Algorithmic Presentation to European Central Bank

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What’s all the BUZZ about Algorithmic Trading /eFX?

Electronic trading systems capture one half of global FX volume

CME, Reuters finalise FXMarketSpace

State Street acquires Currenex

What holds the key to mainstream adoption of Algorithmic FX trading?

CME forex volumes rose 29% in January
Why is Algorithmic Trading Exploding in the industry?

**Its Growing because**

- Technology Barrier is less expensive
- As market access grows via ECN’s anonymity and powerful ability to place orders are more easily achieved (Prime Brokerage and Market Access (EBS, Reuters))
- Technological Growth on Buy/Sell Side (API’s, processing thousands of tickets at minimal cost.
- Euros are being made!!!!

**Target Clientele**

- Hedge Funds
- CTA’s
- Proprietary Trading Houses
- Bank Proprietary Trading Desks
- Corporates
- Retail
- Next generation market makers
**Average Reported Buy-Side Trading Volume by Geography**

<table>
<thead>
<tr>
<th>Region</th>
<th>2006</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Global</td>
<td>$70.6T</td>
<td>59.0</td>
</tr>
<tr>
<td>Europe</td>
<td>$42.3T</td>
<td>35.9</td>
</tr>
<tr>
<td>Americas</td>
<td>$20.5T</td>
<td>16.8</td>
</tr>
<tr>
<td>Asia Pacific</td>
<td>$ 7.4T</td>
<td>6.1</td>
</tr>
<tr>
<td>Asia (ex Japan)</td>
<td>$ 5.2T</td>
<td>3.6</td>
</tr>
<tr>
<td>Japan</td>
<td>$ 1.7T</td>
<td>2.2</td>
</tr>
</tbody>
</table>

Based on Interviews with 1,663 institutions in 2006 and 1,549 in 2005.
Greenwich Associates
Adoption of FX Electronic Trading Globally

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Trade Online</td>
<td>53%</td>
<td>44%</td>
</tr>
<tr>
<td>Plan to Start</td>
<td>11%</td>
<td>13%</td>
</tr>
<tr>
<td>Not Considering</td>
<td>36%</td>
<td>43%</td>
</tr>
</tbody>
</table>

2006 Total Reported Electronic Volume = $35.5 Trillion
2005 Total Reported Electronic Volume = $16.9 Trillion

Greenwich Associates
## Current and Expected FX e-Trading Activity Globally

<table>
<thead>
<tr>
<th></th>
<th>2006</th>
<th>2005</th>
<th>2004</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Current % of Volume</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic</td>
<td>60%</td>
<td>53%</td>
<td>48%</td>
</tr>
<tr>
<td>Traditional</td>
<td>40%</td>
<td>47%</td>
<td>52%</td>
</tr>
<tr>
<td><strong>Expected % of Volume</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Electronic</td>
<td>63%</td>
<td>57%</td>
<td>54%</td>
</tr>
<tr>
<td>Traditional</td>
<td>37%</td>
<td>43%</td>
<td>46%</td>
</tr>
</tbody>
</table>

Based on responses from 628 institutions trading electronically in 2004, 679 in 2005, 877 in 2006

Greenwich Associates
Algo & e-FX proliferate growth in the search for Alpha

$2.5 Trillion Traded Daily from $1 Trillion

Based on research conducted by Client Knowledge 2007 and CK estimate based on recent Fed and BoE data
How are algo trading revenues split today?

Algorithmic Execution (The art of microstructure trading)

- VWAP, TWAP, Time Slicing, icebergs, etc (order routing)
- Orders – utilization of client intelligence
- High Frequency and Provides Information
- Is becoming a source of low margin revenue, radical shift of strategy in financial institutions offering

Algorithmic Trading (Replacing traditional manpower)

- Electronic market Making
- Auto Hedging

Proprietary Trading

- If I told you I would have to kill you…
Algo is the vehicle, Market Data the Fuel but what is the cost?

**Cost Variables:**

<table>
<thead>
<tr>
<th>Market Data</th>
<th>STP Protocols</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real Time Data</td>
<td>Compliance</td>
</tr>
<tr>
<td>Historical Data</td>
<td>MiFID</td>
</tr>
<tr>
<td>Connectivity</td>
<td>APIs</td>
</tr>
<tr>
<td>Infrastructure / Network</td>
<td>Algo Maintenance</td>
</tr>
<tr>
<td>Latency Tools</td>
<td>Algo Creation (Quants)</td>
</tr>
<tr>
<td>ECN brokerage</td>
<td>IT specialists</td>
</tr>
<tr>
<td>E-sales</td>
<td>Client Analysis</td>
</tr>
<tr>
<td>Back Office</td>
<td>Marketing</td>
</tr>
<tr>
<td>Security</td>
<td>Ticket Processing</td>
</tr>
<tr>
<td>Prime Brokerage</td>
<td>Order System etc…</td>
</tr>
</tbody>
</table>

What you do know is that the future of your business is at risk if you don’t do it....
The Classic approach:

- Traditional traders claim to master the feel / instincts to make money
- Trading behavior can be analyzed using a systematic approach
- This exercise leads to a list of conditional rules which can result in an extremely complex decision tree
- Traders process a wide panacea of market information that is aggregated by the brain producing a trading decision:
  - Visual information (prices, graphs, news, flows) coming from various economical sources
  - Audible information (news, market noises, internal / external flow trading)
  - Accumulated information that form a market sentiment (a feeling)
- Everything that can be formulated is a candidate for algorithmic trading
Using Algorithms to Increase Business

The Approach going forward:

- Algorithmic rule-based approach enables:
  - Reproduction, enhancement (speed, accuracy) and trading behaviors
  - Creation of new trading paradigms by overcoming brain calculation limitations (the brain used to be a winner because of its unique synthetic approach; chess has been for long a battle ground but debate is over)

- The challenge is to program computers with complex rules and awareness of corner cases which humans have no problem recognizing.

- The traditional first level algorithmic application reveals weakness as humans typically outperform simple and linear problems.

- Algorithmic trading requires sophisticated quantitative methodologies and techniques.
Unlocking Artificial Intelligence

- Since mid 20th century, researchers have heavily contributed in the development of artificial intelligence.

- Much like neural organization, it is not about the complexity of the basic constituents but more about the complexity of their assembly.

- Most Algorithmic topics focus on simple inference engines that link ensembles with decision trees resembling a living intelligent design.

- The backbone of Algorithmic is machine learning which is an extension of statistical science. Most of you have already dealt with this concept by implementing a simple regression calculation!!!

- Today’s Algorithmic trading involves neural networks, fuzzy logic, pattern recognition…

- Make no mistake, there is no magic or wizardry. It is always a more evolved form of regression technique using more/less complex filter design…

- Again, complexity is more in the circumvolution of these algorithms.
Algo – Magic or Science??

Interpreting the Fuzzy Inference Diagram
Algo Trading Strategies

- **Signal Processing**: Mathematical extension of technical analysis based on the art of filtering to eliminate noise and discern trading patterns.

- **Market Sentiment**: The computer is entirely unaware of market activity until you feed a model market data flows. The algorithm becomes aware of market agitation and participant activity. The intent is to provide algos the appropriate context to analyze and learn market psychology of supply and demand.

- **News Reader**: Algos are not reacting to major political events unless you teach them how to artificially read news headlines.

- **Pattern Recognition**: Enable the machine to learn, adapt and re-act when patterns arise creating revenue opportunities.

  - **Note**: Single strategies are vulnerable: It is in the mix and diversification that algos show strengths and consistent productivity.
Trading Strategies
Algo Trading Applications

- **Trading Signals Automate**: Design proprietary strategies to generate non-traditional revenue pools with cold steel and logical trading behaviors

- **Auto Hedging**: Manage trade flows to maximize revenues/reduce risk in a high frequency mode.

- **Risk Allocation Algorithm**: Automatically adjust your portfolio exposures to adapt to the current market conditions optimizing revenues

- **Pricing**: Market making generation via intelligent auto-pricing that adapts to market volatility, current position and activities of market participants. Ability to answer thousands of price requests accurately and in rapid succession, enabling new market standard adjustments.

- **Execution Engines**: Enable programs to search/discover fragmented liquidity pools to optimize execution via complex/high frequency order routing strategies
Cycle of Algo trading

1. Idea derivation is predominantly based on market intuition and practice
2. Discover quantitative support to model initial instincts. Surprisingly this discovery comes from very diverse industries & scientific fields
3. Sketch & Prototype research algorithms
4. Backtest and evaluate robustness and productivity
5. Improve production via cross fertilization of existing algorithmic library
6. Test algorithms in semi-vivo environment to detect corner cases and validate in/out sample results
7. Design and implement production version
8. Monitor real time signals: Algorithmic baby-sitting
10. Recycle technology to other asset classes and diversify frequency and candidates
Dangers related to Algo Trading

- No human intervention: need to hunt for corner cases as programs have no conscience of improper trading activities. Time is spent in design regarding: security, limits breaches, controls, etc…
- IT becomes an unprecedented dependency (servers, networks, hardware, data feeds, latencies)
- Your success relies on a 100% error-free code (memory leakage, infinite loops, etc). The risk of running a bugged algorithm can be enormous especially if in-vivo at high frequency.
- Uptime monitoring requirements have to be high and attending resources must be highly educated
- The technology is highly portable and risks of information property infringement are high by nature
- Market volatility lowers by wide spreading of algorithmic activity and chances of contagious systemic collapses are increased
- No universal recipe and promotion of human risk managers to activate/deactivate automates (mean reversion, trends)
- As in the Aviation industry, even if auto-pilots are capable of landing airplanes smoother than human pilots, the need for experienced supervisors is required in case of a major systemic failure (9/11).