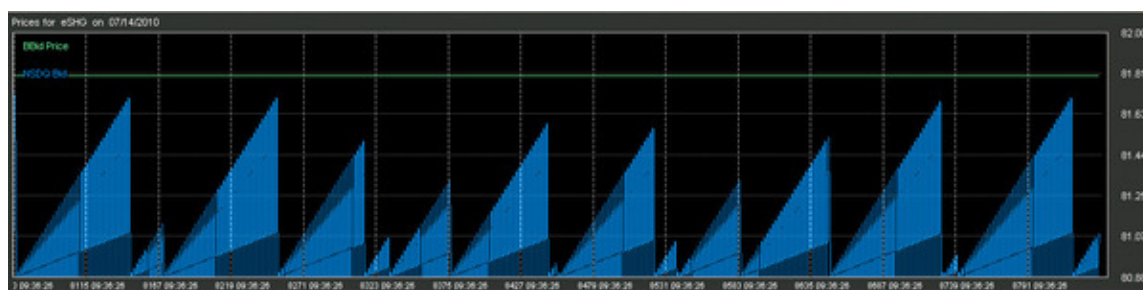



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# Market Data Firm Spots the Tracks of Bizarre Robot Traders

By Alexis Madrigal



Mysterious and possibly nefarious trading algorithms are operating every minute of every day in the nation's stock exchanges.

What they do doesn't show up in Google Finance, let alone in the pages of the Wall Street Journal. No one really knows how they operate or why. But over the past few weeks, Nanex, a data services firm has dragged some of the odder algorithm specimens into the light.

The trading bots visualized in the stock charts in this story aren't doing anything that could be construed to help the market. Unknown entities for unknown reasons are sending thousands of orders a second through the electronic stock exchanges with no intent to actually trade. Often, the buy or sell prices that they are offering are so far from the market price that there's no way they'd ever be part of a trade. The bots sketch out odd patterns with their orders, leaving patterns in the data that are largely invisible to market participants.

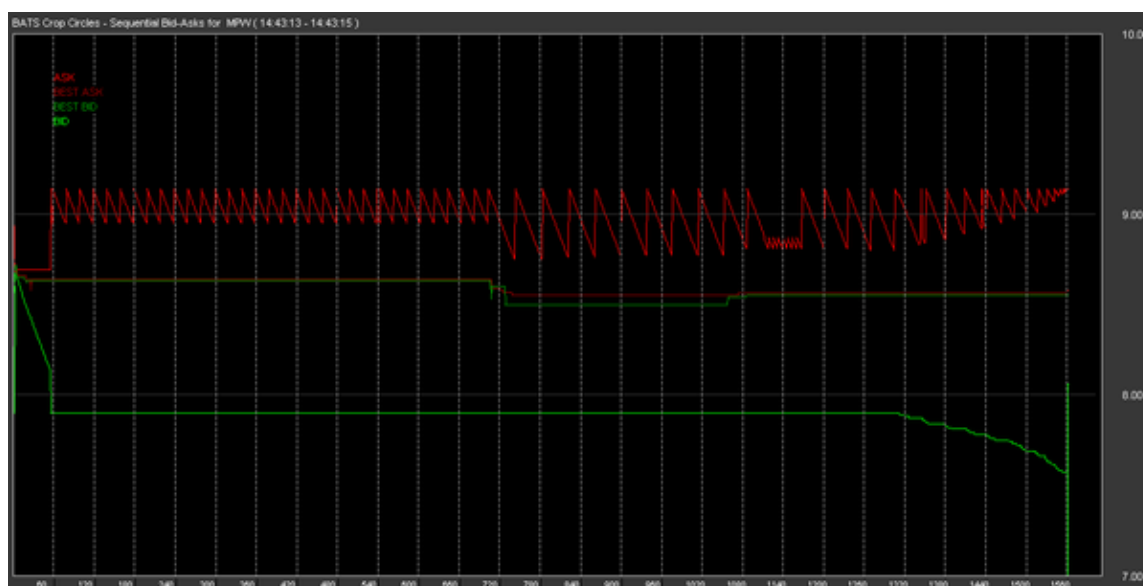
In fact, it's hard to figure out exactly what they're up to or gauge their impact. Are they doing something illicit? If so, what? Or do the patterns emerge spontaneously, a kind of mechanical accident? If so, why? No matter what the answers to these questions turn out to be, we're witnessing a market phenomenon that is not easily

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explained. And it's really bizarre.

It's thanks to Nanex, the data services firm, that we know what their handiwork looks like at all. In the aftermath of the May 6 "flash crash," which saw the Dow plunge nearly 1,000 points in just a few minutes, the company spent weeks digging into their market recordings, replaying the day's trades and trying to understand what happened. Most stock charts show, at best, detail down to the one-minute scale, but Nanex's data shows much finer slices of time. The company's software engineer Jeffrey Donovan stared and stared at the data. He began to think that he could see odd patterns emerge from the numbers. He had a hunch that if he plotted the action around a stock sequentially at the millisecond range, he'd find something. When he tried it, he was blown away by the pattern. He called it "The Knife." This is what he saw:



"When I pulled up that first chart, we saw 'the knife,' we said, that's certainly algorithmic and that is weird. We continued to refine our software, honing the algorithms we use to find this stuff," Donovan told me. Now that he knows where and how to look, he could spend all day for weeks just picking out these patterns in the market data. The [examples that he posts online](#) are just the ones that look the most interesting, but at any given moment, some kind of bot is making moves like this in the stock exchange.

"We probably get 10 stocks in any 10 minutes where we see something like this," Donovan said. "It's happening all the time."

These odd bots don't really make sense within the normal parameters of the high-frequency trading business. High-frequency traders do employ algorithms to look for patterns in the market and exploit them, but their goal is making winning trades, not simply sending quotes into the financial ether.

## Explaining Bizarre Bot Trader

### Behavior

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### Tech and the Flash Crash

Here's the way a stock trade is supposed to work: a buyer says they'll pay some amount for 100 shares of a company, a seller makes an ask for slightly more money, and the two of them usually meet in the middle. Perhaps a middle man (no joke intended) helps match buyer and seller and takes a cut. That's the role that a lot of high-frequency traders play: they help make markets work. Regulatory changes over the past several years have extended their usefulness and provided a nice business model for those that can move quickly to provide options for buyers and sellers.

"Under the maker-taker model, market participants that offer to provide, or make, liquidity by posting an order to buy or sell a certain number of shares at a particular price receive a rebate," explained Michael Peltz in a June feature for [Institutional Investor](#). "Those that execute against that order -- that is, take the liquidity -- have to pay a fee. Exchanges earn the difference between the rebate they pay and the fee they charge. The SEC limits taker fees to 0.30 cents a share; rebates tend to be lower for economic reasons, but for high frequency firms trading millions of shares a day, they can make for a pretty good living."

In a sense, they take nickel-and-dime down an order of magnitude or two. The advantage is that their trades are low-risk: they rarely hold positions for very long and any individual stock, future, or currency can't really sink the boat. High-frequency traders have become a target for all kinds of people, but most of them appear to make their money being a little faster and little smarter than their competitors. And if they are playing by the rules, they improve the quality of markets by minuscule amounts trade after trade after trade.

But the algorithms we see at work here are different. They don't serve any function in the market. University of Pennsylvania finance professor, Michael Kearns, a specialist in algorithmic trading, called the patterns "curious," and noted that it wasn't immediately apparent what such order placement strategies might do.

Donovan thinks that the odd algorithms are just a way of introducing noise into the works. Other firms have to deal with that noise, but the originating entity can easily filter it out because they know what they did. Perhaps that gives them an advantage of some milliseconds. In the highly competitive and fast HFT world, where even one's physical proximity to a stock exchange matters, market players could be looking for any advantage.

"They are moving the high-frequency services as close to the exchanges as possible because even the speed of light matters," in such a competitive market, said Stanford finance professor Peter Hansen.

Given Nanex's data, let's say that these algorithms are being run each and every day, just about every minute. Are they really a big deal? Donovan said that quote stuffing or market spoofing played a role in the Flash Crash, but that event appears to have had so many causes and failures that it's nearly impossible to apportion blame. (It is worth noting that European markets are largely protected from a similar event by [volatility interruption auctions](#).)

But already since the May event, Nanex's monitoring turned up another potentially disastrous situation. On July 16 in a quiet hour before the market opened, suddenly they saw a huge spike in bandwidth. When they looked at the data, they found that 84,000 quotes for each of 300 stocks had been made in under 20 seconds.

"This all happened pre-market when volume is low, but if this kind of burst had come in at a time when we were getting hit hardest, I guarantee it would have caused delays in the [central quotation system]," Donovan said. That, in turn, could have become one of those dominoes that always seem to present themselves whenever there is a catastrophic failure of a complex system.

There are ways to prevent quote stuffing, of course, and at least one of the members of the Commodity Futures Trading Commission's Technology Advisory Committee thinks it should be outlawed.

"Algorithms that might be spoofing the market are something that should be made illegal," said John Bates, a former Cambridge professor and the CTO of Progress Software. But he didn't want this presumably negative practice to color the more mundane competitive practices of high-frequency traders.

"There is algorithmic terrorism and then there is reverse engineering, which is probably just part of good business practice," Bates said.

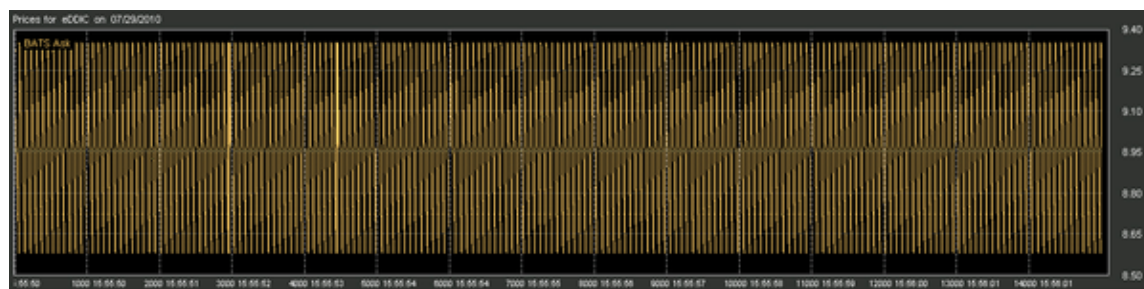
For now, Donovan plans to keep putting out the charts, which he calls "crop circles," of the odd trading algorithms at work. That's an apt name for the visualizations we see of this alien world of bot trading. And it certainly gets at a central mystery surrounding them: if trading firms aren't sending out these orders, how are they getting into the market?

On the quantitative trading forum, [Nuclear Phynance](#), the consensus on the patterns seemed to be that they simply just emerged. They were the result of "a dynamical system that can enter oscillatory/unstable modes of behaviour," as one member put it. If so, what you see here really is just the afterscent of robot traders gliding through the green-on-black darkness of the financial system on their way from one real trade to another.

No matter why the bots end up executing these behaviors, the Nanex charts offer a window onto a kind of market behavior that's fascinating and oddly beautiful. And we may never have seen them, if not for the mildly obsessive behavior of one dedicated nerd.

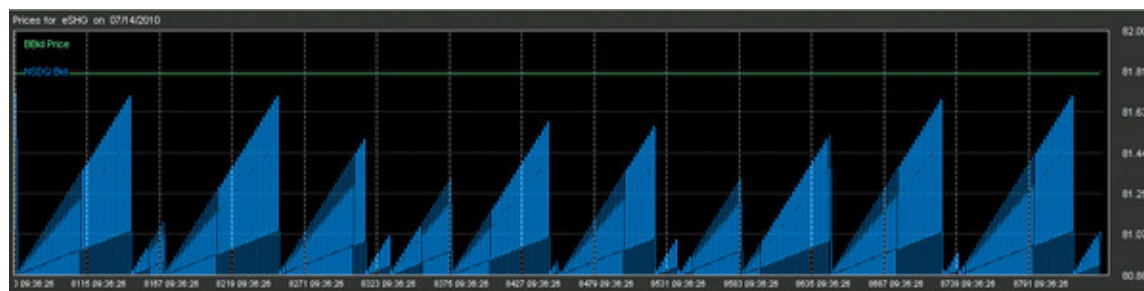
"Who looks at millisecond charts?" Donovan said. "You'd never see those patterns in any other fashion. The SEC and CFTC certainly weren't."

*Here are a few more bots at work with explanations of what's going on.*

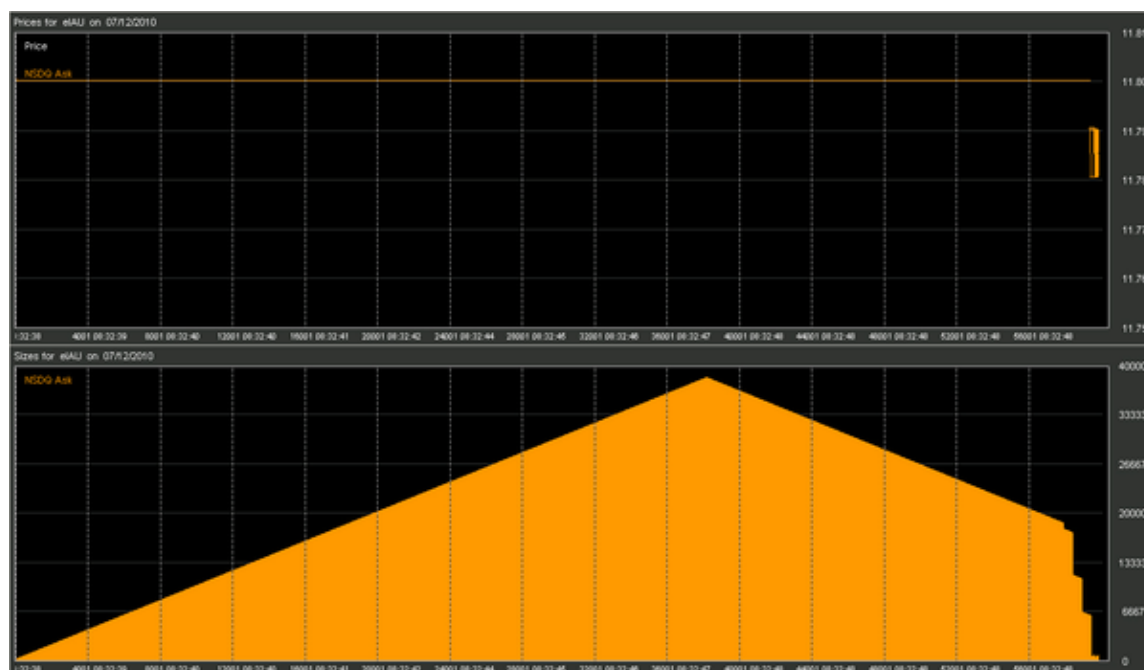


Here we see a "flag repeater" being executed on the [BATS Exchange](#), the third-largest equity market after the NYSE and NASDAQ. 15,000 quote requests were made in 11 seconds in a repeating pattern.

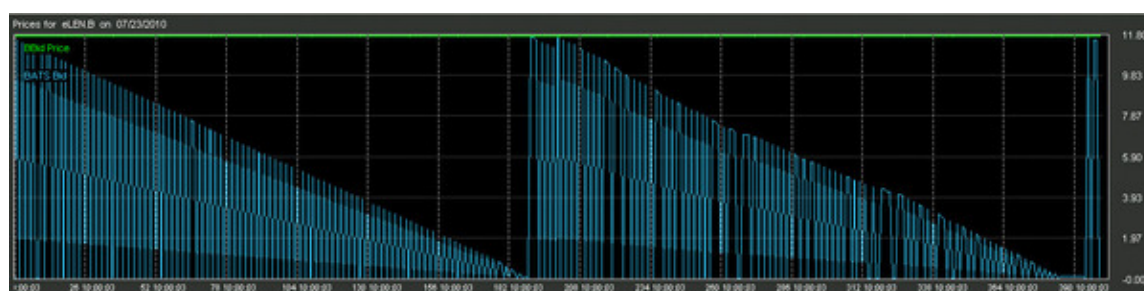
Each iteration upped the quote a penny until \$9.36, and then the algorithm went down the same way, a penny at a time.



This is an extreme closeup of just one second of trading of the stock SHG, the Shinhan Financial Group. This is 760 quotes from a total of 10,000 made in 12 seconds.



This chart shows a different kind of strategy. It represents 56,000 quotes in one second all at the same price (the top chart) but with the size of the order increasing by one (i.e. 100 shares) all the way up to 40,000.



Finally, we see what Donovan calls the "stubby triangles" chart. It shows high quotes being made and then immediately followed by a stub order of \$0.01 (basically canceled in most contexts). The quote is then remade at a lower price and followed with another stub quote. This cycle happened at the rate of 380 quotes a second. [This last description was clarified thanks to the kindness of author Joe Flood.]

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