How “Stopping” Helped Fort Robotics Keep Going — and Growing

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The world of automation is changing. Unlike in the past, machines now have sensors that can let them perceive the world. They have brains that let them think about what to do. They now have different types of actuations that let them do different things. And it all happens at a much lower cost – but also at much higher risks. In this article for the *Coller Venture Review*, Samuel Reeves, CEO of Fort Robotics, describes his journey and challenges as an entrepreneur to capture the opportunities he saw in the robotics market and explains the perfect storm of factors that have transformed smart manufacturing, the emerging risks of these technologies, and how the pandemic impacted the robotics industry.

Entrepreneurs are often asked, "What's the have-to-have part of what you're offering?" In the case of Fort Robotics, a Philadelphia-based automation company that builds and operates smart machines safely and securely, it happens to be a function known as "the stop feature." As its name implies, this feature stops the machine functioning at a moment's notice. How can such a seemingly unsophisticated function be a key differentiator and the "have-to-have" feature of Fort Robotics' products? As Samuel Reeves, CEO of Fort Robotics explains in this article for *Coller Venture Review*, the reason is that in large machines, the failure to stop can mean death. The fact that Fort Robotics' products had the stop feature helped customers recognize their safety. This caused a pattern of widespread acceptance and adoption that propelled Fort Robotics' sales and revenues.

Why was this innovation so crucial to Reeves and Fort Robotics? As the article explains, Reeves started at age 22 in the landmine clearing business. At a time when human deminers were used – often with traumatic or even fatal consequences – to clear conflict zones of buried landmines, Reeves used robots to do the job. Rollers would go in front of the robots to deactivate a mine before it could kill or maim a human. In that context, being able to stop the machine before anyone died was a crucial requirement. That was the origin of the stop function. It is also the reason it remains a critical part of Fort Robotics products.

Another element that is apparent in the emergence of Fort Robotics is that it demonstrates Samuel Reeves's extraordinarily persistence as an entrepreneur. Although serendipity undoubtedly played a role, his tenacity in bringing the landmine clearing device to market, understanding the importance of the stop feature, finding out that this feature was critical not just to demining equipment but also to machines serving other industries, and using that to drive sales is what helped Fort Robotics leap forward. The company doubled its sales during the pandemic, thanks to Reeves's intelligence, resilience and creativity.

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It is understandable how, during the COVID 19 pandemic, companies such as Clorox – that made soaps, wipes and products that kept people safe – grew rapidly. It is less obvious why companies such as Fort Robotics thrived. In addition to entrepreneurial drive and imagination, this not-widely-anticipated bounce came from an opportunity that the COVID 19 pandemic mobilized. Across the board, large manufacturers were focused on safety, the stop feature resonated with them, and they used this time to bring change onto the production floor. These are some key lessons from the Fort Robotics story, and we use it here as a mini case study to illustrate what the often-academic theories of persistence and resilience mean in entrepreneurial practice.

It may sound trite to say it now, but automation is transforming society. We have heard that for a long time. Industrial robot arms started production in the 1950s and 1960s. Machines – like, a lot of manufacturing operations – have been automated for a long time. But the thing that we often don't see is that a machine takes a long time and money to program. Once it has been programmed, it runs for a long time. You don't want to change it because it took you so much time and money to program it. That process is applied to a very narrow aspect of production, which is high volume and low variability. That is how automation has worked in the past in industries such as automobiles and electronics.

The upside relative to what has changed today is huge – estimated at around a $30 billion market in the U.S. when smart machines hit scale. And nobody owns it yet. There is truly a blue ocean opportunity to create a new layer of the tech stack that is being pulled along by an industrial revolution, that's an enabler to an industrial revolution. This is a unique opportunity that doesn't come around very often.

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At Fort Robotics, we have three elements of creation: Creation of the market, creation of the category, and creation of the technology. There's ambiguity all over there. There's a lot of risk in ambiguity, but there is also a big reward. We're not easy to understand. In machine control you're looking for very high reliability. Imagine the networks that control our aircraft and cars and nuclear plants. These are safety critical control networks. That's what we need to have to send an emergency stop signal to a machine. But with mobile machines, you don't have a wire so, you have to do it over wireless. You have these two forces coming in together – yet safety critical systems and wireless communications have never been together before. We created a way of doing high-integrity information transfer over the wireless networks. We have the experience of a wired safety-critical network, but over a wireless network. We created an overlay that would basically do a virtual control system. With those two things, the governance system that told it what kind of box it had to stay in, and then the safety critical coms, we were able to create a safety approach for this 10,000 lb. autonomous machine with people around it.

We saw the robotics industry growing around us. By 2017, companies were doing things that were similar to what we had done. There was a whole defense robotics community. There started to be the commercial robotics community. Then everybody that makes an existing machine, John Deere, etc., started to have these skunk works projects to make their machines autonomous. At that time, we started to see companies trying to come and buy pieces of our system. So, we started selling this stuff. We realized everybody is going to need this kind of thing.

In 2018, I started Fort going from the vertical application of landmine clearance. There was this crazy industry that was a super niche market, but it had a very high humanitarian appeal. The goal there was, we started with safety, and then grew into security. But the overarching mission was to accelerate automation, to achieve that automation in society. We were motivated by the fact that we were talking about taking three key risks off people's plates – safety risk, security risk, and economic risk.

Our first products have been related to communications. Once we connect every piece of technology that is interacting with a robot, and every human that is interacting with a robot, then we can move on to doing governance of the systems. Right now, we're just focused on communications. In our case, we're trying to create a category here. The category within our customer market is not established. We're trying to invent it. And we are simultaneously creating the technology on which the category is based.

Our investors include financial VCs that manage money for a standard slew of limited partners (LPs), both private and institutional. We have a few angels and a few individuals. Mark Cuban is one of our investors. We have a few entrepreneurs from the robotics and telecom industries who are individual investors and a couple of corporate investors. Stanley Black and Decker is a giant name in construction, and Prologis is the world's largest owner of warehouses. They have multiple tens of billions of market capitalization. Those are the three groups: standard, traditional financial VCs, angels, and strategic.

Dealing with the Three D's

As a career-long robotics entrepreneur, I'm a true believer in the potential for smart machines to make life better for humans. That is often lost in the discussion about smart machines. Generally, discussion about smart machines tends to focus on their risks. There are also conversations about the potential for labor dislocations, and if smart machines will cause job losses. But there's not as much focus on the potential for smart machines to help humans live better. In the robotics business we call it the three Ds: the dirty, the dull, the dangerous. There are a lot of jobs out there in the world that are dull, dirty, and dangerous. The United States has about 4.5 billion injuries in the workplace each year that require some type of medical consultation. This costs employers tens of billions of dollars. That's just the dangerous part of dull, dirty, and dangerous. The dull piece is way beyond that, and the dirty piece is way beyond that.

If we could wave a magic wand and have humanity focused on the things that make people feel alive, productive and happy, and have machines doing the drudgery, wouldn't that be an amazing society? There is a world out there – the "automated society" – that is very compelling. We have been building towards that my whole career, ever since I started my first company, Humanistic Robotics, which built robots to get rid of landmines. In that company, we became a UN contractor. We went into UN peacekeeping operations across Africa in the border region between Sudan and South Sudan. We worked on different UN missions there: Mali, Somalia, Kuwait, and Syria. I think those were the main ones. We ended up clearing thousands of miles of roads in Africa. We produced distinct technology that was more cost effective, easier to service in these environments that were remote in the middle of nowhere, and highly effective. We learned enough to see the potential for smart machines to make life better for humans. That's when I fell in love with the potential for smart machines to create an automated society.

Fast forward, and we eventually spent quite a bit of time figuring out a safety system that could sit between the machine and the artificial intelligence (AI) that governs the machine's behavior. Basically, we let the machine know the boundaries it could not cross. Then we created a way of controlling these machines so that somebody didn't need to be around them all the time. That required a new approach to wireless communications because, if you think about it, if you put a wi-fi network or a private cell network or a Bluetooth node on one of these things, the number of times that our basic communications technologies malfunction is unacceptable for machine control.

Focusing on the Future

If you screen for drive, creativity and raw brain power, you usually can come to a point of getting to know a potential employee's expectations. You need alignment in expectations. I have an executive coach who always says that you should never have expectations. You should only have agreements and commitments.

In building our team we have emphasized five values. We want all our people to deliver a customer experience worthy of loyalty; own their priorities; accomplish the impossible; think out loud; and build together.

Personally, for me, the transition from doing to leading is an interesting point. That's only recently happened. A key for me has been over-communicating my style. My style is pushy and creative and very verbal and full of ideas. I'm thinking out loud all the time. I expect my team to push back when I am working on a crazy idea or getting distracted by something that I'm fidgeting about.

If you don't have that latter part, you just have somebody that's pushy and thinking about a bunch of crazy things all the time. You could go off the rails. So cultivation of the team's capacity to push back against me has been very important. Now in my leadership team, we have an open and fluid relationship because– and we wrote it into one of our corporate values – we are thinking out loud. This was so important in dealing with me that we wrote it into a value, thinking out loud.

We rarely step back to take stock of what's done in the past. We pay attention to the present and focus on the future. After we close a big deal, we say, "Great, where's the next one?" We don't celebrate a lot, just do a lot of driving.

Pursuing Persistence – Surviving a Perfect Storm

Now, we have automation flowing out to every machine, thanks to a perfect storm of forces. It's not just about programmability. This is not first-generation automation; it is much more intelligent. Machines now have sensors that can let them perceive the world. They now have brains that let them think about what to do. They now have different types of actuations that let them do different things. It all happens at a much lower cost and a compressed time frame. The cost and the timeframe had a critical bearing on what happened in mobile phones. In mobile phones, processing and sensors and the inputs to robotics made them cheap and super capable. That was one of the elements of the perfect storm.

Another element of the perfect storm has been that all the components got cheaper. All the technology required in terms of AI and perception got better. And then we had macro-economic factors such as labor shortages in every production environment. Consider industries such as mining or transportation. Every one of those areas has seen labor shortages. Rather than pay high costs for scarce labor, automation is cheaper. Automation is possible ➔

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because the technology is better, and it is required because labor is scarce and expensive. Those are the elements of the perfect storm. There is a drive to automate production and to do it differently than we did in the 1960s.

As these changes happen in automation, what new risks has this created? That is a loaded question. Safety and security risks are paramount. We used to have machines that were programmed or we had a mobile machine that only did whatever a sensor told it to do, nothing else. Now we are taking smart machines and removing the fences and having people around them and having them think on their own. And then we are connecting them to the internet. The software is so much better, but it still doesn't actually perceive the world around it in a super safe way. These machines are still, compared to humans, kind of dumb.

We are putting these machines that can kill us in the same place with humans, sharing workspaces, and they're not smart enough all the time to fully perceive the unpredictable world around them. That is a major safety risk. Then we connect them to the internet, so that adds to the security risk.

The security risk is different for this kind of system than it is for a standard company. If a standard company gets breached, it's a data-loss problem. It's usually a financial problem, and a customer trust problem. Those are non-physical problems.

In contrast, if a manufacturing operation or a physical environment gets breached, you can have major safety risks. You could have machines that go crazy and kill people. Machines can plow down warehouse racks. They can poison the water in a water treatment plant. Machines can overload an oil refinery or a power station. They can mix the concrete wrong so two years from now maybe a bridge might fall down. These risks have physical world implications. Cyber security risks are truly, truly terrifying in a way that the world has not yet fully appreciated.

Some companies have appreciated them in the national security or critical infrastructure business. But I don't think the average humans have appreciated how integrated into the Internet our basic services that run their lives are, and how the physical world connects with the Internet. We are concerned with the safety risk; we're concerned with the security risks. We have built a platform to address them for the next generation of automation.

Yet another risk will be taken care of over time, but we are still working to address it, which is that everyone's really excited about this world of smart machines. We can all see the benefits. But the fact is, there are no platforms to build on yet. So, the smart machine world looks like the Internet did in the 1990s, where everybody bought all these servers and they had to spend many millions of dollars just to get up and running. And you had to have rooms full of people. It was all very hard and bespoke.

You take that kind of format, and you add the physical world. The physical world makes everything harder. It means that starting a robotics company, starting a smart machine company, or doing a smart machine retrofit to a production environment is something that takes a really long time to do. It takes a lot of money to do. It's just painstaking engineering and manufacturing rollout and installation.

That's another thing that we need to address – economic risk – by providing platforms that mean the people have to build less themselves internally. Smart machines are at this interesting point. They have proven their return on investment in enough cases for people to believe that there's going to be huge scale there. We all believe in this industry that it will go from proof of concept to scale within the next few years. But the longer this kind of painstakingly bespoke economic dynamic persists, the harder it will be for these machine companies to reach scale.

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It's not a question of whether it will happen. It's a question of when it will happen. But it all has to go together in a coalition. The developers, the users and the investors of the machines have to be making enough progress. Everybody has to benefit along the way for the coalition to stay together.

If it takes too long to develop these machines, then I would worry about seeing an investment winter. You see that right now in the lidar space, for instance. Lidar is this type of sensor that goes on smart machines, especially on cars. It's viewed as a major input to autonomous vehicles. That got substantial investment five years ago. Hundreds of millions, billions of dollars were invested in lidar.

Then, these companies built themselves and they tried to get deals with OEMs and some of them did well and some of them failed. Some of them consolidated, and some went public. Now, if you're raising money for a sensor company, you will probably have a hard time.

I don't want there to be an investment winter in smart machines. That means the coalitions will need to stay together, and it also means people need platforms to build on to make it cheaper and faster to build smart machines.

The Pandemic's Impact

What impact did the pandemic have on the smart machine market? There's the stock answer that applies to everything, and then there's a nuanced answer. Let us consider both.

The stock answer is that crises like the COVID 19 pandemics accelerated every trend by 10 years. Smart machines are no exception. If a bunch of these startups and smart machine suppliers were planning on scaling in the next 15 years, now they could look at scaling over the next five. In general, the pandemic was that kind of shock.

The reality is more nuanced. There was a labor shortage in every one of these environments, as I stated above in my discussion on why we went through a perfect storm. There was a labor shortage in every one of these environments before the pandemic hit. It made labor shortages worse, for sure, but they already existed. People were already working on this.

But then the pandemic accelerated a few sectors tremendously, like e-commerce. The e-commerce acceleration has been very well documented. Consider autonomous trucks. I think the pandemic and the supply chain shortages and the supply chain disruptions fed the decoupling of autonomous cars and autonomous trucks. This is because autonomous cars are mainly useful in city centers where there's high density, while autonomous trucks are mainly useful on the highway. These, from an autonomy perspective, are different levels of difficulty. We can have autonomous trucks today for limited routes. Autonomous cars in dense urban environments are harder.

So, in terms of the pandemic acceleration, we saw a major uptick in anybody doing robotics for e-commerce. That applied to robot arms that were picking up packages and putting them in boxes or unloading crates and putting stuff away. There are a lot of things in a warehouse or distribution center that a robot arm can do. All those activities saw an acceleration.

Accelerations also occurred in other industries. Construction was one of them. This industry has been dealing with labor shortages for a long time, and the technologies are a little further away from prime time. You may have wished that you could do autonomous construction because of the pandemic, but it was not possible to push a button and accelerate it as much as it was for warehousing. Also, a lot of those environments were outside. Social distancing was more possible. That kept construction going a little longer than expected.

Agriculture is another area where there was already a major labor shortage. Berries were dying on the vine. The world's projection of food needs has been substantially outstripping our current ability to make food. We need automation in order to fill that gap. The macro long-term trends remain the same.

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Many of the technologies are almost there – as in the construction industry – but they are not yet ready for prime time. You cannot simply press a button and turn them on, as we could in e-commerce. Activities like picking a weed or picking a berry are hard to do from a robotics perspective. A lot of companies are still working their way through these challenges. But it's inevitable. If the pandemic did anything for funding, it will have pulled in the eventual date by which that kind of technology sees the world.

Another area that's very frothy in robotics and smart machines is turf care. We have seen a major acceleration in autonomous mowing. Those companies are out there, proving ROI and making scale. Again, that was a labor shortage issue before the pandemic, and it has just continued to grow from a smart machine perspective.

Mining was already fairly autonomous before the pandemic. I don't believe it has changed course. In general, we pulled in the date at which some of these technologies go prime time. We had a few examples of major accelerations. We didn't know what to expect when the COVID 19 pandemic started. The general thought in startup land when the pandemic hit was, we need to conserve cash. Nobody is going to invest. Nobody is going to buy. There's going to be no economic activity. There's going to be no investing activity. Do layoffs or public-private partnerships, or whatever one needs to do to survive.

At Fort Robotics, we doubled our revenues during the pandemic. It was really interesting. We polled our clients. They told us, nobody's sitting out the fastest industrial revolution that our people had ever seen. Nobody's sitting that out because there's a pandemic. The fourth industrial revolution is still happening. While there was some initial thought that the pandemic was going to be disruptive, it was positive from a business perspective, if you leave aside the obvious human cost. Obviously, no one can claim that the pandemic was good. But if you were to leave aside the human cost, it was positive for the smart machine industry because of the acceleration. It took a few months for people to realize that.

Resilience in Facing Future Risks

Which areas will see the greatest risks in the future? I have been thinking a lot about this. I am going through all my verticals, and thinking through the safety, security, and economic risks.

From a safety perspective, the larger the machines, the greater the risks. So far, a lot of the e-commerce robots have been small. A lot of the new industrial robot arms, like the collaborative robots, have also been fairly small. If they hit you, the injury is not very great. But when you start getting into autonomous forklifts, excavators, or tractors, then you have machines that truly are big enough to kill you. We already see those machines automating. We are already starting to sign seven-figure deals to help them be safer. Many companies recognize the risk that is out there.

The machines that are biggest have obviously the greatest safety risk. Both the opportunity and the challenge in this industry from a safety perspective is that these risks are so new, there are no regulations yet to mitigate them. We do not even have well-recognized, well-understood practices that could be written into regulation. We are trying to invent the best practices for dealing with safety for autonomous systems. Once we do that. and the practices get accepted by the industry, which we're on our way to doing, then these could be written into regulation. But we're still a few steps away from stability in the appreciation of safety in this kind of world.

You look at something like aerospace, and the Boeing 787 or 737 Max aside, – let's take that as an exception because it was a bit of an exception – those safety practices are well understood. Car safety practices are well understood. The design principles, the regulation, the oversight principles, the certification principles – they are all very understood. Even in industries like pharmaceuticals and medical devices, these practices are stable and understood.

Smart machines are a space where you have massive change, and the regulations have not yet caught up. The best practices have not yet caught up. That represents a huge risk. If you're not reading about autonomous excavators killing children in the school yard yet, that is because the industry has not yet scaled to massive numbers of machines without a solid approach to safety.

If the industry scales too fast, without having figured that out, then statistically, you're going to see a lot more injuries that will halt the progress. That's a major risk.

In addition to the safety risks we have described above, we should put a coda on the security risk. The security risk applies to every connected machine that has any operation in the physical world. In any operation whatsoever, there's a way for a smart machine to cause trouble. Any connected device or machine is exposed to cyber attack. The IOT security industry is not nearly as mature as the IT security industry. That should scare everybody a lot, but we should not let fear paralyze us. Progress will depend on how well we overcome the fear. ■

About

Samuel Reeves is the CEO of Fort Robotics, an automation company that builds and operates smart machines safely and securely. Prior to joining Fort Robotics, Reeves served as Co-Founder and President of Humanistic Robotics, a technology company that addressed landmine & IED clearance using robots. He received his B.S. in Economics with concentrations in Finance and Management from the Wharton School of the University of Pennsylvania.