

is only one trading opportunity available, which produces a “winner take all” event where the fastest firm wins the trade. This gives rise to what we call “the arms race” or the “race to zero latency.” The trading system designs you encounter generally reflect the goal of winning the arms race. Oftentimes, these designs run counter to best practices for software architectures seen in other industries.

There are many internal and external systems in the inner loop for the round trip from order (an outgoing instruction to execute a trade) to tick (evidence of trade processed by an exchange on the price feed). HFT firms will often precalculate and cache as much as possible to minimize latency. The algorithms and data structures are highly tuned to the exchange and products traded and tend to look “hard-coded.” However, more often than not, the emphasis is on the network layer. HFTs were early adopters of FPGAs (field programmable gate arrays) and kernel bypass networking technologies (i.e., Myricom).

Ed.: This case has been dragged out for more than four years and is only now finally coming to a favorable conclusion for you. What kind of roller coaster ride have you been on since this began?

HB: The time it took to be vindicated came as a surprise to me, but, in hindsight, that should have been expected. In 2012, senior executives in the industry were confiding to me that the industry as a whole knew I was right about the technical detail of the abuses I had discovered. The question that really had to be answered was whether the abuses were illegal or simply unethical. If the regulators had determined it was the latter, my findings would have been regarded as a market reform issue. Thankfully, the regulators determined that my findings were indeed an enforcement issue.

Ed.: You stated that there were only a few people in the world with the technical sophistication to solve this problem. What kind of high-tech brainpower is there at the SEC that could understand the scope of your whistleblower claim? Has that had any impact on the speed with which this case is being handled?

HB: It isn't only technical know-how that is required but also regulatory understanding. The National Market System in the equities space is composed of 11 exchanges, more than 40 dark pools, and hundreds of broker-dealer internalizers. Very sophisticated regulations govern how the entire apparatus is knitted together functionally and technologically. It may come as a surprise that some of the most senior executives at the top high-frequency trading firms have previously worked as regulators, and their opinions are extremely well respected. You can imagine what sort of industry resistance this creates with respect to my allegations. Many industry insiders thought the order type controversy, as it was called, would go away. Instead, the regulators pressed ahead with one of the most sophisticated cases yet undertaken with regard to electronic trading. As it stands, the order type expertise the regulators have developed is definitely ahead of electronic trading desks at top-tier banks. I like to think I've had some influence, but the credit goes to very bright people inside the agency.

Ed.: How long did it take you to pinpoint the cause of the unfair use of order types? How many other dead ends did you take before you finally had your “Aha moment,” when you narrowed it down to this? Once you solved the mystery, what was your emotional reaction?

HB: It took me six months to find out about the unfair usage of order types, and it would have taken longer if I hadn't been told about the abuses explicitly.

During that six-month period, I was on a perpetual bug hunt, oblivious to the fact that the bug was in the market itself. After I was finally let in on the game, it felt like a punch in the stomach. As I did more research into each exchange, it became clear to me that you weren't going to figure out the order types unless you got assistance from insiders. At that time, the exchanges were releasing order types into the market with deficient (or nonexistent) regulatory filings and with minimum technical disclosure. I analogized this situation to receiving a chess game without any instructions and a few missing pieces, which clearly puts the player at a disadvantage at any reasonable play unless he already knows chess! My main contribution was mapping out the order type abuses across the bulk of exchanges.

Ed.: How have you recovered from being ostracized by your peers several years ago?

HB: I can't say it has been an easy path to follow, but I have managed to keep many good relationships in place and my reputation intact. Currently, I advise very sophisticated clients on how to avoid order type abuses. I am also working on a new trading system based on Erlang, which I am piloting with a sizeable proprietary trading firm in Chicago in the options space. I also continue to do a lot of work on market reform and have spent the last two years assembling whistleblower teams to address market structure abuses. The work I am doing with these teams will probably have greater impact than the work I have done with order type abuses.

Ed.: At one point you mentioned you had been invited to enter the inner circle that would benefit from this HFT scheme. Were you ever tempted to just join the group and remain silent?

HB: I spent a year getting up to speed with the order type game and was able to become a pseudo insider. Presently,

my advice to clients is that they have no choice but to use the order type advantages or use a broker with such knowledge; otherwise, they will “bleed” on the losing side of the trade. It took quite awhile for me to understand that the main abuse was really the selective disclosure of order type features and not the order type features themselves (in most cases). As for being an insider, I have been told a few times that the HFTs think of me as “one of them that has gone astray.” More recently, I have been collaborating with a few leaders in the HFT space on market reform proposals. I guess I am still an HFT at heart.

Ed.: How difficult was it to contact the SEC, and did they believe you? Did you seek legal counsel before you approached them?

HB: I worked with Shayne Stevenson at Hagens Berman to bring my complaint to regulators in 2011. I never felt like I had a credibility issue, but I came overly prepared, having put the work in beforehand to support my claims with evidence and analysis. I can’t emphasize how important it is for anyone seeking to engage regulators to be represented by counsel. It really is the road not traveled, and there are lots of potential pitfalls, especially if your whistleblower status is made public.

Ed.: The time-consuming investigative work to find the necessary proof as well as the subsequent industry backlash has to have been difficult on home and family. What has the most difficult part of this been for you personally?

HB: I like to tell people that “being right” isn’t enough. I spent so much time trying to defend my reputation through technical arguments. Although it provided me industry goodwill and respect, it wasn’t reflected in business opportunities. Probably the most difficult part was coming to terms with the fact that the victims of the order type abuses were not very happy I had blown

the whistle. Many firms that I thought would be natural allies saw me as an inconvenience that increased their legal risk. Meantime, many HFTs actually were quite friendly to me over the period. It was disorienting. It really made me question what I was doing it all for and why I had subjected my family to the risks in the first place.

“It was difficult to see that even the organizations that lost money (i.e., pension funds) were not supportive [of Haim] because the fund managers did not want to be held liable for investor losses. Both the perpetrators of the crimes that make a lot of money and the organizations that lost money would have preferred that none of this was made public, which is a case of placing self-interest first.”

—Haim’s father, Arie Bodek, the George E. Pake Professor of Physics University of Rochester

Ed.: With the amount of potential profit from these transactions, did you ever think your life was in danger after you brought these exchanges under the scrutiny of the SEC?

HB: I am asked that question quite frequently. Sure there were times when I felt uncomfortable with certain communications. My natural response was to build a stronger complaint against my targets. I tend to get focused and very strategic under pressure, which is a good trait to have as a high-frequency trader or a whistleblower.

Ed.: Were there specific courses or projects at Rochester that prepared you for the methodical process you used to discover the algorithm that was being used to gain the unfair trading advantage by these exchanges?

HB: The independent studies I did at UR in mathematics and sociology had

a significant influence on me, both of which focused on interdisciplinary topics that intersected with my cognitive science major. UR’s acceptance and support of interdisciplinary research probably made me more confident in tying together disparate disciplines, a confidence I demonstrate in my role identifying structural relationships in securities markets, which include technological, quantitative, trading, and regulatory elements. For me, the order types weren’t just a technology feature of the exchange APIs but a design element that was introduced to create deliberate asymmetries in the marketplace between classes of participants by circumventing regulation. That kind of assessment is really an interdisciplinary view of the market microstructure involved and market structure overall.

Ed.: Financial economics is currently a common double major among our undergraduates. Any advice to help them avoid the same quagmire you found yourself in?

HB: The regulatory environment is changing rapidly, and many common industry practices are now under scrutiny. At some point, you will be exposed to the “edge” associated with your the business unit. If that “edge” doesn’t sit right with you ethically, you really should consider leaving the firm or transferring to another unit. Relying on your manager’s view of the permissibility of certain practices is no longer something you can count on. I expect to see a lot of change as regulators make progress sorting out the more complex areas of finance.

Ed.: If readers are interested in more information about this, could you provide some links to articles or books?

HB: Scott Patterson’s book *Dark Pools* tells the story about the creation of the modern electronic marketplace as well as my experience with order type abuses

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Andrew Uzilov's baby daughter, Julia

Uzilov, Andrew '05—I do still work for Mount Sinai as a bioinformatics scientist specializing in cancer genomics and technology development. Also, my wife, Kathleen, and I welcomed our baby daughter Julia in Dec of 2014, so now we have two wonderful children (our son Alex is turning 3 this summer).

Vandegriff, Evan '011—Nomi, the tech startup I work at, was acquired last year by a larger company called Brickstream, which means we are international now and have a fair bit more money to play with. Nomi does some cool data crunching of data collected from cameras, wifi, and beacons in order to give brick and mortar stores analytics on customer movement trends inside and directly outside the store.

Wang, Alex '07—I'm working at Ecovent now. We're building a system that provides homes with room-by-room temperature control using a series of vents, sensors, a control hub, and mobile apps.

Wang, Chunpai '14—I just got admitted by SUNY-Albany to pursue my PhD degree of Computer Science. And I will work with Prof. Feng Chen at UAlbany in data mining and machine learning.

Ward, Justin '03—I am at AppNexus now. AppNexus is one of the largest pre-IPO startups in NYC and likes to consider itself one of the true homegrown success stories of Silicon Alley. We're still hiring at a pretty solid clip, as well. I am a Technical Services Consultant there. We hire lots of engineers, as well as product, sales, support, you name it. I'm also recently engaged, to Katherine Palmiter. Katie and I have known each other since our undergraduate days and are planning our wedding for October of this year.

Yang, Chuq '99—I now am working at I.M. Systems Group in College Park, MD, as Senior Research Engineer. I am building a computing cluster (based on HTCondor from U. Wisc.) for NOAA's NESDIS/STAR group to help process incoming weather satellite data so we can all enjoy better forecasting up to about a week out. Right now, it's pretty accurate up to about 3 to 4 days.

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at my firm Trading Machines. Marije Meerman's documentary The Wall Street Code (on YouTube) sheds some light on my whistleblower experience. My own book, The Problem of HFT, gives detail on the order type controversy. Also worth checking out is the Wall Street Journal article by Scott Patterson and Jenny Strasburg, "For Super Fast Stock Traders, a Way to Jump Ahead in Line," which disclosed my whistleblower status. For a discussion of the impact of my contributions on securities regulation, you may take a look at the article "High-Frequency, Trading, Order Types, and the Evolution of the Securities Market Structure" by Stanislav Dolgoplov. The SEC settlement with Direct Edge for order types gives the inside story on the case. If you want more detail on market structure and order types, there are many of my research papers and commentary on <http://haimbodek.com> and <https://decimuscapitalmarkets.com/dcm>.

Ed.: What do you do for fun and relaxation? How do you find a work-life balance?

HB: For better or worse, a career on Wall Street doesn't give you the best work-life balance proposition, especially as you go up the ranks. As a whistleblower, I have probably worked harder than I did at my startup or at the investment banks. Still, I am managing to be more of my eccentric self these days. I recently took my 13-year-old to a Slayer concert. I also excavated a 1920s bottle cache with my sister that I found near my house. This has been one of the better summers in awhile.

Meliora Weekend

If you graduated in a year that ends in 0 or 5, please join us Meliora Weekend, **October 9, 3:30–5:30 p.m.**, for the **Computer Science Undergraduate and Graduate Reunion Open House** in room 601 of the Computer Studies Building.