

# Algorithmic Trading Trends and Drivers

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# AGENDA

- Background
- Algorithmic Trading Components
- Trends
- Factors Impacting Algorithmic Trading
- Design Flaws of Central Limit Order Books
- System Design Limitations
- Conclusions

# BACKGROUND

- Liquidity pool hubs and spokes:
  - Equity/Options and Futures Exchanges
  - Equity ECNs
  - Fixed Income Intra-Dealer Brokers
  - Market Makers, Specialists, Proprietary Trading Firms, Trading Arcades, Scalpers/Day Traders
  - Buy Side/Quant Trading Shops
  - Boutiques
- The evolution of trading technology solutions:
  - ECN aggregators, smart routers, algorithmic slicers, etc.

## BACKGROUND (Cont'd)...

- Program trading, automatic order generators and automated order routing systems are used mainly by sell-side firms to conduct business as:
  - Principal/proprietary trading
  - Agency/customer facilitation
  - In: Equities, Fixed Income, Futures and Options
- Strategies include index substitutions, risk modifications, liquidation of exchange for physicals (EFPs), etc.
- Buy programs occur when the futures market is overvalued, relative to the cash market.
- Sell programs occur when the cash market is overvalued, relative to futures.

## BACKGROUND (Cont'd)...

- Largest players today include:
  - Citadel Investment Group
  - Citigroup
  - Credit Suisse First Boston
  - Deutsche Bank
  - Goldman Sachs
  - Lehman Bros.
  - Morgan Stanley
  - Susquehanna Investment Group
  - UBS

## BACKGROUND (Cont'd)...

- Computers do at warp speed what traders used to do by hand:
  - e.g., Auto-quoting options across 100 price points
- A large percentage of order flow arrives via computer to computer API's.
- Proprietary trading systems can bombard an electronic trading system with high burst rates of orders/second.
- Volume created by program trading engines has become the dominant mode of trading (\*now >50% average daily NYSE volume).

\* - Source – New York Stock Exchange.

# ALGORITHMIC TRADING COMPONENTS

- Real time and historical market data.
- Algorithms to:
  - Perform correlation analysis
  - Identify trading opportunities
  - Determine optimal timing to launch
  - Measure trade execution against benchmarks (VWAP TWAP, etc.)
- Order management/order processing.
- Connectivity to liquidity pools:
  - Exchanges, ECNs', inter-dealer brokers, etc.
- Integration with internal systems:
  - Trading
  - Order Management
  - Risk Management
  - Compliance
  - Back Office

# TRENDS

- Intense pressures on trading costs:
  - Impact of decimalization on spreads, market maker and specialists' profitability.
  - Impact of penny jumping on institutional order flow, block trades
  - Implicit and explicit costs - slippage/market impact, floor brokerage and commissions
- Reduction in soft dollar relationships.
- Buy-side firms focusing on trading strategies that involve a combination of equities, fixed income and/or derivative instruments that lower overall trading costs and risks when traded together.

## TRENDS (CONT'D) ...

- More sell-side firms offering program trading functions to compete/attract more order flow.
- Sell side firms moving deeper into the aggregation business:
  - Provide buy side clients with the ability to diversify risk, get comprehensive pricing, acquire research, increase anonymity, maintain relationships, etc.
  - Integrate algo trading strategies into OMS and front end trading systems:
  - Buy side users want to use algorithmic strategies to split up large orders into smaller ones, to reduce market impact.
  - Algos for VWAP, TWAP, small-cap illiquid, mid-cap liquid, passive, aggressive, etc.

## TRENDS (CONT'D) ...

- Buy side firms getting access to algorithms from multiple brokers, OMS vendors.
- Internalization/crossing of order flow.
- Cost of market entry continues to get lower:
  - Technology costs less – HW/SW/NW
  - Buy versus build, time to market issues
  - Application solutions availability
  - You don't need to be Goldman or Salomon any more!
- Market structure evolution – SEC Reg. NMS reforms:
  - NYSE “Hybrid Market” initiative
  - NASDAQ/the remaining ECNs
  - Regional equity exchanges

# FACTORS IMPACTING ALGORITHMIC TRADING

- The velocity and volume of trading:
  - Growth of order flow and program trading volumes
  - The “talk to trade” ratio
  - Recent Citigroup Euro MTS trade rocked the bond market
- Technology choke points:
  - Systems processing/capacity planning challenges
  - Latency of matching engines
  - The 80-20 Rule
- Evolution of smart routing:
  - ISV front end trading and order routing systems

# DESIGN FLAWS OF CENTRAL LIMIT ORDER BOOKS

- CLOB's were designed almost 30 years ago and may not be up to the task of supporting and processing the business of the 21<sup>st</sup> century.
- Heavy loads occur when firms are rapidly deleting and adding orders:
  - When a trade is executed or the price of an underlying security changes, all of the orders are cancelled and replaced, stressing the system
  - Most quotes follow the primary market, resulting in a burst of new quotes immediately after the primary quote changes
- During periods of peak volume, the systems experience degradation in order turnaround.

## DESIGN FLAWS OF CENTRALIZED LIMIT ORDER BOOKS (Cont'd)...

- There has been a growth in the ratio of orders to fills.
- Additionally, order book transactions per second already exceed their original design parameters and continue to grow at a geometric rate.

## DESIGN FLAWS OF CENTRALIZED LIMIT ORDER BOOKS (Cont'd)...

- The first sign of system stress is the degradation in system response:
  - Usually sub-second, the latency can begin to increase to seconds
  - During extreme market conditions, this can degrade to minutes, as transaction volumes increase
- Exchanges, ECNs and ATS' have met the growth in TPS by using faster processors and adding additional CPU/memory:
  - Some exchanges and ETS have denied service to high volume API users during peak periods
  - Some have large server farms to facilitate segmenting processing resources into increasingly fine pieces

# SYSTEM DESIGN CHALLENGES

- The most granular CLOB design dedicates a single system thread/process to a single, individual security or series:
  - This constraint arises from the need to guarantee a FIFO matching process
- Having separate threads and processes for individual securities or series can facilitate higher scaling, and for the most part does:
  - Even with multiple securities bunched together, such as a combination of active/liquid issues and less active issues
- However, just as there are peaks in trading (the opening, closing, special events, etc.), there are concentrations in instruments that get traded.

## SYSTEM DESIGN CHALLENGES (Cont'd)

- Algo trading strategies often have order cancellation rates of ~90%, consuming ~50% of ETS system resources.
- A recent study at a major U.S. Futures exchange found that 60% of all trading for that exchange was done in the near-month of a single financial futures contract.
- A similar measurement of the market opening at a U.S. regional Equities exchange pointed out that 70% of all trades (priced and executed off the primary market opening) were in the three most active stocks:
  - The most active issue accounted for 35% of the volume
- Therefore, system processing power and software efficiencies need to focus on the busiest instrument:
  - Scaling is probably only achieved with 3-5 separate processes for the actual matching engine

## SYSTEM DESIGN CHALLENGES (Cont'd)

- Further issues arise by attempting to separate shared memory regions:
  - If options strategies, spreads or complex orders are being processed, it is a technical challenge to have instruments that interact resident in separate memory pools

# CONCLUSIONS

- The next generation of matching engines needs a re-thinking:
  - Design of the central limit order book
  - Support for higher volumes of trades and quotes
  - Exchange rule impact/changes thereto
- Market structure changes must go hand in hand with technology changes:
  - Quote structure changes in the face of raising auto-quote volumes because of narrow spreads
  - Filtered quote streams for pro traders
  - Mechanisms for price improvements without penny jumping