positions after major news; shifts in investors' opinions will push prices in one

direction and they will not likely return within the day. Since we don't have the tools or the expertise to program this rule into our system, the exit order must be placed manually. Moreover, depending on the nature of the news and the position of the trade, there could be a significant boost to profits. This means that deciding whether or not a particular event will have a negative impact on a trade is up to the discretion of the trader. If the exact impact is uncertain, however, it is better to be safe than sorry, and the position should be exited.

The second the second of these rules is to exit if the direction indicator is pointing away from profits, but only if the waiting time has passed. For example, when we are in a short position (meaning the price gapped upward), if several hours go by without the gap ever closing and then the direction of the price suddenly turns upward, we quickly exit. Whether we are trying to hold onto our profits or we are trying to avoid further losses, it is the same rule for exiting.

Finally, if 3:30pm rolls around and a position is still open, we promptly exit. As was mentioned earlier, we don't want to hold positions overnight and waiting until the last few minutes can be risky. To reiterate, holding an overnight position in a stock that frequently experiences price gaps between one day's close and the next day's opening runs two risks: a large loss may be suffered, or a trade opportunity may be missed. Waiting until the last minute can also be risky since the two most volatile times of the day (in general) are shortly after the market opens and shortly before the market closes.

Rules for Exiting after Inactivity

This system has no rules specifically for exiting after inactivity. Due to the volatile nature of the stocks being traded, it is rare for long periods of time to go by without any significant movement in the price. Even if this were to somehow occur, the position would be exited by the end of the day anyway. Keeping money tied up in an inactive trade all day isn't an issue either since the system only places entry orders at the beginning of the day. All things considered, this system has no reason to exit an inactive trade.

Our Custom "Direction" Indicator

As was mentioned earlier, our direction indicator looks at the change in price compared to four different points in the past, which are each separated by an equal amount

of time. For each point of reference, the indicator looks at the closing prices for that bar, the previous bar, and the next bar. Then, it calculates the average difference between the current bar's closing price and each of the three prices for that reference point. Once this is done for all four reference points, it determines how many are positive and how many are negative. If three or more are positive, the stock is considered to be moving up; if three or more are negative, the stock is considered to be moving down, otherwise, there is no definite direction.

For this system, the optimal length of time between reference points depends on the stock being traded, but we have found that 25-30-minute intervals often yield good results. However, our most recent optimization determined that using 40-minute intervals when trading AAP (1-minute bars) yields the best results, based on historical data. When trading WYNN (5-minute bars), we use 25-minute intervals.

This custom indicator has proven to be very useful for determining the likely direction of short-term price movements, performing notably better than commonly used techniques, such as those involving exponential moving averages (EMAs), which will be demonstrated later in this paper. One popular indicator for price trends compares a short term EMA to a long term one, then determines that the price is moving upward if the short term EMA is greater than the long term one and the price is moving downward if the reverse is true. While this may be quite useful for identifying price trends over longer periods of time, it is ineffective in identifying the quick changes in price direction, which need to be noticed quickly in order for our system to be effective. Another common indicator that can be more sensitive to quick changes in direction is known as "momentum". This simply calculates the difference between the current price and some price in the past. Obviously, momentum alone is based on too little information to be a statistically significant indicator of which direction the price is moving. However, it was the inspiration for our direction indicator.

Our direction indicator is ideal for the short term trading involved in the gap trading system. It is sensitive enough to detect quick changes in the direction of the price before it's too late. Yet, it is also robust enough that random fluctuations in price will not produce false indications. On top of that, the calculations involve only simple arithmetic, resulting in fast computations. Being able to determine the likely direction of price movements in such

short time frames gives this gap trading system a distinct advantage over other similar systems.

Order Types

As was mentioned earlier, our gap trading system exclusively uses market orders. This system enters positions in highly volatile stocks during the most volatile time of the day. When prices are moving that quickly, it is imperative that entry orders are filled as soon as possible. While market orders are bound to incur some loss due to slippage, the price gap may close entirely before a stop or limit order gets filled. Although this is slightly less of an issue for our exit orders, it is still very important that we don't miss our chance to make money, especially when the gap closes early in the morning.

Position Sizing and Risk Management

There are a few different ways in which our gap trading system controls risk, and most of them involve using proper position sizing for each trade. First, each stock being traded is allotted a percentage of the total equity in the account for the gap trading system. The allotted percentage for each stock is the maximum amount that may be used for trading, not the amount that will be used for each trade. By setting a limit on how much of the account can be put into a single stock, we ensure that we never put too much of the account at risk. The percentages for each stock are determined by the expected returns from trading that stock, based on historical data. Although this system is currently only trading two different stocks, we choose to invest only 60% of the available equity in the two of them combined because we would rather not risk more than that in only two different positions with this trading system. Since WYNN is expected to generate higher returns with lower risk, we allow 40% of the total gap trading account to go to WYNN and the other 20% to go to AAP. The remaining 20% is left unused because we are not willing to risk more than 60% of the account with the gap trading system at this time.

After a maximum position size has been set, we must determine the position size of each individual trade. Instead of simply investing a fixed percent of the account in each trade, we choose to put 1% of our account "at risk". Although there are multiple ways of discerning how much is "at risk" in any given trade, depending on how someone defines the

term, we consider it to be the largest amount we would expect to lose on any given trade. In other words, we determine the largest amount we expect the price to change during the day, and we assume that will be the most we would expect to lose per share if the trade were to go wrong. Once we have determined the risk per share, we divide the total amount we are willing to risk (1% of the account) by the risk per share, resulting in the appropriate number of shares to purchase or sell short for that particular trade.

Determining how much is at risk per share is no trivial task, however. Since we have an exit rule in place for when a trade hits the maximum amount we are willing to lose, we could set our total amount at risk per trade to be that maximum loss value, but we prefer to think that we do not *expect* to lose that much, whether or not it may happen. Instead, we look at the range of price values within each day in recent history. We figure that the difference between the highest and lowest prices for any given day is the largest loss we would incur per share if we traded on that day. For this reason, we calculate the average range of daily prices over the previous seven trading days, and determine that to be our amount risked per share.

Although it would probably be more appropriate to look at a larger span of time than seven days, perhaps a month, TradeStation's function for average true range will only make calculations based on bars and therefore won't calculate the average true daily range unless the strategy is currently using daily bars. When trying to write our own function to calculate average true daily range for a variable number of days, we encountered several problems associated with how TradeStation's EasyLanguage editor is developed. In order to save time and further headaches, we decided to just stick with seven days.

Finally, we adjust position sizes depending on the day of the week. Running TradeStation's walk-forward optimizer over the previous year's historical data for our gap trading system on each stock provided us with the percentage of trades that were profitable for each day of the week as well as the ratio of average profits for winning trades to average losses for losing trades. For each day of the week, we multiply the ratio of average win size to average loss size by the ratio of percentage trades that were profitable to percentage of trades that lost, resulting in a ratio of our expected profit to expected loss. We use these values to scale our position sizes so that the days of the week that yield the highest expected return over loss have the largest position sizes. Since a value less than one for this ratio implies that the expected loss is larger than the expected profit, any day of the

week that does not have a value greater than one is not traded at all. For any other day with a ratio greater than one, we subtract one from that ratio and multiple the remaining number by the position size to get new position sizes that are adjusted for the historical risk and return for trades on that day of the week.

For example, if trades on Mondays are profitable 60% of the time and the size of the average win is equal to the size of the average loss, the ratio of expected profits to expected loss will be (60%/40% x 1/1) = 1.5. This means for every dollar we expect to lose on Monday trades, we can also expect to gain one and a half dollars in profit. In other words, for every dollar loss we accept, we expect to make one and a half dollars back, resulting in fifty cents net profit. Since our net return is expected to be equal to 50% of the losses we will incur, we scale our position sizes for Monday trades to be 50% of what they would have been without using this position sizing technique. If our ratio of expected profit to expected loss is 3 for Tuesdays, we would expect a net profit of two dollars for every one dollar of loss we accept, so we multiply or position size by two. However, any risk adjusted position size that exceeds the maximum position size allowed is reduced to be equal to that maximum.

System Monitoring

Determining when a system is no longer effective can be very difficult. It is entirely possible for a quality trading system to lose several consecutive trades simply due to a string of bad luck. However, knowing how often a trading system *should* win (based on testing over historical data) makes it possible to calculate the probability of a series of trades occurring. Viewing each trade as an independent Bernoulli trial in which the probability of a success is the probability of a winning trade allows us to treat a series of trades as a sample from a binomial distribution with a probability parameter equal to the probability of a winning trade. The probability of losing any particular number of times after a specified number of trades can be calculated using the probability mass function for binomial distributions. Here is the formula for that function:

$$f(k;n,p) = \Pr(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$$

n = #of total trades, k = #of winning trades, and p = probability of winning a single trade

To determine the probability of obtaining k or fewer winning trades for a given historical win rate (probability of winning a single trade), simply sum the above formula for all values of X, one through k. An alarmingly low value for this probability suggests that the chance of winning a trade is no longer equal to what it was in the past. If at any point we find that our gap trading system has lost an unusually high number of trades for a particular stock, we calculate the probability of that many losses (or more) occurring after however many trades we made during that time (n in the above equation). Although deciding how unlucky is "too unlucky" is at the discretion of the trader, a series of trades with a probability under .05 will certainly raise a red flag. This process is conceptually similar to hypothesis testing in statistics, and in practice, they are the same.

In fact, the first stock that we decided to actively trade with our simulated account using the gap trading strategy was Eastman Chemical Company (EMN). At the time of our first trade (January 31, 2013), back-testing our strategy over the previous three years yielded 63.7% winning trades and 71.4% in just the previous year. We profited in the first trade, but suffered a massive loss (nearly 1.7% of the account) in the next trade, which was the day after Eastman Chemical released their earnings report. After that, we suffered losses in four out of our next five trades. The one trade we did win out of those five was successful only because we manually closed our position long before our system dictated, resulting in a profit of $25. This was very distressing, but we felt confident that EMN would begin behaving more like it had in the previous few years, so we continued to trade the system.

The last trade we made before suspending our system for EMN was on March 5th. We did not always trade exactly how our system was programmed during that time, but if we had, we would have lost 12 out of 18 trades. Based on the win rate of the previous three years (63.7%), the probability of losing at least 12 out of 18 is .00930. Moreover, the last 5 of those 18 were all losses. Based on the same win rate, the probability of losing 5 trades in a row is .00658. Although we had not yet set specific rules for when to suspend trading, it was clear that we should wait before trying to trade EMN again.

Although our system was clearly not working with EMN at the time, it was performing far better with other stocks. This was an indication that the system as a whole was not "broken", but EMN's prices were exhibiting unusual behavior. Therefore, we

stopped trading EMN, but continued with other stocks. Had we consistently seen the same performance on all stocks, we would have considered shutting down the system entirely.

Once trading has been suspended for a system or for a particular stock, it is also important to continue monitoring how well it would have performed if the trading continued. It is not uncommon for stock prices to change behavior for a period of time, making certain strategies less profitable, and then eventually revert back to their typical, profitable behavior. That being said, determining when to resume trading a suspended system can be as difficult as choosing to suspend it in the first place. However, a similar approach may be taken.

When a suspended (temporarily deactivated) system or stock starts looking profitable again, we want to be confident it is not simply due to a string of good luck before we resume trading. Since we stop trading after determining that the probability of winning has (most likely) changed, we should similarly determine whether or not it has changed once again by using the same formula. However, our new value for the probability parameter will be equal to the win rate during the time when trading was unsuccessful. The values for "n" and "k" will be the total number of trades since that period and the number of winning trades since that period, respectively. Since this period of time is not precisely defined and can be relatively small, using the win rate over that period as the value for our probability parameter may cause the result to be slightly skewed. For this reason, we must use stricter requirements for how low the resulting probability must be in order to confirm that the chance of winning has changed once again. If the calculated probability is under .02, we will consider resuming trading.

Since suspending our gap trading for EMN, it has actually shown considerable profitability. If we had continued trading the same system, ignoring the revisions we have made to the system since that time, we would have won 12 out of 18 trades. Using the win rate from the time when we first started trading until our last trade for EMN (6 out of 18) for our calculations, the likelihood of winning 12 or more out of the next 18 trades is .00392, suggesting that something has changed. Moreover, the current version of our system would have lost 11 out of 16 trades in that first period, and then it would have won 15 out of 20 trades since then. That being said, we are considering resuming trading sometime in the near future.

System Development Process

When developing a trading system, it is important to start with a basic strategy and then build upon it, piece by piece. A trading system in its simplest form, which includes an entry strategy with a fixed number of shares and a fixed exit strategy, should at least be able to make some amount of profit (ignoring commissions and slippage). If it can't do that, then it is not worth pursuing. The following section describes the various stages of development for our gap trading system.

The Basic System

Our gap trading system, in its most basic form, would buy 1 share after the first bar of the day if the opening price was less than the previous day's closing price and would sell 1 share short if the opening price was higher. Then it would exit the position after 10 bars, which were 5 minutes each. Just to see if it could make any money with such simple rules, we back-tested it on Apple's stock (AAPL) over the past year. We were pleased to find that the system had made money and was clearly profitable. After that, we tested the system on several other popular stocks, varying the length of the bars and the number of bars before exiting. Some tests profited more than others and some ended in loss, but the system was clearly capable of making money. A graph of the equity curve for the year of trading AAPL with this system, using 5-minute bars and a 10-bar exit, is shown in Figure 2 (below).

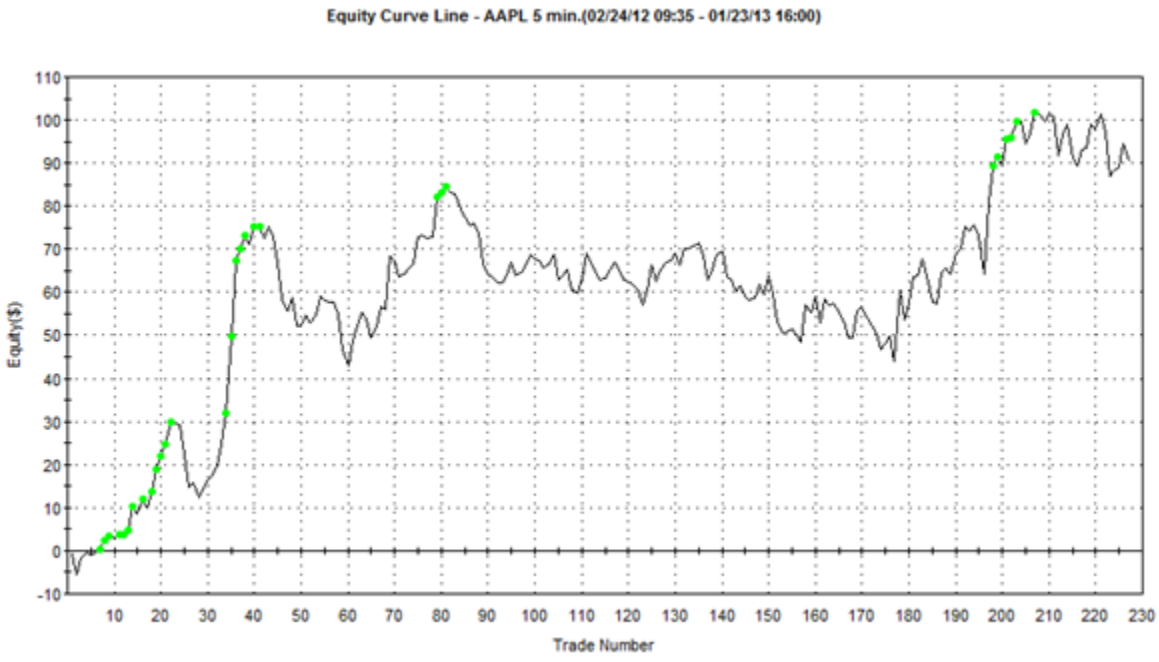


Figure 2 - Equity Curve for Trading AAPL with the Basic System

The Variable Exit Strategy

The next step in developing the system is to introduce a variable exit strategy. We added an exit rule that exits any position (short or long) if the price crosses the closing price of the previous day. To ensure a good price if the position was long, the price had to cross from below, and if the position was short, it had to cross from above. Although the addition of this new exit strategy reduced profits in some situations, it increased the frequency of winning trades, especially when setting the fixed exit to occur after a greater number of bars because it allows more time for the price gap to fill. Previously, back-testing on AAPL with a 50-bar fixed exit resulted in a 55.47% win rate, but introducing the new exit strategy raised it to 58.06%. Even though the net profits dropped a fair amount (from $176.43 to $104.92), the increase in win rate suggests progress toward trading the price gaps effectively.

Considering how our system at this stage was entering a position every time the opening price in the morning was either greater than or less than the previous day's close, it was making trades nearly every day during back-testing. As long as the open and the close were at least 1 cent apart, the system entered a position. We figured gaps this small are likely not significant enough to be particularly profitable, so we decided to increase the required gap size. While there are multiple ways to do this, we decided to try comparing the opening price to the high and low prices of the last bar of the previous day, instead of the closing price. Additionally, we exited as the price crossed the closing price, regardless of the direction in which it crossed. This raised net profits to $115.18 and raised the win rate to 59.56%. We also tried using those high and low prices as the exit prices, requiring that the price crosses in a good direction. This improved results slightly, but the difference was minimal.

A Second Round of Entry Strategy Revisions

Next, we decided we wanted to control the minimum size of the gaps that we trade. To do this, we required that the day's open be at least some percent higher than the last bar's high or that same percent lower than the last bar's low. We introduced the percent as an input variable to the system so that it can be optimized for each stock. The new variable made an insignificant difference when trading Apple stocks, but it tripled the net profits from back-testing on Hewlett-Packard stocks (HP) over the previous year, and it raised the

win rate from 51.61% to 60.63% after optimization. The equity curves for back-testing the system on HP before and after introducing the new variable are shown (below) in Figure 3 and Figure 4, respectively.

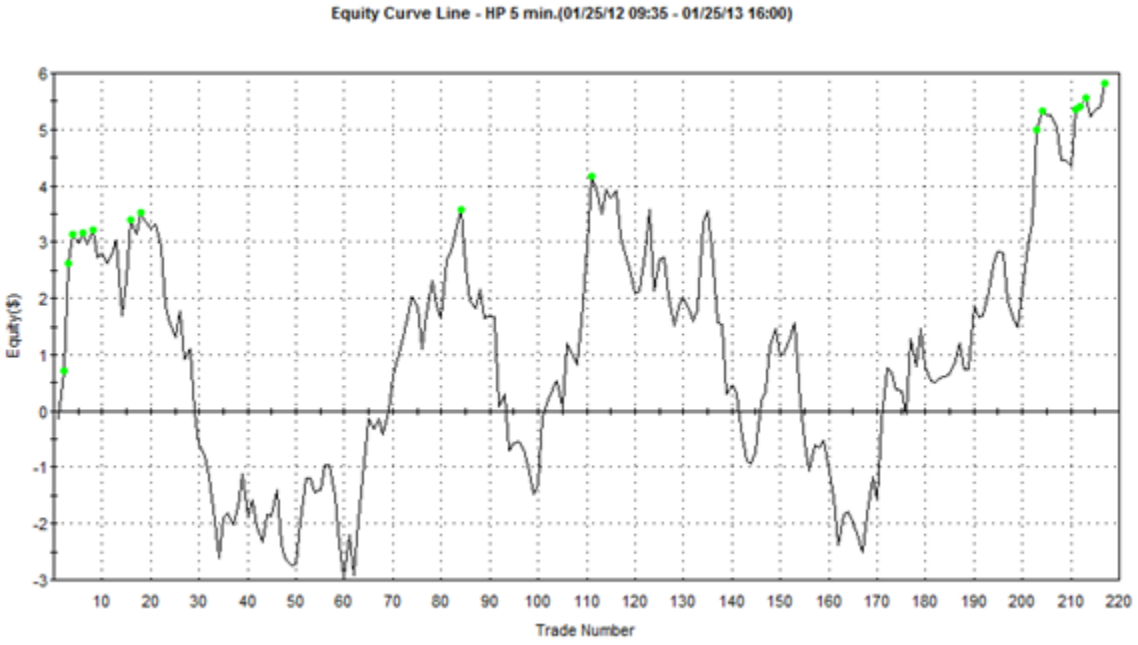


Figure 3 – Equity Curve for HP before Adding the New Entry

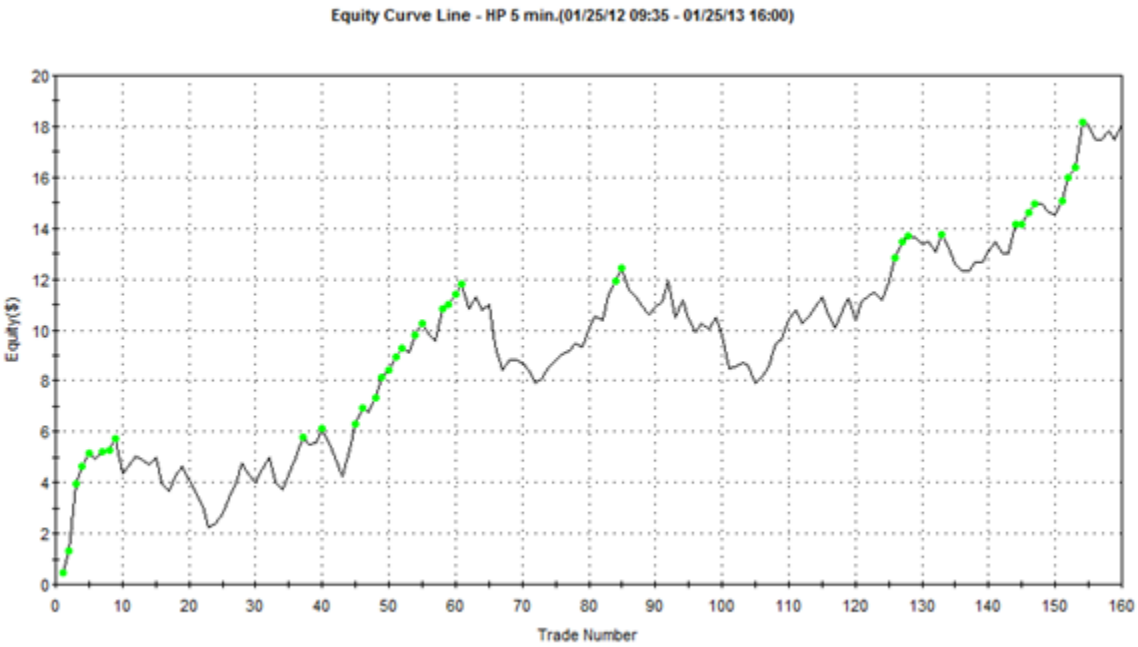


Figure 4– Equity Curve for HP after Adding the New Entry

A Second Round of Exit Revisions

After making these refinements to our entry strategy, our back-testing profits for some stocks were still below what they were before introducing the new exit strategy, particularly for AAPL. For this reason, we decided to temporarily remove our "closed gap" exit strategy, which was price-specific, and tried using an exit strategy that would stay in while profits are going up and exit when they start to go down. Our first attempt at this was with a commonly used indicator for determining the general direction of price changes, which compares a short term exponential moving average (EMA) to a long term exponential moving average. As was mentioned earlier in this paper, prices are moving upward when the short term EMA is higher than the long term EMA, and they are moving downward when the reverse is true. The new exit strategy we introduced stays in long positions while the direction is up and short positions while the direction is down, exiting as soon as the EMAs cross each other. The numbers of bars used to calculate each EMA were set as input variables so they could be optimized. Unfortunately, profits and win rates significantly decreased, regardless of the values for the input variables.

Since the new exit strategy failed, we decided to try an approach that combined the new strategy with the old, where we exit positions when the gap closes, unless the direction of the price is toward more profits. This hybrid exit strategy increased AAPL profits to $159.52 while maintaining a reasonable win rate of 58.33%. However, HP had notably higher profits and win rates before introducing the EMAs. We decided to keep both ideas on the table for the time being.

At this point, it occurred to us that the system generally performed better when we set the fixed exit to a large number of bars, and our only constraint was that we needed to exit before the end of the day. We stopped using a fixed bar exit and instead set it to automatically exit any position held past 3:30pm. We knew there was high volatility at the end of the day, so we decided to play it safe and exit when there is a half hour left in the trading day. We then also realized that the high volatility in the morning could be throwing off our EMAs. This is when we decided to set a "waiting time", before which all EMAs are ignored.

While our quitting time was specifically set to 3:30pm, we made the waiting time an input variable since some stocks may calm down earlier in the day than others. Introducing these time-dependent rules slightly reduced AAPL profits to $142.29, but raised the win

rate to 59.46% after optimization. Profits with HP, on the other hand, increased to $21.68 (from $18.25) while the win rate dropped to 56.22%, and it continues to perform slightly better without the EMAs. However, we also back-tested the system, with and without the time-dependent rules, on stocks for Eastman Chemical Company (EMN). Before the new rules, optimized inputs yielded $19.34 in net profit and a 61.98% win rate with EMN. Including the new rules, optimized inputs yielded $25.37 in net profit and a win rate of 66.18%. EMN was specifically selected for back-testing due to its high daily volatility, so the increased performance was not surprising.

We decided to look at the individual trades that occurred during back-testing so that we could get an idea of where we might be missing out on profits, if at all. When looking at the trades for EMN, we saw several occasions where the system could have exited much sooner and either avoided large losses or held onto more profit. Since the inputs for the EMAs had already been optimized for maximum net profit, we began thinking they may not be best suited for determining the direction the prices are moving on such small time frames, especially for EMN.

We wanted to detect changes in direction quickly so that we could exit long positions as close as possible to the tallest peak of daily price charts and exit short positions as close as possible to the lowest valleys. Doing this requires an indicator that is sensitive enough to identify sudden changes in direction. We realized that after a stock's price has been consistently going up, if it suddenly drops, the first indication of change will be the fact that the difference between the current price and the last price will change from positive to negative. While it seems simple, the difference between the current price and some recent price can be highly sensitive to sudden changes in the direction of price movement. In fact, the difference in price between two separate times is a well-known indicator called momentum.

While momentum is far more sensitive than the indicator we tried that uses EMAs, it is far too sensitive to use on its own. When using only one past price as a point of reference for the current price can cause misleading results, especially if the price experiences a random spike at one point and that point becomes the reference for a future calculation. However, using multiple past points for reference will provide more reliable results. For this reason, we decided to try looking at prices at 4 different, recent points for reference. To further improve stability, we also looked at prices for the bars immediately before and after

each point of reference. This provided prices at 3 adjacent bars for each reference point, resulting in 12 different calculations for momentum in total.

With 12 different calculations for momentum, effects from random spikes in price can be completely overshadowed by the other 11 prices. While this should prevent us from being misled by outliers in price data, it is also possible for seemingly random spikes to be indicative of some underlying change in the market. It is common for spikes to occur due to uncertainty in the market and, therefore, random chance. However, there are other possible explanations. First, it is not uncommon for a major investor to buy several shares of a stock at an extremely high price (or sell at an extremely low price) compared to the current market value. Large investors sometimes do this either to shake up the market or to drive prices in a particular direction.

The remaining potential cause for price spikes is far less common, but can create drastic consequences. On occasion, a small group of investors may know something about the particular stock that will significantly affect its future price and the rest of the market may be completely unaware. If the resulting price change is expected to be large enough, whether it is due to insider information or simply exceptional clairvoyance, the few who know will all suddenly enter massive positions or completely exit their current positions within a short span of time. When this occurs, the price will suddenly jump (or drop) and then quickly return since the majority of the market has not changed its opinion of the stock's value. As the information reaches more people, the price will begin to accelerate in one direction. Once news reaches the masses, the price will either take off or plummet, depending on the nature of the information, causing great losses to those who do not react in time.

Since price spikes may not be truly random, we decided not to eliminate their influence over our direction indicator. In order to do this without giving them too much power, we calculated the average momentum at each reference point (using the 3 associated prices). Due to the volatile nature of the stocks we are interested in, the calculated value for momentum can vary greatly from bar to bar. Since the precise value is easily changed, determining whether momentum is positive or negative is of greater significance. If we were to calculate average momentum over all 12 prices, a large price spike could skew the results significantly. To account for this, we decided to calculate average momentum for each of the 4 points of reference separately, and only consider

whether each resulted in a positive or negative momentum. If all 4 are positive, it is a strong indication that the price is going up, and if all 4 are negative, it is a strong indication that the price is going down. Since this gives no indication of how fast it is moving up or down, we decided to simply call it a "direction indicator", as was mentioned in the details for this system.

Applying this indicator in the place of our EMA indicator resulted in improved performance for both AAPL and EMN after optimization. The profits from AAPL increased to $172.69, but the win rate dropped to 55.56%. These numbers look a lot like those seen from using just a 50-bar exit strategy, but looking at the average profit per trade and the standard deviation, we see that the 50-bar exit strategy averaged $0.71 per trade with a standard deviation of $6.73 while the system with the new direction indicator averaged $0.80 per trade with a standard deviation of $4.08. This suggests that the new system is far more reliable, and is more likely to keep up the same level of profitability in the future. On top of that, results from back-testing on EMN improved with a net profit of $28.28 and a win rate of 63.90%, which is back within our target range. However, results with HP were no improvement over the strategy with the EMAs, which may suggest that HP is simply not an ideal stock to trade with this system. Considering the clear improvements in results from introducing this new direction indicator, we decided we would continue to use it instead of the EMA indicator.

A Third Entry Strategy Revision

Looking through the individual trades from back-testing once more, we noticed that instances where there were abnormally large gaps often resulted in losing trades. This reminded us that gap trading systems can also be designed for trading full gaps instead of partial gaps. Since systems for trading full gaps are based on the idea that the price will continue in the direction of the gap instead of returning to the prices seen at the end of the previous day, this means seeing a full gap in one of our stocks is a sign that we should not trade. Although a full gap is generally defined as a gap where the opening price is either lower than the lowest price of the previous day or higher than the highest, we chose to set a maximum gap size as a percent of the stock's price, letting the percentage be an input variable that can be optimized for each stock.

After introducing the new entry rule and optimizing the inputs, AAPL's performance improved, but only very slightly; EMN increased in profits to $30.26, but also in win rate to 66.85%, slightly out of our target range; and HP's performance did not change at all. Although the limit on gap size didn't seem to have much of an impact, it doesn't hurt to keep it in the system.

The Variable Position Sizing Strategy

At this stage of development, the system contained a sufficient set of entry and exit strategies to produce consistent profits. In order to increase those profits and reduce the losses suffered, the next step was to implement a strategy for sizing the positions of each trade appropriately. The first method for position sizing that we tried was setting each trade to use a specified percentage of the account. This has two significant effects: the same amount of capital is utilized, regardless of the stock's price, and the amount invested per trade will increase as the system makes profits and decrease as the system suffers losses.

Scaling position sizes based on the amount of money in the account primarily serves to improve the results of trading a system, regardless of whether the system makes money or loses it. Every time the system makes a winning trade, the next trade will utilize slightly more capital. Similarly, each loss will reduce the capital involved in the following trade. This allows a consistently profitable system to increase its rate of return over time. Moreover, a system that repeatedly fails will suffer smaller losses. It is a simple, yet effective way to bolster a system's performance.

Additionally, using a consistent amount of capital makes it easier to compare performance among different trades and different stocks. It also makes it easier to compare multiple different systems. In any business, regardless of the work involved, one of the most important factors to consider before spending capital is the expected return on investment. In the business of trading, we must consider the gains and losses from each trade as well as the capital required. Evaluating how profitable systems are, in relation to the amount of capital they use, is imperative to making accurate comparisons. If a trader buys 100 shares of a $1-stock and 1 share of a $100-stock, then if both stocks' prices were to increase by 50 cents, the trader would make $50 on the first stock and only 50 cents on the second. Keeping total amount invested constant, buying the first stock produced 100 times the return of the second. By using the same amount of capital for each of the two

trades, we could easily tell that the first yielded a higher return on investment. Similarly, forcing our system to use a consistent portion of the account per trade made our comparisons easier, which was quite useful to us since our system was still in its early stages of development.

After applying the position sizing strategy to our system, we compared the system's performance results from back-testing on various different stocks. We initialized our account size at $100,000 and used only five percent of the account for each trade. Using the same values for the input variables as those that were optimized previously, AAPL made $1,532.93 in profit, HP made $1,799.77, and EMN made $2,667.74. Given equal amounts of capital to trade, regardless of stock, the system made significantly more profit with EMN than with the others. AAPL, which had made far greater profits trading 1 share at a time, resulted in the smallest profits per dollar invested. However, the losing trades for AAPL caused losses that were roughly half as large as those with EMN. Moreover, EMN experienced a maximum drawdown of $370.45 while AAPL's maximum drawdown was only $206.87. This suggests that, while AAPL is more expensive to trade, it involves a lower risk of large losses. Still, HP was the cheapest to trade, suffered the largest losses, and had drawdowns as large as $533.64, making it clearly the worst of the three for trading this system. While we had tested on several other stocks by this point, we specifically compared AAPL, HP, and EMN to maintain continuity in the examples used for this paper.

Apply Risk Management Strategies

While it is good to consider the total amount of capital being invested in any given position, it is equally (if not more) important to consider the level of risk involved. Recalling the example mentioned earlier where a trader bought two different stocks with one costing 100 times as much as the other, that trader would have lost 100 times as much on the cheaper stock if the prices had fallen instead. If both stocks had the same probability of dropping 50 cents in price per share, they involve an equal amount of risk per share. Buying 100 shares of the cheaper stock subjects the trader to 100 times as much risk as a single share of the other stock. For every trade we make, we must consider how much we risk losing per stock when we determine how many shares we should trade.

Since determining the risk involved with any particular stock is up to speculation, we needed to formulate our own method for calculating the amount of risk per share. As

we mentioned earlier in the system details, the risk in any trade is typically considered to be the largest amount that the trader would expect to lose in that trade. Since the largest amount we can lose per share in a trade is the difference between the highest and lowest prices of the day, since that is the greatest change in price a stock experiences within a single trading day. To determine what we expect that value to be, we decided to take the average of the values for the past seven trading days. Determining the amount of risk per share involved in trading a particular stock allows us to size our positions more appropriately.

Combining our previous position sizing technique with our knowledge of risk management led us to calculate our position sizes based on how much of our account we were willing to risk in each trade. To do so, we specified a percentage of the current account to risk per trade, and then we determined how much will be at risk per share for each trade. By dividing the total dollar amount we are willing to risk by the amount of risk per share, we arrive at the appropriate number of shares, which we round to the nearest whole number. Additionally, we applied a limit to the percentage of the account that may be used in any single trade; it is smart not to invest too much in a single position, even if the calculated risk is low.

After applying the new risk-adjusted position sizing strategy, we back-tested our system on stocks with the percent of account risked per trade set to 1% and the maximum percent of account to use per trade set to 50%. All of the other variables were optimized since this has a significant impact on how the system is traded. Evaluating the improvements made by introducing this strategy is not simple, since previous versions of the system traded different amounts of stock. While the net profit will be different, regardless of how effective our strategy is, we expect the largest losses to be smaller in relation to our profits because our risk management strategy was designed to trade smaller positions when the potential losses are large. One way to draw comparisons is to look at the ratio of average winning trades to average losing trades, but a more appropriate value to compare is the ratio of net profit to maximum drawdown because that provides a direct relation between the return from trading and the largest amount of capital that could have been lost over a series of consecutive trades throughout the test period.

Back-testing the system on EMN previously yielded a profit-to-drawdown ratio (net profit divided by maximum drawdown) of 7.20, which improved to 10.70 after

implementing the new strategy. For HP, the ratio improved from 3.37 to 4.43. For AAPL, however, the ratio improved only slightly from 7.41 to 7.97. We suspect that the system's performance with AAPL didn't change much because AAPL was already a lower-risk stock for this system. However, it is now clear that trading EMN provides greater reward in relation to the amount risked than trading AAPL does. In fact, risking a total of 1% of the account per trade with EMN resulted in a net profit of $24,696 with a maximum drawdown of $2,300 over one year, while risking the same percent on AAPL yielded only $13,231 with a drawdown of $1,659 over the same time period. Moreover, if the system allowed them to use the entire account, instead of limiting each trade to less than 50% of the account, the profits for each would improve slightly, but the maximum drawdown for EMN would only rise by $11 while AAPL's maximum drawdown would increase to $2,308.

After back-testing our system with greater values for our percent risked per trade, we decided to implement a new exit rule to provide further risk management. As was mentioned earlier in this paper, a stop-loss is a commonly exit strategy that forces an immediate exit from the market once the loss in a position reaches a specified limit. We decided to implement an exit rule that would do effectively the same thing using market orders. This protected us against the risk of catastrophic losses, and it gave us the option to risk more in each trade without needing to worry about losing more in a single trade than we are comfortable with.

The maximum loss exit is primarily used to protect against major losses and should be set to take action when the trader's limit of comfortable loss has been (or is about to be) hit. With our maximum loss set to 1.5% of our account, the results from back-testing were virtually unchanged. However, we realized that we can gain some interesting information by making maximum loss allowed an input variable and optimizing its value for a stock. The resulting optimal value is the point where any position that has not reached a loss beyond this value is still likely to move back in the other direction, reducing the amount lost. This is because increasing this value, which would let the system hold onto positions that reach greater losses, would result in lower net profit. While it is not necessarily a good (or bad) idea to use the optimized value, it can at least serve to give the trader confidence when one of their positions is suffering a loss, but has not yet reached that value.

An Exception to the Entry Strategies

While comparing the efficiency of the two different versions of our direction indicator on individual trades, we noticed that there were some occasions where the price gapped at the open of the market, but the gap had already filled before the close of the first bar. This resulted in entry orders being placed at price that were already passed what would have been the gap-closing price. On multiple occasions, the price moved back, crossing the gap-closing price once more, and triggering an exit order with a loss. In order to prevent this from happening, we introduced a condition for entry that requires the price at the close of the first bar to have not yet passed the gap-closing price.

At first, making this adjustment surprisingly reduced net profits. Then we realized that these trades had such a significant impact on the system's performance that the input variables would need to be optimized once again. However, even with the newly optimized values, the net profit was lower and the win rate was significantly higher (increasing from 66.85% to 71.15% for EMN).

Additional Exit Strategy

We continued to try to think of ways we could increase profits and reduce losses. To do this, we inspected many individual trades our system executed on the stock charts and looked for situations where we missed out on large profits or suffered unnecessary losses. As a result, we devised one more exit strategy. We realized that, after the waiting time passed, we were only exiting long positions when the price direction was downward and short positions when it was upward. This is not the optimal exit strategy when the gap has already closed, so we implemented a new exit rule that allows positions to continue through the gap-closing price as long as the direction continues to be toward profit. As soon as the direction becomes either neutral or downward and the gap has already been filled, we immediately exit.

Introducing this new exit strategy had a surprisingly small impact on the system's performance. Trading with AAP and trading with EMN each dropped slightly in profits with minimal difference in win rate, drawdown, or any of the other performance factors. On the other hand, performance results with WYNN were virtually unchanged, with profits increasing by less than $100.

Additional Position Sizing

By this point we had run several walk-forward optimizations/analyses on our system with various different stocks so that we could determine which (if any) were likely to be consistently profitable in the future and to determine how often the input parameters would need to be re-optimized. While looking through the analyses, we noticed that they provide the win rate for each day of the week as well as the ratio of average win size to average loss size. We realized that certain stocks perform particularly well on certain days of the week and quite poorly on certain other days, giving us the idea to scale our position sizes based on how much we expect to win for each day of the week.

As we mentioned in the system details, we multiplied the ratio of average wins to average losses by the ratio of win rate to loss rate, giving us a ratio of expected profit to expected loss. If the number is less than 1 for any day of the week, then the stock is not traded on that day. Otherwise, the number is subtracted by 1 to obtain a value for the ratio of expected net profit to expected loss, which is a risk adjusted value we multiplied our position sizes by in order to obtain new position sizes that are scaled according to the anticipated risk and reward. Of course, any position that exceeds the maximum position size after scaling will be reduced to the maximum allowed.

While the calculations themselves could not be implemented into the system's programming, we were able to introduce input variables for scaling position sizes for each day of the week. We simply needed to do the calculations externally and supply the values to the system manually. Using results from a walk-forward analysis on stocks for Wynn Resorts Ltd. (WYNN) over the past three years we determined the appropriate scalars for position size based on the day of the week as follows: scale Monday trades by 1.14, scale Tuesday trades by 0 (no trades on Tuesdays), scale Wednesday trades by .90, scale Thursday trades by 1.13, and scale Friday trades by 1.23. Putting these values into our system increased net profit over a one year period with WYNN from $24,740 to $27,107, without increasing drawdowns. What is particularly interesting is that the distribution of profits between long and short trades became a nearly even split. Furthermore, the coefficient of variation (standard deviation of profit per trade divided by average profit per trade) dropped from 361 to 304, indicating that the variability of returns decreased in relation to the total return.

Incorporate Commission Costs

At this point, we felt as though we had a complete set of well-defined entry and exit rules with appropriate position sizing and risk management strategies. Therefore, we decided it was time to begin considering implementation costs. Predicting the amount of slippage that will occur during trading can be quite difficult, especially when we have only made a limited number of real-time simulated trades. However, estimating commission costs is fairly easy since they are specifically defined by TradeStation, but they vary depending on the frequency of trades. Accounts with fewer than 10 trades per month receive a flat fee of $10 commissions per transaction. Accounts with 10 or more trades per month pay $0.01 per share for the first 500 shares, with a $1.00 minimum, and $0.006 for each share after 500. Until we had enough trades in the gap trading account, we had to pay the flat fee, so when we back-tested our system, we assumed we would pay $10 per transaction. While this marginally decreased our total profits and lowered our win rate slightly, it really made no major impacts on the system as it continued to be profitable overall. After applying commissions costs to EMN ($9.54 per transaction on average), its optimized net profit over a 3 year span dropped from $51,207 to $40,733, while its win rate only dropped from 61.02% to 59.74%.

Incorporate Slippage Costs

As we mentioned earlier in this section, predicting costs due to slippage can be tricky. After we had made a substantial number of trades, it became easier since we could estimate it based on what we experienced in the simulated trades. However, there were several occasions where prices received were worse than the automated system expected due to a wide bid-ask spread and not just slippage. Unfortunately, TradeStation keeps no historical data on bid and ask prices, so it is impossible to account for them directly during back-testing. Looking back at the simulated trades we made, we cannot recall the specific bid or ask prices, so we were forced to just lump these costs in with slippage costs and treat them as the same entity.

By taking the average of the unaccounted costs as our estimate, we were able to back-test our system with the costs incorporated. Unfortunately, the profits for most stocks became significantly less consistent, and some stocks even resulted in losses in the end. It

became clear that these extra costs were taking a major toll on the system's performance. After re-optimizing inputs with these costs incorporated in the back-testing results, we were able to regain some of the profits lost and restore some consistency, but the effects on performance were still obvious. With commissions already included, WYNN net profits were $17,680, but dropped to $11,992, even after re-optimizing input variables. Below, Figure 2 shows the equity curve before slippage costs and Figure Y shows the equity curve with them included.

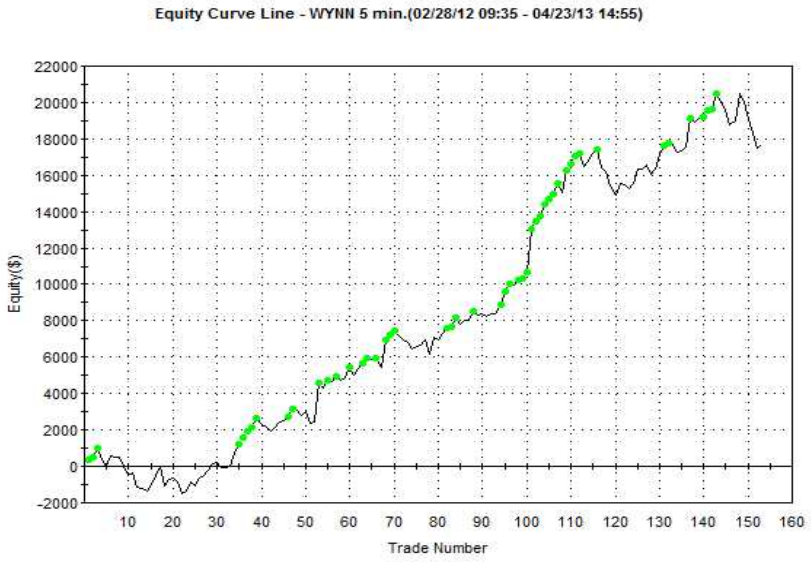


Figure 5 – Equity Curve for Trading WYNN without Slippage

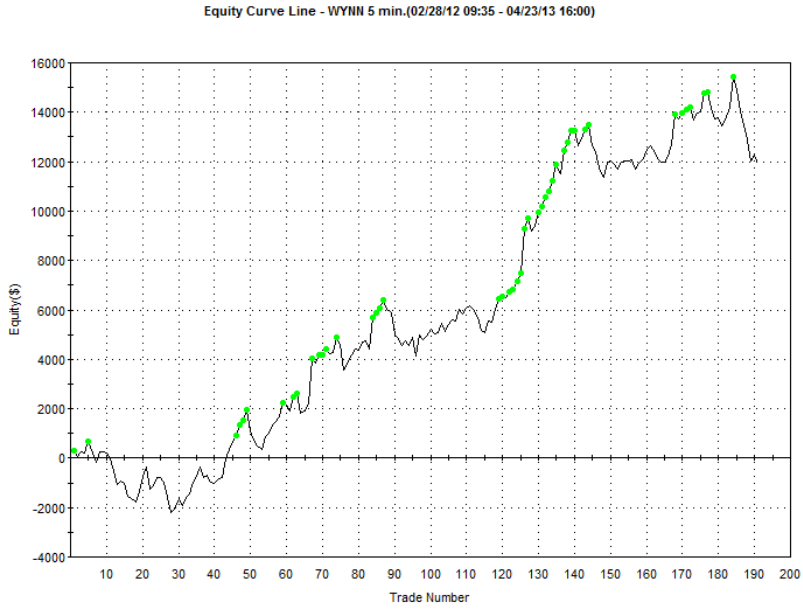


Figure 6 Equity Curve for Trading WYNN with Slippage

Since it is so difficult to directly account for these costs, we contemplated ways that we could reduce the size of the costs. The first idea we tried was to change the settings to allow intra-bar orders to be placed. Unfortunately, due to the way that TradeStation executes code, we encountered several issues when back-testing, resulting in positions being held overnight and extreme position sizes, among other things. As far as we could tell, there was no easy way of fixing these issues, so we needed to find another way to combat the extra costs.

Since we couldn't place orders within the bars, we decided to try to come as close as possible by using the minimum bar size, 1 minute. In theory, reducing the amount of time between making entry or exit decisions should make it easier to get the price that we want. However, it also changes how the system is executed, since it was mostly designed and developed for using on 5-minute bars. In fact, back-testing on stocks for WYNN on 1-minute bars caused notably worse, so we continue to trade it with 5-minute bars. While we still suspect the 1-minute bars to improve the system for AAP, we need to make a substantial number of trades before we can tell whether or not it reduces the costs. Unfortunately, there have been limited trade opportunities since we made the change. By the time this project concluded, we were still not able to estimate (with certainty) the effects on slippage of switching to 1-minute bars.

Final Revisions

Since we were having so much trouble trying to account for slippage, we took another look at the system itself in hopes of coming up with a way to improve profits enough so that the slippage costs and costs caused by the bid-ask spread would be smaller in comparison to the returns from trading. With the time we had left to complete this project, we were only able to implement and test one revision to the system. We figured that our direction indicator might be stricter than it needs to be when determining whether there is upward, downward, or no significant direction in the price. Instead of requiring all 4 average momentums to have the same direction, we decided to try having it simply require at least 3 of the 4 have the same direction. The results from this revision were mixed from stock to stock, so we altered our system so that the minimum number required is an input variable that can be optimized for each stock individually.

Process of Choosing Stocks

As we mentioned in the system details, the stocks we choose to trade with our Gap Trading system must exhibit frequent overnight price gaps, which must have a greater chance of closing than not. The stock must have good liquidity so that our entry and exit orders will be filled quickly, preventing significant losses due to slippage. We determined that the easiest way to determine if a stock consistently closes price gaps is to simply back-test our system on that stock. Trying to do this would take an enormous amount of time, so we narrowed down the potential stocks to try by using TradeStation's scanner. The table below displays the criteria we currently use for our scan, which are explained in the paragraphs that follow:

Criteria	Time Frames	Values
Last Price	N/A	Greater than $10, Less than $200
Average Daily Volume	10 days	Greater than 1,000,000
Average Daily Volatility	500 days	Greater than 1.5
Average Weekly Volatility	50 weeks	Less than 7.5

We limit the price range because stocks that are too cheap can be very risky and stocks that are too expensive may not yield high enough return per share to make them worth trading. While we don't know for a fact that stocks under $10 or over $200 would not be profitable, we need to narrow down the list, so we use our intuition. We are interested in stocks that have daily trade volumes higher than one million on average because such high volume is a good indication of high liquidity.

We are looking for stocks that tend to move a significant amount within the time frame of a single trading day. A stock that does this consistently will regularly have a large price range within the day. TradeStation's volatility indicator, when applied to daily bars for a stock, calculates a smoothed average of the stock's daily range. This means that the stocks we are interested in should consistently have relatively high volatility on a daily time frame. Since roughly only 7.5% of all stocks in our price range have daily volatility greater than 1.5 (averaged over 500 days), we consider 1.5 to be a reasonable threshold for minimum daily volatility.

It is worth noting that we look at the average over 500 days for two reasons: we want long-term consistency, and we don't want to trade stocks that do not have substantial

history in the market. This system relies heavily on historical data, which means it would be risky to trade stocks that have only been traded for a short period of time.

While we are interested in high daily volatility, we also must be cautious of stocks that have high volatility over longer time frames. If a stock is strongly trending over several days, the price ranges for those days will be large, resulting in high daily volatility. We are not interested in stocks that experience frequent trends, so we want to filter those out with our scan as well. Since the trends span multiple days, these stocks will also tend to have high volatility over weekly time frames, while the stocks we are looking for will generally stay within a smaller price range over such time frames. This is why we apply a threshold for maximum weekly volatility (averaged over 50 weeks). We set the threshold at 7 because a stock that moves in only one direction over the course of a week, with a daily volatility of 1.5 or more, will have a weekly volatility of at least 7.5.

It is necessary to note that these are the stock filtering criteria that we currently use when we look for new stocks to try with our system. While we were always aware that we wanted high volume and high volatility, we did not always know what values would be appropriate thresholds. That being said, majority of the stocks we have tested to this point were picked from older scans that had thresholds at values that were less strict.

When we run TradeStation's scan software using these criteria, it looks at all stocks with sufficient historical data (excluding those we already tested) and filters out any that do not meet our specifications. Once the scan is complete, we randomly select stocks from the list, and then we back-test our system on them over a one-year period (ignoring commissions and other external costs). Since the success of the system on a particular can be significantly affected by the values for our input variables, we run a very quick optimization for the variables, testing a few different values for each. We give further consideration to stocks that show potential profits, which entails more intensive optimization and closer inspection of the performance report. Specific details in performance reports that we pay closest attention to are described in the next section.

Stocks that appear to be consistently profitable with a reasonably low level of risk, even after applying commissions, are then tested and analyzed using TradeStation's walk-forward optimizer, which analyzes the system's performance as though the inputs had been re-optimized multiple times over various time intervals. It is called "walk-forward" optimization because the window of data advances one "step" through time for each round

of re-optimization. Only stocks that "pass" the walk-forward test are ever traded in real-time with our simulated account, which is the true test of a systems performance. The specific test criteria for walk-forward analysis are described in the next section.

Gap Trading System Performance Analysis

There are several different aspects of trading systems that must be considered when evaluating their overall quality. The obvious thing to look at is the net profit from trading the system, but the actual value of a system's net profit is meaningless unless it is given relation to other aspects of the system and its performance. When evaluating our system and its performance on a particular stock, we had to consider the return on investment, the consistency of profits, and the risk involved, among other things. Furthermore, there are multiple ways of measuring each of these aspects of the system, all of which must be taken into account.

One common measurement used to represent the overall quality of a system is known as expectancy. It is calculated by taking the ratio of resulting profit (or loss) of a trade to the amount that was risked in that trade, for every trade the system makes. The system's expectancy is the average of these ratios. This effectively incorporates both the returns from trading and the risk involved into a single measurement. However, in Paul King's book, "The Complete Guide to Building a Successful Trading Business", he describes a more complete measurement that also accounts for consistency in profits as well as frequency of trading. He calls it "system value", and calculates it using the same ratios, but he takes their average, divides that by the standard deviation of those ratios, and then multiplies the result by the frequency of trades (typically in the form of a number of trades per year). Since our system is designed to risk the same amount for each trade (in relation to the size of the account), we estimate our system value simply by dividing our average profit per trade by the standard deviation of profit per trade and then multiply the result by the average number of trades per year.

In order to give a thorough analysis of a system's quality, we consider all of the different factors that impact overall quality. The following is a break-down of the factors we find most important for our Gap Trading system's performance as it is currently trading

WYNN as well as for its performance with AAP, each back-tested over the last 300 trading days, with commissions and slippage costs included.

Measurement	WYNN	AAP
Net Profit	$6,598.98	$1,020.79
Profit Factor (Gross Profit/Gross Loss)	1.71	1.23
Percentage of Time Spent in the Market	1.77%	0.61%
Win Rate	61.44%	63.24%
Average Win / Average Loss	1.07	0.71
# of Trades	153	68
Average Profit per Trade	$43.13	$15.01
Standard Deviation of Profit per Trade	$223.92	$268.54
Paul King's System Value	29.47	3.80
Maximum Drawdown (from trade close to trade close)	$1,319.63	$1,370.16
Net Profit / Maximum Drawdown	5.00	.74
Expected Profit per Trade / Expected Loss per Trade	1.70	1.27
Walk-Forward Efficiency	62.9%	59.0%
5th Percentile for Total return (Monte Carlo Simulations over Normal Distributions)	8% on investment	1.5% on investment
95th Percentile for Maximum Drawdown (Monte Carlo Simulations)	3%	3%
Walk-Forward Analysis – Test Results	Pass	Fail

While these values were different when we first began trading WYNN and AAP, it is clear that WYNN is now the better choice, and AAP should likely not be traded at all. Overall, the system proves to be profitable when trading WYNN, and its win rate and maximum drawdown are well-within the ranges specified in our objectives. Considering how trading WYNN with our simulated account has produced profit (despite recent losses), we feel that we have successfully developed a profitable, working gap trading system. The following figures display the results from trading WYNN and AAP in real-time with our simulated account. Figures

TradeStation Performance Summary Expand

	All Trades	Long Trades	Short Trades
Total Net Profit	($1,035.42)	($768.80)	($266.62)
Gross Profit	$1,793.49	$309.83	$1,483.66
Gross Loss	($2,828.91)	($1,078.63)	($1,750.28)
Profit Factor	0.63	0.29	0.85
Total Number of Trades	17	9	8
Percent Profitable	41.18%	22.22%	62.50%
Winning Trades	7	2	5
Losing Trades	10	7	3
Even Trades	0	0	0
Avg. Trade Net Profit	($60.91)	($85.42)	($33.33)
Avg. Winning Trade	$256.21	$154.92	$296.73
Avg. Losing Trade	($282.89)	($154.09)	($583.43)
Ratio Avg. Win:Avg. Loss	0.91	1.01	0.51
Largest Winning Trade	$991.70	$185.15	$991.70
Largest Losing Trade	($1,427.33)	($444.22)	($1,427.33)
Max. Consecutive Winning Trades	3	1	3
Max. Consecutive Losing Trades	6	5	2
Max. Shares/Contracts Held	2087	1658	2087
Total Shares/Contracts Held	15861	7201	8660
Account Size Required	$1,698.13	$941.03	$1,427.33
Return on Initial Capital	(1.04%)		
Annual Rate of Return	(6.81%)		
Return Retracement Ratio	(1.58)		
RINA Index	n/a		
Trading Period	1 Mth, 24 Dys, 6 Hrs, 24 Mins		
Percent of Time in the Market	1.18%		
Max. Equity Run-up(Daily)	$1,116.38		
Max. Drawdown(Daily)			
Value	($1,698.13)	($941.03)	($1,439.85)
Net Profit as % of Drawdown	(60.97%)	(81.70%)	(18.52%)
Max. Drawdown(Trade Close)			
Value	($1,698.13)	($941.03)	($1,427.33)
Net Profit as % of Drawdown	(60.97%)	(81.70%)	(18.68%)
Max. Trade Drawdown	($1,398.29)	($426.74)	($1,398.29)

Figure 7 - AAP Simulated Trading Performance

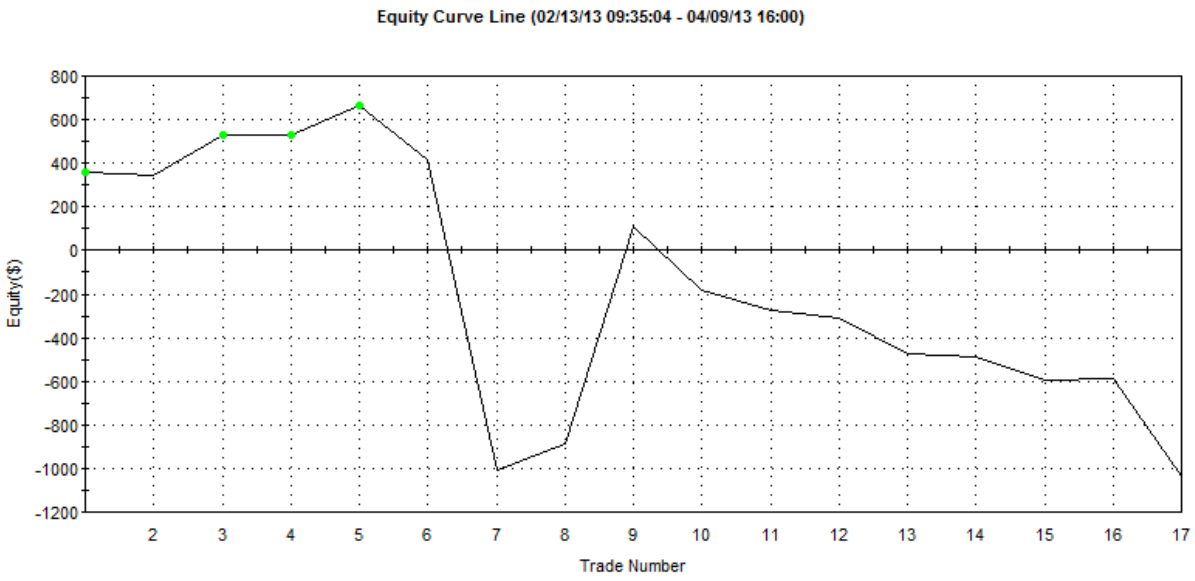


Figure 8 - AAP Simulated Trading Equity Curve

TradeStation Performance Summary				Expand
		All Trades	**Long Trades**	**Short Trades**
Total Net Profit		$341.30	$380.44	($39.14)
Gross Profit		$2,153.60	$1,144.85	$1,008.75
Gross Loss		($1,812.30)	($764.41)	($1,047.89)
Profit Factor		1.19	1.50	0.96
Total Number of Trades		26	10	16
Percent Profitable		46.15%	50.00%	43.75%
Winning Trades		12	5	7
Losing Trades		14	5	9
Even Trades		0	0	0
Avg. Trade Net Profit		$13.13	$38.04	($2.45)
Avg. Winning Trade		$179.47	$228.97	$144.11
Avg. Losing Trade		($129.45)	($152.88)	($116.43)
Ratio Avg. Win:Avg. Loss		1.39	1.50	1.24
Largest Winning Trade		$637.26	$637.26	$491.36
Largest Losing Trade		($509.76)	($509.76)	($442.98)
Max. Consecutive Winning Trades		3	2	2
Max. Consecutive Losing Trades		4	2	2
Max. Shares/Contracts Held		451	384	451
Total Shares/Contracts Held		5165	2099	3066
Account Size Required		$1,141.49	$655.31	$486.18
Return on Initial Capital		0.34%		
Annual Rate of Return		1.77%		
Return Retracement Ratio		0.90		
RINA Index		n/a		
Trading Period	2 Mths, 9 Dys, 6 Hrs, 24 Mins			
Percent of Time in the Market		1.78%		
Max. Equity Run-up(Daily)		$1,861.32		
Max. Drawdown(Daily)				
Value		($1,141.49)	($655.31)	($486.18)
Net Profit as % of Drawdown		29.90%	58.05%	(8.05%)
Max. Drawdown(Trade Close)				
Value		($1,141.49)	($655.31)	($486.18)
Net Profit as % of Drawdown		29.90%	58.05%	(8.05%)
Max. Trade Drawdown		($505.04)	($505.04)	($438.84)

Figure 9 - WYNN Simulated Trading Performance

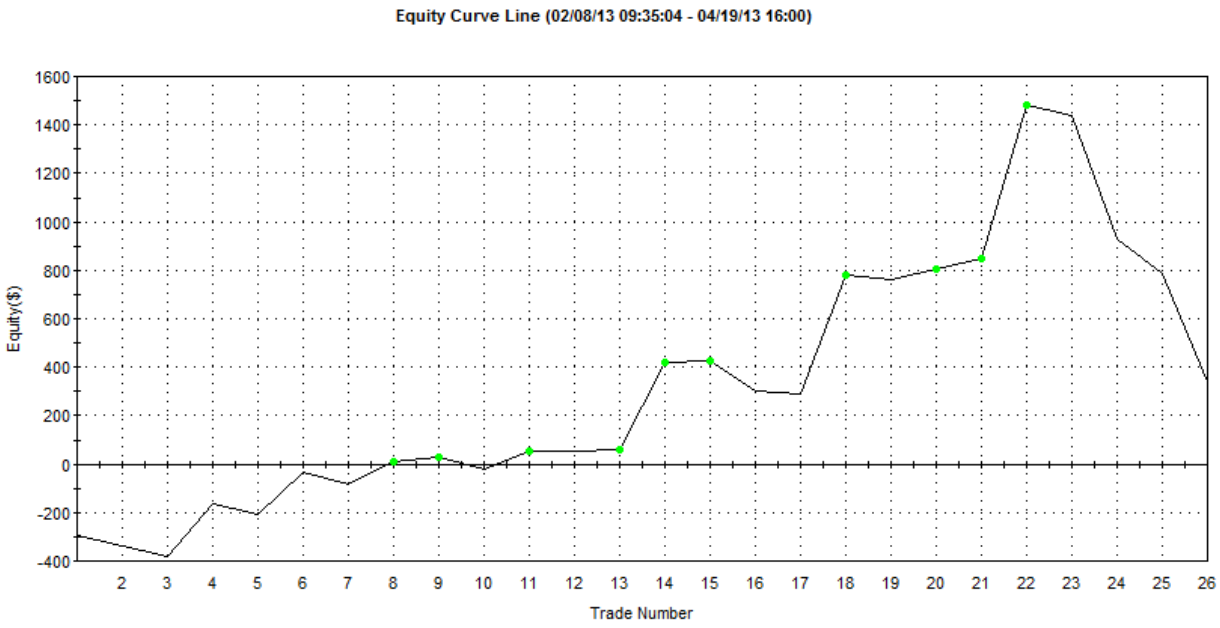


Figure 10 - WYNN Simulated Trading Equity Curve

Recommendations for Future Research

Developing this gap trading system was an open-ended venture. It started with the basic idea of gaps between stock prices that are likely to be filled, and we built upon the idea as we saw fit. With so much room for creativity, we had several ideas for the system that we simply did not have time to fully explore. That being said, we have several recommendations for future work with this system.

First, we would recommend testing the system on more stocks. Once we had found a handful of promising stocks, we shifted our focus toward refining the system. By the end of the project, we had tested this system on roughly 100 different stocks, but our most recent stock scan resulted in more than 50 potential stocks that we had not yet tested.

Secondly, we would have liked to incorporate more statistical techniques into our system. For example, we tried to find correlations between the event of a stock closing its gap and that stock's trading volume at that time as well as its volatility. While our efforts proved unsuccessful, there are countless other indicators to consider that could have some correlation with gaps closing. We would recommend looking into other indicators that may exhibit such a correlation.

While our system was specifically designed to trade partial gaps with high probability of closing, it certainly would be possible to implement strategies for trading full gaps into the system. We chose not to pursue these strategies because we felt it was more important to take a simple, profitable system and refine it to increase profits instead of trying to increase profits by making it more complicated. That being said, it may be worth trying to expand upon the system at this stage.

Finally, we just thought we should point out the fact that this system was restricted in its potential due to the limitations of the TradeStation software. To be fair, it is an excellent program for the average trader, who probably looks at a few charts and indicators and may want to improve their trades by using some simple strategies. That being said, we often had to go to the TradeStation forums for help with resolving issues with EasyLanguage, since the built-in guides and coding dictionary failed to explain how certain functions worked. From the point-of-view of a computer programmer, there seem to be multiple flaws in how EasyLanguage is designed and how it is executed in the TradeStation platform. While these may be overlooked, the major problem with using TradeStation for our Gap Trading system is the complete lack of historical data on the bid and ask prices of assets. Being able to directly account for the bid-ask spread when back-testing would greatly benefit our system. For these reasons, we recommend looking into other software for automated trading before deciding to pay to use TradeStation for the purpose of working with our Gap Trading system.

Gorilla Swing System

System Objectives

Our system of systems is based on the idea of being in the market the smallest amount of time while accumulating the most profit possible. This theory is the backbone of our system and partially why we chose the three diversified system approach. The Gorilla Swing System is a clever way of stating a strategy that refers to the "GorillaTrades" pay-to-use system found online at www.gorillatrades.com. The "Swing" aspect to the strategy is a twist to the Gorilla system that involves a swing trading, analyzed entry and exit, calculated stop loss redefined strategy. This strategy was inspired by the active use of the GorillaTrades system with an interest in improving an already profitable strategy. Our team researched the Gorilla system in terms of user reviews and major write-ups in newspapers or magazines. The majority of the reviews were positive in nature but many of the major newspaper articles criticized the system for barely outperforming major market indices. Another criticism from our group's firsthand experience is the embellishment of profits from the Gorilla's portfolio. The portfolio will assess the profit margins according to the trigger price of the stock, when the Gorilla clearly states in the tutorial to only purchase a long position if the stock has confirmed. Trigger price and confirmation price are two entirely different concepts as the confirmation price includes specific volume. Our objective for the Gorilla Swing System is that the ideas set in place by GorillaTrades can be optimized with a smaller amount of time spent in the market and tweaked system.

System Details

The idea of swing trading the Gorilla system came from our original idea of staying in the market for the least amount of time possible. GorillaTrades informs investors that they should wait patiently for the behind the scenes work to trigger and confirm a stock pick. The Gorilla originally finds stocks by using a behind the scenes screener that looks for important values in a company. After research our group determined some of the indicators used include MACD, Volume, Moving Average, Money Flow, OBV, Volume/Price Trend, Volatility, Volume Oscillator, SK-SD Stochastic(s), Relative Strength Index, Accumulation/Distribution, and Velocity. By using these indicators and coming up with a list of stocks the GorillaTrades system will then wait for a stock to "trigger", or hit a specific

price according the applied indicators. The system will also identify when a stock has "confirmed", which means there is minimal risk in purchasing the stock. The graphs of the potential GorillaPicks are also given to investors so that they can see its most recent behavior. See Figure 5 for an example chart.

Figure 11: GorillaTrades DNKN Chart

The idea of our group's swing trading strategy was to maximize the profits in the GorillaPicks by using quick swing trades of picks that have yet to trigger. This idea was back tested by the group and proved to be the best approach to swing trade the Gorilla system. Other options were considered such as the purchasing of a pick that has confirmed

and swinging it for no more than two or three days. The back testing on this theory proved that more than 70% of the time this strategy resulted in negative profits. Swing trading picks immediately after they have triggered proved to be the most effective option and showed more than a 50% chance of being profitable when back testing. We would then make a portfolio similar to the GorillaTrades portfolio that documented our trades and the current profit. See Figure 6 for a sample portfolio:

Figure 12: Sample GorillaTrades Portfolio

Company Name	Symbol	Risk	Trigger Date	Confirm Day	Confirm. Volume	Trigger Price	Current Price	Stop Loss	1st Target	Gain	2nd Target	Unrealized Gain/Loss
										Sold 75%		
Advance Auto Parts, Inc.	AAP	3	4/12/13	Not Yet	885,000	83.38	78.92	76.75	90.00		100.00	-5.35%
Abbott Laboratories*	**ABT**	**3**	11/15/11	12/7/11	**8,250,000**	27.31	36.88	32.00	**29.50**	**8.04%**	44.00	**35.04%**
Arch Capitol Group, Ltd.	**ACGL**	**2**	4/13/12	4/17/12	**540,000**	37.91	51.60	45.00	**40.25**	**6.17%**	63.00	**36.11%**

Trading Time Frame

The time frame used for the Gorilla Swing System is based on multi-day swing trades. The swing trading strategy is meant to maximize the profits of the GorillaPicks with a short amount of time in the market. The short amount of time in the market is meant to minimize risk by minimizing exposure. The time frame was back tested by our team and proved to be effective when looking at past GorillaPicks.

Entry

Stock choices

GorillaTrades offers a very effective stock scan to its paying customers. The Gorilla will then send the investors an email with new picks for the day. The existing system gives all readers trading advice and provides a "confirmation" for investors to buy the given stock. Our group eliminated the confirmation day and started trading the stocks on the trigger date. The triggering stocks are picked using indicators such as the MACD, Volume,

Moving Average, Money Flow, OBV, Volume/Price Trend, Volatility, Volume Oscillator, SK-SD Stochastic(s), Relative Strength Index, Accumulation/Distribution, and Velocity.

We carefully analyze the picks that GorillaTrades sends us. Our analysis is based on the specific volume at the time of triggering and the risk to return ratio. This ratio is assigned to the new GorillaPicks and gives the investor an idea of how volatile the position may be. Our group decided that we want to lean towards a higher risk to return ratio because we are in the market for such a small amount of time and a stop loss will prevent large losses. Two stocks that we traded were Dunkin Brands Group Incorporated (DNKN) and SanDisk Corporation (SNDK).

Set-Up and Trigger Rules

The set-up for the Gorilla Swing System relies upon the picks of the day from GorillaTrades. If there are no picks that trigger on any given day, the system will not be active. This is an important aspect of the system because limiting the team's market exposure is our system's backbone. If we were to start a position on a day where there are no triggered picks we would be compromising the integrity of the system. After a pick is sent to our team we carefully analyze it taking into account the market news for the day and the risk to return ratio. Earnings reports can be another aspect that could shift investors' expectations significantly. Taking this into account our team avoids all trades near a company's earnings report or any other major news as these provide more risk than necessary.

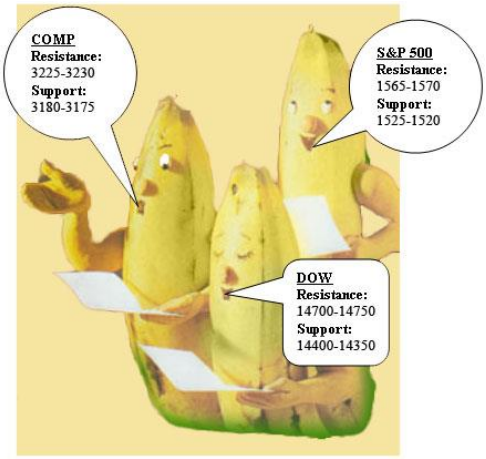
Exits

Exiting with a Profit

The system rules for exiting with a profit in the Gorilla Swing System are based heavily on fundamental analysis but have some technical aspects also. These fundamental analytics comprise of broad categories such as health of the market, risk ratio, earnings reports and any major news that involves the company. As stated before, positions in this system may be held overnight for more than one night depending on the trend of the stock and the fundamental analysis. The GorillaTrades site provides many valuable sources for investors to perform fundamental analysis on their portfolio of GorillaPicks. One of the assets the site provides is the Banana Barometer. This tool is very helpful to the investor as it provides an overall current market feel. It shows the support and resistance levels of

important market indices and also provides the user with investing tips. See the following figure for an example Banana Barometer:

Figure 13: Example Banana Barometer



The market is showing signs of being

NEUTRAL

The Gorilla defines a NEUTRAL Banana Barometer reading by the following:

-A market that lacks any concrete direction (holding a defined trend for at least 2-3 months)

-A market that lacks any firm, consistent volume, above key technical levels

-A market that may be susceptible to unexpected volatility

This market action is usually a result of the market sorting out its next move. However, money is always changing hands. Therefore, please review the many GorillaTrades Systems Tools to help reduce trade risk: "CONFIRMATION DAY," RISK RATINGS, DOLLAR COST AVERAGING "UP."

If the stock is on a bullish trend the system will hold that position until it hits a first target. This first target is shown on the GorillaTrades charts for the given company in the portfolio. If the target is hit within the swing trade period the system will sell 75% of the position size and hold on to the remaining 25%. The remaining position will continue to be held with a rising stop loss until it falls below the floor.

If a position is trading flat for two consecutive days it will be sold because of inactivity. The goal in this system is to hold positions that are bullish and active and to eliminate those that are not. The unrealized gain is the percentage of profit that is generated from the last 25% of the position that is held until it falls below the rising stop-loss.

Exiting with a Loss

Exiting with a loss in the Gorilla Swing System is fairly simple compared to profits. The chandelier stop-loss implemented by the swing system will help our group avoid any large losses that will hurt our system performance as a whole. The rising stop-loss helps encourage growth while conserving profits as well. The system will immediately exit a position that gaps down sharply after it is entered which allows for improved risk management. The rising stop-loss is originally set with a maximum amount of drawdown that we want to allow for on the initial position. If this drawdown is exceeded the position will be promptly exited.

Order Types

Our Gorilla Swing System exclusively uses market orders to fill a position. This strategy will enter the market with a volatile position that could potentially trend either bullish or bearish. When the position is this volatile it is important that the order is filled as soon as possible. Although market orders incur some slippage costs, the swing strategy is not using bars that will make slippage a major factor. Market orders give the swing system the best chance to make a profit in a volatile position.

Position Sizing and Risk management

Risk management in the Gorilla Swing System is enforced by the chandelier stop-loss method and fixed fractional position sizing method that our group implemented. Position sizing in a trading system is arguably one of the most important factors because it deals with the size of profits and risk management. The fixed fractional method fit the swing system because it allows our group to allocate a percentage of the total equity and assign it a trade risk. Our group now only risks a fixed fraction of our equity on each trade. The formula for fixed fractional position sizing is as follows:

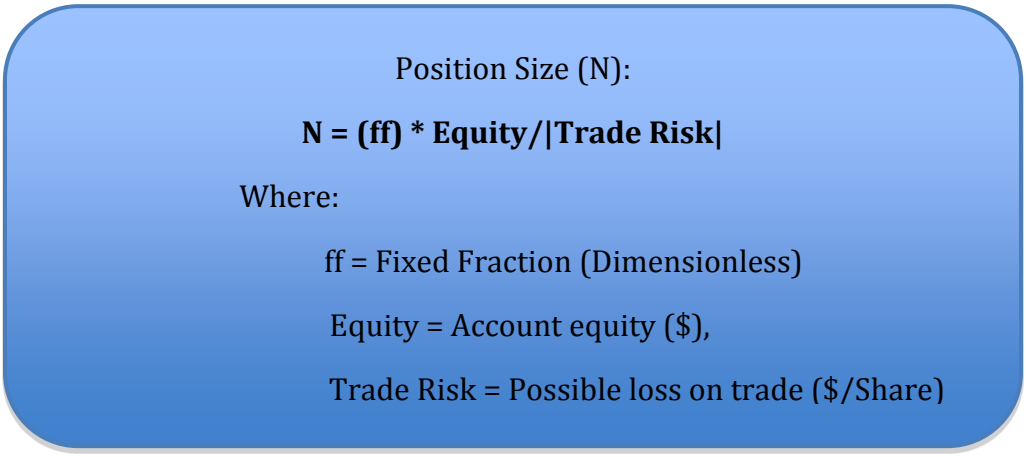


Figure 14: Fixed Fractional Position Sizing Equation

The group decided on this option of position sizing because it will maximize our profits using a lower trade risk with confident trades while minimizing our losses using a higher trade risk with lower confidence. Our group used fixed fractions in the range of 10 to 20 percent and experimented with how this would affect our profits and losses. We concluded that the best fixed fraction would be 15 percent of one group member's $100,000. We consider this percentage of equity to be the maximum amount of loss on any given trade. When calculating the trade risk for our fixed fractional equation we have to take into account all the risks associated with the given trade. These risks may include fundamental factors such as breaking news for the company or technical aspects such as liquidity. We look at historical data and previous trends to determine the future pattern of the stock or any volatile gaps it had in the past. The VIX index is also utilized as this shows us how volatile the market is at any given point. We also take into account the risk ratio that GorillaTrades associates with the given pick.

System Monitoring

Determining whether a system will be effective in the long run by using its current and past performances can be a very difficult task. Since our Gorilla Swing System is virtually impossible to back test on TradeStation our group had to use current results to obtain future predictions of how the system will perform. Analyzing current GorillaPicks in the portfolio and applying them to the swing system to see how they performed is how we achieved this. This test does not take into account the fundamental approaches that we would have with any new picks. The percentage of winning picks that were analyzed was

great enough that our team was able to determine the system as effective for current trading.

As was said earlier in the Gap Trading System section, we applied Bernoulli trials to our systems to calculate the probability of observing a set of wins and losses under the assumption that the historical win rate is the true probability of winning. See the following equation:

$$f(k;n,p) = \Pr(X = k) = \binom{n}{k} p^k (1-p)^{n-k}$$

Final Revisions and Modifications

The ending modifications to the Gorilla Swing System are by no means the last that should be done. This system, like our other systems, will need tweaking in the future to account for possible market shifts and for our complete portfolio analysis. Back testing the Gorilla Swing System is virtually impossible because our group does not have access to historical GorillaTrades data.

The last modifications to the system include a change to the chandelier stop-loss method that was implemented. The chandelier stop-loss is a moving floor that adjusts to the stock price as it rises. If the stock were to dip down, the floor of the stop would stay the same. Our goal for this floor was to raise it at a pace that will promote the most growth in the stock. As previously mentioned, the Gorilla system lets 25% of the position stay in the portfolio as long as the stock has hit its first target in the time allotted. Our original idea was to have the same chandelier stop-loss algorithm for the final 25% position as we did for the full position. This however would cause us to lose much of our unrealized gain from the 25% position size that we are still holding. The modification was made to the stop-loss for a floor that will hug the stock price tighter after 75% of the position size is sold for a profit. This revision will increase our profits by not letting the smaller ending position plummet through the original resistance line of the stop-loss.

Performance Analysis

In its first stages, the Gorilla Swing system was tested by tracking GorillaPicks from the day of triggering and seeing how they performed in a two to three day time period. From this point our group determined that the strategy should be traded and the EasyLanguage code was implemented. Simulated trading came soon after and we tested

the system on two stocks: Dunkin Brands Group Inc. (DNKN) and SanDisk Corporation (SNDK).

The two stocks were each bought at $37.40 (DNKN) and $52.16 (SNDK) respectively. Both of the positions ended up making a profit in the span of three days. Each made slightly less than 1% of the original stock price entered. This may not seem like much but if the correct position size was analyzed these gains could result in massive profits. Both of the positions were not sold at the end of the three days, as we wanted to continue the analysis of our stop-loss. If the strategy that we used for position sizing were implemented, the unrealized gain of the final 25% position would be 2.51% for (SNDK) and 1.15% for (DNKN). These are large gains for a low risk position in a trade that has already made a substantial profit. The shocking factor is that if the chandelier stop-loss was implemented on the final 25% position size for each stock, our group could have made upwards of 13% of the SanDisk position and 6% of the Dunkin Brands position. Overall we had very successful, but limited, simulated trading results and this gives us confidence in the future of the fully implemented system.

Future Work

There are many possibilities to improve and change the Gorilla Swing system, the only constraints are time itself. The ideas that our group had for the system in the future included, artificial intelligence applications and a re-calculated first target.

As stated earlier in our brief explanation on artificial intelligence, this field is seen to be the future of investment and trading. The applications are endless and many have yet to be developed. An application that we would look into if we had the time would be the processing of big data for fundamental analysis of a stock. In the Gorilla Swing System an important factor that our team relied on was how the fundamental aspects of a company can affect its stock price. We used things such as company financial and earnings reports to evaluate the way a stock would move. The suggestion for future research would be to look into the big data of a financial twitter feed in order to determine the state of a specific market. This would significantly lower the risks of trades if the system had the knowledge of a specific market.

The first target recalculation would help improve the Swing System in the long run because most of the stocks we tested did not reach the GorillaTrades optimized first target. Part of the reason why this target was rarely hit is because our swing trading system uses a

different time frame than GorillaTrades. A recalculated first target would allow for the system to sell the position and making a profit off of a small percentage gain.

Paul Woldt's Opening Range Trading System

The Opening Range Strategy focuses on the market at the opening of the trading day. Its goal is to follow the changes of the market overnight, and to predict its behavior during the open. Because of how rapidly a market can move during this first half hour, a successful prediction can yield large profits in a short amount of time.

This strategy was originally developed by trader Paul Woldt as a manual strategy. The goal of this system is apply Mr. Woldt's rules to a TradeStation scan and EasyLanguage strategy to create an automated trading system.

System Objectives

The primary appeal of the Opening Range strategy is that it requires a minimal amount of time from the trader to operate. By definition, this system only operates during the market opening, which is defined here as the first half hour of trading in a day. However, large volume shifts due to overnight orders can cause a market to move at a relatively fast pace and successfully trading these markets can create profits comparable to longer-term strategies.

The main difficulty in trading this strategy comes from attempting to predict the markets. Prices can move quickly both up and down, not move at all, or simply behave as they would during the normal trading day. Therefore, creating a strategy that has a majority of winning trades is not a practical goal. Instead, this strategy will focus on creating a higher return from the few winning trades. This will be accomplished by creating a strict exit strategy that will minimize the impact of any failing trades. This exit strategy will also end winning trades quickly, to prevent sudden fluctuations in the market from harming their return value.

Because the system only trades during a certain time every day, some of the strategy's properties are limited. For example, because the strategy is based on exploiting the chaos of the first few minutes of trading, there is no reason to hold onto a trade any longer than for the first half hour. This has the effect of placing a limit on the amount of time a given position can be held. In addition, while the system will scan the market's behavior for the rest of the day in order to predict its behavior on the next opening, it will not trade during this time, nor will it hold any position overnight.

Since this strategy is just a part of a larger system of systems, the maximum drawdown this strategy can take may vary. While keeping the maximum below 2% was a common goal, this can be increased or decreased based on the effectiveness of the strategy in relation to the other two.

Trading Time Frame

As previously mentioned, this strategy will exclusively trade during the first half hour of the trading day. This allows the system to work during a time when a market's volatility is at its highest, and large profits can be made quickly. Continuing to trade after this opening period creates the risk of the market stabilizing as orders overnight are filled and prices converge to their daily values, which creates long-term positions that are not the focus of this strategy.

In order to track information most effectively during this time frame, the strategy will use one-minute time bars when trading. This provides the highest resolution for viewing the price changes, which is useful during periods of high volatility. In addition, since the time frame is so small, it's possible to track the complete movements of a market during the time the system is trading. As will be seen, the exit strategy also benefits from this setup, as this allows it to cut off a trade the moment it begins trending down.

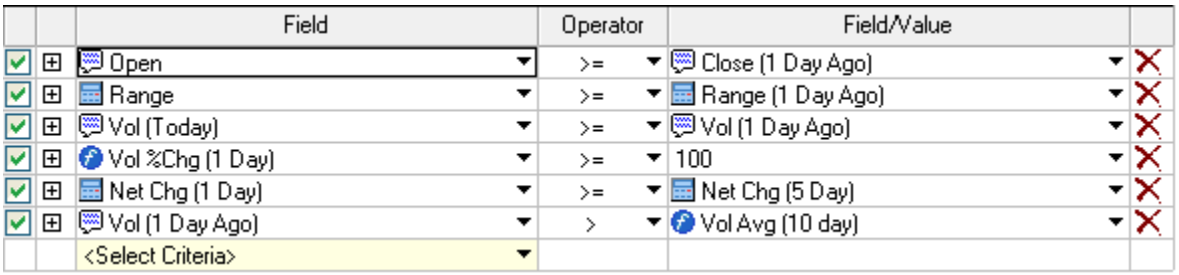
System Details

Entry Rules

The entry rules for the Opening Range strategy are primarily based off a series of filters that scan the market before opening. The exact criteria used are shown in Figure 9.

These parameters were chosen in order to find stocks that could be expected to have a large increase in price upon the market open.

Figure 15: Parameters used for Opening Range Scan.



These parameters can be divided into two categories: those that measure changes in the market over the last few days and those that measure changes in the market between the close of the previous day and the opening of the current day. The first group is an indicator of the market's health. If the market has had a relatively low volume or price during the past few days, this indicates that the market is not performing well, and attempting to trade it during the day's opening. Conversely, a market that is trending up at the close can be expected to continue the next day, as traders continue to buy stocks or hold positions overnight. The second group is designed to monitor orders that have built up overnight, which will be filled by the open, which will cause the price to change accordingly. For example, if a large number of orders were placed overnight, there can be a substantial change in price by the market open. Therefore, checking changes since the close allows a smart trader to predict opening behavior, and enter into a market confidently.

The specific criteria selected for the filters are: Opening price versus closing price of the previous day, current range versus range of the previous day, current volume versus the volume from the previous day, whether the volume change over the past day was greater than 100%, whether the net change over the past day was greater than the change over the past five days, and the current volume versus the 10-day average.

Before the opening of the market on days when the strategy is active, the scan is first run on all stock symbols to find what markets pass all of the criteria. Typically, anywhere from a dozen to approximately thirty symbols pass through the filter, creating a list of potential trades for the day. In order to determine which symbols to trade at the opening, this list is further inspected to determine which stocks have the most growth, and can be expected to continue this growth. For example, in Figure 10, APL has the highest volume change, well above the average for the other stocks in the list. This type of change

can possibly signal a "bubble," where many traders will enter into the stock only to exit around the same time, driving the price down quickly. Therefore, this stock's extreme volume change shows too much risk to consider trading. Once a few stocks are found that have the right balance of all the criteria that stock is chosen to trade.

Figure 16: Example Scan using Opening Range parameters

	Symbol	Open	Close (1 Day ...	Range	Range (1 Day...	Vol (Today)	Vol (1 Day Ago)	Vol %Chg (1 ...	Net Chg (1 Da...	Net Chg (5 Da...	Vol Avg (10 d...
1	AAV	3.52	3.49	0.27	0.15	723,166	553,781	245.65	0.24	-0.16	396,550.00
2	AMCC	6.85	6.81	0.75	0.47	493,759	463,691	101.96	-0.09	-0.82	453,460.00
3	ANAD	1.80	1.80	0.14	0.13	687,334	644,957	188.42	-0.07	-0.27	582,640.00
4	APL	34.51	34.24	0.66	0.64	7,531,635	2,677,065	656.92	0.46	-0.39	653,090.00
5	ARQL	2.87	2.84	0.13	0.10	593,483	397,688	132.63	0.13	0.10	393,840.00
6	ATEC	1.90	1.89	0.17	0.11	222,963	168,473	108.27	-0.12	-0.29	88,670.00
7	BERK	8.43	8.38	0.68	0.16	28,504	5,866	292.64	0.05	-0.41	3,460.00
8	CNBKA	33.97	33.81	0.65	0.56	15,775	8,256	244.57	0.25	-1.12	3,680.00
9	CPN	20.90	20.87	0.48	0.42	7,318,844	5,637,164	176.16	0.03	-0.51	3,196,030.00
10	DCA	4.18	4.18	0.12	0.09	119,245	98,050	141.54	-0.07	-0.08	56,840.00
11	ESBF	13.63	13.49	0.46	0.38	31,752	22,100	224.86	0.40	0.39	9,200.00
12	ESP	25.23	25.21	0.70	0.51	11,409	8,159	159.92	0.17	-0.19	2,340.00
13	FCS	14.21	13.48	2.25	0.52	5,861,902	3,361,694	156.64	-1.33	-2.09	1,436,680.00
14	HNSN	1.95	1.95	0.11	0.06	318,863	287,216	129.86	-0.05	-0.18	244,540.00
15	IIIN	14.75	14.67	1.46	1.27	91,931	76,608	213.58	0.70	-0.44	40,790.00
16	IXN	68.37	68.10	1.20	1.18	142,849	76,785	438.28	-0.82	-2.84	25,220.00
17	KIE	51.16	51.16	0.72	0.55	247,016	85,104	102.47	-0.45	-1.86	77,820.00
18	KINS	5.31	5.30	0.10	0.01	4,300	2,020	152.50	0.00	-0.10	820.00
19	LINC	5.15	5.12	0.46	0.30	144,206	89,973	200.55	0.33	0.00	55,680.00
20	MNOV	2.45	2.38	0.30	0.10	109,813	42,142	280.89	0.16	0.14	29,500.00
21	MZF	15.43	15.35	0.16	0.16	22,170	16,083	165.26	0.18	0.17	10,980.00
22	NWFL	29.90	29.79	0.30	0.04	1,291	755	179.63	0.70	0.49	420.00
23	OCFC	13.64	13.58	0.54	0.39	90,212	84,829	199.60	0.43	-0.26	32,990.00
24	ONNN	8.01	7.88	0.70	0.35	20,004,171	16,363,066	112.66	-0.42	-1.04	8,549,490.00
25	PBS	19.53	19.50	0.40	0.24	328,121	231,321	174.75	-0.30	-0.63	126,490.00
26	REDF	2.72	2.68	0.20	0.12	50,579	34,258	153.65	-0.01	-0.08	31,040.00
27	SIFY	2.02	1.94	0.30	0.06	461,432	53,195	112.69	-0.02	-0.03	39,810.00
28	SNDK	56.61	55.72	5.92	2.63	16,455,595	11,199,282	174.14	-3.85	-6.75	4,496,140.00
29	SOXX	57.21	56.58	1.61	1.47	456,146	199,818	183.10	-0.61	-3.06	129,090.00
30	TSM	18.14	17.08	0.44	0.18	24,319,564	21,227,098	115.37	0.89	0.63	11,068,850.00

While searching for potential trades, it is important to keep track of current news that could have an effect on a certain stock, and to plan around this news accordingly. If any sources indicate that the market is ready for a poor day, it is often advisable to simply ignore trading that day. Trades made during the opening are often emotionally based, and bad news has a large impact on these early trades.

Once a stock is found that has passed through the filter, appears to be steadily growing, and there is no bad news about it (or if there is good news), it is now time to enter into the market. Once a position is successfully held, it is the exit rule's role to end the trade at the right time.

Exit Rules

The exit rules for this strategy are fairly simple. The first rule for this strategy is once the time hits 10 a.m., sell the stock, regardless of its performance. Once the opening

range is done, the market will begin to settle into an orderly trend for the rest of the day, which the system is not designed to handle.

Of course, this rule only applies if a position is being held for the entire half-hour. In order to exit the stock at an earlier time, another exit rule is needed. Because of the speed with which a stock can fall in price during the market open, holding onto a losing position for any length of time is risky. In order to prevent any losses, a simple stop loss rule is included in the strategy. It records the price at which the stock was bought. If the price stays below this for more than a few minutes, at the discretion of the trader, the stock is sold. Although this has the risk of exiting some positions prematurely, it is a compromise to prevent any major losses during this volatile period.

Order Type

This system will exclusively trade market orders. These orders were picked because they are the fastest to enter the market, and given how little time the system spends in the market, any time spent searching for an order is significant. Limit and stop orders, by comparison, take too long to enter the market and, as a result, waste valuable time that could be used to hold a position.

In addition, the opening range strategy works best with high volume, volatile markets. Market orders, of the order types studied, are the ones most suited to these markets. Under these conditions, it is difficult to ask for stock prices, or to predict when a stock may find resistance or support. This makes limit orders impractical, since there often will be a lower offer in the mass of orders. Market orders, on the other hand, can simply enter the market and hold the position instantly. This makes market orders the desired choice for this strategy.

System Development

The First Filter

The first iteration of the Opening Range system was a simple TradeStation filter. The parameters were directly derived from example trades provided by Paul Woldt. Woldt's personal strategy is summarized in Figure 5, and the text provided describes the values that he uses to track the opening range. These parameters are: Price between $10 and $40, with an average range of 0.6, the volume of the current bar is greater than the close of the previous bar (i.e. there is an upward trend), and the price breaks through the

opening range set at 9:34 am. Apart from this last value, all of these were used to create a filter in Tradestation which scanned the market every morning at 9:30.

At this point, the purpose of the filter was not to help trade. Instead, it was a tool to analyze the market, and attempt to determine qualitatively which markets would breakout. This period continued for some time, simply looking at the scan results every day and attempt to predict which markets would break out on a given day. This procedure was a great help during later development.

The First Strategy

At the same time that the filter was being developed, a simple Easy Language strategy was also created. This script was a few lines of code that gave two rules for trading: after 10:30, sell the stocks at the market and finish trading, and if the price ever dropped during this session, sell the stocks and finish for the day.

This was a very naïve system. The goal here was to create a base that would be further developed as the opening range was better understood. Like the filter above, it was not meant to be traded at this point.

Figure 17: Example of Paul Woldt's Opening Range trading system.

Here are the 6 stocks that came up in the Bull Gap scan 6.6.6 from open until 9:34. Market was down today. I have the price filter set at $10-$40, the avg rng set at .6. I vary these parameters from time to time based on the market. Here are some random notes/thoughts on how I do this type of fast play. Remember, what works for me might not work for you. And this is a continuing work in progress. The OR is set at 9:34, so the green and red OR dots show up at 9:35. I want the volume to continue after open (bars to be above the blue average volume line), opening volume should be higher than previous closing's volume, and a tight consolidation from the end of previous day, and the price goes through the OR green dotted line. These charts are from TradeStation. As always, do your own DD. And scalps at open are not

Figure 18- Example of Paul Woldt's Opening Range trading system

Experimenting with Filters

After spending some time analyzing markets using the original filter, it was decided that the selection criteria was too specific. Specifying price ranges, and volume having to constantly go up, which meant that even a negligible downturn removed an viable candidate from the selection pool, yielded results that often would not break out to the degree expected, if at all. Oftentimes, the scan would not find any markets fit into the criteria, which meant that a day of trading was wasted.

After this decision, a new theory arose that became the new base of the strategy. Stocks which show growth right before opening often experience a breakout right at the open; exactly the types of markets the scan is meant to find. In addition, growth is a more general quality than a price range or volume trend. Scanning for growth involves percentile based criteria, rather than actual numbers, which encompasses far more stocks and gives a greater selection for trading at the open.

With this theory, the focus of the scanner shifted from searching within a certain price range to searching for market growth. The first step in this shift was to modify the existing filters. Price range simply became the price of the stock, which would be required in the future for position sizing. The volume, which compared current volume to that of the last bar (V[x] > V[x-1]), was changed to monitor the percentage change. Also included was a new parameter that checked if the price of the stock at the open was greater than its price at the previous day's close, a simple, but still effective, method of checking for growth.

Range was similarly modified to check if it had increased over the past day. This was done as an attempt to gauge the volume and volatility of the stock, as a greater price range was believed to show a more fluid price.

The immediate results were apparent. While many of the scan results before had a small amount of stocks, and many were poor candidates for trading, the new filters often yielded upwards of 30 stocks, many of which often showed the desired breakout behavior. While this required more time manually picking stocks, the benefits of having a large selection pool was immense.

When modifying the filters, other options in TradeStation's scanner were tested. The parameters included values such as searching for a volume breakout over the past ten days, and searching for a percentage change in the price. Most of these, while useful in further refining the selections, contributed to a previous problem. Having too many criteria for a filter to pass resulted in the scanner giving very few potential stocks. While the benefits of having stocks that were effectively already picked by the scanner are obvious, it was decided that the greater flexibility from having a larger selection group was more useful. In addition, some of the criteria were again too strict, and some scans would not return any stocks at all. In the end, a decision was made to ignore these other filters, and to minimize the total number in the scan.

Expanding the Exit Strategy

With the new filter in place, it was almost time to start trading. Now the actual EasyLanguage strategy needed to be expanded. Because most of the stock selection and entry actions were being done manually, it was decided to simply make the script into the exit strategy. To do this, the naïve system created before was expanded slightly.

The first change to the script was changing the final exit time from 10:30 to 10:00 a.m. It was believed that holding on to a position for an hour was too long for this system, and that going past 10 o'clock risked leaving the breakout phase of the stock.

The second change involved expanding the rules for exiting at a loss. While before, any decrease in stock price resulted in the system immediately exiting, the new strategy tests the price in the last five minutes to see if it has been trending down. Although this is still a short time frame, testing for any longer during this volatile period was not an option, and would take a significant amount of the system's limited time in the market to test.

Final Filter Changes

With a working filter and a simple exit strategy, the system began trading. The trading was all simulated like the rest of the systems, which turned out to be beneficial, since the initial trades did not go as expected. Most trades simply exited after the five minutes that the strategy required, and the few that exited at 10 o'clock had little to show in terms of profits.

Development took a step backwards here, and determined that the scanner's filters, and the rationale behind choosing stocks from the scanners results, were flawed. Choosing stocks that broke out of their opening range was inconsistent, and any criteria that were added to improve the scanner did little to help. In addition, the new filters created the same problems discussed earlier, yielding few results that more often than not did not breakout as hoped.

After some time attempting to improve the system, a new perspective was found. Taking advice from Professor Radzicki, it was found that the scope of the filter was too small. By only looking at data from the close of the previous day to the open of the current day, a large amount of data was being overlooked. If information about the stock's performance over a longer period of time was taken into account, it became noticeably easier to track the stock's growth.

With this new understanding, two new filters were added to the scanner. The first was the net change in price over one day compared to its change over five days. The second was the volume of the stock on the previous day compared to the five-day (one business week) average. These two new parameters gave a greater insight into the market's health.

While these new changes did not create a perfect system, there was a noticeable improvement. While many stocks still exited very quickly into the system, generating a string of losses, judging markets by the new parameters helped to finally find a few breakouts, which made the system roughly break even.

System Analysis and Future Work

Simply put, the system does not yet perform well enough to warrant being used for full-time trading. The criteria for scanning the markets are complete, and it is possible to

find potential stocks that will break out. The issue comes in evaluating the scanned stocks and determining which of the potential stocks to trade. The most common scenario was that although a stock passed through the scanner, it did not actually break out and instead either trended horizontally or downward slightly for the half hour. In these cases, the exit strategies would simply exit with either no gain or a small loss. However, in the case where a stock did break out of its opening range and began trending upwards, it often resulted in a relatively large profit that managed to balance the losses accrued. In conclusion, the system has a very small winning percentage, and the profits gained on these wins are not enough to make the system viable.

In future work on the system, the main goal should be to increase this winning percentage by better quantifying the criteria used to choose stocks to trade. Given more time, this system would have included a weighted value analysis script that would objectively evaluate the filters and determine stocks automatically. However, time constraints and difficulties implementing this in the TradeStation platform means this part is not completed. In addition, improving the exit strategy into a more refined stop loss measure may also help to minimize losses, and provide better rules for exiting with a profit.

Conclusion

It seems like there is potential for our system of systems to make money as a whole if we had more time to develop the individual systems and could analyze their performance on a combined portfolio. We successfully created three individual trading systems that met our objectives in theory but it is unclear whether or not they will work in the practical sense because we did not have enough time to test the completed system as a whole. Before we would be willing to trade the system of systems with real capital, we would need to perform portfolio analysis.

The majority of the challenges we encountered in our project were a result of EasyLanguage programming issues and other technical problems with the TradeStation software. The biggest problem we faced with the Gap Trading System involved accounting for the costs associated with slippage and the bid-ask spread of stocks being traded. In order to handle this we looked at the costs incurred during simulated trading and treated the average of these as our estimate for the costs of future trades. Major problems

encountered with the Gorilla Swing System were position sizing and back-testing. Our fixed fractional position sizing method was implemented toward the end of the development stage; therefore we had limited simulated trading results with this active. As previously mentioned, back-testing was nearly impossible to perform on the system but this was overcome by manual technical analysis of stocks in the Gorilla's portfolio. For Paul Woldt's Opening Range system, the main difficulty included creating an adequate strategy for choosing stocks to trade. Limitations in EasyLanguage made scripting this process impractical, and manually picking was slow and inaccurate. In addition, there was difficulties position sizing, which stemmed from the previous issue.

We would recommend that a system quality analysis be performed on our portfolio in addition to what we recommended for each individual system. This would allow us to optimize the equity curve for our entire system. Most importantly we would be able to efficiently allocate capital among the three different systems. Future researchers interested in this system of systems should consider other trading software as TradeStation was not suited for our particular systems.

Appendix A – EasyLanguage Code

Gap System Code

```
// Gap Trading System

// Basis for trading: When a stock experiences a "partial" gap between the last price of the previous day
//                    and the first price of the current day, there is a high probability that, before the
//                    end of the current day, the stock's price will return to where it was at the end of
//                    the previous day. This is referred to as either "filling" or "closing" the gap. This
//                     strategy uses the high and low of the previous day's final bar instead of its close.
//
//
// Entry: Look at the first bar of the day and the last bar of the previous day. If the opening price
//    is lower than low of the previous bar (by some minimum percent of the stock's price), then the
//    stock has gapped down and should be bought. If the opening price is higher than the high
//    of the last bar (by some minimum percent), then the stock has gapped up and should be sold short.
//    **All enrties are at market
//
//     Entry exceptions: -If the gap in prices is abnormally large (greater than some percent of the
//                               stock's price), then it is likely making a price movement and will not fill
//                               the gap. When this happens, we make no entry.
//                               -If the close of the first bar is beyond the gap-filling price, we make no entry.
//
```

```
// Position sizing: Risk a fixed percent of total cash in each trade. To calculate the risk per share,
//                  look at the difference between the daily high and daily low prices for the past 7
//                  days and calculate the average difference. Use this average as the risk per share.
//                  To calculate #of shares, divide the total amount you want to risk (some percent of
//                  total cash available) by the calculated risk per share.
//                  -Additional option to scale position sizes based on day of the week
//                  -All positions are limited to a maximum size as a percentage of the account
//
// Exits: - when gap has filled and the "waiting time" has not passed
//    - when gap has filled and the waiting time has passed, unless the price direction is toward more profit
//    - when the price direction is away from profits and the waiting time has passed
//                   (waiting time gives the stock a chance to turn around within the first hour or so of trading)
//    - when the end of the trading day is approaching (no positions held overnight)
//    - **any** time a trade hits the maximum loss allowed
// Note: no positions held past 3:30pm

inputs:
      GapPct( 0.1 ) ,        {determines minimum size for gaps to be traded}{default=0.1% of stock price}
      BigPct( 2 ) ,          {determines maximum size for gaps to be traded}{default=2% of stock price}
      DirectionInterval( 5 ) ,        {separation between bars for calculating the "direction" of the price}{default=5}
      QuittingTime( 1530 ) , {time of day when any remaining open positions are closed}{default=3:30pm}
      WaitingTime( 1100 ) , {gives the stock time to fill the gap before it is considered a losing trade}{default=11:00am}
      PctRisked( 1 ) ,  {percent of the account risked per trade}{default=1%}
      PercentofAcct( 100 ) , {proportion of the account available for trading; puts limit on maximum position size}{default=100%}
      MaxLossPct( 2 ) , {maximum loss allowed per trade as % of account}
      MondayMultiplier( 1 ), {position size scalar for Monday}{default=1}
      TuesdayMultiplier( 1 ), {position size scalar for Tuesday}{default=1}
      WednesdayMultiplier( 1 ), {position size scalar for Wednesday}{default=1}
      ThursdayMultiplier( 1 ), {position size scalar for Thursday}{default=1}
      FridayMultiplier( 1 ), {position size scalar for Friday}{default=1}
      DirectionIndNumb( 4 ), {determines whether The direction indicator requires all 4 calculations to have the same direction or only 3}{default=4}
      allowshort( true ) ,{lets user to turn short trades on/off}{default=true}
      allowlong( true ) ;{lets user to turn long trades on/off}{default=true}

Variables:
            int myposition(0), {current position: 0=out of market, 1=long position, -1=short position}
            int entrybar(0), {bar number when position was entered. this variable is no longer used, but I didn't bother deleting it}
            Acct(100000) , {total cash currently in the account}
            RiskSize( 0 ) , {amount of risk per share}
            AMomentum1( 0 ), {current average momentum in price over first interval}
            AMomentum2( 0 ), {current average momentum in price over second interval}
            AMomentum3( 0 ), {current average momentum in price over third interval}
            AMomentum4( 0 ), {current average momentum in price over fourth interval}
            NumberUp( 0 ) , {number of calculations for average moment that are positive}
            NumberDown( 0 ) , {number of calculations for average moment that are negative}
            MovingUp( False ), {conditional variable for upward direction in price}
            MovingDown( False ), {conditional variable for downward direction in price}
            PSize( 0 ) , {current position size in # of shares}
            MaxPSize( 0 ) , {current maximum position size in # of shares}
            closingprice(0) , {price at which the gap is considered "filled"}
            JEnot( true ) , {condition used to make sure we dont enter and exit at the same time}
            dayssofar( 0 ) ; {variable for the number of days passed}


// It is now a new bar, so we have not entered any positions yet
JEnot = true;

// Reset price direction variables to zero
NumberUp = 0;
NumberDown = 0;


// If it is the first bar of the day, calculate the position size for the day
If Date <> Date[1] then begin
      // increment the number of days passed
      dayssofar = dayssofar+1;
      // calculate the maximum position size, TradeStation allows us to trade using up to 4 times the amount currently in the account
```

```
      MaxPSize = round( 4*Acct * PercentofAcct / ( Close * 100) , 0 );
      // calculate the risk per share for any trade made today
      //                    note: HighD(x) and LowD(x) are only accurate once x days have gone by since the first day the strategy is applied
      RiskSize = (HighD(1) - LowD(1) +
                                    HighD(2) - LowD(2) +
                                    HighD(3) - LowD(3) +
                                    HighD(4) - LowD(4) +
                                    HighD(5) - LowD(5) +
                                    HighD(6) - LowD(6) +
                                    HighD(7) - LowD(7) ) / 7;
      // calculate the appropriate position size based on the risk per share
      PSize = minlist( round((Acct*PctRisked/100) / (RiskSize),0) , MaxPSize );
      End;

// apply position size scalar depending on the day of the week
If Date <> Date[1] and dayofweek(date)=1 then
      PSize = Round(PSize*MondayMultiplier,0);

If Date <> Date[1] and dayofweek(date)=2 then
      PSize = Round(PSize*TuesdayMultiplier,0);

If Date <> Date[1] and dayofweek(date)=3 then
      PSize = Round(PSize*ThursdayMultiplier,0);

If Date <> Date[1] and dayofweek(date)=4 then
      PSize = Round(PSize*WednesdayMultiplier,0);

If Date <> Date[1] and dayofweek(date)=5 then
      PSize = Round(PSize*FridayMultiplier,0);



If dayssofar<8 then
      MaxPSize = 0;

// Set-Up Conditions
// Condition1: (out of market) and (first bar of the day) and (gapped down by minimum percent of price) and (gap is not too large) -->> go long
Condition1 = ( (myposition=0) and (Date <> Date[1]) and (Open < ( Low[1] - GapPct*Low[1]/100 )) and (Open > ( Low[1] - BigPct*Low[1]/100 )) );

// Condition19: the close is already beyond the gap-filling price -->> do not enter position
Condition19 = Condition1 and Close >= low[1];

// Condition2: (out of market) and and (first bar of the day) and (gapped up by minimum percent of price) and (gap is not too large) -->> go short
Condition2 = ( (myposition=0) and (Date <> Date[1]) and (Open > ( High[1] + GapPct*High[1]/100 )) and (Open < ( High[1] + BigPct*High[1]/100 )) );

// Condition29: the close is already beyond the gap-filling price -->> do not enter position
Condition29 = Condition2 and Close <= high[1];

// If the close is already beyond the gap-filling price, do not enter position (setting position size to zero prevents an order from being placed)
If (Condition19 or Condition29) then
      PSize = 0;


// calculate the average momentum for each reference point
AMomentum1 = AVGMomentum( close,DirectionInterval*1 );
AMomentum2 = AVGMomentum( close,DirectionInterval*2 );
AMomentum3 = AVGMomentum( close,DirectionInterval*3 );
AMomentum4 = AVGMomentum( close,DirectionInterval*4 );

// determine how many of the calculations for average momentum are positive
If AMomentum1>0 then
      NumberUp = NumberUp + 1;

If AMomentum2>0 then
      NumberUp = NumberUp + 1;

If AMomentum3>0 then
```

```
    NumberUp = NumberUp + 1;

If AMomentum4>0 then
    NumberUp = NumberUp + 1;


// determine how many of the calculations for average momentum are negative
If AMomentum1<0 then
    NumberDown = NumberDown + 1;

If AMomentum2<0 then
    NumberDown = NumberDown + 1;

If AMomentum3<0 then
    NumberDown = NumberDown + 1;

If AMomentum4<0 then
    NumberDown = NumberDown + 1;



// determine if the price direction is downward
MovingDown = NumberDown>=DirectionIndNumb;


// determine if the price direction is upward
MovingUp = NumberUp>=DirectionIndNumb;


// Condition5: end of day is approaching
Condition5 = t>QuittingTime;


// Condition6: true if MovingUp is false (the direction is not upward)
Condition6 = IFFLogic( MovingUp, false, true);


// Condition7: true if MovingDown is false (the direction is not downward)
Condition7 = IFFLogic( MovingDown, false, true);


// Make sure the position size does not exceed the maximum we want to allow
PSize = Minlist( PSize , MaxPSize ) ;

//////////////////////
// Enter long
if Condition1 and allowlong then begin
    // place the market order
    Buy ( "FGapDown" ) PSize Shares next bar at market ;
    // adjust variables according to the new position
    myposition = 1 ;
    entrybar = Currentbar ;
    closingprice = Low[1];
    JEnot = false;
    End;


// Enter short
If Condition2 and allowshort then begin
    // place the market order
    Sell short ( "FGapUp" ) PSize Shares next bar at market ;
    // adjust variables according to the new position
    myposition = -1 ;
    entrybar = Currentbar ;
    closingprice = High[1];
    JEnot = false;
    End;
```

```
//////////////////////////////////////


//////////////////////////////////////
// Exit long ////////

// If  (long position) , (it is early in the day) , and (gap has been filled)
If myposition=1 and t<WaitingTime and (close crosses above closingprice or close crosses below closingprice) and JEnot then begin
      // place the market order
      Sell ( "ExitLong-Filled" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (close-Entryprice)); {add profits/loss to cash}
      End;


// If  (long position) , (gap has been filled) , and (there is no upward momentum)
If myposition=1 and t>WaitingTime and (close > closingprice) and Condition6  and JEnot then begin
      // place the market order
      Sell ( "ExitLong-OvrFill" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (close-Entryprice)); {add profits/loss to cash}
      End;


// If  (long position) , (waiting time has passed) , and (there is downward momentum)
If myposition=1 and  t>WaitingTime and MovingDown  and JEnot then begin
      // place the market order
      Sell ( "ExitLong-Quit" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (close-Entryprice)); {add profits/loss to cash}
      End;



//////////////////
//// Exit short

// If  (short position) , (it is early in the day) , and (gap has been filled)
If myposition=-1 and t<WaitingTime and (close crosses below closingprice or close crosses above closingprice)  and JEnot then begin
      // place the market order
      BuyToCover ( "CoverShort-Filled" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (Entryprice-close)); {add profits/loss to cash}
      End;


// If  (short position) , (gap has been filled) , and (there is no downward momentum)
If myposition=-1 and t>WaitingTime and (close < closingprice) and Condition7  and JEnot then begin
      // place the market order
      BuyToCover ( "CoverShort-OvrFill" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
```

```
      Acct = Acct + (PSize * (Entryprice-close)); {add profits/loss to cash}
      End;


// If  (short position)  and  (there is upward momentum)
If myposition=-1 and t>WaitingTime and MovingUp  and JEnot then begin
      // place the market order
      BuyToCover ( "CoverShort-Quit" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (Entryprice-close)); {add profits/loss to cash}
      End;




//////////////////////
//// Exit before market closes

// If  (long position) and (it's quitting time)
If myposition=1 and Condition5 then begin
      // place the market order
      Sell ( "ExitB4Close-L" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (close-Entryprice)); {add profits/loss to cash}
      End;


// If  (short position) and (it's quitting time)
If myposition=-1 and Condition5 then begin
      BuyToCover ( "ExitB4Close-S" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (Entryprice-close)); {add profits/loss to cash}
      End;




//////////////////
//// Exit at maximum loss

// If (long position) and (losses reached maximum allowed)
If myposition=1 and (PSize * (Entryprice-close)) > ( Acct * MaxLossPct/100 )  and JEnot then begin
      // place the market order
      Sell ( "Exit-MaxLoss-L" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
      myposition = 0 ;
      entrybar = 0 ;
      closingprice = 0 ;
      Acct = Acct + (PSize * (close-Entryprice)); {add profits/loss to cash}
      End;


// If (short position) and (losses reached maximum allowed)
      If myposition=-1 and (PSize * (close-Entryprice)) > ( Acct * MaxLossPct/100 )  and JEnot then begin
      // place the market order
      BuyToCover ( "Exit-MaxLoss-S" ) PSize Shares next bar at market ;
      // adjust variables after exiting the market
```

```
myposition = 0 ;
entrybar = 0 ;
closingprice = 0 ;
Acct = Acct + (PSize * (Entryprice-close)); {add profits/loss to cash}
End;

//////////////////////
```

Average Momentum Function

```
//// Function:  AVGMomentum( Price , Length )

// This function looks at the price of an asset some number of bars ago, specified in "Length". It also looks
//        at the price one bar before and one bar after the specified bar. The momentum of the asset is calculated
//        with respect to each of these three prices from the past (momentum = current price - past price). Then,
//        the three resulting values for momentum are average together. The output of the function is this average value.

inputs:
        Price( numericseries ), { can be high, low, open, or close}
        Length( numericsimple ) ; { number of bars back to look; will get divide-by-zero error if Length = 0 }

variables:
        Sum( 0 ),
        Mean( 0 ) ;

Value1 = Price - Price[Length-1];
Value2 = Price - Price[Length];
Value3 = Price - Price[Length+1];


Sum = Value1 + Value2 + Value3;


Mean = Sum / 3;

AVGMomentum = Mean;
```

Paul Woldt's Opening Range System Scripts

```
Input: StartTime( 0930 ), EndTime( 1030 );

While CurrentTime>=StartTime and CurrentTime<=EndTime

        If Open(CurrentBar) <= Close (CurrentBar-1) then
                Sell next bar at Market;
End
        Sell next bar at Market;
```

```
Input: StartTime( 0930 ), EndTime( 1000 );

While CurrentTime>=StartTime and CurrentTime<=EndTime

        If Open(CurrentBar) <= Close (CurrentBar-1) then
                If Open(CurrentBar-1) <= Close (CurrentBar-2) then
                        If Open(CurrentBar-2) <= Close (CurrentBar-3) then
                                If Open(CurrentBar-3) <= Close (CurrentBar-4) then
                                        Sell next bar at Market;
End

                Sell next bar at Market;
```

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