Derivatives Trading Systems: Core Functionality

Business factors to consider when adapting a cash-market trading system to handle derivatives

A White Paper from Alberta Market Solutions Ltd. (February 2004)

Table of Contents

Alberta Market Solutions Ltd. provides technology and business intelligence to capital markets, challenging conventional wisdom with new insights and perspectives based on research and direct experience.

Any questions regarding this document or others should be forwarded to the following:
Alberta Market Solutions Ltd.
Calgary: +1.403.246.5104
Vancouver: +1.604.603.0880
e-mail: info@albertasolutions.com
www.albertasolutions.com

INTRODUCTION

At a certain stage in their evolution, many exchanges contemplate introducing derivatives trading to their exchange.

Exchanges in this position have two choices. They can buy an existing purpose-built derivatives system to run alongside their existing cash-market system or they can adapt their cash-market system to handle derivatives. While the former may be a lower risk option, it is almost certainly more expensive than the latter. Derivatives trading systems like OM's Click Trade XT™ and LIFFE Connect® cost many millions of dollars. Converting the cash-market system to handle derivatives may make more sense.

But it is not only for reasons of development costs that the exchange should consider adapting its cash system to trade derivatives. Operational costs are also lower when the exchange runs both markets on the same shared platform, or at least on compatible technology.

There is also a liquidity benefit to be derived from merging trading onto a single platform. Certain trading strategies that use symbols in both markets can be executed, making the market more useful to investors. Also, risk can be reduced in a market where the execution of underlying hedges is timelier. Because the orders are being executed on effectively the same market, the time gap between the trade and the hedge is reduced.

Ultimately, a combined marketplace offers investors more choice than one that is separate.

In terms of functionality, a derivatives-trading system contains just about everything required in a cash-market trading system plus some more. A "standard" cash-market system therefore contains the core functionality for derivatives exchange trading system, but is not sufficient without further customisation. A derivatives-trading system[1] could be more easily adapted to a cash market than vice versa.

This paper describes the main issues that would need to be addressed in adapting a cash-market exchange trading system to handle the key functionalities for a derivatives market. It may be used as a reference document for highlighting those key areas—a checklist prior to performing a detailed impact evaluation.

System performance considerations

One high-level difference is the nature of the critical system performance characteristics. In general, performance requirements for a cash market are different from those of a derivatives market. For example, the most heavily traded symbol on a cash market exchange probably sees more activity than the most heavily traded symbol on a corresponding, related derivatives exchange; although futures can see some very heavy trading indeed (e.g., Euro-Bund futures on Eurex regularly trades over one million contracts in a day). On the other hand, the total volume of system transactions (messages) for a derivatives market that trades options may be much higher, mainly because of all the market maker quotes, which contain large quantities of frequently updated data.

So the two markets present different types of challenges in terms of performance. Cash markets may be thought of as deep and narrow posing major throughput challenges, while derivatives markets are wide and shallow, posing bandwidth challenges.

[1] One exception, something which may be in a cash market trading system and not in a derivatives system is the contents of the product definition file: details like number of shares in issue and other characteristics of the traded entity itself – but these are not really core to the trading functionality anyway.

Effects of futures and options

In the hierarchy of complexity, futures trading may be viewed as the next level up from cash-market trading. And options trading would be the next level up from futures trading. An exchange may feasibly graduate from cash market to futures trading, assess its position and then move on to options trading. This is the logical sequence in terms of system functionality, if not necessarily in terms of commercial logic.

The introduction of options calls for a considerable amount of new functionality. Options are simultaneously (a) more numerous (in terms of tradable symbols) than futures and (b) more complex in terms of the symbol attributes and trading models that are required to support trading in them.

Quantity

A futures contract needs just three variables to define it (underlying asset, lot size and expiry date), while an option contract needs these six: underlying asset, lot size, strike price, type (i.e., call or put—respectively the right to buy or the right to sell), expiry date and exercise style. ("Exotic" options can include even more variables, but the day when exchanges trade exotics has not yet arrived and may never arrive, given their esoteric nature. So we can ignore them for the time being).

Because of the strike-price variable, exchanges can issue options in virtually unlimited quantities. On the other hand, futures contracts are limited to a pre-set number of expiry months. Generally, for each underlying, there is one futures contract per expiry month.

There can be exceptions. Exchanges can list different types of futures contracts over the same underlying asset, such as the E-mini on S&P500 at the CME, but a practical limit is quickly reached. And at some exchanges, for example the London Metal Exchange and Nordpool, the number of possible expiry dates is equal to the number of days over the forthcoming few months plus each month several years into the future. But even in these extreme cases, just one option class can easily contain far more tradable symbols than the entire set of such “daily” futures contracts.

The result of these differences is that the trading system needs to handle a far larger number of symbols than it would if it were handling equities or futures alone. It also has to handle a greater number of administrative tasks such as the automatic introduction of new series as underlying prices change and the ordering and presentation of mass quantities of data.

Format of this document

The main topics here are grouped into sections. This is not an exhaustive list of differences but it does address the main areas and can serve as a basis for further elaboration and discussion. Here are the main areas where derivatives trading introduces new functionality:

Market making

- Quotes as new order types
- Automation of quoting
- Quoting rules
- Measuring market maker performance

Effects of underlying market

- Introduction of new series
- Suspensions/trading halts
- Limit-up and limit-down
- Dealing with corporate events
- Opening and closing procedures

Data reporting

- Impact on the data feed
- Determining settlement prices

Product definition

- New attributes: underlying asset, strike prices, expiry date, lot size
- Expiry calendar
- Strike-price interval
- User-interface issues

Orders and trades

- Market orders
- Crossing rules
- House/client differentiation
- Position-limit vetting
- Combination orders (spreads, etc.)
- Inter-market activity

MARKET MAKING

Only a few options markets, especially new ones, can function without market makers, so market making is core functionality. Market making is needed because an options market without it would rarely have sufficient natural liquidity in each option series to ensure a reasonable supply of counter-parties. Holders of option positions who are unable to liquidate would quickly become disenchanted with the market.

This applies even to options on the most liquid underlying assets—even IBM options need market makers. To see why, consider somebody who purchased a $100 call option when IBM was at $99. At the time of the purchase, with the stock at $99, the $100 call would have been “hot” with plenty of liquidity provided by end-users as well as market makers. But if the stock price moves in his favour and rises to $130, the natural liquidity in the $100 call may no longer be there since it is now so deep in the money. By that time, it may be that nobody particularly wants to buy that $100 call. The holder could exercise it of course but that is not necessarily desirable and he would lose whatever additional “time value” was in the fair option price. A market maker is always—well, nearly always—able to buy it from the investor because the market maker is able to hedge away the risk by trading the underlying asset or trading other offsetting derivatives. Options market making most likely needs to be mandated by the exchange and the market makers given concessions accordingly.

Futures are also less prone to the liquidity problem. First, they do not have strike prices so their “relevance” to the market is not affected by underlying price movements in the way that an options contract is. Also, the market interest is not spread across so many series. It is focused on one or two single contracts. In fact, if liquidity in futures is a problem, it is likely to arise from some flaw in the product and hence is not something easily fixed by introducing market makers. But even successful option classes need market makers, as evidenced by the IBM example above.

Market maker role definition

The market maker may be classified as a separate user type with different access rights. It is necessary to create associations between symbols (or classes of symbols) and market maker users since different market makers are responsible for different symbols. Sometimes if a firm is both a market maker and a broker and holds only one seat, the system may still be required to identify the market maker as a different "member" from the brokerage division. So "trader" and "member" might not be one and the same.

Alternatively, the system may, based on order type (quote vs. normal order) and account (house vs. client) information, determine whether a user is playing the role of a market maker or a trader for that transaction.

Auto-quoting

Although front-office systems normally generate the market maker quotes, the system needs to handle the simultaneous submission of rather large quantities of quotes. A volatile stock can easily have a couple of hundred separate series being quoted simultaneously. And the prices can require updating frequently in a volatile market.

Also note that, normally, several market makers are competing and so this can generate very heavy traffic.

As a result, some systems design the quote function as a separate message type. Rather than treating a quote as a pair of limit orders (a buy and a sell), the quote transaction can actually be a record that contains a large number of prices for a single option class—so one message handles multiple prices. In any case, as seen below, it is often necessary that the system be able to distinguish a quote from an order because the trading rules can require they be treated in different ways.

Market maker decision support systems include quote price calculation (i.e., input the assumptions—type of option, underlying price, volatility, interest rate, dividend—and have the system generate the prices). These price calculations can be performed by third-party software but some traders would prefer to use their own in-house proprietary black box to generate the prices (even though they often employ precisely the same algorithms—such as the binomial formula for equity options but programmed from within their own systems).

Quote parameters

The rules governing quotes need to be written into the system and these can get fairly complex. The rules are needed to ensure that the market makers are providing an effective service to the market place. If there were no quote rules, the only thing ensuring market quality would be competition between market makers and sometimes that is not enough. Particularly in times of illiquidity, it is vital that market makers are there to provide a market.

Some examples:

a) What is the maximum spread size permitted?

b) What is the minimum lot quantity per side?

c) Is a wider spread permitted for a large quote quantity (and vice versa—narrower quote for small quantity)

d) Is the quote obligation applicable to all series or just some?

e) Does the quote auto-refresh when there is a fill?

f) When does the market maker have to quote (e.g., can obligations be temporarily suspended in a "fast market"; if so, what is the definition of a fast market (e.g., a 5% move in the underlying within 2 minutes)? This underscores the importance of flexibility in the way the rules are enforced and monitored.

g) Is there a requirement for automatically pulling the quotes for a class in a fast market?

Remember that some market makers may only be required to make markets in certain option classes, not all.

Example a) can be tricky. In an efficient market, the derivatives spread size is governed by the spread size of the underlying—basically, you can't expect a market maker to offer futures or options quotes whose spread is narrower than that of the underlying instrument. In some markets, the tick size of the underlying varies depending on the price range. The options market needs to reflect this.

Moreover, market makers cannot really be expected to quote for a greater quantity than is readily "hedgeable" in the underlying market. Reflecting the dynamics of this in the quote rules is not such a simple task but it is important the exchange and its market makers find common ground, a level at which liquidity is sustainable.

Quote request

Some markets allow for quote requests rather than requiring the market makers to continuously make markets in all series. For example, it may be determined that market makers only need to make continuous markets in the most commonly traded options series (generally those whose strike price is near the current market price). So when an investor wants to trade a series that is not currently very active, a quote request can be issued.

This may also apply in markets where demand from investors is only intermittent and the costs of maintaining continuous markets do not justify the returns for market makers; although, with automation, the marginal costs of maintaining quotes is lower than it has ever been.

A quote request generally takes the form of a specific transaction type issued by a member who is interested, either for his own benefit for a client, in a particular series or set of series. Typically, the quote request message is broadcast to the whole system so that all participants can see that a request has been made. Some issues:

a) Can a quote request be issued for one series at a time or for more than one?

b) If there is a quote request, how soon does the market maker need to respond?

c) How long does a quote have to be held in the market after submission?

d) Can a user request for a specific number of lots? And if so, do the rules allow different responses from the market maker? See c) above for quote parameters.

e) What restrictions exist for users issuing too many quote requests? Excessive requests can be an irritant and most exchanges would like to limit them to reasonable levels.

f) Can a quote request be submitted when there is already a valid quote in the market? Such a request can be viewed as a "request for improvement."

g) Who is prohibited from issuing quote requests? Typically market makers cannot issue quote requests.

Measuring market maker performance

All these rules need monitoring so the system must offer a statistics function that monitors market maker transgressions and performance. The exchange wants comprehensive statistics on market maker performance and these records can be the source of much contention since they tend to determine fee levels.

The data to be collected includes identification of periods where market makers were not fulfilling quote obligations—essentially identifying breaches of the "rules" described earlier in this section. Real-time alerts of such violations are also desirable so that market control may react promptly to restore market quality. Some exchanges also want to use these statistics to advertise their market makers' performance (e.g., reporting the percentage of the trading day when a two-sided quote was available in the market place or reporting what the average spread size was for products they trade).

The percentage of time during trading hours when a market maker is making the best market may also be calculated as another scorecard item that can be used to determine rebates.

EFFECTS OF THE UNDERLYING MARKET

As seen above, the underlying market determines the behaviour of the derivatives market, so there is a good deal of specific functionality relating to the underlying market.

Corporate events

This issue only applies to derivatives on single stocks or on narrow based indices. It does not concern options on non-equity products.

Adjustments arising from corporate events, splits, etc. cause a change to the strike price and lot size in an options market (and in a single-share-futures market). The need to adjust closing prices to reflect this is something cash-market trading systems are already required to handle; although, many cash markets do this manually, which is not a realistic alternative with an active derivatives market.

The ideal way to deal with capital adjustments is to have total flexibility so the exchange can create whatever profile it wants from a given event. The typical corporate event is fairly simple (e.g., a 2 for 1 stock split simply doubles the contract size or the number of contracts and halves the strike price for all options on that stock). But a complex event, such as a spin-off where a new tradable entity is created from an existing listed company, can create quite complicated adjustments to contract terms.

Most systems "automate" the calculations, which is fine, but limit the extent to which the user can populate the database manually. Obviously the corporate world is capable of anything when it comes to capital restructuring so the system needs to be flexible in order to create whatever result the exchange requires.

The system should optionally be able to download the new adjusted symbol data from a clearing system.

Some users don't like to see adjusted series cluttering the screen since (post adjustment) these series tend to trade less. So there may be a need to modify the presentation of price data for adjusted series. Again, this could be viewed as a front-office issue since the trading screen can and generally is controlled at the user-interface level.

Suspensions/trading halts

Much of this functionality may already be in a cash-market system if the system is used for warrants trading.

When a stock is suspended, the exchange generally needs to automatically suspend all the derivatives related to that stock. There may be more than one product affected by the suspension so this needs to be efficiently incorporated so the classes don't need to be closed one by one.

It may be decided to delay re-opening of the derivatives until after the cash products have started trading so the ability to have different schedules for different product groups could be important.

Limit-up and limit-down

Like cash markets, derivatives markets can have limit-up and down rules, but because derivatives markets are sometimes dependent on activity in another market, the exchange needs to consider the way in which market information is fed and the processes for trading suspension are triggered.

Most limit rules are based on a percentage movement in the underlying from the previous closing price; although, some still use a fixed value rather than a percentage. One of the issues here is whether the suspension is automatic or whether it triggers an alert and the exchange closes the market manually.

Not all markets have limit-up and limit-down. To dispense with such rules certainly simplifies market supervision. There is plenty of disagreement about whether this is a good thing or not, but this is something for the exchange to decide.

Introduction of a new series

The system needs to be able to automatically add new option series at the start of each day in line with changes in the underlying market price, unless the exchange has good business reasons to implement:

Intra-day introduction of a new series

Most of the time, this is not needed, but when markets are very volatile and an underlying price moves into a new range where there are no options available at those strike price levels, the inability to trade options with strikes at the current market price is a major frustration for traders, investors and exchange operators.

Before markets were automated this was a no-brainer—the exchange just told the floor they could trade that new strike price. But now it is hard to introduce a new series intra-day because of the way that most trading systems upload the symbol database into memory at start-of-day, for efficiency reasons. If the trading system can get round that restriction, not only would it help deal with that problem but it would also greatly enhance the ability of the exchange to trade FLEX-style products, which are options first developed by the Chicago exchanges to allow investors to define their requirements in real-time and trade them immediately.

This could also have implications for the ability to dynamically trade spreads (see *Combination orders (spreads, etc.)* on page 10).

Deletion of series

Conversely, series with no open interest but whose strike price is far from the current market may as well be deleted. They waste space and reporting bandwidth. This is a facility that is best performed manually rather than automatically; although, tools can be provided to make it easier for an operator to select multiple series at a time.

PRICES, DATA FEEDS AND REPORTING

A timely and reliable data feed from the underlying market is an essential component of the derivatives trading system—despite the fact front-office systems and more open data vendor systems have reduced somewhat the need for derivatives exchanges to obtain this data directly from the underlying market. Obviously if the underlying market is operated by the same exchange operating the derivatives market, the communication of underlying prices does not need to go through a third party.

As for dissemination of derivatives prices themselves, the volume of data—particularly if the data feed updates all market maker quotes—suggests a need for a high bandwidth feed. The relative improvement in recent years in bandwidth availability at manageable prices has made this slightly easier but the volume of data being generated has increased along with the bandwidth.

Reporting implied volatility

Option prices are affected by a variety of factors. They include: the current underlying prices, the current interest rate, the strike price, the time to expiry and, lastly, the market's perception of how volatile the underlying price is going to be (the higher the perceived volatility, the higher the option premiums). This last factor is generally referred to as "implied volatility" and it is an important piece of information used by options traders.

It is not necessary—it actually could be considered a waste of bandwidth—to include implied volatility in the real-time data feed. Because it is derived from other data, calculation and reporting of implied volatility in real-time is better handled by an external front-office system.

But at the day-end, most exchanges like to report implied volatility along with the closing prices. The system therefore needs an implied-volatility calculator—at least for daily closing prices. In fact, there may be a need for reasonably sophisticated options pricing tools, as is seen below.

Determining settlement prices

In most markets, the exchange determines the settlement price instead of, or in addition to, the clearinghouse. Determining the settlement price of an option can be a little tricky since you are trying to find the best representation based on prevailing market conditions (as previously noted, most series do not trade at all during the day). A relatively simple algorithm can be used to determine the settlement price (e.g., last trade price if that is within the current bid/offer or mid-price if the last trade price is outside), but exchange officials want to be able to override these and need a set of options pricing tools to help them. The trading system must then generate and distribute a full set of settlement prices.

A minimum requirement to enable the calculation of settlement prices is for the trading system to interface with option pricing software (i.e., software that can calculate the value of an option given the required parameters and can calculate the implied volatility of an option). The ability to use this software to process a large number of prices is important. Many users of such tools now employ Microsoft® Excel add-ins to do this. The important thing is to maintain data integrity and include sufficient checks and balances to avoid errors.

The *FRONT OFFICE & ISVs* section (see page 12) explains more about how option prices are calculated and how market users interface with the broader market in order to fulfill their information and processing needs.

Open interest reporting

Open interest is the number of open positions currently in the market. When one participant buys a new futures contract and his counterparty sells a new contract (as opposed to closing an existing position), then open interest increases by 1. The clearinghouse calculates this data, but most exchanges also report open interest. So there needs to be provision for this data to be obtained from the clearinghouse and included under exchange reporting.

Risk parameters

Some exchanges require their members to margin their clients in accordance with official exchange closing prices and to enable them to do this, members can download the "official" parameters from the exchange. These are the closing prices and the theoretical prices that should be used to determine margin requirements. The most common standard for this is SPAN™. (SPAN is an algorithm that takes closing prices, projects certain risk scenarios, and applies them to a derivatives portfolio to calculates the amount of risk margin required in respect of that portfolio. It is a well-established tool that was first developed by the CME Clearing House and has been licensed widely). The exchange may be required to produce this data and make it available to members or to all-comers via its website.

OPENING AND CLOSING PROCEDURES

Markets have different customs for market opening. Floor-based markets traditionally have had complex opening rituals—"rotations" as each of the option series is opened in turn by the market makers announcing their quotes.

However, in automated markets (and it is assumed that any new derivatives exchange will not operate a trading floor), there is no need for such procedures. It is not a major challenge for a market maker to issue quotes for all options on an underlying simultaneously. And, today, even the floor-based exchanges have automated this process.

Drawn-out opening procedures are still found in cash markets, notably the NYSE, but are increasingly rare in derivatives markets.

Handling of open orders at the opening

One of the main issues is how to handle stale customer orders that are way off market. There is a need to ensure stale orders get filled at fair prices. Many exchange supervisors watch out for such errant orders and contact the member responsible before the market opens to verify that the order was intentional.

One way of reducing the risk of a stale order matching at a bad price is to open with a call auction, inclusive of market maker quotes, displaying the current price at which the maximum number of orders would trade. This helps detect the impact of any wayward prices.

Many derivatives markets only open after the underlying market has opened. This is particularly true of option markets where it rarely makes sense to have the market open when the underlying is closed. Some derivatives markets open at the same time or even before the underlying: this is particularly appropriate for futures markets.

If there are variances in the timing of the opening of the underlying market (e.g., NYSE stocks open gradually stock by stock and at no particular predictable time) and if the derivatives market only opens after the cash market has opened, then that may demand flexibility of opening procedures in the derivatives system.

Closing

Some markets operate closing rotations as well, to determine settlement prices. As with opening, these procedures vary from market to market but typically involve requiring market makers to issue their final quotes for the day based on the most recent activity in the derivatives and in the underlying. If there is a closing rotation, it can eliminate the need for the exchange to have its own procedure for settlement price determination (see description in *Determining settlement prices* on page 7).

However, with automation, this procedure is increasingly viewed as unnecessary and most all- electronic markets operate a settlement price algorithm as described also in *Determining settlement prices* on page 7.

PRODUCT DEFINITION

It was mentioned earlier that a derivative instrument is defined by reference to at least three variables: underlying asset, lot size and expiry date. This defines a futures contract while an option contract is defined by adding strike price, option type, and exercise style. This section describes the data sets that arise from these and other variables and includes a discussion of the types of data required by market users in order to interface effectively.

Underlying asset, strike prices, expiry date and lot size

It is important to ensure product definitions are as flexible as possible and the system does not impose unnecessary restrictions on them. An exchange should ideally be able to have any strike price and expiry month it wants.

Lot size may not be needed— it depend son the nature of the market. Its most likely application is the exchange has position limits based on monetary value rather than numbers of contracts. In that case, the lot size is a necessary input parameter to the position monitoring system. See *Position-limit vetting* on page 10.

Expiry calendar

A calendar of expiry dates needs to be maintained. Some markets have different expiry months for different times of the year (e.g., only introducing a new “3-month expiry” month once a quarter). Also different product types may expire on different days in the month. Many varieties exist—flexibility is needed to ensure the system can accommodate the formula. A simplistic method is to create a table that contains all the expiries that are extant during each period. This is cumbersome to set up but once done, it rarely needs to be changed and avoids programming complex algorithms to deal with each eventuality.

Strike price interval

The intervals at which strike prices are automatically added are set by a strike price table, which is basically a list of valid prices associated with each product group. The intervals are not fixed and vary depending on the price of the underlying. Keep in mind the need to fill the gaps in strike prices when there has been a massive market movement.

The above standing data (*Underlying asset, strike prices, expiry date and lot size* and *Expiry data*) determines what is automatically generated at the time of expiry and/or when underlying market prices change.

ORDERS AND TRADES

Most order types are the same as for the cash market. American markets have complicated, elaborate rules about small orders and large orders and how they are handled. For example, in some markets, orders above a certain size cannot be routed to the limit order book and instead have to be allocated amongst the market makers. Most new exchanges do not want to operate that sort of system and it is certainly the exception for derivatives markets to have complicated rules about order allocation. Most of these types of rules are relics from an earlier era, when trading was much less automated than it is today.

The main differences between cash and derivatives markets concern how orders interact with market maker quotes.

Market orders

Because of the danger of stale prices, market orders need to be handled carefully. The market order can be somewhat complex because of this. One algorithm that is used in some markets is to have a rule stating the market order will only match if a valid quote is in the order book but matches with a limit order if that limit order is better than the quote. If no quote is in the system, it automatically issues a quote request, then matches with the quote that results—unless there is already another market order on the other side, in which case it matches with that market order at the mid-price of the quote.

House/client differentiation

A variety of rules exist in relation to client priority. In some markets, client orders have priority over house orders (this is not unknown in cash markets) or are subject to special rules (such as crossing rules—see below). The key point to note is that house/client differentiation is much more prevalent in the derivatives markets than it is in the cash market because of the core role that "professionals" (another term for the house) have always played in ensuring liquidity in the derivatives markets and there may be special-order-handling logic required, based on the source of the order to enforce these rules.

Crossing rules

In order to prevent market manipulation and to promote best execution, there are often crossing rules to govern if and how a client order can match with a house order. The idea is that a member should show the order to the whole market before crossing it with a house order. These rules take many forms but generally they involve limiting the time between client order submission and house order submission. It can also happen that the crosser has to pre-announce his intention to cross to the market at large before entering an order, which means introducing a new broadcast message type.

These rules can become quite complex in terms of timing and allocation rules. This depends on the extent to which the market is hostile to or tolerant of internalisation.

Position-limit vetting

In some markets, it is possible and desirable to check for breaches of position limits as part of the validation process of order submission. This obviously assumes an interface with the clearing operation since that is the only master source for position keeping at the member level (position-limit checking for individual clients would be the responsibility of the broker entering the order).

However, some position limit rules can get quite complex (e.g., controls over the "directional" aspect of the order such as aggregating long calls and short puts as bullish positions and aggregating short calls and long puts as bearish positions and treating each as an overall position). This is one of the areas where the trading system needs details of contract lot sizes in order to ascertain the value of the equivalent underlying position.

Combination orders (spreads, etc.)

In options trading, even simple spreads are less commonly traded than people imagine; although, there is always interest in bull spreads, bear spreads, straddles and strangles and it is worth providing this functionality if possible.

Futures spreads, which are time spreads, are a different matter. They are very common and it is important to provide the functionality to handle these as a separate order book. But whether an exchange has to do it for options depends on the exchange's assessment of the trade-off between system cost (these types of orders consume more resources than conventional orders) and benefit to the marketplace. If it is affordable to introduce combination orders, then it is better to have them than not to have them.

The main complexity with spread trading is ensuring a good "fit" with the rest of the market (i.e., if you want to buy the near month and sell the far month, then the spread price should not be greater than the actual spread between the two individual futures contracts in the futures markets). The system also needs to report the two legs of the spread as separate trades and establish a "price" for the two separate trades.

Elaborate techniques exist to allow for interaction between the "spreads" market and the futures market. For instance, it is possible for prices for the individual legs to be match against the spread order itself in a way that generates new liquidity. Most trading systems handling spreads do so by creating a new symbol (at start of day) rather than dynamically creating a tradable spread during the trading day. We mentioned earlier the ability to introduce new symbols during the trading day. In this context, that would be a particularly valuable system capability.

Inner-market activity

As noted several times already, a derivatives market depends on its underlying market for sustenance. So this introduces a new, closer kind of interaction between the underlying market and the derivatives market.

This suggests the provision of several types of contingency trades. The most popular and obvious of which is the covered call—buying the underlying and simultaneously selling a call option on it. This requires locking both markets to ensure both legs of the trade are executed. It can be done, but only if the same operator using a linked system controls both markets.

Other contingent orders include derivatives orders which are triggered by events in the underlying market, but these can generally be handled by a good front-office system unless locking of the order book is required for the avoidance of legging risk.[2]

Basket orders

Index arbitrage and related derivatives trading calls for basket execution (i.e., executing an order for the purchase or sale of a whole group of stocks in a single transaction). Some front-office systems offer sophisticated basket execution tools but the ideal way for a basket to be reliably traded is for the control to reside in the trading system so that the order books can be locked and legging risk avoided. This is the only way of ensuring price integrity for each component stock—a front-office system can't guarantee it.

Prohibit market makers hitting own quotes

In some electronic markets, it may be a requirement that market makers are not allowed to hit their own prices, so that reported trades reflect genuine market activity. But most exchanges don't object (because it boosts their reported trade volumes!).

"Wrongly-priced" orders and/or trade reversals

Many front-office systems are able to issue a warning prior to submission of an order that is considered, potentially, to be wrongly priced. Such a requirement would involve an algorithm to check for price reasonability, using data based on current underlying and derivatives market prices. While this is relatively easy to do with cash markets or futures markets (e.g., issue a warning if a price is more than x ticks away from the last trade), with options it is more complicated because

[2] If a single order containing multiple symbols is entered as two separate transactions, there is a danger that the market may move in the time lapse between executing one leg and another, thus incurring losses for the trader – this is known as "legging risk." By being able to "lock" the order book of one symbol pending the completion of the trade in the other symbol, legging risk is eliminated.

option prices can move very rapidly in a short space of time. An algorithm that could detect option mispricing would have to be very sophisticated to avoid impeding legitimate business.

Alternatively, trade reversals can be used to correct so-called "mistrades." This need not have a major impact on the trading functionality; although, it requires a precise audit trail be maintained to identify prevailing prices in both the underlying market and in the derivatives market at the time of the alleged mistrade (see also *Surveillance* on page14). The determination of what constitutes a mistrade may also involve some elaborate algorithms to identify price reasonability.

FRONT OFFICE & ISVs

Front-office tools

A good front-office system is absolutely vital to support a successful derivatives market; although, it is generally not embedded into the trading system. Front-office tools include:

a) Options pricing models

b) Index/basket tracking modules

c) Contingency orders

d) Market maker quote generation

e) Implied volatility calculators

f) Order handling mechanisms

In most current markets, the user interface is provided by third-party suppliers, who are commonly known as Independent Software Vendors (ISVs). Some exchanges provide their own workstations or license ISVs to provide them to their members.

The way in which traders and market makers access the market varies depending on their requirements but there is a set of common attributes that are needed. The Financial Information eXchange (FIX) protocol is the standard for exchange-traded instruments, and it is suitable for derivatives (version 4.3 and 4.4 support derivatives trading). FIX (w/ or without extensions) is used by a number of major derivatives exchanges. One day, all exchanges will probably be FIX compliant.

Options trading relies on computational analysis to a much greater extent than is the case with equity or futures trading. For this reason, there is greater use of direct transfer of data—as opposed to manual entry and visual output—for users at all levels. The greater the reliability and availability of two-way digital exchange of data between the exchange and its users, the better the chances of success for an exchange. The existence of a standard, ubiquitous protocol like FIX to support this activity is an important component in a new market's success, since it reduces the barriers between participants and the market.

The user interface

Let us look at some of the attributes of the user interface.

Market data presentation

Futures prices are normally presented in a linear manner, each row representing a particular expiry month, like so:

Generic 100 Index Futures				Current Underlying: 2990.45		
Month	**Bid**	**Ask**	**Last**	**Change on prev**	**Open Interest**	**Volume**
Oct 00	3010	3015	**3014**	9	1908	80
Dec 00	3019	3022	**3018**	11	346	21
Mar 01	3023	3030	**3022**	8	99	5
Jun 01	3035	3050	**3030**	-1	17	0

Open Interest is generally not updated intra-day and is based on previous close. Volume means "contracts traded today." Options prices are normally displayed in a tabular form. Below is an example. Here "Vol" and "Chg" are volume and change on close.

ACME Co. Options							Current Underlying Bid/Ask: 25.50/25.55					
Calls							Puts					
Last Trade	**Chg**	**Bid**	**Ask**	**Vol**	**Open Int**	**Expiry/ Strike**	**Last Trade**	**Chg**	**Bid**	**Ask**	**Vol**	**Open Int**
						Oct						
3.62	0.00	3.25	3.62	0	175	**22.50**	**0.06**	0.00	0.00	0.19	0	1,239
1.00	-0.12	1.00	1.25	161	1,954	**25.00**	**0.12**	-0.06	0.12	0.25	521	4,783
0.06	-0.06	0.06	0.12	86	4,142	**27.50**	**1.62**	+0.12	1.62	1.88	34	2,209
0.06	0.00	0.00	0.06	0	3,571	**30.00**	**4.00**	0.00	3.88	4.25	0	354
0.06	0.00	0.00	0.06	0	423	**32.50**	**6.38**	0.00	6.50	6.75	0	242
						Nov						
0.06	-0.06	0.06	0.12	6	142	**25.00**	**1.62**	+0.12	1.62	1.88	4	2,209
0.05	0.00	0.00	0.06	10	31	**27.50**	**4.00**	0.00	3.88	4.25	1	354
-	0.00	0.00	0.06	0	3	**30.00**	**6.38**	0.00	6.50	6.75	0	242

More sophisticated users monitor option prices by using a combination of the following:

- Standing data
- Digital real-time sources
- Other analytical data
- Risk management and decision support
- Core data elements for calculating option prices

Standing data

This covers the basic defining characteristics of the tradable contracts, as described in the *Product Definition* section. User software may also need to ensure that the specific contract defined by those characteristics actually exists as a tradable entity at the exchange. This of course is not an issue in the case of an OTC market where the product specification is infinitely variable.

Digital real-time sources

Users need access to the real-time data feed for both the underlying assets and the derivatives contracts themselves, together with the usual array of exchange announcements and news feeds. Other critical data includes trading halts, limit-down announcements and other market interruptions.

Other analytical data

Interest rates and dividend assumptions are a vital component for deriving futures and options prices.

Some derivatives traders make extensive use of the historical prices of the underlying as well as of the derivatives themselves. This is particularly true of futures traders who tend to trade on a technical basis using charts and trends.

Also, historical volatility data sometimes drives options prices—not so much for market makers but more for options traders who use technical analysis.

Risk management and decision support

ISV software or traders' in-house software is used, amongst many other things, to assess risk (e.g., calculation of the "Greek letters"—delta, gamma, etc.), to generate quotes (for market makers) or to recommend trading ideas (for technical traders). These systems use all the data types above as input and rely strongly on this data being real-time.

Core data elements for calculating options prices

In summary, we can list the key data components of the pricing models. In the general case, an options-pricing model needs to use the following variables (note these are the same requirements for all market users who need option pricing data, including exchange officials and traders/market makers).

Fixed Data

- Expiry date
- Strike price
- Type (call or put)
- Exercise style

Variable Data Direct from Real-Time Feed

- Underlying asset price
- Option price

Variable Data calculated from Real Time Feed

- Implied volatility[3]

Variable Data from other sources

- Risk-free interest rate
- Known or estimated dividends payable and schedule (if applicable)

---

[3] Implied volatility and the option price are mutually exclusive results of the option calculation. Either a user wants to know the option price, in which he inputs the implied volatility, or he wants to know the implied volatility, in which case he inputs the option price. The option price is calculated analytically using an option-pricing formula. Implied volatility is derived from an iterative process using the same formula. Details of the exact formulas are commonly found in any finance mathematics book.

OTHER

Fees

Fee structures in derivatives markets can be more complex than in cash markets (e.g., market maker fees vary in accordance with performance and this can give rise to a complex set of fee calculations, which often may as well be calculated "off-line" rather than building the functionality into the system. A fair rule-of-thumb in this area is to say that anything calculable by Microsoft® Excel may as well be calculated by Excel. Just ensure users have the raw data.

Statistics

Derivatives market operators can be obsessive about trading statistics— number of contracts traded, number of trades, notional value of contracts traded, etc.—and pay much more attention to them than cash market people. All it requires is a good, flexible database, but remember the data volumes can be enormous in a lively market.

Surveillance

Although the surveillance techniques employed in derivatives markets are similar to those used in the cash market, there are additional considerations associated with tracking data in both markets simultaneously. There are two points to note here:

a) Surveillance needs to have a good handle on whatever was going on in the cash market at the time of suspected price manipulation or whatever event is being tracked. This may require that the historical order, trade and volume database contains both cash-market and derivatives-market data with accurate and consistent time stamping between the two markets.

b) In addition to monitoring futures buying and selling, surveillance requires the system find evidence of call-buying or put-writing (in a ramping exercise or insider buying case) or put-buying and call-writing (if the scheme involves shorting or selling stock). In these cases, the call-buying and put-writing are treated the same way as purchases are treated in a cash market and put-buying and call-writing are treated the same way as sales are treated in a cash market.