MESA Users Guide

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NOTE TO USERS: This product includes information on using MESA studies. Using this software may have significant financial implications. Before using this software or adapting it to your business, you should consult with a market expert.

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Preface

This guide explains how to use the features available through Aspen Systems' MESA subscription. In this guide, the noun "Aspen Systems" refers to the software packages published by Aspen Research Group, Ltd. for Bonneville Information Systems, S & P Comstock, Knight Ridder, and Signal data feeds. It also refers to software for standalone computers and network workstations.

Companion information is available in the following publications:

- *Aspen Systems Users Guide*
- *Aspen Systems Reference Guide*
- *Basic Options Users Guide*
- *Basic Options Page Guide*
- *Aspen Options Users Guide*
- *Price Volume Users Guide*
- *PLATT'S User Guide*
- *PLATT'S Quick Reference Guide*

For Microsoft Windows users, windows help modules are currently available for:

- Aspen Systems
- PLATT'S
- Basic Options
- Aspen Options

Conventions

Unless otherwise noted, this guide employs the following conventions:

Convention	*Meaning*
Enter	Keycaps indicate keystrokes.
Shift + `	Keycaps separated by a plus sign (+) indicate multiple keystrokes.
Retrieve Page	Italics indicate menu selections.
Main Menu Sizing a Window	Initial caps indicate menu titles and cross references.

MESA Studies

MESA (Maximum Entropy Spectrum Analysis) studies are an adaptation of filtering techniques developed by geophysicists as a tool for oil exploration, and later adapted for advanced radar jamming by defense-industry scientists. In these contexts, MESA has been used to obtain "high-resolution" measurements from short data sets. Now, John F. Ehlers, the pioneer in applying these breakthrough techniques to trading, has supervised an exclusive real-time implementation for Aspen Research Group Ltd.—only for the users of Aspen Research Group, Ltd. software.

Now you can replace the primitive methods of parallel-line cycle detection with the most sophisticated mathematics available. For the first time, traders have the tools to cut through market "noise" and spot previously invisible intraday and long-term cycles—and use Aspen Systems' MESA predictions to turn them into profits.

MESA Studies on Aspen Systems comprise a unique set of six tools (see MESA on Aspen Systems, page 6), plus Equitick charting (see Using Equitick Bars, page 24), that not only detect cycles as they develop and predict their course, but also simultaneously evaluate market characteristics to indicate the likely validity of the predictions.

Once you identify a length for your data set, MESA renders measurements that move smoothly between shorter and longer dominant cycles. However, when tradable cycles are not present, the cycle length measurement is erratic. Erratic measurements can aid your interpretation of market activity. Cyclic measurements are most erratic when the market is in a trend. Therefore, erratic measurements indicate that you should avoid trading on the basis of a market cycle. (For more information on using MESA, please read Using MESA, by John Ehlers, page 16; see also Applying the MESA studies, page 22.)

Installation

Installation of MESA Studies on Aspen Systems is easy—MESA functions are already included in your version of Aspen Systems software and require only a password or additional entitlement to function.

MESA does, however, require that your computer be equipped with a math co-processor chip. If you have a co-processor, simply call Aspen Research and get a new Password.

MESA & Fourier Analysis

MESA, which stands for Maximum Entropy Spectrum Analysis, is an advanced mathematical method for filtering any cyclical components of different frequencies from complex signals or data sets. MESA has been used to identify the cyclic components of data sets that originate from chaotic bursts of radio waves, sub-terranean explosions, and, more recently, from military radar. An outgrowth of the scientific and engineering technique of Fourier analysis, MESA makes a radical break from earlier cycle-detection methods.

Traditional Fourier techniques such as the fast Fourier transform identify cycles with a high degree of certainty, but require very large data samples—an integral multiple of the wavelength of the cycle or cycles detected. Furthermore, even larger data samples are required to allow "good resolution"—identification of concurrent cycles of unrelated wavelengths. These restrictions render traditional Fourier methods impractical for real-time market applications because cycles recurring over a long period tend to be apparent on a bar chart, without the aid of complex mathematics.

MESA, by contrast, focuses on the identification of the maximum amount of cyclic activity in a very short data sample. Whereas Fourier techniques work best for identifying cycles whose wavelengths are a tiny fraction of the length of the data samples, MESA can find a cycle in a sample only as long as the wavelength itself. This sensitivity equips MESA uniquely to pick out market cycles as they develop in fast-moving markets.

John F. Ehlers, a Ph.D. holder in electrical engineering and radar-jamming scientist (see Radar Jamming, page 5), is the pioneer and acknowledged authority in applying MESA for trading purposes. His MESA end-of-day trading program was the first of its type. It is with his cooperation and supervision that MESA studies have been incorporated in Aspen Systems, in their first and only real-time implementation.

For a more complete exposition of the development, mathematics, and particular characteristics of MESA, refer to Ehlers' authoritative book *MESA and Trading Market Cycles* (see MESA References, 34).

MESA Origins

An understanding MESA's origins in the geophysics of oil exploration and the high-technology wizardry of radar jamming helps to make its workings comprehensible.

Oil Exploration

MESA was first applied as an oil-exploration tool, drawing on the 1976 work of John Burg, a researcher who first developed and published the method. A common way of searching for oil is to set off explosions that send out sound bursts at known frequencies, and then "listen" to the echoes at different locations. Since oil-bearing and non-oil-bearing subterranean geologic formations reflect the sound differently, "maps" of an area's subsurface geology can be created and likely oil deposits pinpointed.

The key information for mapping lies in the exact way that the principal frequencies of the explosions are modified by their underground travel. However, by the time the sound bursts from the explosions reach the listening sensors, their sound has been dampened and distorted by reflections and by passage through irregular bodies of sand, clay, water, different types of rock, and so on. The result is a burst of apparently chaotic noise. The challenge facing the prospecting geophysicists, then, is to pick out the now-faint principal frequencies from the jumbled noise recorded by their sensors, all within very short data samples due to the brevity of the explosions themselves.

MESA was the technique developed to accomplish this task. The geophysicists know the original frequencies emitted by the explosions, and they usually have a rough idea of what the subsurface geology is and how it is likely to modify the original frequencies. So they can predict a range of frequencies where they expect to hear the principal sounds of the explosions. They then tell MESA to check different frequencies within that range, or beyond if necessary. Thanks to MESA's sensitivity and ability to home in on cyclic data even in the presence of a large amount of chaotic "noise," they can then pick out just the principal sounds of the explosion, and analyze the modifications due to the geology, while discarding the jumbled echoes, reflections, and other sonic junk.

Radar Jamming

Later, defense-industry scientists discovered that MESA was a crucial tool for electronic countermeasures, and they gave it its first real-time application. Radar jamming is a vital weapon in modern air warfare—if a warplane can detect and analyze the radar signals of another aircraft, a missile, or a ground installation, then it can defend itself by emitting signals that confuse or deceive the enemy's listening radar receivers.

Initially, the challenge was to quickly tune in to the fixed frequencies of older radars, and then start jamming on those frequencies. However, as radars became more sophisticated and made increasing use of powerful computers, they became harder to tune in on: irregular noise was superimposed on the radar signals to cloak them, the signals were broken up into bursts too short for older jammers to analyze, and the frequencies used were varied rapidly and constantly, making it difficult for would-be jammers to detect a signal at all.

Radar scientists recognized that MESA techniques could solve these problems. MESA's ability to filter out cyclical activity from background noise handled the cloaking transmissions; and its ability to find cyclical signals based on a very short data samples meant that it could both detect short bursts of radar, and cope with rapidly changing frequencies. So MESA's methods were coupled with full-spectrum scanning and jamming transmitters to quickly lock in on and jam even the trickiest, most quickly varying radar signals.

The same features that led to MESA's use in oil exploration and radar jamming, developed through the efforts of mathematicians, geophysicists, and radar scientists, are the ones that equip MESA so well to quickly filter cyclic components from incoming market price data, and respond with a potentially profitable prediction.

John Ehlers served in the U. S. Air Force in electronic countermeasures during the Korean War, which led him to obtain his bachelor's, master's and doctorate degrees in the field of communication engineering and information theory. His continuing work in radar jamming research introduced him to MESA, and thanks to his curiosity and interest in trading, led to the application of MESA techniques to market analysis and to MESA Studies on Aspen Systems.

MESA on Aspen Systems

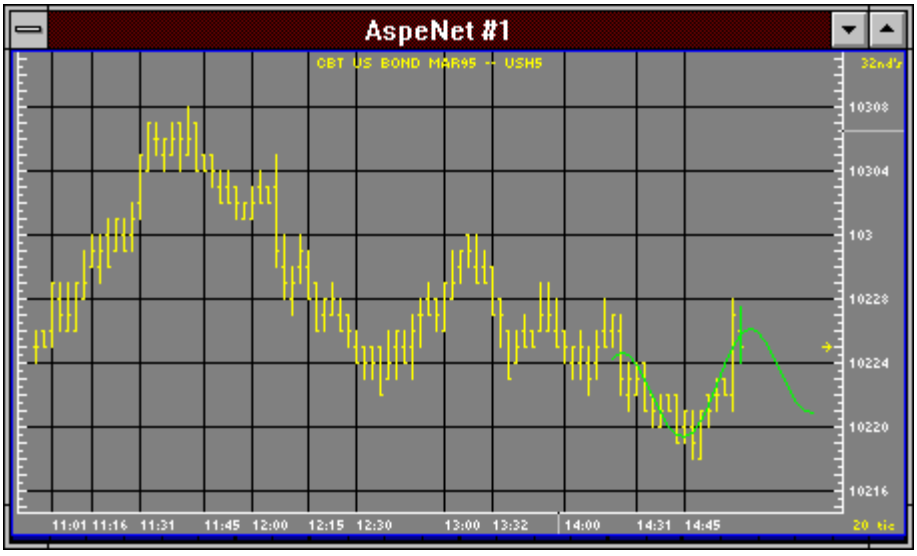
MESA is an analysis technique in which four overlay studies and two conventional studies are employed. The following sections summarize these studies,

- MESA Standard Prediction
- MESA User Prediction
- MESA Best Fit
- MESA Trend
- MESA Phase
- MESA Spectrum

MESA Standard Prediction .MPRED

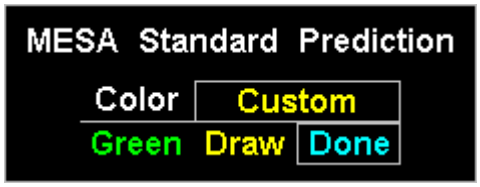
The MESA Standard Prediction study renders the cycle prediction based on the measured dominant cycle. The MESA Standard Prediction answers the question, "Of all the identifiable levels of cyclic activity in the last 30 bars with a wavelength of 10 to 50 bars, what is the strongest sine-wave component, and what does it predict in the next 10?"

MESA Standard Prediction is the "basic" prediction study. It uses MESA mathematics to measure the strength of all possible cyclic components with wavelengths of 10 to 50 bars, over 30 bars' worth of history; selects the component with the largest average cyclical movement; combines this with measurements from previous bars to calculate the "dominant" cycle; displays one cycle's worth of that dominant cycle; and makes a 10-bar prediction into the future. This study is best for general purpose cycle detection.



The prediction uses the trend slope and only the measured dominant cycle phase and amplitude, conforming to a simplified model where the price action is comprised of a trend plus a single cycle. The prediction is carried forward ten bars to the right of the cursor prediction. The prediction is also carried to the left of the cursor position for one full cycle period of the best-fitting, back-tested cycle, allowing you to compare the cycle prediction to the actual price data.

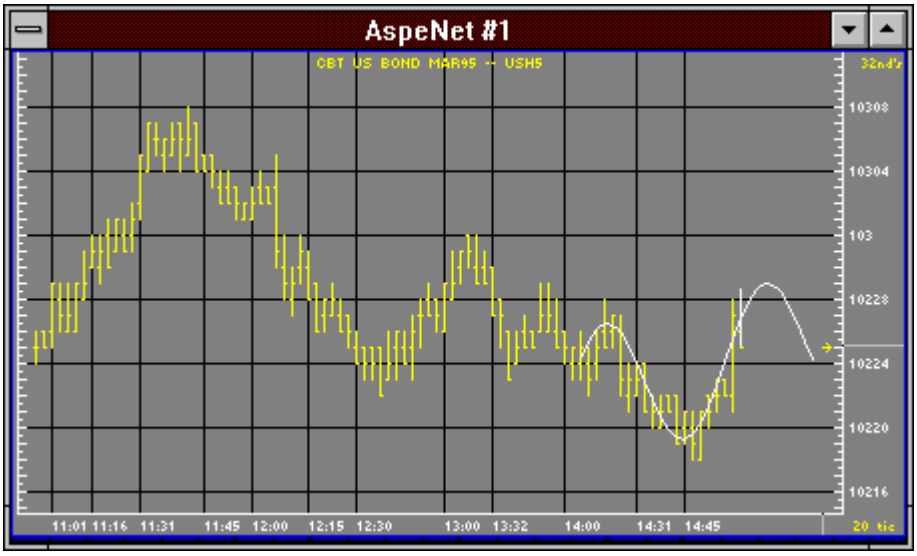
The MESA Standard Prediction study has one adjustable parameter, color:



MESA User Prediction .MUSER

The MESA User Prediction study renders the cycle prediction based on the sine wave cycle period you select. The MESA User Prediction answers the question, "Assuming that there is a sine-wave cycle of the user-specified wavelength operating in the price data, what does that cycle predict over the next 10 bars?"

It allows a user to make a prediction based on a cycle when he believes that it exists. even when it's neither the dominant cycle of the standard prediction, nor the best-fitting cycle found by the best-fit prediction. The user prediction can also be thought of as a limited version of the best-fit prediction—it shows one of the sine-wave cycles that would be tested for goodness of fit[1] by the best-fit prediction, and a 10-bar prediction based on that cycle.



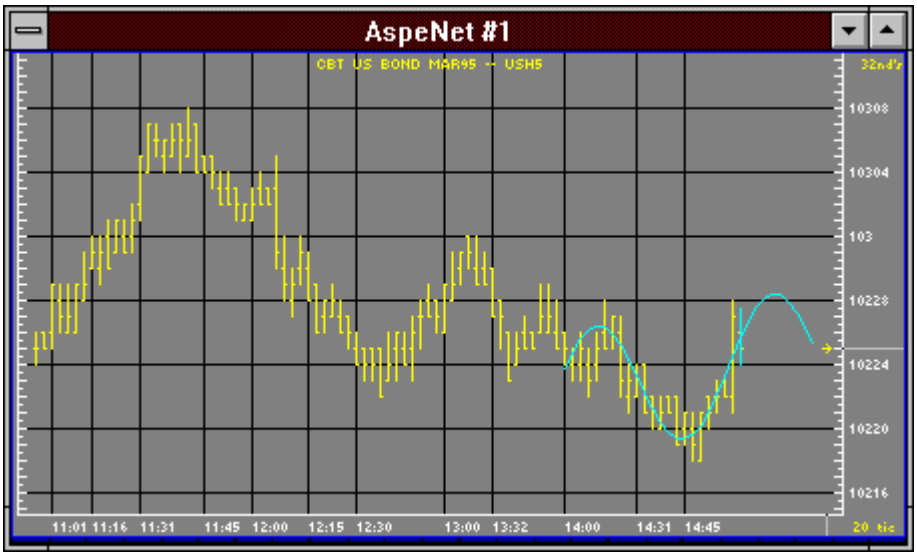
1 Goodness of fit is determined using standard least-squares correlation, and the best-fitting cycle is displayed and used as the basis for a prediction.

The MESA User Prediction study has three adjustable parameters, calculation price, cycle length, and color.

MESA Best Fit .MBEST

The MESA Best Fit study is a cycle prediction based on a sine wave cycle that best fits data over cycle lengths from 6 to 50 bars. The MESA Best-Fit Prediction study answers the question, "Among the sine-wave cycles that have wavelengths in the user-specifiable range, which one best fits the price data over its own wavelength, and what would that cycle predict over the next 10?"

It is a more customizable study that makes it easier to identify any short-wavelength cycles as they develop. Cycles that do not extend back close to 30 bars have not lasted long enough to be identified as the dominant cycle of the standard prediction, but other evidence sometimes indicates that they may exist. The study searches for cycles of wavelengths in a user-specifiable range that is usually set at the default of from 6 through 50 bars. Each one is then tested for goodness of fit to the price data over its own wavelength, instead of the 30 bars of the standard prediction. Goodness of fit is determined using standard least-squares correlation, and the best-fitting cycle is displayed and used as the basis for a prediction.



The MESA Standard Prediction is based on using the measured dominant cycle, and 30 bars of data are used to measure the Standard Prediction. By contrast, the MESA Best Fit prediction is useful when a new, shorter cycle is starting to emerge. Such a shorter cycle can be swamped using data over the longer 30 bar period and therefore does not appear as the dominant cycle.

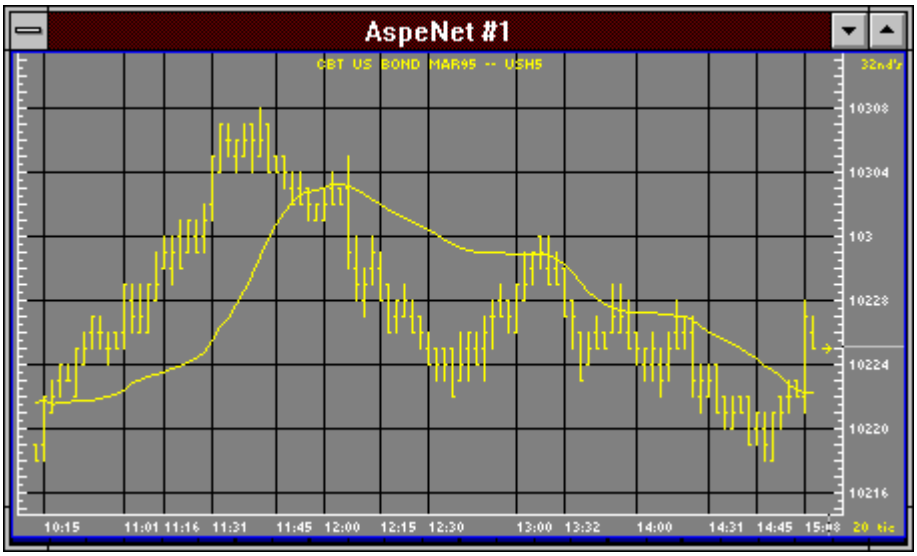
The MESA Best Fit prediction is useful to test the MESA Standard Prediction when the slope of the back-tested Standard prediction does not match the slope of the price action over several bars prior to the cursor prediction.

The MESA Best Fit prediction is also carried to the left of the cursor position for one full cycle period of the best-fitting, back-tested cycle, allowing you to compare the cycle prediction to the actual price data.

The MESA Best Fit study has four adjustable parameters:

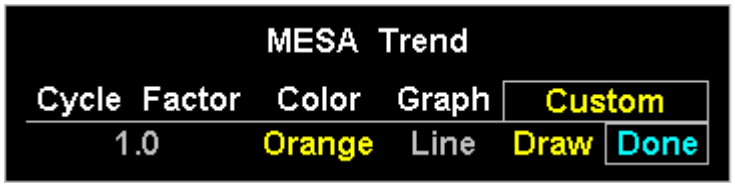
MESA Trend .MTREND

The MESA Trend study renders the trend line used in MESA cycle analysis.



The price is modeled as the simple addition of a trend plus a single cycle. The MESA study measures the dominant cycle. The cyclic component of the model is completely removed by taking a simple average over the period of the dominant cycle, leaving the trend component as the residual. The process is repeated for each bar to compute the MESA trend.

The MESA Trend study has three adjustable parameters, cycle factor, color, and graph type:

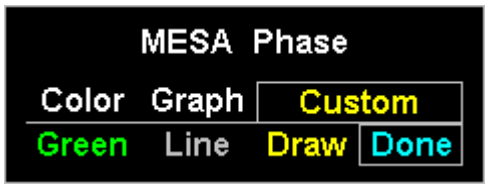


MESA Phase .MPHASE

The MESA Phase study enables you to identify the viability of a cycle. A smooth, saw-tooth formation indicates a strong cycle while an irregular formation indicates a weak cycle, or an absence of any cycle. The following MESA Phase study suggests a weak or absent cycle.

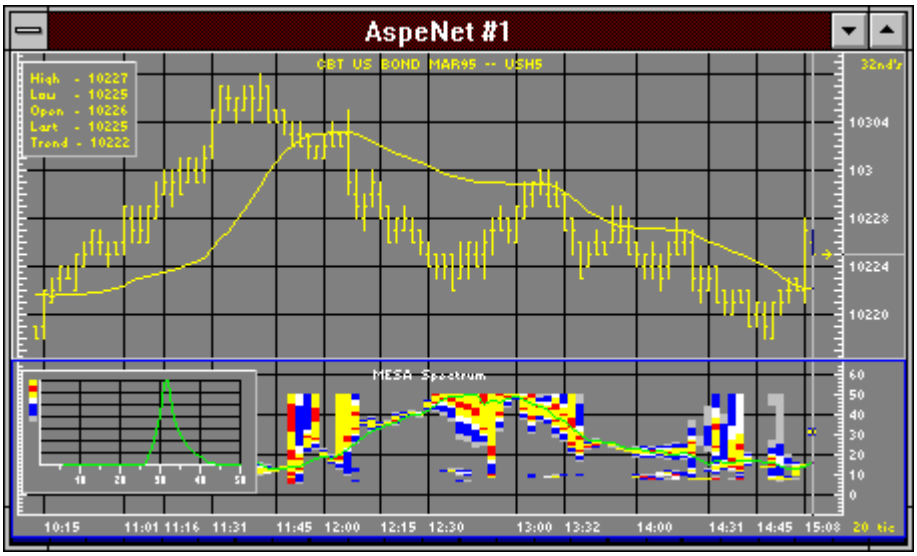
The figure on page 19 shows MESA Phase study that indicates a strong cycle.

The MESA Phase study has two adjustable parameters, color and graph type.

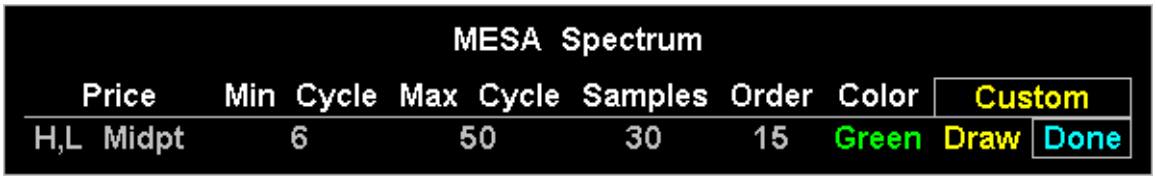


MESA Spectrum .MSPECT

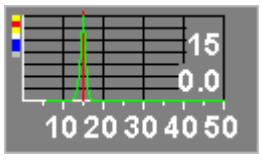
The MESA Spectrum study renders the *frequency* of data in a cycle. The Spectrum study consists of two graphs, a spectrum for showing amplitude, and a line graph showing cycle length at the position of the chart cursor.



The MESA Spectrum study has six adjustable parameters:



Although these parameters are adjustable, John Ehlers recommends that you do not change them.



Using MESA, by John Ehlers

MESA is a unique way to accurately measure short-term cycles in a market. The name is an acronym for Maximum Entropy Spectrum Analysis. MESA is unique because it can detect cycles using a small amount of data. Because MESA uses small data sets, the probability of getting a valid measurement is great. A valid measurement is a measurement that satisfies the *stationarity constraint*. That is, a cycle must be consistent over an observation period for a measurement to be valid. The stationarity constraint is difficult to apply to market data using traditional methods such as Fourier Transforms.

The measured cyclic data can be used two ways:

- First, the cyclic turning points can be predicted under the assumption that the measured cycle will continue into the future. The prediction allows anticipation of buy and sell points when the market is in a cycle mode.

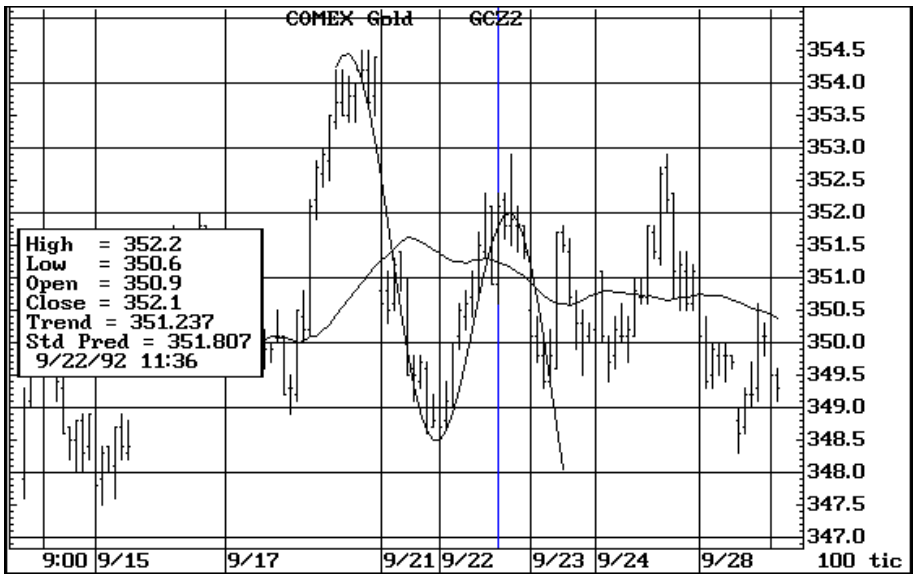
- Second, the cyclic component can be removed from the data to leave the trend line as a residual. A trading strategy can be established by observing the price action relative to the trend line.

In the cycle mode, the price level is expected to cross the trend line every half cycle. If the price fails to cross the trend line within a half cycle, hold the position until the trend is exhausted. MESA includes four overlays and two studies. The overlays denote the following:

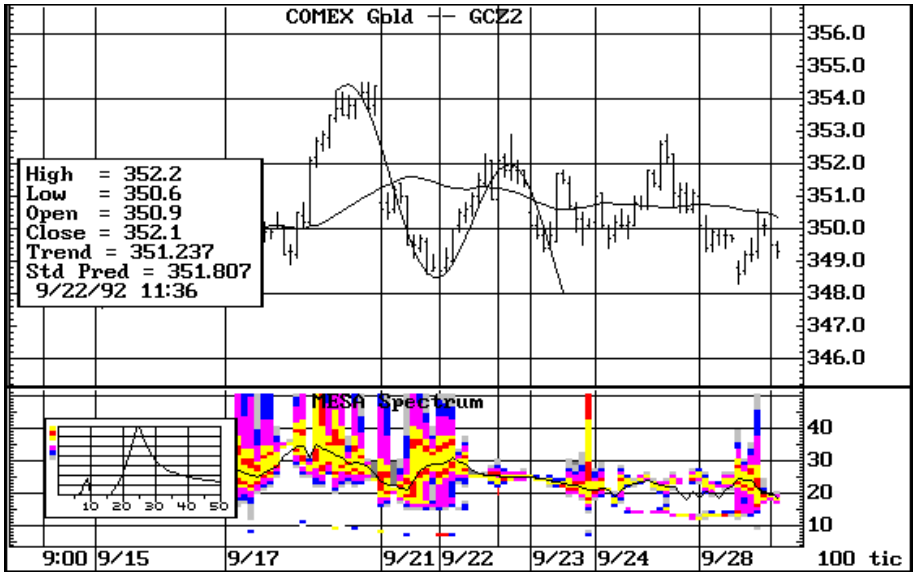
- The first overlay is the MESA trend line. The remaining three overlays are price predictions:
- The second overlay is the most commonly used prediction and is based on the measured dominant cycle.
- The third overlay is the second prediction, based on a sine wave cycle that best fits the data over the cycle lengths from 6 to 50 bars.
- The fourth overlay is the third prediction, based on a sine wave cycle period you select.

All cycle predictions are displayed as history over one full cycle period. This perspective enables you to compare the prediction to the price data and to project price activity ten bars into the future (from the position of the vertical cursor).

Predictions are obtained at any point on the bar chart by first moving the cursor to the desired position on the chart and double clicking the left mouse key. This feature enables you to back test the prediction. The following figure shows the price in the cycle mode with the price alternating about the trend line approximately every half cycle. This figure also shows the forward prediction from the cursor position at 11:36 on September 22, 1992, as well as the fit of the measured dominant cycle to the data for the previous 25 bars.

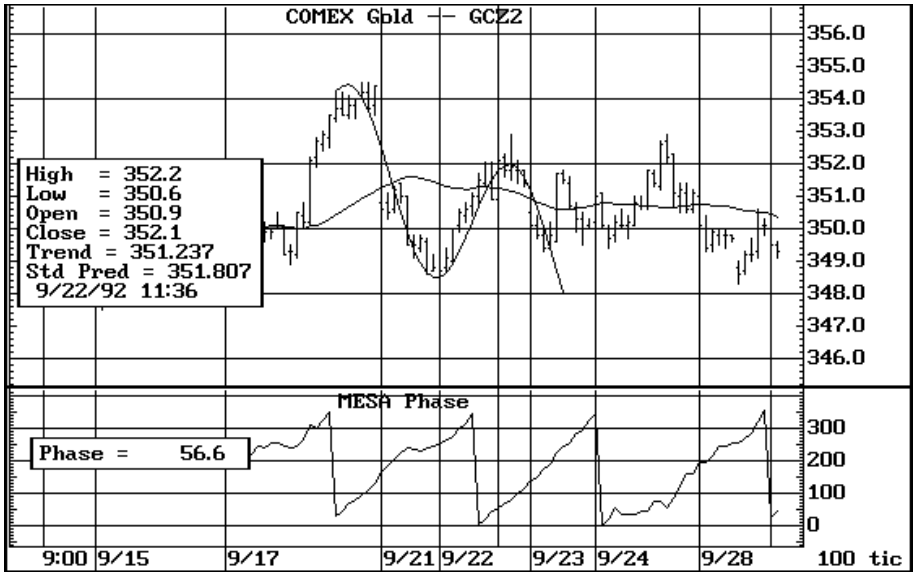


The *frequency* of the data is displayed in the MESA Spectrum Study. The spectrum for the bar on which the cursor is located is displayed as amplitude versus the cycle length. Each horizontal graduation denotes the amplitude and is half the amplitude of the next higher graduation. This logarithmic scale enables an amplitude display over a range of 100:1. The existence of a single cycle is a simple spike on this display. Several simultaneous cycles appear as multiple spikes with amplitudes relative to the strongest dominant cycle. More complex cycle contents appear as wide bell-shaped or distorted curves. Such displays indicated that the cycle energy is spread across a range of the spectrum and is therefore not focused at a single cycle. Spectra showing poorly formed cyclic content commonly appear when the market is in a trend mode. The following figure shows that the dominant cycle at the cursor location is 25 bars. There is also a very low level 9 bar cycle present in the data.



The *amplitude* axis of the spectrum display is color coded, with the highest amplitude graduation being yellow. The colors usually vary. Higher amplitudes are lighter while lower amplitudes are darker. These colors can be displayed below the bar chart on a split screen. Displaying the study in a split window aligns the spectrum with the bar chart. The vertical axis of the spectrum contour is the length of the cycle period. The cyclic history is apparent at a glance. The formation of the cycle length varies as a function of time, and cycles have distinctive patterns. A sharp contour indicates a well-defined cycle while splotches of bright colors indicate that the cycle energy is spread across the spectrum. The averaged length of the dominant cycle is shown as a green line in the cycle contour display. The following figure shows that the measured dominant cycle is consistent in the vicinity of the cursor.

The second MESA study displays the phase angle of the dominant cycle you measure. The phase of a pure cycle increases smoothly from 0 degrees to 360 degrees, and then begins at 0 degrees again for the next cycle. The following figure show the relatively smooth phase of the measured dominant cycle when the market is in a cycle mode.

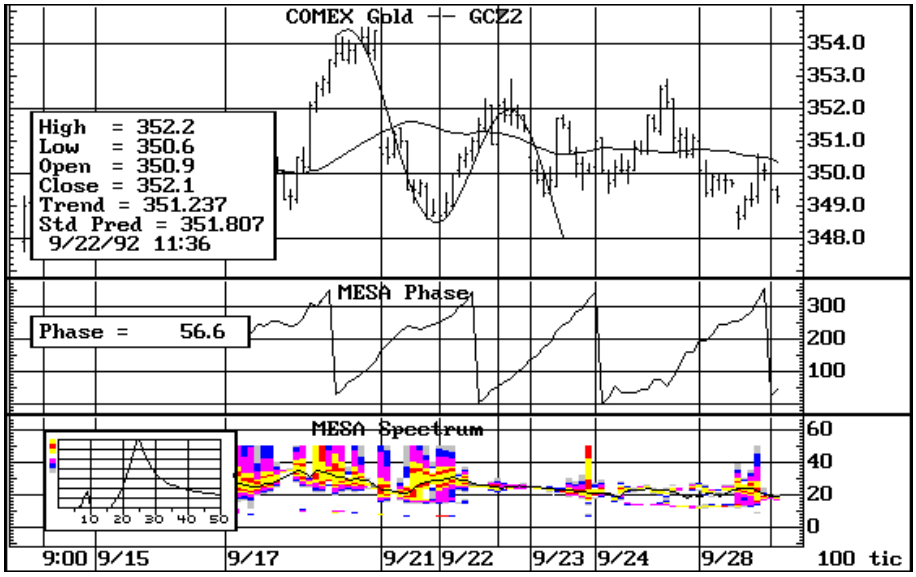


The smoothness of the phase angle's rate-of-change enables you to assess the quality of the cycle. Additionally, the phase angle can help you anticipate cyclic turns.

A sine wave has an amplitude peak when the phase angle is 90 degrees and an amplitude minimum when the phase angle is 270 degrees. The phase display enables you to anticipate these cycle turning points. For example, if the dominant cycle has a 20 bar period, the rate-of-change of phase is 18 (360/20) degrees per bar. Therefore, to make an entry exactly at the lowest cyclic point, a trade decision should be made when the phase angle is 252 (270-18) degrees.

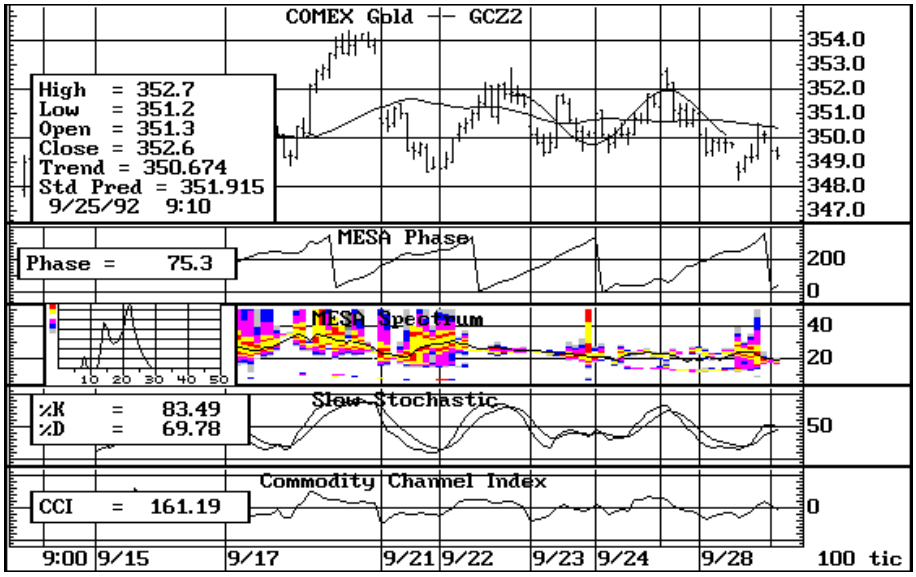
Cycle predictions are valid only when the *stationary constraint* is met, making the cycle consistent over the observation window. The MESA observation window is 30 bars for each measurement. Since the observation window is fixed, it is possible to alter the data to satisfy the constraint. Success is judged by the resulting output. The most consistent cycle is a pure sine wave of un-changing amplitude and frequency. On the spectrum contour plot, a consistent cycle appears as a single horizontal yellow line at a single frequency. It is often possible to approach this ideal condition by using the compression feature to alter the data. For example, starting with a split screen tick chart, compress the tick bars by entering the .EQTICKS 5 command and examine the spectrum contour. You can also observe other compressions by entering .EQTICKS 10, .EQTICKS 20, and so on. Since different data appears in the observation window with each compression, MESA often produces a nearly straight, horizontal dominant cycle period in the spectrum contour. As a practical matter, it is

best to set the dominant cycle length to less than 25 bars. The following figure is a tick chart that has been compressed to 100 ticks to produce the best cyclic performance, as indicated by the well-defined horizontal spectrum contour display. Compressing to produce the best cycle modes produces the best phase display and the best cyclic predictions.



To identify the optimum cycle mode, you can also compress the time scale. For example, you can compress the time scale by changing a 1 minute bar chart to a 5 minute bar.

Having achieved a reasonably solid dominant cycle display by compression, the market will most likely be in cycle mode. When a market is in cycle mode, the probability that the predicted cycle turning points and phase displays are accurate is increased. Additionally, you can verify trade signals by looking at cycle-sensitive indicators like the Slow Stochastic and the Commodity Channel Index. The following figure shows the same 100 tick compressed display with a slow stochastic and CCI. The prediction, phase angle, slow stochastic, and CCI all indicate a selling opportunity at the cursor location. Buy and sell opportunities can be correlated at other positions on the screen.


COMEX Gold — GCZ2
High = 352.7
Low = 351.2
Open = 351.3
Close = 352.6
Trend = 350.674
Std Pred = 351.915
9/25/92 9:10
354.0
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352.0
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350.0
349.0
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347.0
MESA Phase
Phase = 75.3
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%D = 69.78
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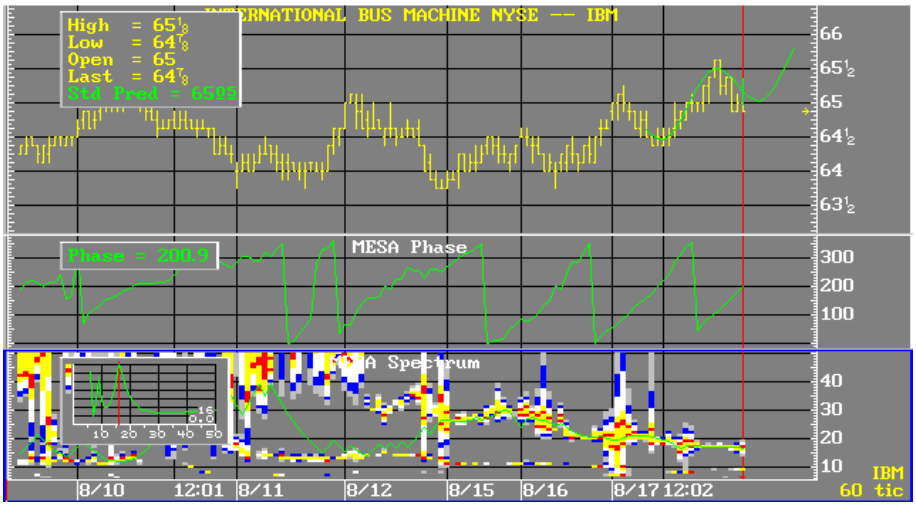
Applying the MESA studies

This section provides a brief introduction to MESA studies and their application. For additional information on MESA, please consult the references cited in MESA References, page 34.

Recommended Page Layout

The recommended page layout for using MESA is a full-screen chart with two study windows; on the chart, the MESA Standard Prediction (or Best-Fit or User) and MESA Trend overlays; in the upper study window, MESA Phase; and in the lower study window, MESA Spectrum.



Choosing the Appropriate Prediction Study

Users have a choice of three prediction studies. The MESA Standard Prediction study brings the full mathematical sophistication of MESA to bear in identifying and measuring the strongest sine-wave component, the "dominant cycle," in a fixed range of bars. The MESA Best-Fit Prediction finds the best-fitting cycle over a specified range of bars, allowing better detection of short-wavelength, just-emerging cycles. The MESA User Prediction allows a user to input a sine-wave wavelength and displays the corresponding prediction.

MESA Standard Prediction

The MESA Standard Prediction study answers the question, "Out of all the identifiable level of cyclic activity in the last 30 bars with a wavelength of 10 to 50 bars, what is the strongest sine-wave component, and what does it predict in the next 10?"

It is the basic prediction study. It uses MESA mathematics to measure the strength of all possible cyclic components with wavelengths of 10 to 50 bars, over 30 bars' worth of history; selects the component with the largest average cyclical movement; combines this with measurements from previous bars to calculate the "dominant" cycle; displays one cycle's worth of that dominant cycle; and makes a 10-bar prediction into the future. This study is best for general purpose cycle detection.

MESA Best-Fit Prediction

The MESA Best-Fit Prediction answers the question, "Among the sine-wave cycles that have wavelengths in the user-specifiable range, which one best fits the price data over its own wavelength, and what would that cycle predict over the next 10?"

It is a more customizable study that makes it easier to identify any short-wavelength cycles as they develop. Cycles that do not extend back close to 30 bars have not lasted long enough to be identified as the dominant cycle of the standard prediction, but other evidence sometimes indicates that they may exist. The study searches for cycles of wavelengths in a user-specifiable range that is usually set at the default of from 6 through 50 bars. Each one is then tested for goodness of fit to the price data over its own wavelength, instead of the 30 bars of the standard prediction. Goodness of fit is determined using standard least-squares correlation, and the best-fitting cycle is displayed and used as the basis for a prediction.

MESA User Prediction

The MESA User Prediction study answers the question, "Assuming that there is a sine-wave cycle of the user-specified wavelength operating in the price data, what does that cycle predict over the next 10 bars?"

It allows a user to make a prediction based on a cycle when he believes that it exists. even when it's neither the dominant cycle of the standard prediction, nor the best-fitting cycle found by the best-fit prediction. The user prediction can also be thought of as a limited version of the best-fit prediction—it shows one of the sine-wave

cycles that would be tested for goodness of fit[2] by the best-fit prediction, and a 10-bar prediction based on that cycle.

Using Equitick Bars

MESA theory dictates that the best results from intraday cycle trading are to be obtained using Equitick bars (see Ehlers' 1993 article and, for a much more lengthy discussion, the Arms book listed MESA References, 34). Aspen Systems' Equitick mode has been tailored to MESA's requirements.

You can create an Equitick chart, with or without MESA, using any number of ticks per bar. A chart can be converted to an Equitick chart by displaying the chart rescaling menu and selecting *EqTick*:

A chart can also be converted to an Equitick chart by typing the .EQTICK command. If you enter the .EQTICK command by itself, you get the default number of ticks per bar, which is 10. If you append a number to the command, i.e.,

.EQTICK 20

you get 20 ticks per bar.

Before you use Equitick bars, study the instrument you want to analyze for trading activity. Setting up an Equitick bar of 100 trades on an instrument that rarely trades more than 50 times per day will in fact create an Equitick bar that looks and, where MESA cycle analysis is concerned, acts like a daily bar chart. Equitick bars get reset at the beginning of each session. Therefore, knowing about an instrument's typical trading activity is important in selecting an Equitick bar amount.

Equitick is a chart state. Once you place a chart window in the Equitick state, it displays Equitick bars until you tell it to do otherwise. When a chart is in the Equitick state, you can change the number of ticks per bar by entering a number. For

2 Goodness of fit is determined using standard least-squares correlation, and the best-fitting cycle is displayed and used as the basis for a prediction.

example, if you have a chart displaying 10 tick bars and you want to see 20 tick bars, you would type 20 and press Enter.

To change an Equitick chart back to an interday chart, just type "day," "week," etc. To change it to an intraday chart, type "0" to get a tick chart and then the number of minutes, or display the chart rescaling menu and select *Time* (selecting *Time* displays a 15-minute bar chart).

Aspen Systems will provide as many bars as it has tick data to fill; so the number of Equitick bars you can view depends on the size of your tick data file (TICKS.DAT).

MESA in Action

Once you have set up a page, chosen a prediction method, and decided whether you're going to look at an Equitick chart or a conventional bar chart, you are ready to put MESA to work finding trading opportunities.

The basic method of using MESA is a searching process—look at an instrument's chart and MESA studies in different timebases, or different number of ticks per bar, until you spot indications of tradable cycling. Once you believe that a cycle exists at a certain wavelength, watch a MESA page showing the appropriate time- or tick-base until you can best take advantage of the cyclic activity to open a position, or close it.

MESA's studies work together to make a prediction, give you a sense of how reliable the prediction is under current market conditions, and pick the best entry and exit points for trading when cycling activity is confirmed. They also indicate when cycling activity is likely to give way to trending and when trending is likely to give way to cycling.

Identifying Trading Opportunities

The following section explains the basic trading opportunity identification process. This summary is based on Ehlers' own explanation—see *MESA and Trading Market Cycles,* Chapter 12, "Trading with MESA," pages 113-127. Also see Chapter 10, "Using the Spectrum to Identify Cycles and Trends," pp. 93-101, and Chapter 11, "Putting It All Together," pp. 103-111.

Measuring the Wavelength of the Dominant Cycle

An important first step in making sense of MESA's indications is to read MESA's measurement of the wavelength of the dominant cycle.

The simple definition of the dominant cycle is the cyclic component identified by MESA that has the greatest amplitude. The dominant cycle is described by its wavelength, measured in bars. In order to prevent dramatic but short-lived variations in the dominant cycle, instead of just taking the measured wavelength of the cyclic component with the greatest amplitude, Aspen Systems' MESA studies filter the dominant cycle a little further. First, the dominant cycle wavelength is only permitted to change by 25% from bar to bar. Second, the result of the 25% limit criterion is then fed into a 3-bar exponential moving average, using the previous two bars' dominant-cycle calculations as the other inputs. The resulting wavelength identifies the current bar's dominant cycle.

You can read the wavelength of the dominant cycle in two places on the recommended MESA screen setup. One is from the MESA Standard Prediction: if you position the prediction on the current bar, the prediction study shows one cycle's worth of history of the dominant cycle. So you can count the number of bars (not including the current bar) in that historic cycle, moving the red cursor back with the left cursor key to keep your place.

The other place to read the dominant cycle is from the MESA Spectrum study. The green line in the colorful spectrum contour plot in the main study window shows the wavelength of the dominant cycle. Just position the point of the mouse arrow on the green line at the current bar, and read the value off the wavelength scale on the vertical axis. Odd wavelengths fall between the gradations, but you can read the wavelength exactly.

MESA Spectrum

MESA Spectrum is the first study to look at because it provides a variety of nuanced information regarding dominant cycle length, the purity and consistency of the measured cyclic activity, and whether the market is starting to trend or not.

For Ehlers' discussion of the meaning and use of the spectrum study, see "Using the Spectrum to Identify Cycles and Trends," Chapter 10, pages 93-101, *MESA and Trading Market Cycles*.

The MESA Spectrum study has two parts: a colorful spectrum contour display, in the main study window, and a small line graph in a subwindow at the left end of the main window.

The subwindow graphs wavelength in bars on the horizontal axis against relative amplitude (in negative decibels or a related unit) on the vertical axis, at the current position of the prediction cursor. The graph shows the raw MESA cycle measurements over 30 bars, the same measurements used to generate the dominant-cycle wavelength and the standard prediction, calculated from the current position of the cursor.

The line graph is like a cross-section or "snapshot" of the spectrum contour plot—in fact, the spectrum contour is constructed from the data shown in the subwindow. You can read the exact wavelength and the relative amplitude in negative decibels from the upper and lower figures in the lower right corner of the subwindow by clicking in the subwindow to create or move the subwindow's cursor.

Note that the highest point on the line graph does not always correspond to the dominant cycle as shown in the spectrum contour's green dominant-cycle line and in the standard prediction, due to the smoothing used in calculating the dominant cycle's wavelength.

The spectrum contour plot itself shows the same relative strengths of the different cyclic components shown in the line graph, but represents them with the color scale that appears on the left side of the line graph, and charts them against wavelength on the vertical axis. So the yellow parts of the spectrum (using the default color scheme) correspond to the strongest cyclic components, while the light gray parts correspond to the weakest color-coded ones. The green line in the spectrum indicates the dominant cycle's wavelength.

As noted above, to read the current dominant cycle's length, position the mouse arrow on the green dominant-cycle line at the level of the current bar, and read the wavelength from the vertical axis.

Next look at the spectrum in the main study window. An ideal indication of cyclic activity would be a horizontal, straight green line with no other colors. This would correspond to a single, sharp peak in the line graph subwindow, and its meaning would be a persistently dominant cycle of unchanging wavelength, with no cyclic components of significant strength at any other wavelength. Bright colors far away from the dominant cycle line, or high secondary peaks or plateaus in the line graph, correspond to significant cyclic components of multiple wavelengths, which suggests that the dominant cycle may not be dominant for very long, and therefore may not be worth trying to trade on.

In practice, a perfect indication is extremely unlikely. What you do want to see for a tradable cycle is a reasonably horizontal, preferably straight dominant-cycle line, with little color anywhere except right next to the green line. You are very unlikely to see this combination of features across the whole spectrum; but you do want to see it for a distance corresponding to at least half of the wavelength of the dominant cycle. So, for example, if the dominant cycle's length is 11 bars, you want to see at least 6 bars' worth of encouraging spectrum display before judging it a positive indication.

Because the spectrum contains so much information, it is difficult to specify exactly what the minimum requirement for a positive indication is. However, there are some rules of thumb for each type of information presented by the spectrum display. In general, bright colors any distance away from the dominant-cycle line are worse than dark colors; more color showing is worse than less color showing; and more distance from the dominant cycle line is worse than less distance.

Finally, particular features in the MESA Spectrum studies can alert you to the onset of a trending mode in the market, and the end of a cycling mode. The clearest sign of such a shift can be seen in the subwindow graph. If the line graph slopes upward to the top of the graph on the right side, this indicates that a trend is developing. When a trend is developing, when you move the main chart cursor from the left toward the current bar, the right side of the graph rises up to form such a sloping line. This phenomenon is called a "rising tail". The corresponding but less clear sign in the spectrum display is a lot of yellow right at the top of the spectrum display, over a number of bars, with gradually darker colors tapering off below it.

Determining Questions for MESA Spectrum:

1. What is the dominant cycle length?

2. Over a range corresponding to at least half of the dominant cycle length, does the spectrum display show a fairly horizontal, preferably straight line with little or no color, especially bright color, far away from the line? If yes, this is a positive indication. If no, try looking at another time- or tick-base or another instrument, or wait for more favorable indications.

3. Alternatively, does the line graph in the subwindow show a sharp peak with the line near zero elsewhere? Does this pattern hold for a number of bars to the left of the current bar equal to or greater than half of the dominant cycle's length? Does the indicated dominant cycle length stay stable over that range? If the answers to these questions are yes, this corresponds to the spectrum display above and is a positive indication.

4. Does the graph show a line sloping up to the left, to the top of the graph? If you move the main cursor toward the current bar, do you see the right side of the graph rise to form such an upward-sloping line? If yes, this is a negative sign for a cyclic trading opportunity, but it is a positive sign that a trend is beginning and that trend-following trading opportunities may present themselves.

MESA Phase

MESA Phase backs up the spectrum study by giving you another way to see how perfectly cyclical the market's cyclic components are.

The indication of perfect cycling behavior, and therefore of a perfect trading opportunity, is a neat saw-tooth formation stretching all the way across the page. "Saw-tooth" in this case means repeated triangular chart formations with a long, straight sloping side facing the upper left, followed by a near-vertical straight line returning to the bottom of the study window. The illustrations on pages 8, 9, and 10 of the MESA addendum provide good examples.

In practice, getting a whole row of neat triangles is very unlikely. However, if you don't see at least one nearly complete, straight-looking swath pattern at the right side of the screen, you don't have a trading opportunity. When trying to decide the quality of a not-quite perfect saw-tooth, keep in mind that a rising line that rises unevenly but keeps rising is slightly more positive than one that rises, then drops, then rises again.

Determining Questions for MESA Phase

1. Is there at least one promising, reasonably triangular saw-tooth at the current end of the study window? Or is there at least one appearing to form over the last half-wavelength of the dominant cycle? If yes, the indications of the spectrum are confirmed. If no, this corresponds to inconclusive indications from the spectrum study and indicate that you should probably seek a cyclic trading opportunity elsewhere.

MESA Trend

Next, take a look at the MESA Trend study. This study provides confirmation of cyclic activity or evidence of trending, and should correspond to indications from the spectrum study.

For predictive purposes, MESA models price activity as a trend plus a sine wave, the dominant cycle. The MESA Trend line shows that trend, that is, what's left once the dominant cycle and all other cyclic components detected by MESA have been filtered out of price activity.

MESA Trend offers a test for cycling or trending conditions in the market which is often clearer than indications from the spectrum study. Because MESA models market activity as a trend plus a cycle, the prices should cycle up and down across the trend line over time. Even if the other studies seem to indicate cycling activity, if the price bars don't cross, or at least touch, the trend line within one half-cycle of the dominant cycle, this is a strong indication that a trending mode is beginning.

For instance, if the dominant cycle's wavelength is 18 bars, count back 9 bars from the current bar. If the price bars have not crossed the MESA Trend line between the 9th bar back and the current bar, then this is a strong indication that the market is not in fact cycling. This kind of phenomenon corresponds to, for instance, a "rising tail" in the MESA Spectrum subwindow, but may in fact be visible earlier than a rising tail.

On the other hand, if the price bars have crossed or at least touched the trend line within one half of the dominant cycle's wavelength, or have crossed and re-crossed the line over a longer period, this confirms other evidence of cycling in the market. If the price bars touch or preferably cross the trend line after a period of trending, this evidence that the market is shifting from a trending mode to a cycling one.

Determining Questions for MESA Trend

1. Do the price bars cross or at least touch the MESA Trend line within half of the dominant cycle's wavelength? If not, this is a sign that regardless of the indications of MESA Phase and MESA Spectrum, the market is probably not in a cycling mode, but is in a trending mode. In this case, trending trading opportunities should be pursued.

2. If price bars do cross the trend line, the market is probably in a cycling mode. If they cross or touch it after not crossing or touching

it for some time, this is an indication that the market may be switching from a trending mode to a cycling mode, raising the likelihood of spotting trading opportunities through MESA.

Indentifying Entries, Exits, and Stops

Finally, look at the prediction itself. Naturally, if you decide to trade, you want to put your long positions on near the trough of a cycle, and put your shorts on near the top. In addition, the prediction makes explicit your expectations about where prices will go, allowing you to set stops with some precision, and to define when you will begin to consider exiting the trade if the cycle does not develop as expected.

An important point to keep in mind is that, in Ehlers' words, "The MESA [standard] prediction is more successful predicting the timing of turning points rather than the level at which the turning points occur" (*MESA and Trading Market Cycles,* p. 110). So from a MESA point of view, it's a neutral indicator if the price level of a predicted cyclic trough or peak does not remain consistent from bar to bar; but if as a chart develops, a predicted trough or peak moves, that is a bad sign. Ehlers suggests back-testing the prediction for 3 to 5 bars before the current bar. If the turning point stays in the same place in the prediction, this is a sign of reliability. If it doesn't, this is a negative sign and probably corresponds to negative indications in the other MESA studies.

Checking Other Bases and Other Instruments

Once you have run through these decision-making steps, if you have not spotted a trading opportunity, you are ready to look at the same instrument in a different time- or tick-base. If you already have, you're ready to look at another instrument.

Experience will show which time- and tick-bases are likely to be most fruitful for a particular instrument or market.

Summary: Identifying Trading Opportunities

This checklist summarizes the detailed explanation above.

- Type the symbol and time- or tick-base to be examined into a MESA page.
- Look at the MESA Spectrum study's line graph to measure the dominant cycle.
- Look in MESA Spectrum's main study window for signs of consistent cyclic activity over a half-cycle of the dominant cycle.
- Adjust the time- or tick-base and repeat as necessary to find the best spectral indications.
- Verify cyclic activity using the MESA Phase study: look for a saw-tooth pattern.
- Verify cyclic or trending activity using the MESA Trend line.
- If the studies' indications are positive, back-test the prediction to confirm that the predicted turning point is consistent, and if it is, use the prediction to identify an entry point, a likely exit level, and stops.
- If the indications are negative, try a different time- or tick-base or a different symbol, or wait until they are positive.

MESA References

A first reference:
"MESA Studies on Aspen Graphics," addendum to the *Aspen Graphics Users Guide*, Version 2.217.

This supplement not only offers a good explanation of what each study is and how to control it, but also a useful six-page illustrated guide written by John Ehlers, the pioneer and main promoter of market applications of MESA, that provides an excellent overview of what MESA is and how to trade with it. Virtually identical selections are also available in the Aspen Graphics manual version 2.2.227, pages 8-79 through 8-88, and pages 8-30 through 8-34.

A useful introductory supplement:
"Cycle Analysis and Intraday Trading," by John F. Ehlers, reprint from the magazine *Technical Analysis of Stocks & Commodities*, published by Technical Analysis, Inc., Seattle, 1993.

This readable article, again from John Ehlers, introduces MESA in a slightly different way, with some useful discussion of Equitick charting, and comes complete with 10 illustrations. Also check out the goofy Aspen ad on the back page.

Depth for the enthusiast:
MESA and Trading Market Cycles, by John F. Ehlers (Wiley Trader's Advantage Series, series editor Perry J. Kaufman, John Wiley & Sons, Inc., New York, 1992, 140 pages).

John Ehlers wrote this book as the authoritative source on MESA. The first part of the book lays out some of the background to the development of MESA techniques, their rationale, and various applications, and goes into more mathematical detail than will be interesting to most users. The last four chapters focus on actually using MESA studies and expand on the briefer explanations offered in the *Aspen Graphics Users Guide* addendum and the magazine article.

For the hard-core MESA maven:
The Ehlers article described above finishes with a short bibliography for further reading. Look for a 1992 article by Ehlers,

"1991 Cycles" in *Technical Analysis of Stocks and Commodities*

1984, four articles by Anthony Warren on maximum entropy techniques, which are ancestors of MESA, in the same magazine.

1983 book *Volume Cycles in the Stock Market: Market Timing through Equivolume Charting,* by Richard W. Arms, now available through Arms Equivolume Corp. in Albequerque, New Mexico, U.S.A., which lays out the rationale for Equitick and equivolume charting.

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