

# Building a better market

INTERVIEWED BY DANIEL P. COLLINS AND JEFF JOSEPH

**Reg NMS created a huge bifurcation in equity markets and while much of what has followed has been positive, in terms of lower fees and greater liquidity, many traders would like to see the market come back together.**

**B**rad Katsuyama may be best known as the antagonist in Michael Lewis' controversial book "Flash Boys: A Wall Street Revolt," but he is an innovator. As global head of electronic sales and trading at RBC Capital Markets he didn't like the way his customer orders were being filled. He never seemed able to hit the entire bid or lift the entire offer that the market showed when executing orders. He realized that faster players were able to see what he was up to and get in front of his orders when the order moved from one trading venue to another.

Katsuyama and his team at RBC devised smart order routing technology, Thor, which allowed an RBC order to hit different trading venues at the same time. This solved the problem in terms of RBC customers, yet Katsuyama saw the market as an uneven playing field and thought he could create a simpler and more balanced market: IEX Group, the first equity trading venue owned exclusively by a consortium of buy-side investors, including mutual funds and hedge funds. While there are those that say technology has simply allowed traders to continue the practice of finding an edge, Katsuyama feels it can be used to level the playing field among all market participants.

He cites a Nordic market study where Nasdaq sped up the matching engine by 10 times. It went from matching orders in 2.5 milliseconds to 250 microseconds. What they found was that the effective bid-ask spread of the stocks widened by 32%. Katsuyama is applying that lesson at IEX. "We've been trained to believe that faster speed led to narrower spreads and here you have a 10-fold increase in speed and a 32% widening of the quote," he says. His explanation for why this happened was that in a slower market you just had high-frequency market makers. When the market got faster a new breed of high-frequency firm came into the market, which he described as bandits.

We sat down with Katsuyama to talk about market structure, colocation and what he hopes to accomplish with IEX.

**FUTURES MAGAZINE: Is it an advantage to be creating an exchange now when all the issues surrounding the market structure are out there?**

**BRAD KATSUYAMA:** Absolutely. Part of it was that the market evolved. It is hard to say if anyone intended for the markets to end up the way they did. We have the benefit of saying we know what is exactly in play; we know the types of behavior we are trying to prevent and we are trying to do that with how we operate our market by the technology we build.

**FM: How is your market structure more fair?**

**BK:** The first 'aha' moment was when I could never get 100% of what was [shown]. When we did research what we found out is that the 100,000 shares of Intel on the offer is actually located across 12 different exchanges. I would say 'buy 100,000' and type it in my screen and hit enter. That would send that order to a smart order router; that smart order router would take that order, break it into 12 pieces because the 100,000 was never just at one place. So we built Thor, but the issue was this: Even though we were sending the order to the exchanges at the same time, they would arrive at different exchanges at different times. The delta in the arrival times between the different exchanges back in 2009 was [the] 2 milliseconds it would take from our first to the last order arriving. One of the guys I hired at RBC, who's now part of IEX, said when he built [routing systems] he got from this building to that building in 476 microseconds--a quarter of the time. While our order is in route he actually can beat us there. That's what was happening. We were missing liquidity because we were arriving at one venue first--the entire offer disappeared, it disappeared on the second venue and that's the signal to say, 'what's going to happen in venue three, four, five, etc.?' The second 'aha' moment, which gets to the fairness of the market, happened when we were designing our matching engine for IEX. We're filing it with [regulators] and I realized the market has a pretty significant responsibility in terms of determining the price where a buyer and seller can match. Reg NMS lays out the structure that says the NBBO (National Best Bid and Offer) is kind of like the goal posts where you can trade.

**FM: What did you find?**

**BK:** So 70% of the trades on IEX are happening right now at the mid-point (mid-point peg is one of our four order types). The NBBO is changing rapidly. We have a pretty significant responsibility to price trades, and that responsibility hinges on our knowledge of what the NBBO is. There are multiple ways you can calculate the NBBO. Someone can take the SIP [Session Initiation Protocol], an aggregated feed, [from] the 11 exchanges into a central processor. The central processor spits out one stream and says this is the NBBO. The problem is the SIP is quite slow because it's an aggregator. You also can calculate it yourself by subscribing and buying the direct data feeds from the 11 exchanges. You can calculate the NBBO probably 10 times faster than someone who subscribes to a SIP; so if IEX used the SIP, any time the market changed there's a subscriber of IEX that would know that 10 times faster than we would.

A mutual fund sends us an order to buy 10,000 shares of

XYZ at the midpoint peg. The market is 10 by 11; we stick that order there at 10.5. The market changes to 9 by 10; a HFT firm knows that the quote has just changed, we don't. If they're co-located to us, they get the update and lob in an order across all the securities they see are changing. They want to sell stocks at 10.5 or at 11 because they know that the new offer is 10. So our 10.5 order sitting there, they'll sell at 10.5, the new market is 9/10, they can cover at 10. It's riskless. You're making a bet knowing the outcome of the horse race.

So you say let's not use the SIP. Let's calculate our own version of the NBBO, which is what we did. The problem is, when we built our own NBBO, we were 80 microseconds slower at calculating it than the fastest HFT firms. And we know that because our network engineer came from an HFT firm. Why were we slower? We weren't as well capitalized, but also as a market we had to build certain amounts of stability and redundancy around our market data platform. If a proprietary trading firm has an issue with market data, they'll stop trading, they'll fix the issue and they'll start trading again. If we have a five-minute issue with market data that's a regulatory issue. So an HFT firm knows that the market changed 9 by 10, if they're co-located next to us they know 80 microseconds before us (see Off Topic, page 19).

**FM: You say regulatory requirements ensure you can never be as fast as the HFT firms?**

**BK:** It's not economically viable for us to lock horns and get in this arms race. What we would rather do is slow all of our participants down. Now 350 microseconds is a time that's imperceptible to any normal investor. It's significant to only a certain type of HFT player, and that's the key. It's not all HFTs. It's a strategy predicated on trading on IEX with information that we don't have, picking off essentially a slow venue. They can't pick us off any more because we always know what the right price is. The big reason why people pay rebates is because they want resting orders. Send me a resting order, like a bid or an offer, and I'll pay you to do that if it gets executed--it's the principle behind maker taker pricing. I'll pay you to rest orders on my venue. What we're saying is you should be resting orders on IEX, you should let us price them--mid-point peg's one of our most popular order types--because we will ensure that those resting orders are pegged or priced to the true price in the market, and a significant amount of volume right now is trading when one party knows a piece of information and the other party of that trade doesn't know that information. I would call those conditions of trading unfair and the exchange is really the only [entity that] can make it fair.

**FM: Aren't you 350 microseconds later than everyone else?**

**BK:** No, we're saying that someone's ability to place a trade on IEX takes 350 microseconds longer than at any other exchange and that amount of time ensures that IEX always has the most up-to-date pricing information. What we want to ensure is that no participants in our market have information that we don't have on behalf of all of our participants. And in order to do that, 350 microseconds is the amount that we have to slow down the fastest players. It solves two problems: First we will always know



the right price; second, [it prevents the situation where if the] entire offering in Intel was just wiped out at BATS, they send a microwave message to the other [venues], cancel my sell orders and buy stock. Colocation enables taking a trade on one venue and using it to act in another trading venue.

**FM: Is the remaining order delayed to the NBBO?**

**BK:** Our connection to the other exchanges is as fast as we can get. So there's no delay in how we send orders out. The customer just doesn't receive that order for 350 microseconds. So 350 microseconds is irrelevant to anyone other than the person who wants to get that information and race me to the next building.

**FM: Some people argue that this is no different than the floor days when traders would vie for the best spot.**

**BK:** Yeah and people will say the carrier pigeon. The difference is that technology is the great equalizer. If you use technology the proper way, it will make things more fair than they've ever been. Of course there were physical constraints before electronic trading, but as electronic trading developed, you can't say well, this has always been a problem. Because that problem in some way, shape or form should be solved and can be solved through technology, which is exactly what we're doing.

**FM: How much of the problem with HFT is simply market structure: Reg NMS, maker-taker, payment for order flow, etc.?**

**BK:** One of our biggest principles is that we're fair access. We have HFT customers. And the funny part is when we laid out our architecture to a bunch of HFT firms; some of them said, 'I don't care.' Other HFT firms had pretty vicious reactions. They refused to connect to IEX. Both players will call themselves market makers. Both players will say we provide liquidity yet one doesn't seem to care about a 350 microsecond delay.

**FM: Do you split HFTs firms into predatory vs. market-makers?**

**BK:** Yes. You can say whatever you want, about how your strate-

gies work. Show up and prove it.

We're happy that there are HFT firms trading on our market because it proves that there are good and bad HFTs, which is what we've said all along. There is computerized trading that benefits the market and provides value and there are some strategies that completely take value away from the market.

**FM: Who are your customers and why are they choosing IEX?**

**BK:** Based on total volume, independent prop trading firms, which include HFTs, make up 17.5% of the volume, retail brokers 25% and the balance will be what we call full service brokers. The big investment banks, agency brokers, we have about 110 brokers trading on IEX right now. There is a growing contingent of buy side firms that are directing their brokers to IEX. The primary reason why people are trading here is because we've designed the market in a way to provide a neutral trading experience.

**FM: American Funds, Mass Mutual and Templeton are investors. They're trading there as well, right?**

**BK:** Yeah, they are, but no more than other firms. Some of our largest supporters are not investors.

**FM: You have something called broker priority where a broker can jump in front of other bids to take the other side.**

**BK:** The broker has to have the other side of the trade. For example, if Goldman Sachs is third on the bid and a Goldman seller comes in to hit the bid, we'll take Goldman's order and move it to the top. It trades for free. And if the Goldman's seller is bigger, it'll trade against broker 1 and broker 2, depending on how big they are. Broker priority exists today but in private, in the broker's own dark pool. Which means that, in that same example, if Goldman's third on the bid, and they catch a seller, and they're on Nasdaq, they're going to take that order, pull it off of Nasdaq, and trade it in their own pool. It makes perfect sense for them to do that. You have the seller. Why sell it to someone else? This is our way to say you have the right to internalize for free but you should be doing it out in the open. The more important thing for us is to get all the uninternalized orders, the 90% of those orders and get them all in the same place.

**FM: Many market participants would like to see internalization and payment for order flow disappear.**

**BK:** There are two definitions of internalization. One is that a broker just has both sides of the trade and they just want to match the buyer and the seller. The other part of internalization is TD Ameritrade selling their order flow to an HFT firm and that HFT firm trading it away from the broader market. That's also called internalization, but they're two different things. One's the broker having both a buyer and a seller of Microsoft. We want them to be able to match that on IEX so that the residual part of that order stays on our exchange as opposed to them pulling it off and resting it in their own dark pool.

**FM: Isn't the lesson to have a transparent market with first-in-first-out priority?**

**BK:** The best example is in Canada. They've had broker prior-





ity since the late 90s. No Canadian bank has grown egregiously in their market share. The most important point is no Canadian broker has a dark pool. Why? Because they can internalize on the exchange. Broker priority is the single best way to reduce the number of trading venues we have. If there are 55 trading venues broker priority reduces the amount of venues that are necessary because it gives brokers the ability to internalize.

**FM: Is it bad having a lot of venues?**

**BK:** Definitely. It increases the complexity of the market and it also prevents naturals from trading. If there were only one market the buyer and seller could find each other easily (see, if there are two markets there's a chance the buyer's in market one and the seller's in market two won't find each other. [With] 55 markets [what's the chance] a buyer in market 21 and a seller in market 37 find each other? Direct Edge and Bats have four exchanges. New York has three and NASDAQ has three. People ask us all the time, 'Will IEX have a second exchange?' The answer to that is no. If your goal is to match buyers and sellers you should only give them one place to come. Unless your goal isn't necessarily to match buyers and sellers. What this does is it provides you with the opportunity to keep them apart so that an intermediary, an HFT firm, can sell on exchange one and buy and exchange three at the spread and it doubles the amount of volume that's traded.

**FM: What's the problem with maker-taker?**

**BK:** Say there's 100,000 shares on the bid and 1,000 shares on the offer. A client gives me an order to buy 1,000 shares market not held. The obvious answer is take the offer [but the fee structure makes it more profitable for the broker to put it at the end of this giant 100,000 line [to get a rebate]. The rational trader would say take the offer. Maker-taker takes rational decision and make them irrational.

**FM: It seems that any structure can be exploited. Isn't the lesson here to have as open rules as possible.**


**BK:** For us the broker has to have the other side of the trade. If we were 100% of market volume which is not realistic but let's say we were, I would say broker priority could be perceived as an issue. [But] if there was gaming of broker priority we would've seen it in Canada because it's been going on for 15 years. We haven't seen any evidence of that. The absence of broker priority is why we have 55 markets. That's why every broker has their own dark pool because exchanges have not given them the ability to internalize for free.

**FM: Should certain market participants have an advantage? Are there good guys and bad guys in the market?**

**BK:** The advantages of the market should come from a better

**LOCATION, LOCATION, COLOCATION**

The old adage for real-estate holds true for where you locate, or collocate your match engine. And it turns out that not all collocation is equal — exchanges offer tiered pricing and different levels of latency. Below are links to the various collocation offerings.

Colocation links	 For more on collocation go to <a href="https://futuresmag.com/tieredcolocation">futuresmag.com/tieredcolocation</a>
<b>ICE</b> <a href="https://www.theice.com/connectivity">https://www.theice.com/connectivity</a>	
<b>NYSE</b> <a href="https://www.nyse.com/connectivity/colo">https://www.nyse.com/connectivity/colo</a>	
<b>CME Group</b> <a href="http://www.cmegroup.com/content/dam/cmegroup/trading/files/co-location-data-center-services.pdf">http://www.cmegroup.com/content/dam/cmegroup/trading/files/co-location-data-center-services.pdf</a>	
<b>NASDAQ</b> <a href="http://www.fibercloud.com/Colocation?gclid=CMLDv4y6kcECFeVaMgodKmcACg">http://www.fibercloud.com/Colocation?gclid=CMLDv4y6kcECFeVaMgodKmcACg</a>	
<b>BATS</b> <a href="http://cdn.batstrading.com/resources/features/bats_exchange_Latency.pdf">http://cdn.batstrading.com/resources/features/bats_exchange_Latency.pdf</a>	

Source: Exchanges

understanding of the fundamentals. Possibly better trading technology, but it shouldn't be structural. It shouldn't be built into the market. Right now there are structural inefficiencies that only a very small set of people can take advantage of. There's nothing wrong with speculators, there's something inherently wrong with people who are placing bets where they already know the answer.

**FM: You created Thor as a solution to the problem. Isn't that the way it should work, a market solution rather than a different market structure or additional regulations?**

**BK:** What Thor solved was the client's ability to trade with RBC. It didn't solve the client's ability to trade overall. And the only way for us to really address that was not to be a broker but was to be an exchange. Nor was it an answer to collocation and people being able to get information and race us.

**FM: Does IEX have protected intellectual property?**

**BK:** We built our own system. Thor is RBC property [but] we patented a bunch of things.

**FM: What is IEX's advantage?**

**BK:** We're a low-cost operator, so incumbents would have to do harm to their existing business model to follow our lead. [We're] kind of an anti-collocation, you can't do some of the things that you're selling.

**FM: You exploded on the scene with the release of Michael Lewis' book and all the controversy it caused. How much has that publicity helped IEX? Is there anything you regret about how that all played out?**

**BK:** It helped us tremendously. We're a startup and next thing you know, we're part of a national conversation. It helped us recruit. We found investors that probably wouldn't have known about us otherwise. Our volume since that time has tripled, so it's helped us a lot. It's definitely made my life more difficult than I'm used to, but that's just what happens.

See page 19 for Off Topic with Brad Katsuyama ▶

## Into the dark pool

One of the main problems with the current equity market structure that pushed Brad Katsuyama to apply for a new exchange, ironically enough, is that there are too many trading venues.

Liquidity is disbursed across more than 50 venues, which can create inefficiencies that can be exploited by high-frequency traders.

“One of the issues with market structure is there are too many venues; back in the old days when 90% of the volume was at the NYSE you could go there and get most of [the liquidity that] was available,” says Keith Ross, CEO of dark pool PDQ ATS.

Ross sees many of the same problems as Katsuyama and PDQ has come up with a different way to address it.

PDQ is a dark pool, meaning it does not post bids and offers but is also unique in the dark pool space. Customers do not send orders, they simply make a request for quote—that is PDQ sends the symbol of the stock or ETF a customer wants to trade to its group of dedicated market-makers. Any such request is predicated on the fact that there is a marketable order (within the NBBO) on the other end but the market-makers do not know if it is a buy or sell or the size.

“Essentially we say to them, ‘where are you in Microsoft?’ and they will respond ‘I am \$46 bid for 500, I will sell 500 at \$46.02.’ And we will aggregate the responses from everyone that is interested in Microsoft and create a price time priority book so the best price will fill the client’s order,” Ross says.

There is a 20 millisecond delay, which allows for the aggregation of all the bids and offers from market makers.

Ross says that the market, which launched in 2009, solves many of the problems Katsuyama cited for creating IEX and the results have been a 45% rate of price improvement for orders executed on PDQ, much higher than the industry norm.

He says that they solve many of the common problems with order execution because orders have to come to PDQ instead of them having to chase them.

“I described the running around to different venues as whack-a-mole; we reverse the flow of the river so to speak,” Ross says. “If those shares are going to trade with your order they have to come to PDQ and once they come they are actual executable orders. We pull them all together and trade with them all at one time.”

If a customer does not have a match the PDQ can send it out or cancel it depending on the customer’s wishes.

Ross says many of their market-makers, that typically make markets over several exchanges and dark pools, would be classified as HFT. “We would argue that—even better than IEX—they really have no ability to game the order. We don’t have artificial barriers like IEX does but we do make them compete with each other to offer the best price.”

Competition is the key and Ross says they are attempting to create a virtual trading floor.

“In essence we think that we recreate the competition of the floor in our virtual electronic crowd. No one else has visibility to it. And each order receives a custom auction.”

PDQ has grown steadily and is profitable according to Ross, but is still quite small with less than 1% of equity market share.

PDQ is cheaper than the lit market for customers but does not offer as great a rebate to market makers. “Our pricing to our liquidity seekers is about 30% or 40% less than the lit market and the comparable rebate to the providers is also less but they don’t have to post to the market in advance, they have the option to respond to the order,” Ross says. “Some of our orders we do give rebates but the majority are free for the provider and a cost to the takers.”

Most of PDQ’s customers are retail but they are adding a new “Auction One” facility to draw in the buy-side. Instead of a 20 millisecond delay they will delay the market a full second and require a minimum order size of 2,500 shares. Market-makers will be required to provide a size of at least 500 and they will be able to aggregate liquidity from other dark pools.

“[The buy-side] have the problems of the fragmented whack-a-mole market, we reverse the flow, we consolidate orders from different venues and give you the capability of trading with it all at the same time so that you get more liquidity at your price,” Ross says. “If we have 5,000 to buy and we trade 1,500, if the customer cancels the remaining 3,500, the people that traded the 1,500 have no idea whether they filled the order or not because we don’t show them the size, we only show them the symbol that we have marketable shares in that particular stock.”

The changes wrought by Reg NMS have created competition and innovation according to Ross. But it has also fragmented the market, which has made it difficult to execute size without moving the market. Like IEX, PDQ is looking to bring the market together in an efficient manner.

# OFF TOPIC

with Brad Katsuyama

**ALPHA PAGES:** You mentioned that exchanges have different levels of colocation. Explain.

**BRAD KATSUYAMA:** Exchanges have three versions of cables that they will sell you with tiered pricing and speeds. You could poke around at the [NYSE] and NASDAQ. They have three versions of cables that they will sell you. First you pay to be in the room. Now all of a sudden you have three options to connect to me. You have a one gig cable at New York, it's \$10,000 a month for two cables; you have a 10-gig cable which is \$25,000 a month for two cables and you also have a 40-gig cable for \$40,000 a month for two cables. These cables are not that expensive alright? The difference in the gig is speed, microseconds. You can save two or three microseconds by getting a faster cable.

**AP:** So the economics of colocation provide the exchanges with revenue by creating a tiered system?

**BK:** Yeah. There are those participants who are colocated and those who are not. So if we let someone colocate right next to IEX, even though we've made every attempt at getting information as fast as we can they're still going to be faster. So the only thing that we could do to actually ensure that they were not trading with information that we didn't have, is put them farther away. We had to go anti-colocation. And the distance that we wanted them away was 43.5 miles. Unfortunately there was no 43.5-mile data center away from the data center where our matching engine was so what we did was put them five-and-a-half miles away and coil 38 miles of cable in a box to create distance.

**AP:** That's how you created 350-microsecond latency?

**BK:** Yes, and this is the reason why. The market is 10 by 11 we have a 10.5 buyer, the market changes to 9 by 10, HFT firm gets the update, they place an order to sell stock at 10.5 on IEX. As it's going around the cable we get the update that the market has changed to 9 by 10,

we'll slide the order to 9.5 and by the time the order gets there we will have moved this order to the correct price.

**AP:** Have exchanges, by enabling colocation, undermined fairness in the market?

**BK:** Yeah. The fact that there's a variance in the speed of market data and the speed of participants, offering colocation undermines the exchange's ability to ensure that no participant has information that they don't have.

**AP:** Should the regulators restrict colocation?

**BK:** The problem with doing that is that they'll just go across the street. It will slow them down slightly but they won't force them to go 43.5 miles away.

**AP:** Are those colocation revenues meaningful?

**BK:** Trading is the fourth largest net revenue stream [for equity exchanges]. They bunch [colocation] under technology services [so it is meaningful].

**FM:** Can you compete without those fees?

**BK:** We charge a flat fee: 9¢ per 100 shares for everyone. It's cheaper than the 30¢ per 100 shares to take liquidity off let's say ARCA, but they will also pay a 29¢ rebate. So, the people who are used to collecting rebates we're way more expensive. For the people who are used to paying the high fees, we're cheaper.

**FM:** Is there something the regulators should do?

**BK:** It's always better for the market to try to address market related problems before we look to the regulators. There are things that the regulators can do that aren't directly related to touching the market, i.e., disclosure and certain transparency measures.



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