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MIDAS

TECHNICAL ANALYSIS

A **VWAP** APPROACH TO

TRADING AND INVESTING IN

TODAY'S MARKETS

ANDREW COLES DAVID HAWKINS

MIDAS TECHNICAL ANALYSIS

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*A VWAP Approach to Trading and Investing
in Today's Markets*

Andrew Coles and David G. Hawkins

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To my mother and the memory of my grandmother

—Andrew Coles

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Introduction

Andrew Coles

This book is a study of the MIDAS method of technical analysis based on work that the physicist and technical analyst Paul Levine, PhD, published online in 1995. MIDAS is an acronym for Market Interpretation/Data Analysis System, and although mathematically and conceptually distinct, is a unique development of a market methodology known as Volume Weighted Average Price (VWAP). The latter is an approach to establishing price levels in today's markets that has a variety of uses, from applications in the brokerage industry to trade-management benchmarking and latterly to a growing number of trading strategies and forecasting systems.

Although the MIDAS method uses the volume weighted average price, MIDAS algorithms are distinct from standard VWAP formulations and the more sophisticated techniques for applying MIDAS curves also differ fundamentally from standard VWAP applications. Accordingly, although this book title correctly describes MIDAS as a VWAP approach, it would be quite incorrect to conflate the two.

The aim of this book is twofold. On the one hand, regardless of the reader's experience in technical analysis, one prevalent theme is to teach the basic principles of the MIDAS method as they were originally conceived of by Paul Levine in 1995. However, in many respects the technological changes that have affected the markets since that time on the hardware and software fronts mean that approaches to using the MIDAS method have inevitably evolved too, especially for contexts such as day trading and new markets.¹ It has therefore been important to retain the basic authenticity of Levine's teachings while allowing the approach sufficient flexibility to apply to these new areas, including the development of new MIDAS-based indicators.

Beyond remaining true to Levine's teachings, the book extends them in two ways. On the one hand, with years of experience of applying the curves comes the inevitability of new insights and new methods of working with them. Wherever possible, this book discusses these factors in the context of new markets and timeframes as well as in relation to traditional areas of application. On the other, the book extends the original MIDAS teachings by some distance in relation to genuinely new innovations. These are gathered in the nine chapters that comprise the fourth part of this book.

The MIDAS method is based on the idea that there's a hidden and continually evolving relationship between chart-based areas of support and resistance and trader/investor psychology known as accumulation and distribution. This evolving

dynamic was for Levine the ultimate factor in price development and one that could be made apparent by the curves created by the MIDAS indicators. As a consequence, Levine believed that this dynamic relationship could be seen for what it is, an ordered and progressive structure to price development and not a random jumble of trader and investor impulses. Furthermore, Levine believed that this underlying structure could be detected by the curves at all degrees of trend on the daily charts on which his ideas were originally conceived. Because this orderly price movement was evident on larger as well as on smaller trends, Levine referred to the markets as fractal systems and to the MIDAS approach itself as a fractal method of price analysis. This is why the MIDAS approach can be transferred so successfully to other chart timeframes relevant to the very long-term investor as much as to the swing trader and day trader. Moreover, the approach is serviceable on a range of markets beyond stock prices, including the futures markets and even—with certain adjustments to be made clear in Chapter 10—to the volumeless cash FX markets. Indeed, as will be shown in later chapters, even volume substitutes such as open interest and On Balance Volume curves can work successfully with MIDAS. Since Paul Levine's passing in 1998, the online availability of his lectures has ebbed and flowed in relation to the fluctuation of interest in his work. When I first discovered David Hawkins' interest in the MIDAS approach in December 2008 through the Boston Chapter of the American Association of Individual Investors, it took me some time to track down even a single working link to Levine's notes. However, as I write this introduction in the summer of 2010 I can readily find a number of working links on web-hosting domains as well as credible investment-management and technical analysis web sites. We are delighted by this development but are still disappointed that not a single anthology of technical analysis studies over the past decade has included Levine's lectures.

There is no question that in the years after Levine's passing there was a sharp decline in interest in his work, a factor exacerbated by only a small circle of people ever having become acquainted with it and indeed the man himself (in Hawkins' case) as he published his MIDAS notes online over the months of 1995. During the latter stages of this online publication, Levine developed with Dr Stokes Fishburne Associates a program he called WinMIDAS. A web site was subsequently developed to host the software which was available in a 30-day demo with an option to purchase for \$95. Levine transferred his MIDAS notes to the WinMIDAS web site, and there were also ongoing MIDAS analyses of various markets similar to those on our own web site, www.midasmarketanalysis.com. In 1998 version 2.1 of the WinMIDAS program was favorably reviewed by John Sweeny, the then editor of *Technical Analysis of Stocks & Commodities*,² and there was every reason to believe that the MIDAS method would flourish. Sadly, Paul Levine passed away in 1998 and with his passing the MIDAS method declined in popularity. By the end of the 1990s the WinMIDAS web site was taken offline. By 2001 Dr. Fishburne was still making trial copies of the WinMIDAS program available through a web-hosting site, but this was only on a trial basis and there was no longer product support. WinMIDAS 2.1 was programmed to receive daily data in Worden TeleChart 2000 and Metastock and ASCII formats, but the charting software was soon made obsolete by the introduction of Windows XP

in August 2001. There were a number of incompatibilities with the new Windows operating system and there was no technical backup to upgrade the program. As a result, when George Reyna published his article on VWAP and the MIDAS method in the May 2001 edition of *Technical Analysis of Stocks & Commodities*, all of his chart illustrations of the MIDAS method were in Excel and there was no discussion of the more complex MIDAS topfinder/bottomfinder indicator.³ Behind the scenes, Hawkins had programmed the topfinder/bottomfinder into Excel as early as 1995 even while Levine was publishing his lectures online, and Hawkins continued to work with it in this format right through to 2009 when we were able to develop intraday and higher timeframe versions of the indicator as an external DLL for eSignal and Metastock, our preferred charting platform. Around 2002 Hawkins also had a coded version of the standard MIDAS S/R curves for intraday use in Metastock. In 2005 Hawkins had successfully urged StockShare Publishing LLC to code the standard MIDAS S/R curves for its higher timeframe charts, and in 2009 he also persuaded the company to code the topfinder/bottomfinder for the same chart timeframes. The result is that its charting software StockShareV2 uniquely has both indicators functioning on its charts. Unfortunately, the topfinder/bottomfinder is impervious to a number of charting platform languages due to its complexity, hence the need for an external DLL. Months before becoming acquainted with Hawkins in 2008, I had coded the standard MIDAS S/R curves for intraday use in Metastock and the results were published in the September 2008 edition of *Technical Analysis of Stocks & Commodities*. In that same issue, most of the other leading trading platforms also submitted code for the indicator so it is now extensively available to most traders and investors. Unfortunately this is still less true of the topfinder/bottomfinder, though many trading platforms, including TradeStation and eSignal, do have the resources to code it.

At the time of this writing, there has been a resurgence of interest not just in the MIDAS method but also in the Volume Weighted Average Price (VWAP) more generally. However, as indicated earlier, MIDAS and VWAP are not to be conflated and, this being so, this book is neither about VWAP generally nor about recent developments in related volume-based research. Rather, the book's focus is on the development of MIDAS-based studies and we have had no interest in extending its remit beyond them to include broader VWAP approaches.

Another related point is that while this book will take the reader on an introductory tour of MIDAS through to advanced themes and ideas, it is not an introduction to technical analysis, nor has there been the space available to offer detailed explanations of other indicators when they are introduced. Accordingly, by reading the recommended literature it will be the reader's own responsibility to raise his knowledge to levels necessary to work with other approaches discussed.

The only exceptions to this are Chapters 7, 10, and 12. In Chapter 7 Hawkins provides an introduction to the Float Analysis approach to stock trading as well as a selective introduction to the volume techniques of Richard Arms Jr. in relation to MIDAS approaches. He also works extensively with the equivolume style of charting throughout the book. All of these techniques complement the MIDAS method extremely well. Chapter 10 on the cash foreign exchange markets was a necessary

feature of this book because it is to be expected that an approach to the markets that supposedly relies so heavily on volume would be met with a significant degree of skepticism when it's claimed that it can also be applied to the volumeless cash foreign exchange markets. Accordingly, Chapter 10 explains how to apply the MIDAS method to the cash FX markets and what can be expected from the approach. These concerns are also duplicated in Chapter 6 where the focus is on longer-term chart environments. As for Chapter 12, in the past decade there have been considerable advances in technical applications of open interest data available through resources such as the Commitments of Traders (COT) report. Chapter 12 is of additional benefit in providing a short introduction to open interest as well as summarizing every development in COT report research over the past decade while discussing how the MIDAS approach can utilize open interest over longer-term horizons in the futures markets. It's hoped that readers will appreciate this succinct knowledge resource as much as the MIDAS applications that go with it.

Another point that needs stressing is how this book addresses one of the main weaknesses in Levine's lectures, namely his exclusive emphasis on the forecasting implications of MIDAS analysis at the expense of trade-management criteria in their application. The trading implications of using MIDAS curves are addressed most thoroughly in Chapter 8, the second half of Chapter 1 and the first half of Chapter 3, where detailed implementations of the curves are illustrated alongside trading system criteria. Indeed, the first half of Chapter 3 is motivated by the hope that this book will get traders to use MIDAS curves immediately in their trading, whatever their prior level of skill and experience. With this in mind, the discussion is aimed at newer to intermediate-level traders interested in how MIDAS could be used to create a relatively simple, limited-stress day trading or short-term swing trading system. As such, it should also be of interest to the large number of part-time traders with limited time for complex chart analysis and who require a fairly straightforward but robust standalone system.

Importantly, it's an obvious implication of this book not being a general introduction to technical analysis that there are certain foundational skills that a reader new to technical analysis will need to have in place before getting everything he should from this book. This is an important point, since unlike other areas of technical analysis there are certain key aspects to the MIDAS approach that can be acquired prior to learning it and indeed are highly recommended before a relatively inexperienced trader in technical analysis thinks about utilizing the MIDAS method. For the inexperienced trader, it will be helpful to add to this introduction a brief breakdown of these foundational areas.

1. *A basic grasp of trends and at least the basic ability to analyze them using linear trend lines.* Since MIDAS curves are essentially nonlinear trend lines, it's important that a relatively inexperienced trader new to MIDAS possess a solid understanding of price trends. MIDAS curves interact in certain critical ways with the directional bias of the market through the peaks and troughs that define trends and other areas of support and resistance, and it's crucial therefore that a trader using MIDAS for

the first time possess a prior understanding of trends, how they change, and the key areas of support and resistance that define them.

2. *Appropriate peak and trough analysis.* Technical analysts conventionally refer to the peaks and troughs of trends as areas of support and resistance. These concepts are fundamental in MIDAS analysis because for Levine they objectively identify areas of accumulation and distribution that are the ultimate determinants of price behavior.
3. *Chart timeframe and trend size relationships.* In addition to their direction, trends are also classified according to their size and the corresponding chart timeframe best suited to analyze them. For example, the intermediate-term trend lasts from six weeks to nine months and is typically viewed on a daily chart. In addition, there are higher and lower trend lengths influencing price simultaneously in virtue of what Levine called the dynamic interplay of support and resistance, and accumulation and distribution. This means that at any one time a market can be broken down into various trend lengths and can be simultaneously described as moving up, down, or sideways in relation to them. MIDAS curves can play a corresponding role in analyzing relative trend lengths but not in the hands of those inexperienced in trend analysis.

Since MIDAS curves measure price movement at all degree of trend, traders new to MIDAS analysis should be able to articulate trend sizes with ease. Indeed, the more proficient a trader is at this skill, the more his MIDAS curves will be able to tell him about trend direction and its implications for forecasting. These implications will be discussed thoroughly in Chapter 3 and similar concerns are addressed in Hawkins' Chapters 2, 6, and 8.

4. *Fractal market analysis.* Quite simply, to describe the markets as fractal is to say that they're self-similar at all degrees of trend. Levine felt strongly that the markets are fractal, and it was another reason for him to believe that the same principles of MIDAS could be applied at all degrees of trend. Given this assumption, it's another reason why traders new to technical analysis and MIDAS should ensure that their skill at trend analysis covers trend magnitude as well as directional bias. The fractal nature of financial markets has a further consequence for MIDAS analysis, namely the tendency of MIDAS curves to displace from price. Without anticipating later discussions, the displacement of a MIDAS curve from price means that it is drifting away from immediate price action only for price to return to it later during a much larger pullback. Since displacement is related to trend size, there is further reason for an inexperienced trader new to MIDAS to appreciate the significance of the size of the trend in relation to pullbacks and displaced MIDAS support and resistance curves.
5. *Moving averages.* Since the MIDAS approach is based on (but isn't identical with) the volume weighted average price, it's important that an inexperienced trader new to MIDAS possess some understanding of moving averages. The first reason is that moving averages are, like linear trendlines, another method of highlighting a trend. They can also confirm that an old trend has ended and a new one has begun. Thus, some experience with moving averages is of additional benefit in building the skills

necessary to work with trends. Second, MIDAS curves are a form of “anchored” moving average with cumulative volume. Hence, the nonlinear nature of moving averages is an ideal starting point for working with MIDAS curves. Third, many users of moving averages today don’t look for moving average crossover signals; instead, they look for price pullbacks to the averages for trading setups.⁴ Since the latter is an important component of MIDAS analysis, prior experience of these setups with moving averages will be of benefit. Finally, regular users of moving averages will have probably worked with various length moving averages, especially the 20, 40(50), 100, and 200 moving averages. In so doing they will already have a prior understanding of displacement in the longer-term moving averages such as the 100 and 200.

6. *Volume*. Volume is usually regarded as the next-most-important factor in technical analysis in its role as confirming price activity. The VWAP component in MIDAS is cumulative volume, and it is important when working at a more advanced stage with MIDAS curves to be able to appreciate the influence that cumulative volume plays in their creation in relation to increasing and decreasing levels of volume in ongoing trends.
7. *Candlesticks*. It was noted earlier that the absence of practical trading rules and criteria is a significant weakness in Levine’s lectures, and the careful use of candlesticks alongside MIDAS analysis helps to remove this weakness. For example, Japanese candlestick reversal patterns in particular are of considerable help when working with MIDAS techniques.

As a final point in this introduction, David Hawkins and I decided to collaborate on this book without writing it jointly partly because of the inconvenience of the distance between us, but more importantly because it was felt that there were sufficiently large divergences in our interests for it to be more effective for us—and the reader—if we discussed these areas individually rather than as collaborators in jointly-written chapters. At its best, technical analysis captures what happens in the markets only for the most part. Because of this, it’s a well-known cliché that technical analysis is as much of an art as a science and this in turn means that no two traders are likely to work with the same methods and indicators in the same way. This is certainly true in our case and hopefully another advantage of our writing chapters individually rather than jointly is that the reader will gain additional insights from each of us and will hopefully be better served by this in the longer run.

In the meantime, the reader is invited to visit our web site, www.midasmarketanalysis.com, to pick up on timely market analysis using the MIDAS method as well as to take advantage of other free resources such as indicator code.

Biographical Sketch, Paul H. Levine

David G. Hawkins

The founder of the MIDAS Method of Technical Analysis was Paul H. Levine, born in New York City on September 27, 1935. He grew up in upstate New York, and attended MIT, graduating with his BS in Physics in 1956. He did his graduate work at California Institute of Technology, where he blossomed as a theoretical physicist, earning his PhD in 1963. The title of his thesis was, “Phase Space Formulation of the Quantum Many-Body Problem.”

In July of 1963, he married Burgess Lea Hughes in Copenhagen.

He joined Astrophysics Research Corporation in 1965 as their Chief Scientist. Then, in 1972, he and three colleagues left and founded Megatek Corp. in San Diego, CA, which started primarily as a consulting house, doing contract work for various government and military agencies. Most of Levine’s work was on radio propagation, communications, and navigation problems, resulting, over the years, in dozens of publications. Megatek grew to become more than a consultancy, developing and selling imaging hardware and software. In 1981, the founders sold Megatek to United Telecom, after which Paul did freelance consulting for the rest of his life.

Paul’s interest in trading and the markets started when he was an undergraduate, and grew and stayed with him for the rest of his life. He was always keen on applying his insights from theoretical physics to trading in the stock market. Over the years, the concepts of the MIDAS method grew in his mind, and, with the help of the computing technology that was available at the time, he put them to use in his trading, with considerable success. In 1995 he wrote, and self-published on the web, 18 articles describing the MIDAS method. He worked with a friend, Stokes Fishburne, to have a computer program written for use by the general public that would apply MIDAS to trading. The program was called WinMIDAS, which Fishburne managed, sold, and maintained. They established a web site where one could access the articles, the WinMIDAS program, and other related goodies, and where people could communicate with Paul. This was before the formal establishment of web blogs, but their site essentially functioned as what we would now call a blog, where Paul made postings of his views roughly every week, and people responded. I (Hawkins) was one of those who corresponded with him during that time.

Tragically, Paul succumbed to cancer, and passed away in March of 1998 at age 62. After his passing, Fishburne took down the web site, and ceased selling and supporting the WinMIDAS program.

Paul Levine was a superb theoretical physicist and market trader, but he was also a lot more. He was something of a mystic, deeply involved with Transcendental Meditation. He and Lea traveled to Switzerland and India to live and work with others in the movement. They also enjoyed other travels around the globe, and were especially fond of their place in Hawaii. It may truly be said that he was a polymath.

We are deeply grateful to Lea Levine for her assistance with biographical material.

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Thanks are also due to Bob English of Precision Capital Management for agreeing to supply TradeStation code for the topfinder/bottomfinder in the third appendix to this book. Due to an interpolation requirement that requires looping, the programming languages of a number of trading platforms cannot program the topfinder/bottomfinder. This includes Metastock, our current platform. While it is possible to create an external DLL written in a language such as C++ for platforms such as Metastock, it was felt that the topfinder/bottomfinder should be coded for the book in at least one accessible script and Bob kindly stepped in with a version of his own code. A number of Bob's ideas concerning the MIDAS approach crop up in this book, especially in the final chapter.

A final word of thanks should go to Satyajit Roy who was responsible for programming the topfinder/bottomfinder in C++ for an external DLL application for both Metastock and eSignal.

PART I

Standard MIDAS Support and Resistance Curves

CHAPTER 1

MIDAS and Its Core Constituents

The Volume Weighted Average Price (VWAP) and Fractal Market Analysis

Andrew Coles

It was emphasized in the introduction that this book is not about Volume Weighted Average Price (VWAP) but a particular development of it in the MIDAS approach of Paul Levine. This point requires re-emphasis at the start of the book because at the time of writing there's a lively surge of interest in VWAP. As a result, it's becoming harder for newcomers to this area to differentiate between what lies within the ambit of Levine's contributions and what lies outside of it. A timely first aim of this chapter therefore will be to highlight a number of boundaries to the MIDAS approach in relation to its VWAP background.

A second theme will be to look at the main ideas underlying Levine's philosophy of price movement, especially his fractal conception of the markets and the application of multiple hierarchies of curves. This application adds a powerful ubiquitous forecasting capability to the curves and requires separate attention. The discussion will be partly academic in tone in its brief outline of the fractal conception of the markets that was becoming popular when Levine was working on his approach in the early 1990s.

A final theme lays the groundwork for the practical emphasis throughout this book on trading with MIDAS curves. One of the major shortcomings in Levine's lectures is his emphasis purely on the forecasting implications of the MIDAS method. Never at any time did he consider the trade-management implications of using the curves. The final theme of this chapter begins a trend in this book that focuses heavily on using the curves in practical trading contexts.

This chapter is more theoretical than other discussions in this book in outlining Levine's debt to fractal interpretations of the markets and various approaches to VWAP.

However, these deeper perspectives are helpful in understanding the MIDAS method historically as a product of two unique and very different approaches in the markets, which were just beginning to be felt in the early 1990s.

MIDAS and Its Two Key Backdrops: VWAP and Fractal Market Analysis

The MIDAS approach consists of two primary indicators, the basic MIDAS support and resistance (S/R) curves and the more complex topfinder/bottomfinder curves. Let's make a start by considering very generally the relationship these two indicators have to the broader VWAP background prior to their development and that are still very much a part of the professional market trading context today.

Before MIDAS: Initial Motivations for VWAP

There have been several motivations behind the application of VWAP to the financial markets which emerged prior to Levine's development of the MIDAS method. None of them initially involved technical market forecasting, but since they're still very much a part of today's market environment it will be worth outlining them briefly.

Distortion and Price Manipulation

One motivation has stemmed from a closing price free of distortion due to unusual transactions or even intentional price manipulation. An anomalous transaction could be caused by a large accidental buy or sell at a very high or low price level prior to market close.

As an extreme illustration, while this section is being written \$1 trillion was temporarily wiped off the market value of U.S. equities on Thursday May 6, 2010, in the so-called 2010 Flash Crash. During a six-minute period the S&P 500 fell nearly 5 percent and the crash was the largest one-day point decline (998 points) in Dow Jones Industrial Average (DJIA) history. By the day's close the markets had recovered to a degree, but the S&P 500 was still 3.2 percent lower. Various reasons have been put forward for the crash, including an errant "fat fingered typo" sell order that set off a chain reaction, a sudden movement in JPY/USD, and even market manipulation.¹ Eventually, in a formal statement published in October 2010, the SEC and CFTC blamed the crash on a liquidity crisis caused by a computer trading algorithm.²

Circuit breakers are now being tested to halt such anomalies in the future, but one motivation for calculating the VWAP would be to remove very unusual distortions from the closing price, even if such distortions involve complex intermarket relationships in the currencies and bonds markets through sophisticated computer networks.

Alternatively, direct market manipulation may involve the intentional placing of orders during late market hours at various extreme prices. Again the reasons could be various. For example, closing prices are used for formal statements of the value of a portfolio in a company's annual report and are also occasionally used to calculate directors' remuneration as well as the settlement values of derivatives.³ Again the VWAP is said to help prevent such skewing of market data.

Guaranteed VWAP Executions

A second motivation for VWAP calculations has emerged from the brokerage industry and bears on the ever-demanding relationship between broker and client. Many brokers will now guarantee their clients that orders are executed at the VWAP (so-called guaranteed VWAP execution) in "targeted VWAP" trading. For example, Euronext, the pan-European stock and derivatives exchange, has available what it calls a "VWAP transaction," based on an average price weighted by security volumes traded in a central order book. A large number of brokerage firms will also guarantee the VWAP for large domains of stocks, especially large caps. Due to the growing popularity of VWAP executions data, vendors such as Bloomberg will also display VWAP prices after market close.

The Minimization of Market Impact and Trader Assessment

A third and fourth motivation have arisen from the very heavy volume trading undertaken in the mutual and pensions industry. Here large investors aim to be as passive as possible in their executions and use the VWAP to ensure that they are entering the market in line with typical market volume. This minimizes market impact, which in turn reduces transaction costs. Thus, a final related motivation would be the actual assessment of trading performance: a large institutional trade entry beyond the VWAP may be criticized in light of higher transaction costs; similarly, an order filled above the daily VWAP would be regarded negatively in view of the slippage implications.

Standard VWAP Calculations

Now that the nontrading motivations for VWAP are understood, it would be helpful before turning to Levine's MIDAS approach to obtain a basic understanding of how the VWAP is calculated and how basic VWAP curves appear on a chart. In part, this discussion should also alleviate some of the confusion that has arisen around the relationship between VWAP and the MIDAS approach.

The VWAP is calculated by multiplying the volume at each price level with the respective price and then dividing by the total volume. The more volume traded at a certain price level, the more impact it has on the VWAP.⁴ Here is the basic formula for VWAP calculations:

$$\Sigma(P_n * V_n) / \Sigma(V_n)$$

where

P = price of instrument traded

V = volume traded

n = number of trades (i.e., each individual trade that takes place over the selected time period)

There are variations on the basic formula. For example, George Reyna finds the following version more useful:⁵

$$(((Hc * Lc)/2) * Vc)/(Vc - V(c - s))$$

where

H = high price

L = low price

V = volume

c = current bar

s = launch point⁶

As a simple illustration of calculating the VWAP, we can go back to the original VWAP formula and calculate the VWAP over 15 minutes on a 5m chart of the DAX March 2010 futures. We'll use the closing price of three 5m bars:

Bar #1: 5,827 with a volume of 2,856 contracts

Bar #2: 5,819.5 with a volume of 1,729 contracts

Bar #3: 5,816.5 with a volume of 2,271 contracts

The average price over this 15-minute period is the total number of contracts divided by 3, or 5,821 contracts. But let's calculate the VWAP. The result obtained will depend on which method of utilizing the formula we choose. Day trading software firms will probably use one of two algorithmic procedures to derive it.

The first, usually assumed to be the more accurate method, is known as "cumulative VWAP." The first step would be to multiply the closing price with the volume for each of the three bars, arriving at the following numbers:

16,641,912

10,061,915.5

13,209,271.5

The next step would be to add them together to arrive at 39,913,099. To arrive at the denominator, the volume numbers would be summed to get 6,856 contracts. With the division, the cumulative VWAP would therefore be 5,821.630 (this method is usually calculated to three decimal places).

A second method of arriving at the VWAP is known as "iterative VWAP." It uses the last value of the VWAP as the basis for calculating the VWAP on the next trade.