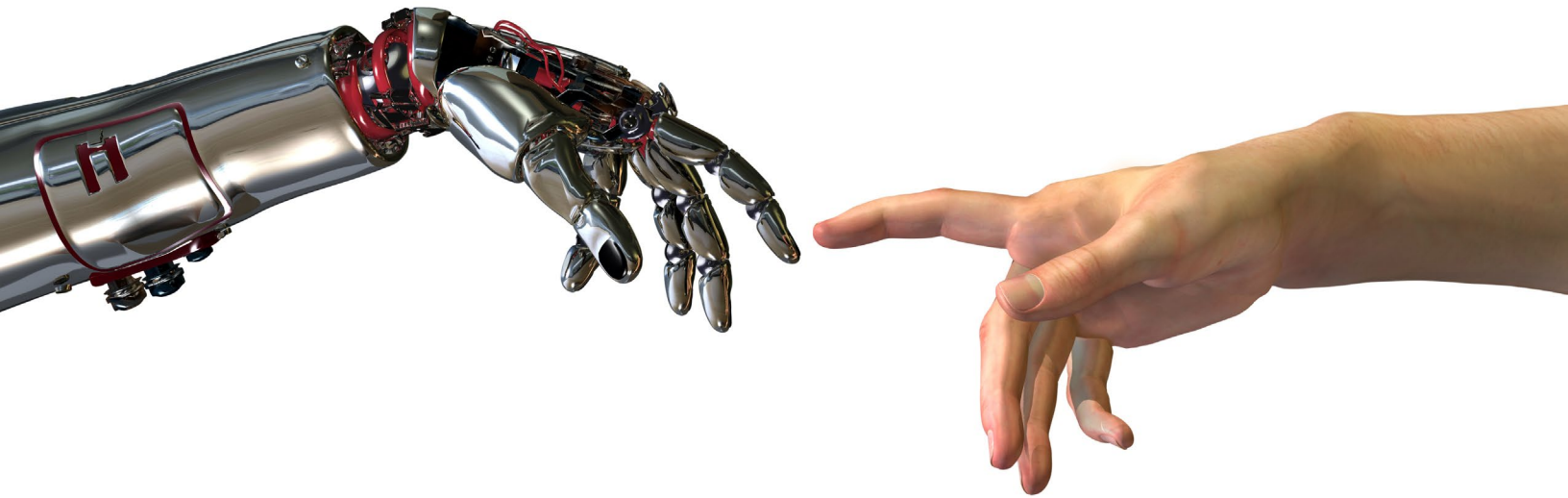
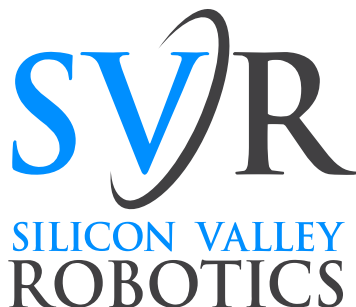


Service Robotics Case Studies in Silicon Valley

November 2015



Interviews with CEOs of robotics companies in emerging industries, with analysis of investments and trends affecting the future of the service robotics industry.



Supporting innovation and
commercialization of robotics
technologies.

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Introduction

Foreword

It's my pleasure to introduce the first of a series of case studies on robotics from Silicon Valley Robotics, the not-for-profit industry group supporting innovation and commercialization of robotics in Silicon Valley and the greater San Francisco Bay Area. As the Founding Executive Director of the organization, I am struck by how far the robotics industry has progressed in the last five years, but also by how nascent the activity still is.

When we first started Silicon Valley Robotics in January 2010 as a grassroots coalition of robotics industry leaders, robotics in the Bay Area was not very well known compared to the work of our friends in Pittsburgh and Boston, and perhaps even Detroit and Philly. There were several success stories that were largely industrial, medical or research oriented. Our local community was not well connected, and we tended to watch while other parts of the country received the credit for moving robotics forward. In the intervening years however, we have helped to position Silicon Valley as a leading force in the emerging robotics landscape by nurturing our small community and helping robotics startups grow, in a range of verticals including the service and consumer industries.

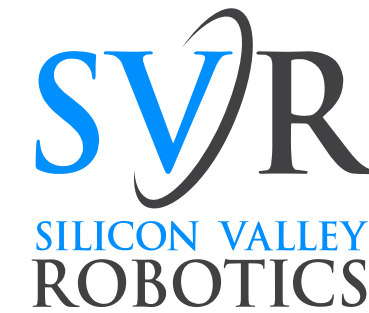


The companies showcased here are all standouts in the emerging world of service robotics, showing us new business applications for a range of robotics technologies. We've added "special sauce" with additional insights from investors and enterprise on the state of robotics commercialization today.

Robotics is starting to make the transition from industrial into service robotics, moving closer towards the consumer end of the spectrum. The lessons learned from these companies will help steer a new generation of robotics companies as they navigate the difficult passage from startup to service robotics. It is still early, but look to Silicon Valley to set the pace for that future.

**Yours,
Rich Mahoney**

Director of Robotics at SRI International
President of Silicon Valley Robotics



Silicon Valley Robotics (SVR) is the not-for-profit industry group (501c6) that supports innovation and commercialization of robotics technologies and represents the cluster of robotics companies in Silicon Valley and the Greater San Francisco Bay Area. We host the Silicon Valley Robot Block Party, networking events, investor forums, a directory, jobs board and provide additional services and information for members, such as reports.

Silicon Valley Robotics was launched in January 2010 by a coalition of 30 robotics companies that included founding board members Adept, Bosch, SRI International and Willow Garage. Rich Mahoney, Director of Robotics at SRI International is the Founding President of the association. Andra Key is the Managing Director, in charge of daily operation.

Membership in Silicon Valley Robotics is open to companies, startups and also individual professionals, who are directly engaged in robotics and support the aims of the organization. We also welcome affiliates, who are interested but not directly engaged in the production of robots or robotics research and development.

Silicon Valley Robotics aims to facilitate networking, fact finding and research between industry executives, potential partners, investors, and customers; to engage in activities that enhance the quality and quantity of the next generation of robotics professionals; to advocate in favor of robotics policies that promote innovation and entrepreneurship; to recognize industry-leading companies and attract thought leaders.

Introduction to Service Robotics

Robotics is finally stepping out of science fiction and into service, if not in our homes, then at least in our hotels, hospitals, restaurants, warehouses, hardware stores and other retail outlets.

This new report series from Silicon Valley Robotics highlights the first steps of startups Fetch Robotics, Fellow Robots, Savioke and Adept into the emerging service robotics industry, with additional analysis contributed by industry experts.

The service robotics industry has long been the subject of science fiction, with robot maids, like Rosie from the Jetsons, or cleaners, like Wall-E. Or medical assistants and all round helpers like Baymax from Big Hero 6. Baymax was actually modeled on the latest in soft robotics research, but there's still a big gap between research and commercialization. So far there have been very few successful service robotics companies.

Robotics pioneer Joe Engelberger founded the world's first industrial robotics company, Unimation, in the 1950s. Engelberger then moved on to starting the world's first service robotics company, HelpMate Robotics, in the 1980s. HelpMate Robotics is best known

for hospital delivery robots, although Engelberger was exploring a range of eldercare and assistive technologies.¹

The International Federation of Robotics defines service robotics as "a robot that performs useful tasks for humans or equipment excluding industrial automation application."² While in general, industrial robots tend to be large arms or gantries and service robots tend to be smaller and mobile, the definition has been dependent on the end application rather than the pure form or function of the robot. The IFR continues to refine the robotics definitions and track the industry statistics.³

Until now, industrial robotics has been the dominant sector for robots, particularly in the car industry and consumer electronics. The industrial robotics sector is worth more than \$32 billion dollars in sales, software and service, although there are only 1.5 million industrial robots in the world, compared to more than 10 million Roombas! There has been steady growth in industrial robotics for the last five years and this trend shows no signs of slowing.⁴

¹ http://www.robotics.org/content-detail.cfm/Industrial-Robotics-News/Joseph-F-Engelberger-the-Father-of-Robotics-Turns-90/content_id/5600

² <http://www.ifr.org/service-robots/>

³ <http://www.ifr.org/service-robots/statistics/>

⁴ <http://www.ifr.org/industrial-robots/statistics/>

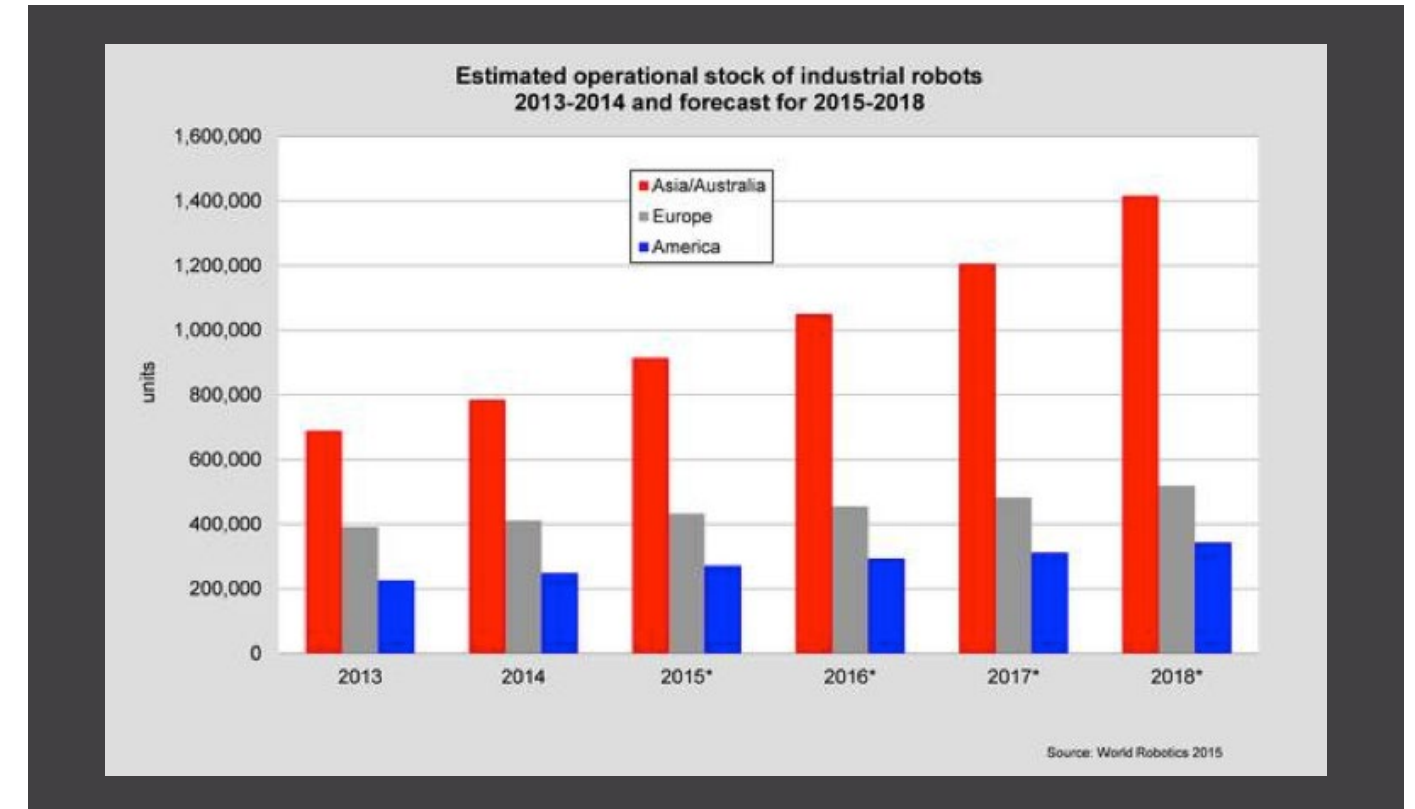


Figure from International Federation of Robotics Industrial Robot Statistics (retrieved October 2015) <http://www.ifr.org/industrial-robots/statistics/>

However, the service industry is also growing strongly and encompasses all of the new market areas not already defined as industrial robotics. It is hard to accurately predict growth here when there is such potential for rapid growth as costs drop, new systems are introduced and new suppliers start to proliferate.

The IFR has tracked overall annual growth at around 11.5% so far and projects more than 20% annual growth to come in the service robotics industry. But some niche areas have already

demonstrated growth of between 150% (mobile platforms) and 650% (assistive technology) in the last year. The primary market areas for service robots so far have been in defense, field (agriculture and inspection), logistics and health/medical applications.

One of the new categories to emerge in the last year is the humanoid helper, kiosk robot or retail assistant. The robotics companies featured in this report showcase some of these emerging opportunities.

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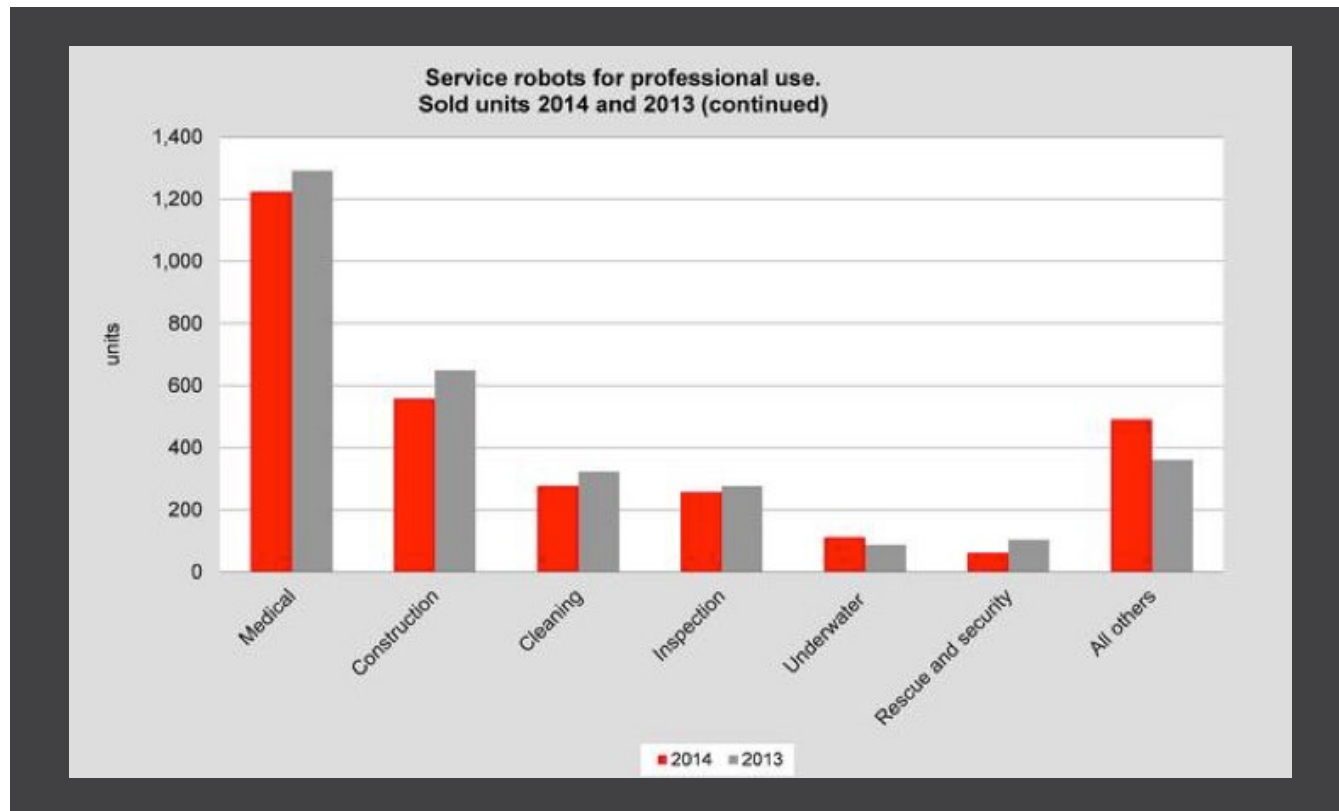


Figure from International Federation of Robotics Service Robot Statistics (retrieved October 2015) <http://www.ifr.org/service-robots/statistics/>

Fetch Robotics provides mobile robots and mobile manipulators for ecommerce warehouse facilities. Fellow Robots provides mobile retail assistants for hardware stores. Savioke provides a delivery robot for hotels and is working on eldercare opportunities. Adept provides a general-purpose mobile base that can be utilized in many settings, including one application as a restaurant server.

The cost of service robotics systems is dropping significantly, putting service robots in reach of many new market partners. But these new market opportunities are also arising due to continual improvements in the safety and compliance of robot systems, alongside their more intuitive user interfaces.

What is also clear is that none of these robots replace workers, but they supplement work at critical bottleneck times/tasks or improve health outcomes making jobs more attractive, especially in areas where there is a chronic shortage or high turnover of staff.

At the end of the day, the value proposition for service robotics is in supporting workers to work better, faster and safer. But these new robot assistants offer a tantalizing glimpse of a reshaped work paradigm, where humans gravitate to managerial jobs, leaving more of the menial and repetitive jobs to robots.

Case Studies & Analysis



Fetch Robotics Core Team



Fetch Robotics



Fetch Robotics builds robot systems for the logistics industry. The company was founded in 2014 and is headquartered in San Jose, CA. Unveiled in April 2015, the Fetch Robotics system is comprised of a mobile base (called Freight) and an advanced mobile manipulator (called Fetch). Fetch and Freight use a charging dock for autonomous continuous operations, allowing the robots to charge when needed and then continue on with their tasks. In addition, the system includes accompanying software to support the robots and integrate with the warehouse environment. The robots are designed to work independently alongside human workers, performing repetitive tasks such as warehouse delivery, pick and pack, and more. Fetch was awarded a GameChanger award by Robotics Business Review for Best Industrial Productivity Solution.

Interview with Melonee Wise, CEO Fetch Robotics *edited for clarity*

What's the current value proposition for Fetch Robotics?

We see the largest opportunity within the logistics and material handling industry. E-commerce and an on-demand economy are putting tremendous pressure on inbound logistics and fulfillment. If you look at the top issues for logistics managers, there are several different types of issues that they're looking to tackle. One is throughput, obviously. Another one is insight into the day-to-day happenings of the warehouse. Logistics managers are making decisions based on data that is sometimes almost a month old in many cases. Lastly, being able to add technology into an aging warehouse. Those three things are what we're trying to capture at Fetch.

How did you identify logistics managers as your alpha customers out of the whole range of service robotics?

We first decided to focus on the logistics market as there is a great deal of supporting evidence that the market needs to turn to automation.

One obvious indicator is that the market is changing. There's a lot more demand for instant delivery, or express delivery, same day delivery, same hour delivery. Businesses somehow have to get goods from a warehouse to a person's hands in a shorter amount of time. The other factor is the current job gap. There are about 600,000 unfilled jobs in this industry and most people estimate that's only going to get worse.

Second, as warehouses add more automation, they're not going to want to knock down a warehouse every time they do so. That means there's a market opportunity for installing "in-place automation."



Melonee with Fetch and Freight

How many trials does Fetch have underway?

Right now we are working on three different commercial pilots, all at different stages. We can't say much about them just yet but we are in the process of doing commercial deployments. We've also sold several robots into research, which is also a means for us to hire as we grow. If we get robots into research labs then students are already familiar with our robots. So that's not so much a sales channel as a recruitment channel.

Looking at your commercial customers, what would you say are the similarities and differences?

Some of our current customers just want to use the software and the robots as we've imagined them in our videos. But others want us to change it up a little bit and do point-to-point delivery or have robots going between people instead of robots following people. There are a lot of options. Some of it is nonrecurring engineering work and some of it isn't.

Lastly, the logistics market in general works with such thin margins. They have to increase productivity or risk losing margin.

Are you offering robots as a service, completely or partially? (What is your business model?)

Right now we aren't specifically offering robots as a service. We are doing engineering work to customize the robots. In terms of our business model, we're still coming to a final solution on our pricing strategy. We have already seen that some potential customers prefer the capital costs of buying the robots, where others would prefer them as a service.

What would a typical deployment of Fetch and Freight look like in the future? How many units of each and how would it integrate with existing systems?

Right now follow-pick is our most popular kind of product, wherein our Freight robot simply follows an individual in a warehouse. Our customers and prospect are still looking at the problem. Do they want better transparency into their warehouse? Do they want better throughput? How much more throughput do they want? How big is the warehouse? How many people do they have picking. So there are a lot of factors determining what is a standard system, meaning that essentially there is no standard system. We're also trying to find ways to talk about it like robots per square foot or robots per employee but we're not there yet.

We seem to find it easier to imagine robots that augment human workers, like Freight, perhaps Fetch is too big a step?

It's very possible that Fetch is going to be an incremental step because of the discomfort some businesses have regarding automation. When you look at Fetch versus Freight, Freight is a lot more understandable and businesses have a better understanding of how it translates directly to productivity. When they look at Fetch they wonder why it looks that way, how many picks it can do, how accurate it is, etc. When you're

talking about a robot that just follows you, it's much simpler to understand.

At this point, we're not worried. We're going to work with our customers to help them understand the capabilities of our robots and we believe that we'll get more traction in the future.

Can you describe Fetch and Freight, what they do, what they cost and what the ROI is?

Fetch and Freight are a pair of robots. When they're working autonomously they're most often working as a team. Fetch is a mobile manipulation robot. It has an arm and can pick up objects weighing up to 6 kilograms. Fetch can navigate autonomously, search out objects on shelves and pick them up. Freight is a mobile robot. It's meant to do most of the freighting or transporting in a warehouse because fifty percent of a picking task is transport.

We decided that when you look at the cost of making Fetch vs. Freight, it's far more inexpensive to make Freight. Fetch is more sophisticated, more like a person. Like a person, when Fetch isn't picking then it's under-utilizing its capabilities. That's why we developed this buddy pair. In terms of cost, we're really not talking about that yet. The cost of the system is extremely dependent on the size of the system, the volume of the order, how many warehouses it's going into and all of that. All of those things factor into pricing our robots.



What is the ROI for a warehouse?

We're positive that it's less than two years but don't yet have data yet to effectively support that.

What so far is staff response to it?

We haven't really gotten past novelty yet, so we'll see.

What are some of the issues you've faced in deployment?

Most of the issues we've faced involve migrating from existing back-end systems. Warehouse systems are a hodgepodge of different technologies.

Do you have specific lessons from these deployments? Has that lead to changes in what you're doing?

Not yet. We haven't been deployed for very long, so we're trying to not make any preliminary conclusions.

What is the competitive market? There is very little that is a mobile manipulator but there are quite a range of mobile solutions, presumably in warehousing as well as other service areas? Can you describe how you differ?

This is really a hard question because it's more about the software than the robots. The hardware is very similar. We know that we are more price competitive, but it really comes down to the software that we're using.

And what about the difference in timing? Whether or not you are serving legacy hardware or not?

Legacy is a big problem for the industry.

What are the environmental factors that contribute to Fetch that might not have been possible five years ago?

ROS, definitely. It certainly helped that many of the core members here at Fetch were also on the ROS core team. Sensor technology has come quite a ways. Also, the way we think about doing things has changed significantly because computational power has finally caught up with some of the algorithms. A really great example of this is particle filters. Our use of particle filters for localization has been limited so far, to using a small number of particles, because of the computing power needed to do the algorithm for a certain amount of particles. The moment you wanted to add thousands and thousands of particles it wasn't practical. But now computing power has gotten a lot more powerful and so some of the things we thought about previously but couldn't implement because of the limited computational power, well now we've changed our thinking significantly. We're starting to use that computational power more effectively to do interesting more novel things, which improves things like better localization.

Freight robot, docked and undocked



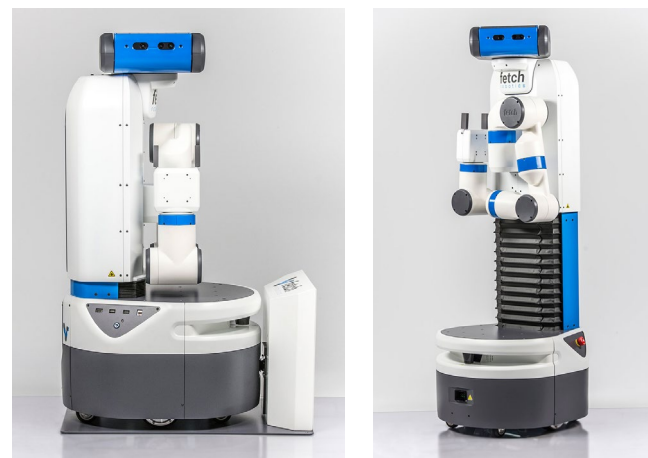
What new areas will that open up for robotics?

We'll be able to use more computationally-intensive algorithms that might produce better visual or navigational results, more natural behaviors, more clever solutions. From my perspective, it's one of these things where technology seems to be time capsuled by the technology that was available at the time it was created. Robotics is specifically susceptible to that because it's so dependent on new sensors and increased computational power. Until everything gets sufficiently fast or powerful you're always going to have this legacy problem where we did this because of x, y or z limitation at the time.

Let's assume that we're reaching a point where our technology is able to meet the needs of service robots like Fetch and Freight? Where do you see future potential?

I think there are market opportunities, specifically in elder care. Everyone sees that as the next big thing. The challenge there is whether we're going to be able to get around the safety issue. There are a lot of edge cases and I just don't know if we can do it. We also haven't done the same legwork that we've done in logistics, so it's hard to nail down where we want to go next.

Fetch robot, docked and undocked



Logistics is pretty broad? At the moment you're targeting e-commerce warehouses, are there other applications in logistics?

We're going to look at light manufacturing: robots actually doing the assembly or the value-add tasks. And that's actually more specific to Fetch rather than Freight, although perhaps Freight can value-add too. I expect there are some value-add services where the robots can probably extend into after logistics.

There's one key thing, people are not necessarily great at walking compared to everything else we do well—excluding the health benefits—walking is not a high value activity for people.

Finally, are there messages that you'd like to get out about Fetch and Freight?

We're trying to make it clear to the world that Fetch Robotics is providing solutions—both collaborative and autonomous—for the logistics space. We don't want people to think that our robots just do x and y. We're hoping to engage people in the idea that we can create new applications and capabilities for these robots, to extend them beyond what our initial vision has been. ■

CEO Melonee Wise



O'Reilly AlphaTech Ventures

OATV, or O'Reilly AlphaTech Ventures, is a seed stage investment firm based in San Francisco with a track record of backing robotics startups in emerging areas. As well as investing in Fetch Robotics, some of their other hardware investments include 3D Robotics, Planet Labs, Misfit Wearables, Littlebits and Sight Machine. OATV typically invest between \$250,000 and \$2 million into startups at a critical early stage of development. This pre-revenue runway helps startups refine their prototypes, determine product/market fit, and achieve strong follow on rounds. OATV invests early, typically before market categories are well defined.

Interview with OATV Principal Roger Chen *edited for clarity*

What's OATV's investment thesis and how does that make you look at robotics companies?

We like to look on the edge. If you take a look at our portfolio, there's a wide array of companies in different categories. You have anything from consumer internet companies like Foursquare to satellite companies like Planet Labs to drone companies like 3D Robotics and logistics companies like Fetch Robotics. We made each investment when we sensed the emergence of a new category. When we think a "thing" is going to become a "thing," we try to find companies and entrepreneurs in those categories very early on and back them just before the categories are really created. Before 3D Robotics, drones wasn't really much of a category. And neither was space before Planet Labs and other pioneering companies like SkyBox.

Our focus has been on that strategy applied at the seed stage. We're a little bit different than other seed firms in that we invest in fewer companies, about six a year. We concentrate

more capital into those companies and take more of an all-in approach. Our personal philosophy and style is to try to work more closely with the companies we invest in, and it becomes hard and unwieldy to do that if you invest in too many companies within one year.

When it comes to robotics, we are seeing a lot of interesting things happen. There has been a confluence of technologies enabling new forms of robotics, from innovations in actuators enabling compliance and collaborative robotics to innovations in sensors and software.

ROS, or Robot Operating System, only emerged these last few years, and before that, software development for robotics was exceedingly difficult. The advent of open source communities and platforms like ROS has really catalyzed the field. So those are some of the enablers on the technology side.

There's also a lot happening on the market side, and market pull is just as important as technology. Just to give one example, let's

take a look at e-commerce and what's happening with consumers. They want things faster, cheaper, and personalized, and this just creates so much pressure on a lot of these manufacturing, supply chain, and logistics companies.

At the same time, there are macro trends within the labor economy, as baby boomers start getting older and labor supply is expected to drop significantly. The confluence of all these factors puts logistics companies in a tough spot. People tend to forget that someone somewhere still needs to make, package, and ship things as part of e-commerce's backend. Suddenly, automation and robots make a lot of sense and are economical.

That's how we see the robotics industry, and while that example is specific to the logistics industry, I think there are a lot of industries where automation and robotics are going to come into play in similar ways. It's going to be a collision between technology enablers on one side and intense emerging market demand on the other.

Could you expand on some of the trends enabling robotics and automation in logistics?

I'll talk a little more about market pull. Depending on country, online sales make up somewhere around 10% of overall retail. You can see how massive companies like Amazon and Alibaba are, and that 10% online share of retail will only continue to grow. It speaks to the growing volume of work that has to be fulfilled on the backend of e-commerce.

I think a lot of people, especially consumers, don't see how much work has to go into fulfilling those online orders. There is a box that has to be moved. There is something that has to be packed. There is something that has to be shipped and transported. That's kind of shielded away from consumers' eyes. But it all has to be done, and it's becoming more and more challenging for

logistics companies to fulfill all these operations economically.

I can give you another statistic on the labor side. A lot of people have concerns about how robotics and automation will disrupt labor, which I think is valid and true to a certain extent. But I think you also have to be nuanced about it because if you actually look at the manufacturing and materials handling industry, particularly in the US, there is a huge job gap of 600,000 people because there is not enough sufficiently skilled labor to execute on the work to be done. That then presents an opportunity for robotics and automation to come in and fill that gap.

These are the powerful forces we see driving robotics: the really intense demand for logistics fulfillment, and simultaneously a lack of people to do all the work at an economical cost.

What other areas of the commerce value chain can robotics, smart automation and AI potentially improve?

There's a ton of room for cost reduction via automation, but it's not necessarily with just physical automation. There are software solutions as well that can make supply chains a lot more productive. For example, our portfolio company Fetch Robotics is tackling the logistics problem by streamlining operations in factories and warehouses with a mobile robotics platform. However, Fetch will be just as much about its future operations management software and application data as its material handling robots.

At some point, all the goods that a company like Fetch moves around will need to be packaged into containers to be shipped all around the world. Another OATV company called Haven is creating a marketplace for streamlining how container shipping is booked. If you think about it, it's rather ridiculous that people still have to call one another and use manual paper-based

processes to mix and match which containers should go on which ship. It's just very inefficient, and it hurts business by not maximizing fulfillment of shipping capacity. This is a case where relatively simple automation through purely software and a web application can go a very long way in driving up productivity in the supply chain.

The take home message here is that when I think about automation for improving supply chains, it's not necessarily just robots with arms that move around and pick things up. It's as much about the software as it is about the hardware.

What are some examples of OATV portfolio companies, perhaps not robotics companies but where the lessons can be applied to robotics?

I just talked about Haven a little bit – it's essentially an online marketplace for more efficiently filling capacity on ships for shipping things.

There are a couple other OATV companies that come to mind. One is Sight Machine. It's a data platform company. They aggregate data streams across the manufacturing floor, perform analytics on them, and offer a frontend dashboard for customers to understand exactly what's happening along their manufacturing lines. That has a ton of value because that kind of intelligence is what will allow decision makers overseeing operations to keep things up and running efficiently.

Another example is Riffyn. They are similar to Sight Machine in that they are also a data platform that aggregates data streams, but their focus is on the R&D lab for life science companies. Currently 70-90% of R&D results in the life sciences are not reproducible. If you are a pharma company, imagine the egregious amounts of R&D money wasted due to poor process control. Companies like Riffyn perform data automation to give science-driven enterprises control of their processes again. They automate data collection,

root cause analysis and continuous deployment of improved process designs to drive up productivity for the R&D pipeline.

Both Sight Machine and Riffyn automate workflows to enable superior operational intelligence, flexibility, and performance to drive up productivity. While neither company is a robotics company in the traditional sense, that exact value proposition very much applies to robotics as well.

How is robotics today different from robotics in the past?

Once upon a time, robotics was about stationary, highly repetitive, high performance, and generally expensive automation. Industrial robot arms would repeat the same action again and again with extreme precision. We're not as excited about those applications. We think a lot more about flexible robotics. We think about programmable robotics.

It's no longer just about robotics automating specific human tasks. It's more about how flexible robotics will enable superior operations overall. I would actually draw a parallel with what's happening in the software world with the DevOps movement, which I think we're shortly going to see in the physical world. With DevOps, the idea is to leverage a closed feedback loop to quickly iterate on software development, deployment and operations in a continuous fashion. I think this concept of continuous development and deployment will extend beyond virtual environments to optimize physical operations as well. Companies like Fetch Robotics have a physical hardware platform that automates some process, which it will do well, but probably not perfectly at first. However, it will continuously improve and learn about the process because of all the operational data and analytics that result from prior deployments. That data will come back

to decision makers and engineers and inform them how to redesign and improve process. Now, imagine a simple firmware or a software push that instantly reorganizes and improves operations.

That's the sort of robotics we're seeing these days, and I think that's what makes these companies really exciting. Robots are no longer one-trick ponies that just automate a single task.

Do you think these trends are leading to a change in the business model away from robots as capital expenditure? Will we see robots as a service? or robots as a delivery mechanism for sensors and analytics?

At the end of the day, the decision to use robotics is still at its core a question of ROI. For some companies the ROI math doesn't add up, but for an increasing number of companies, I think it does.

I do think though that there will be some interesting and innovative business models for robotics. How will future robotics products be priced? Some companies will make money selling hardware like more traditional industrial robotics companies. A company like Fetch Robotics makes a physical product that it will sell, but at the same time, there are potential SaaS-like revenue streams through the data applications and operations software that the company will offer. I'm definitely excited to see what new business models come out of all this.

And in conclusion?

I'm excited about this new wave of robotics companies evolving from traditional robotics that have primarily been about static, repetitive processes. We are witnessing the emergence of the first platforms to offer flexible and programmable robotics that we haven't seen before.

I'm also really excited about learning what other verticals robotics will address. Most of the conversation about robotics has been centered on logistics and e-commerce, but there will be several other verticals as well. Applications like exploration, search and rescue, caregiving and more. I can't wait. ■



CASE STUDY



Savioke is creating autonomous robots for the services industry. The company aims to improve the lives of people by developing and deploying robotic technology in human environments. Savioke was founded in 2013 and is headquartered in Santa Clara, CA. Savioke is the creator of Relay, state-of-the-art robot designed for autonomous delivery of items between people. Relay's first application is in the hospitality industry.

Relay delivers snacks and amenities to hotel guests, enabling hotel staff to focus on other guests' needs. With successful deployments in the U.S. at hotel groups such as Starwood and InterContinental Group, Relay has a proven record of more than five thousand deliveries. Savioke (pronounced "savvy oak") was awarded a GameChanger award by Robotics Business Review for Best Consumer Solution.

Interview with Steve Cousins, CEO Savioke *edited for clarity*

Can you describe the value proposition of Relay?

In a nutshell, what Relay does is let the hotel staff increase the service level at the hotel, and increase the productivity of hotel workers by having Relay handle simple room delivery. The robot is leased to hotels as a service.

How did you select hotels as your alpha customers?

We looked broadly at a lot of industries while some of us were still at Willow Garage, anywhere from manufacturing to the home. Manufacturing is interesting, for example, but already well served by robotics. The home is unstructured and complicated, along with very tight price targets. Of the industries in the middle, we thought the service industry was a pretty interesting place to go. You have repeating tasks. In many cases you have semi-structured environments. You have a lot of human labor doing tasks that are very repetitive.

We then looked industry by industry within the service sector to see how we might go to market, and how our product might fit. After an extensive analysis, we decided that hotels were the best place to start.

In the industry itself, how did you select your alpha customers?

One of our early VC friends told us that we needed more hotel contacts if we were going to make a go of this business. We asked him if he had any and he said he didn't but he suggested that we start cold calling at hotels. So that's what we did. We just went to the general manager of each hotel. Because it's the hospitality industry,



Steve with Relay

the general manager will always come out and talk to you. We simply asked them for 10 minutes of their time, told them what we had in mind, and asked if they might be interested.

And in the end, we kicked off our alpha program with the Aloft in Cupertino. They immediately understood the benefit of Relay and connected us to their corporate base. We then had contacts at both the individual hotels and Starwood corporate, which gave us a really nice platform. In the hospitality industry it's very useful to have both a brand advocate as well as a hotel advocate.

How many deployments do you have and how long have trials been underway?

We are now in four hotels and rapidly signing up more. We've been in the first hotel for almost a year (recorded July 2015). We've been in that one plus the second Aloft since March. Relay can now be found in the Crowne Plaza Silicon Valley/San Jose, the Holiday Inn Express in Redwood City, the Grand Hotel in Sunnyvale, CA and a Marriot in Los Angeles.

So we are in two Starwood hotels, and they also use a third robot as a travelling brand ambassador. We are also now going into multiple chains.

Are you finding similarities or differences between hotels and chains?

When you do something for the first time in a pilot, you learn a ton. And when you go to the second one, you find out what was common and what's new. What we found in the second hotel were little things, like the size of the map was significantly larger and we had to deal with that issue. The elevators were a lot faster, and that was a good thing. The Wi-Fi situation and the LTE coverage situation were really different. Every hotel that we go into we learn some new stuff, some new corner case or some new issue. The number of issues is going down though.

The second hotel came up a lot faster than we expected, to be honest. We find a couple of issues, we fix them and we go. The fourth hotel was almost no problems at all. So it's interesting.

This is a robot that works alongside people. So in addition to the technology, you have to teach the people what they can expect of it. How to work it. How to understand what it does. How to not be threatened by it. In the end, it's people using the robot to do work, so they have to be willing and able to use it.

Can you describe Relay?

Relay is a delivery robot. It's not dissimilar to R2D2. It has a lid on the top that locks and it can open itself. It has some sensors on the front, and is designed to move through human spaces, not hit anybody, not hit anything, not get lost, ride the elevators and move gracefully around people. It has a locking bin, where front desk staff can put something in it, key in a room number, and let Relay make the room delivery. Those are the core capabilities.

In a typical scenario, somebody calls the front desk and says, can I have a couple of extra towels? The front desk puts the towels inside of Relay, types in the room number and sends it off.

The robot navigates to the elevator, rides up to your floor, gets off and navigates to your door, calls your room. When a guest answers the phone it says "There's a robot outside the door with your delivery".

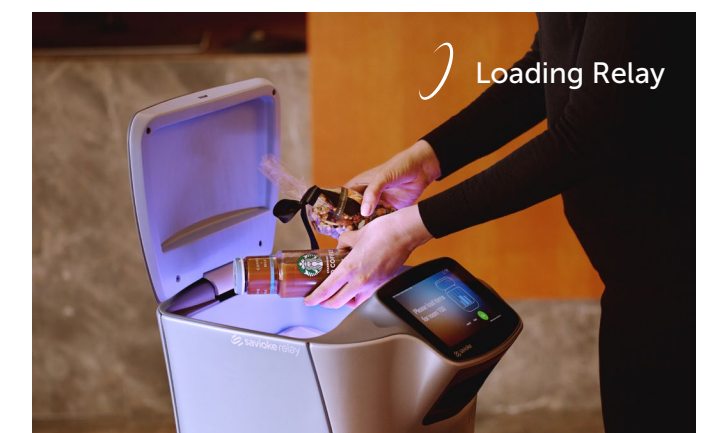
When the guest opens their door, Relay automatically opens its lid, and the guests get their towels. Relay actually hangs around for a few seconds so guests can interact with it. It asks you a question, "How is your stay going?" and then it leaves and goes back to its dock.

What can Relay carry?

The compartment is almost 1 foot by 1 foot by 14 inches deep and has a deep bin. It can carry whatever can fit inside it up to about 10 lbs. It's not designed to be a workhorse or carry luggage, but rather for small items; amenities; a bag of food.

Would a hotel use one or several units?

It depends on the hotel and how they use it. In the first hotels we are deploying a single robot to start. We've recently signed up our first hotel that will take two robots. Most hotels the average size of hotel is around 150 rooms, which you might be able to get away with one Relay in. But there's a lot of opportunities to use the robot to increase service. As hotels discover those, they may find that they need additional robots to handle new services or increased demand.



Loading Relay

Are these unique services that have never previously been available or is it the volume, that the hotel can provide more services?

It could be either. A good example is a lot of hotels limit room service to certain hours of the day. Also, a lot of hotels have only one person on staff on the front desk overnight, in which case they can't leave the front desk and be going out and doing deliveries. This is true in a few of our hotels where we find that Relay is regularly doing 3am deliveries. Because the hotel can now offer that sort of service, so they do.

But it takes a while for people to get used to the fact that they can order something at 3am or 2am if they want to. And if you think about the logistics of it, usually there's something in your room that tells you all the services the hotel provides. And as you get the robot, those things need to get updated and the hotel has to get comfortable with how often they're going to use it and what they're going to offer with it.

There are other kinds of services, as well. The first case is a timing of deliveries. There's other kinds of services that hotels used to do but don't do anymore, probably due to labor costs and the fact that they have to cut back in order to stay within their budget, things like shoe shines and laundry. Of course, hotels mostly have laundry services these days but with Relay you can call for the robot to come with the laundry bag, put your stuff in the bag right there, send that back down to the desk, get it washed and delivered back to your room. Instead of thinking about "Do I have to wear my pajamas down to the laundry room?", you can get it taken care of without having to leave your room.

Is Relay replacing a human? How does Relay fit in to the existing labor force in a hotel?

Relay is not designed to replace people. It's designed to be a productivity aid for the people

who are already there. When you look at what a person at the front desk is doing, they do a lot of different things. Relay can't do all the things that they're doing but some of the times they'll do is run off and do a delivery. That's really kind of menial work for that person. Our position is that you want people doing things that they're skilled enough to do and that way we take advantage of all the great things about being a human. And you want the boring repetitive and redundant tasks being done by a robot.

No one ever writes on their resume that they know how to ride the elevator all by themselves. Right? While it's a pretty cool skill for a robot, it's not worth mentioning for a person. So why should you pay a person \$15/hour to do that sort of work? You stand there and you wait and you ride. And you're not getting anything truly productive done.

Relay is like any other tool right? You don't need power nailers, for example. You could have workers hammering away all day, and then deal with the repetitive stress injury that comes with that job, like roofers and such. But someone invented power nailers, so people can work faster, they can do more roofs. The idea is not that we're trying to put roofers out of work. We're trying to make them more productive and that's how we think about Relay.

What's the ROI? At \$15/hour, most people believe it's still more affordable to hire people rather than robots to do these boring, repetitive and potentially injurious tasks.

They haven't compared the costs to Relay. Basically, look at what Relay costs per hour and it's clear that it's cheaper. We're making Relay available to hotels on a monthly basis. We call it Robots as a Service, and it is less expensive than a person would be for a shift. So it's not that you're paying more for this robot, you're paying less.

What makes Relay so affordable now? Is it a confluence of technological improvements and other factors?

I think it is a confluence of factors. We've seen sensors come down in price. We've seen computational power come down in price. We've seen our ability to prototype get much, much better with all of these new maker tools. It's not that we want to 3D print all robots in construction but in order to get a standing start it helps to have all these tools available, until you actually have that robot in production.

I think the other big piece is ROS, the robot operating system that was grown at Willow Garage and is now supported by the Open Source Robotics Foundation. It gives you a big leg up in terms of being able to get things going sooner. It's not that ROS does everything perfectly for a production product but it gives you a head start.

That combined with all the other relatively low cost technologies that you can combine, makes it possible to make a low-cost robot that you can afford to deploy.

Have there been other successful service robots in the past or is this a new paradigm? (Joe Engelberger pioneered both industrial robotics and then service robotics in the 90s with the first hospital delivery robots)

Ask yourself, how many delivery robots have you seen in your life and where did you see them? If you've seen any then it's probably been hospital delivery robots or office mail delivery robots. In the case of office mail delivery robots, those are technologies that are more than 20 or 25 years old. It basically follows a path and if someone gets in the way it just stops and then continues on. The robots that are in hospitals are doing a good job. They carry large loads. They tend to follow a fixed path and stop. Kind of like a freight train.

And what we've done is said, "That's a really

interesting model but what if we could build, not a freight train, but a FedEx delivery truck?" Something that could go from point A to point B and can do the kind of deliveries that we've all come to expect, with Google Express and Amazon Now and all these modern 21st century technologies. Why can't we have that same thing inside of our commercial buildings?

That's what we went for, and when you dive into the details of earlier service robots, we're built on much more modern technologies and at a lower cost, because we can use modern technologies.

Relay towel delivery



What has the response been to Relay?

Guests love it. You'll need to use special characters to type this, but this guy answers the door, and early on we were waiting in the corners so that we wouldn't interfere with the delivery. And the robot shows up at his door and he says, "Holy Shit!!!" He was so excited. And kids opening the door... "Mum, Mum! There's a robot at the door!" And there've been girls hanging out of the door with their cameras, following it down the hall. The delight is palpable.

There's always a naysayers, but they've been very rare. Mostly you see people, they get their delivery and they smile. The robot always says "How did I do?" or "How was your stay?". Guests

usually give five stars. The robot makes a little happy dance and they smile again and the robot goes away.

You see this in all sorts of different ways. Look on TripAdvisor and you can look on Twitter. People are experiencing this thing and enjoying it. And the “at the door” experience is just fundamentally different than if somebody brings you what you ask for. If you call down for a couple of towels, a persons going to show up at your door and you’re not going to be sure whether to tip them or not, because you’re not buying anything, they’re just towels. Or say they bring you a toothbrush. Are you going to tip them \$2.00 for a 25 cent toothbrush?

I can’t tell you how many people comment, “This is great, I love it, I don’t have to tip it.” Another thing is you don’t have to get dressed for it. If the robot’s coming and bringing you something early in the morning, you don’t have to brush your teeth and get dressed because there’s a person coming to your door. Robots don’t care how you look and they don’t smell your breath. It’s just a more “at the door” experience that people seem to like.

We’ve also found that the hotel staff loves Relay as well. Part of the reason hotel staff are working in that industry is because they like to make people happy. So if the robot makes people happy, they’re happy. It also appeals to their efficiency. It’s a pain to go deliver something to a room when you’re the only one in the building, or when you’ve got other stuff you need to be working on. Whether it’s sitting at the front desk in the middle of the night reading your book or whether you’ve got three more people to check in, it can be annoying or stressful, if you’re rushing to get back.

Instead, staff can just give this thing to Relay and it takes care of the task. Simple. And it gets the task done without you having to spend the nearly ten minutes that it would take to do that work.

Were you expecting this behavior, or have you evolved the behaviors of your robot in response?

We designed Relay to be attractive. We didn’t want it to be industrial or scary. I think we were surprised by the level to which people loved it and in response we’ve been playing up some of those things. As we refine it, we take that into account and we try to make it a little bit nicer, a little bit friendlier. And that becomes a core piece of the product.

What metrics are you collecting? How does staff know that the robot is performing well?

They can see the guests in the lobby, so they can see people are happy when the robot passes them in the lobby. They know it does the delivery because they have a monitoring tool that we give them that let’s them see where the robot is at any given time. It’s not unlike Uber. There is transparency as to where the robot is and what it’s doing. If they send the robot to Room 243 and then realize it was supposed to be room 234, they can just cancel it and redirect it to correct room without any problem. The staff can correct those sorts of errors and recall the robot and basically they have control over it remotely. Basically, it’s a tool that they’re using to get that work done.



Relay in dock

What do you see as the future potential for Relay? Where would you like to see Relay deployed next?

Everywhere.

Any specific commercial realms?

We’ve had a lot of people call to ask us if they can use Relay for this service or that function. We’re trying to stay focused on the service industry. There are certainly opportunities in logistics for delivery robots and in manufacturing. But there are already variations of autonomous guided vehicles in those spaces. We’ve hit a different sweet spot. We offer a robot that can safely be around kids and people. We just basically try to mix right in to the human environment.

But in terms of pushing forward, we’re focused on hotels first, because you have to be focused in a startup. Also, different environments have different requirements and new engineering issues. For example, we took Relay to the last Golden State Warriors home game of the season and had it deliver to luxury boxes. Normally Relay arrives at the hotel room and phones the room. But if you call a luxury box in the middle of the game though, they probably won’t hear the phone. It’s very loud inside Oracle Arena, especially at the Warriors games. So we would have to devise a different way to signal the room occupants that their delivery has arrived.

That’s the kind of scenario that we would examine to see if this technology fits or if we could adapt it. If there’s a big enough opportunity, then we will.

And in conclusion?

The thing that we’ve learned, and has been reinforced over and over, is the notion that a startup has to focus. The more Savioke focuses on a single task, the more successful we will be at handling all the little details correctly. That’s what we’ve been trying to do. That’s why we’re starting in hotels and staying there for the most part. We’ll focus on hospitality until we feel like we’ve really got it and then we’ll see how we can expand from there. ■

Citrix Startup Accelerator

Dr. Michael Harries is Chief Technologist for Citrix Startup Accelerator, using open innovation and investment in early stage startups to better understand emerging trends in computing. His primary focus is on cloud computing, enterprise infrastructure computing and the future of work, including the fields of robotics, machine learning and AI.

Lessons for robotics from enterprise computing by Dr. Michael Harries

Many advances in our technologies occur through borrowing capabilities from one field to progress another. Our technological universe is built from a web of interrelated advances that push one another forward.

The practice of Enterprise IT is being transformed by a variety of innovations that emerged in the last decade. Vendors who have traditionally sold into this space are struggling to adapt. They are facing the Innovators Dilemma,¹ largely captive to their traditional business models.

We can expect a similar dynamic of disruption for the field of service robotics. Cloud computing, Software as a Service, and mobile connectivity represent an important competitive opportunity for every robotics-focused company, and the future of the service robotics industry is inevitably one of Robotics as a Service.

With each new generation, the weight of innovation and market momentum shifts. The latest generation is wrought from a mix of technologies that include cloud computing, Software as a Service, ubiquitous wireless connectivity, and universal end points.

Cloud computing is the notion that computer hardware is no longer something that everyone needs to purchase. Instead, compute cycles can be purchased from a centralized resource. One example of this is Amazon's Elastic Compute Cloud (EC2) which in 2014 had more than one million customers and was growing at 99% year on year.² EC2 is a type of "Infrastructure as a Service" (IaaS).

Software as a Service (SaaS) leverages the centralization of Cloud Computing with a targeted application offering, generally solving the whole of a business problem, whereby a company or individual can purchase a complete solution without needing to deal with servers, with installation, nor maintenance. This approach is increasing in popularity with IDC estimating \$50.8B in revenue by 2018 up from \$22.6B in 2013 on Enterprise SaaS applications.³ SaaS ranges from collaboration technology like Citrix GoToMeeting to CRMs like Salesforce.

Ubiquitous wireless connectivity is about the degree to which every new device is connected wirelessly to the internet and is a significant shift in comparison to only a few

years back. While wireless connectivity has been possible for a long while, smartphone adoption is now at over 64% of the US population,⁴ assisted by massive increases in wireless data reliability, coverage, and speed.

Smartphones have taken over as the primary Internet connection point for most people, and even most businesses. Whereas connected end-points had for several decades been mainly desktop PCs, the emergence of Wi-Fi brought Laptops into dominance, and smartphones have since taken over. The expectation is that Internet Connected devices (the Internet of Things) will dwarf even the number of smartphones with 50 billion connected objects estimated by 2020.⁵

The combination of cloud computing, mobility, and ubiquitous connectivity is transforming Enterprise IT, and will impact a huge number of other industries. One symptom of this is the unprecedented number of startups emerging to reform almost every industry.⁶

Robotics is undergoing a similar transition, but from a different base. In this case, it's enabled by rapid reductions in the cost of components, innovation in physical artifacts, and all of the shifts in the cost and availability of compute cycles. Some of this has been explored over recent years as "cloud-robotics" for shared learning and offload of compute intensive tasks, and is now seeing practical implementation.

¹ Clayton Christensen, 1997, *The Innovators Dilemma: When New Technologies Cause Great Firms to Fail*, Harvard Business Review Press

² AWS re:Invent 2014 | (SPOT 301) AWS Innovation at Scale, Nov 17, 2014, https://www.youtube.com/watch?v=JlQETrFC_SQ

³ Worldwide SaaS Enterprise Applications 2014-2018 Forecast and 2013 Vendor Shares, Dec 2014, <http://www.idc.com/getdoc.jsp?containerId=252568>

⁴ Chapter One: A Portrait of Smartphone Ownership, April 1, 2015, <http://www.pewinternet.org/2015/04/01/chapter-one-a-portrait-of-smartphone-ownership/>

Imagine...

- Device 27 is two feet tall, and specialized for leather cutting. It's a core component in a production line in ShoesRUs, a small shoe factory in Portland, Oregon. After several months of unimpaired operation, Device 27 identifies early signs of a burn out in its motor three.
- Device 27 is part of a whole of life service offering from FactoryRobotsCo, designed to address all the needs of a small local factory in the new "on demand" world of retail. The factory has no margin for downtime, and needs the service to "just work."
- Device 27 coordinates it's own preemptive replacement and Device 27a arrives by self driving Uber or Amazon drone delivery and slots into Device 27's role while Device 27 returns to base for maintenance.

This is not realistic in the near term, but consider the following elements.

1. In this world, winning players will be those who can offer a complete service
2. Big data and forecasting are used to optimize the service
3. All devices are continually connected back to base
4. The Service company integrates with other service offerings, such as Uber and Amazon, all with the goal of providing a seamless experience

As with today's Software as a Service offerings, this solution can now integrate global best practices. In this case for running local robots. Local installation and maintenance are controlled by FactoryRobotsCo, and the owner of ShoesRUs need not maintain a large technical staff, nor incur large consulting fees.

continued on next page...

Let's consider some parallels between the changes in how we use computers in business with similar changes in robotics.

Enterprise IT (Old)

- Desktop Computers
- Installed applications
- Wired in place
- Specialist team on site

Enterprise IT (Today)

- Many types of end user devices: PC, laptop, tablet, smartphone
- Most applications accessed remotely
- Ubiquitous wireless
- Less need for specialist team

And in the robotics arena:

Robotics (Old)

- In the factory: relatively small number of robot families
- Configured on site
- Fixed positions/tasks
- Specialist team on site
- Wired connectivity

Robotics (Emerging)

- More robotic variants with more behaviors
- Simpler configuration: potentially via web browser
- Adaptable devices
- Most support remote
- Ubiquitous connectivity: back to supplier/service

In the same way that every business is now leveraging SaaS and cloud for IT, every business will be able to leverage SaaS and cloud as part of service robotics solutions. The first steps toward this future are already visible – some have been around for a while, some are emerging today – such as Rolls Royce and Tesla.

Once upon a time, Rolls Royce was famous just for their engines. Now Rolls Royce sells “propulsion” or “power by the hour” not engines.

Rolls Royce claim to have real time connectivity to every one of their engines as they fly around the globe, to collect a huge amount of performance and maintenance data and to ensure that maintenance is driven on an “as needed” basis rather than merely to a schedule. They also charge by the mile.

Tesla is another great example of putting service in the driver’s seat of their business. These cars are sold as a whole of life experience, with a focus on “ongoing delight.” Many argue that the rest of the industry will need to follow.

It’s been a perfect storm for Enterprise IT, and the accumulated capability represents a perfect storm for Robotics. This is a shift of power from local technologists calling the shots in the factory/workplace, to a world where capabilities are much more available: in the cloud, on demand, as a service. ■

Commoditized Endpoints	PC/Mobile	Robot
Universal connectivity	Cell/WiFi	Cell/WiFi
Offload capability	Cheap cloud	Cheap cloud

⁵ Wikipedia: Internet of Things, https://en.wikipedia.org/wiki/Internet_of_Things

⁶ The Economist Explains, Mar 30, 2014, <http://www.economist.com/blogs/economist-explains/2014/03/economist-explains-25>



 Fellow Robots OSHbot

Fellow Robots



Robotics today is a fast growing industry with applications in myriad markets, including retail, transportation, manufacturing, and even as personal assistants.

Fellow Robots is at the forefront of reimagining these uses for the best retail experience – to improve your experience when shopping and to help employees with the most up to date product information and location of goods and services.

Fellow Robots a multidisciplinary young team from different backgrounds, ranging from robotic, software wizards and data scientists to designers and business experts. We have built many platforms including telepresence robots, humanoid robots, sensors, cloud computing and more cutting edge technology platforms. We came out of SU Labs at Singularity University at NASA Research Park in Silicon Valley. SU Labs connects corporate innovation teams with startups and other organizations to explore exponentially accelerating technologies and create new sustainable business solutions. What distinguishes Fellow Robots is the ability to partner and work shoulder to shoulder with customers to learn how robotics can improve their retail needs.

Interview with Marco Mascorro, CEO and Co-Founder, Fellow Robots *edited for clarity*



 Marco

Please introduce yourself.

I'm Marco Mascorro, CEO and co-founder of Fellow Robots. Fellow Robots came out of Singularity University. Singularity University focuses on exponential technologies, with robotics being one of them. We started with a team of very passionate robotics engineers looking into industries that have not changed a great deal. We quickly honed in on the retail industry; specifically offline retail. For all the accomplishments of ecommerce and online retail in recent decades, about 90% of retail purchases still take place in store. This is clearly an industry overdue for a big step into technology, and we saw that robotics could be a great fit there.

We began by meeting with retailers and listening to them discuss the problems they are facing today, and have probably been facing for a long time. One of those early conversations was with Lowe's. That conversation very quickly led us down the path toward a customer service robot.

I think that was a really interesting way to hear our customers, to see what kind of problems they were facing and how robotics technology could fit. Today, we have a partnership with Lowe's to launch OSHbot, which is a customer service robot that helps customers find things in the stores. When the robot is navigating in the store, it knows where all the products are located. When a customer comes into the store they can just talk to the robot, in multiple languages. We can add up to twenty-five languages right now. We have English and Spanish working in the Orchard Supply Hardware store, owned by Lowe's.

When a customer comes in and says, "Hey, I'm looking for nails and paint" then the robot can tell that customer where to find those items. It shows

customers that it understands what is said. It displays on-screen the products that the store has in stock. It has a touch screen so customers can just navigate on the screen and see the pictures of the products and then click on the one that they actually want to see. OSHbot then tells the customer that the product is located in Aisle 15, for example, whether it's in stock and some more information about the item. Customers can click on a button and follow OSHbot to the location of the item in the store.

The robot actually guides customers by its own fully autonomous navigation to the product location. Meanwhile customers are following OSHbot, there's a screen on the back and that's for engagement. It's not very often we see robots talking to humans on a daily basis but I think that we are starting to see that now, and Fellow Robots and our customers are pretty happy about that.

The robot takes you to the product and then it gives you some extra options. If someone is buying paint, then it's pretty common that they will also buy a brush. OSHbot can provide that information, and take the customer to the brushes as well. It's a really interesting experience that the customer has now. It's a whole new experience. Customers are going to stores and getting really accurate information about products, about what is in stock and where to find it.

If customers don't want to follow the robot, OSHbot can just show them the product location

on the map. The customer can decide to go on their own. One of the most interesting things we've seen so far is how quickly the adoption of new technologies is happening right now. Of course when we launched the robot in November last year, there was a "wow" factor. "But today if you go into the store it's become so common, there's no more "wow." And we're exactly seeing that path with OSHbot, as we saw with the smartphone industry.

So far you've described really successful interactions with OSHbot? Have there been difficulties?

There were a lot of unknowns when we first launched OSHbot, because hardly anyone has done this before. This is a customer service robot that's actually working in the front of the store, helping customers and guiding them to specific locations. It's very complicated to know how a robot is going to interact with people in stores, and how people and workers will respond to that robot.

In the first month of deployment, we had someone right next to the robot collecting feedback, seeing how people interacted with the robot and where we could improve. That person was there taking notes on how customers were acting around and interaction with OSHbot.

Our primary realization was that customers interact with the robot almost exactly the same way that they interact with humans. The questions asked of OSHbot were questions they would ask a person. "Hi OSHbot!" or "Good morning! I'm looking for this product for my daughter..."

What's complicated is that people ask questions in very different ways. So if someone says "Hi OSHbot, I'm looking for a quarter inch screw for my door." The robot needs to be intelligent enough to know what product they are looking for: Is it the door? Is it the screw? So speech

recognition was one of the things we needed to improve on, and we have. To make the interaction with the customer as smooth as possible we focus a great deal on natural language processing,

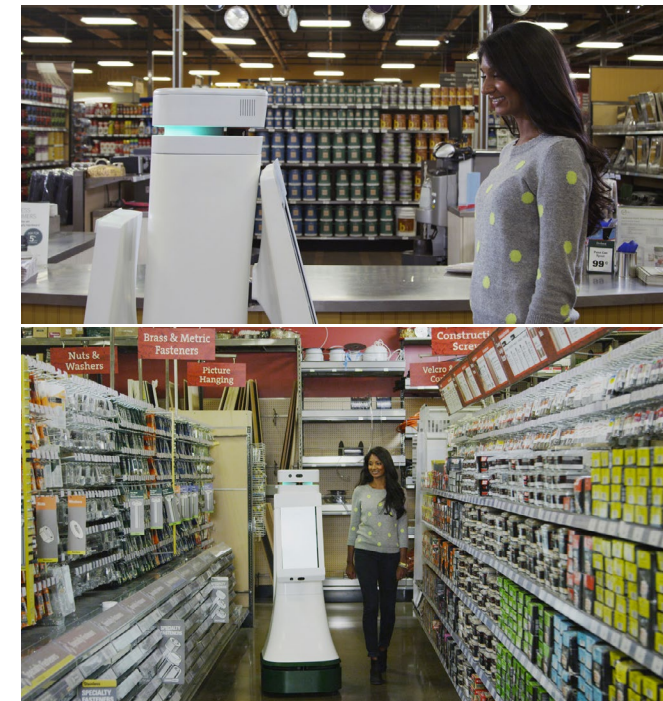
Another priority is our focus on the customer interface. When you open an app, for example, you need to understand what the app does and how naturally to proceed to the next step. We have a very similar challenge with the robot UI. That's why we have people on the Fellow Robots team whose sole focus is on the screen interface and these interactions. How many clicks? Are they clear? Are they sufficient? Too many?

We have come to realize that what's best is a combination of speech and screen interface. When the screen shows off the product, the robot tells you at the same time, "Here are the products available, click on the one you're looking for." People know what to do, and when they click on the product, they can choose to get taken there. So you provide a full interaction with the customer, where there is some speech and some visual interaction. Those were the big lessons learned from the first month of working with OSHbot in the store.



OSHbot displays advertisements and deals based on location in the store

Customer interaction with OSHbot



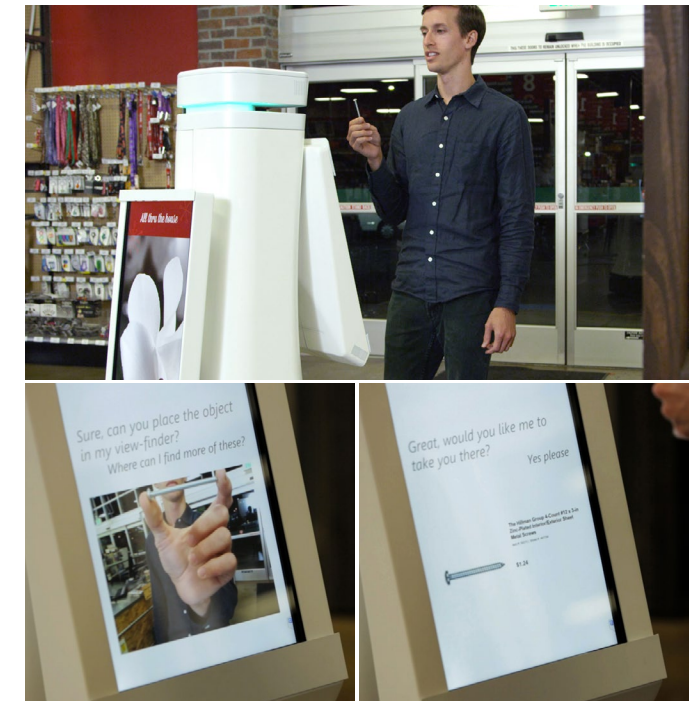
Will you be adding a product scanner to the OSHbot experience?

We have some of the things working along these lines but haven't deployed them in the store just yet. One of the reasons is that there are a lot of factors not under our control. For example, we need to have a full 3D database of the products to be able to match those scans. That's one of the reasons we decided to wait a little bit to deploy that functionality.

Probably about 20 or 30% of people that come to hardware stores have an object with them that they'd like to buy or that they have a question about. When a customer has a very specific question that the robot can't answer, like "My pipe broke. What should I use to fix it?" or "What glue should I use?" we have a store representative available at any time for that customer.

We added a small button on the screen that says "Talk to an expert." If a customer has a complicated question then the robot will tell you to click on that button and it connects you remotely to a store associate. That store

OSHbot locates objects in-store



associate can be located somewhere else, just as in a normal telepresence video conference call. That person can also be an expert in plumbing, in electricity, or any other field. This way the customer gets the ideal mix of automation and high touch service that retailers typically struggle with. That's actually what's happening right now.

So customers can have a mixed physical and virtual shopping experience?

Exactly. They could be talking to someone who's an expert in paint, or electricity, or design, depending on what they need. This enables a really interesting way of interacting with store associates that's very valuable.

What is the staff response to OSHbot?

It's been really positive so far. I think one of the most interesting things we've seen is how fast OSHbot's colleagues got used to working alongside a robot. I think we're lucky that everyone had a very positive response. People like it, people use it.

How many OSHbots are in stores so far?

We currently have two robots located at the OSH in San Jose, CA.

What is involved logistically in rolling out the robots? Are you getting close to rolling out more OSHbots?

We need to integrate the robots with the product database, but one of the nice things is that the robots have everything built in, so we don't need to add any major additional infrastructure or sensors in the store to make the robot operate and navigate.

We are in conversations with customers about rolling out robots elsewhere.

How does OSHbot map the store and identify product locations?

Without going into too much detail, we can say that mapping is one of the robot's core functionalities. The robot knows precisely where it is located at all times. We integrate that with the planogram, so this way OSHbot knows exactly where these objects are located on the shelves.

What other retail experiences would OSHbot apply to?

At the moment, our primary focus is in-store retail, but what's key here is the level of premium customer service that the robot can provide. A robot can maintain accurate information of about 100,000 different products or more.

I think this capability can apply to different industries that also require customer service. When we talk to retailers, customer service is one of the biggest challenges, and one of the biggest opportunities. Therefore customer service functionality in the robot is vital, as is the speech recognition and the human interaction—to make it as natural as possible to provide a really nice experience.

So in the future you see robots greeting people when they walk into bricks and mortar shops?

That's the plan. The idea is to rethink how retail is done in terms of customer service and the experience you actually have when you go and purchase items in a store. You normally come with the idea that you're going to buy a product, but you often ending up buying more. We want to help businesses make the process as smooth as possible, so that their customers find everything they need, everything they're looking for, and have a great experience. That scenario is a win/win for both the retailer and the customer.

That's a clear value proposition for the front of store. Does it extend into the back of store - doing inventory etc.?

There's lots of potential there. For example, when the robot navigates the store it creates a map in order to know where products are located. But if a store associate moves products from one location to another, it's challenging to inform everyone in the store. The robot can then can provide that information to the store associates.

So OSHbot will be providing customer service to the associates too?

Yes, right now we're talking about how we can make this experience even richer for employees.



We feel that we're at the very beginning of a trend where robots are gaining traction with industries that haven't traditionally looked to robotics.

Do you have anything to add? What makes a robotics company like Fellow Robots possible now that wasn't possible five years ago?

This is a really interesting time in robotics because so many forces are coming together. The price of sensors is coming down, because the need is growing. The price of computing is also dropping. The price of software development is much less expensive than in the past.

We're also getting more powerful technologies at the same time that can be combined with robotics, such as natural language processing. That's a technology that has been around for years and years but is getting better and better. Many other industries are benefiting from this, not just the mobile and smart phone industry, and robotics is clearly benefiting.

So all these advances are merging now into robotics and the timing is perfect. All these robotic platforms are coming out of the labs and really going to market.

We are also learning a great deal about the customers as they arrive at OSH. For example, OSH now knows the most common questions that customers ask, so they can factor that information into their store planning. OSHbot already offers service in English and Spanish, but as we grow to include more languages stores will be able to better understand the languages spoken by their customers. All of this information has previously been unavailable.

Do you have any advice for a robotics startup, coming out of the lab and trying to turn into a business?

Everything works fine in the lab, but when you put it out in the real world, interacting with people in a real space in a busy environment, then it's a very different story. You need to be prepared for the unknown and be in a position to quickly adjust. In most cases we need to go back to the lab to figure out what is happening, why the robot is not working as well as it did in the confines of our lab.

One of the amazing things our customers allowed us to do was come and test in their facilities and see how the robot behaved. We learned a lot from that. It's a different environment, it's a totally different interaction and that really helped a lot for us—testing in the real world. ■

Konica Minolta BIC @km_bic

Konica Minolta's Business Innovation Centers (BIC) are established in five major regions around the world as a core engine of business transformation. The BIC mission is to gain a deeper understanding of customers' needs and deliver the greatest value to the world. BIC North America fosters a portfolio of solutions in the areas of robotics, healthcare, connected intelligent ecosystems, workplace and enterprise solutions. BIC manages the entire lifecycle of new business development from ideation to creation of actual business lines.

The Value of Bringing on Strategics in Robotics: Hardware May be Hard, But Strategic Investing Can Make it Smart

by Ekta Sahasi, Vice President at Konica Minolta Business Innovation Center and Greg Lok, Business Strategy Lead at Konica Minolta Business Innovation Center

After years of flying under the venture capital (VC) radar, the robotic industry is finally starting to see a remarkable growth in funding traction. In 2014, VC investments in robotics rose 36% to \$341.3 million up from \$250.7 million in 2013, according to Travis Deyle's annual robotics review.¹ The spike in 2014 investments follows what Deyle believes was a "frothy" funding environment, influx of drone startups, and later-stage medical robots. As a whole, the robotic industry continues to be dominated by industrial and manufacturing products. While this will continue to be the most prominent application, BCG predicts the fastest growing segment in robotics will be those designed for "personal" uses like education, cleaning, and entertainment.²

Although robotic VC funding is growing annually, these investments must be viewed in greater context. The increase in robotic

funding follows the general venture trend of increasing investments in hardware startups, which have increased more than 30x from 2010-2014 (See Figure 1, Hardware Startups by Year).³

For hardware, theories on the increase in investments include strong hardware exits and the rise of crowd-funding platforms, such as Kickstarter and Indiegogo, which lead to the \$2.3 million backing of Jibo.⁴ While few robotics companies reach this level of crowd-funding success, successful campaigns appear to have a positive correlation to increased funding.⁵ Additional investments from the corporate sphere and their associated high-publicity announcements have also served to increase awareness among general public, investors, and entrepreneurs that robotics is a growing and worthwhile industry.⁶

Hardware Startup Investment By Year

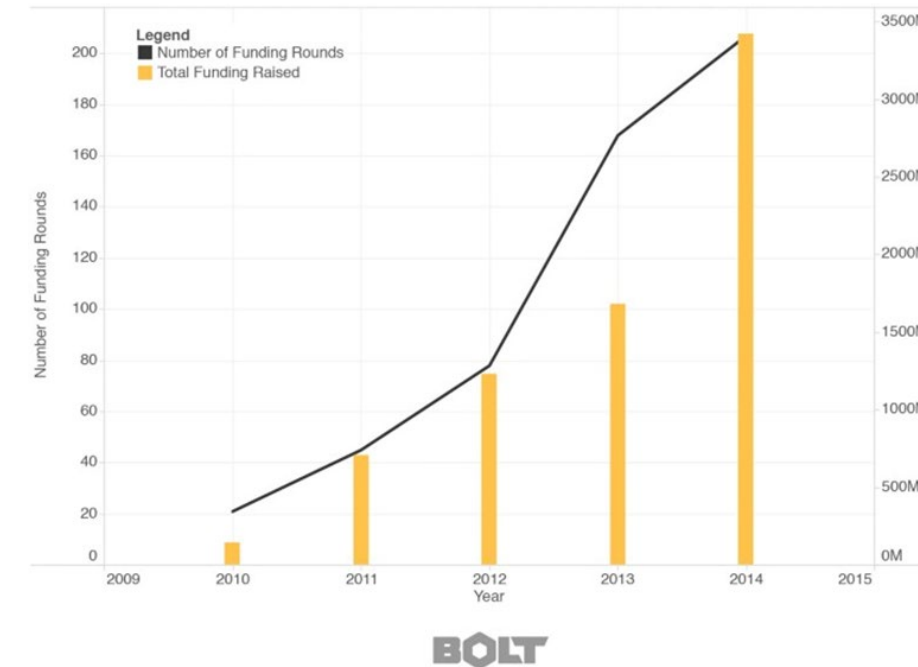


Figure 1. Quintero, C. (2015, September 14). Who Invests in Hardware Startups?

Consumer Hardware Startup Exits (2013-2015)

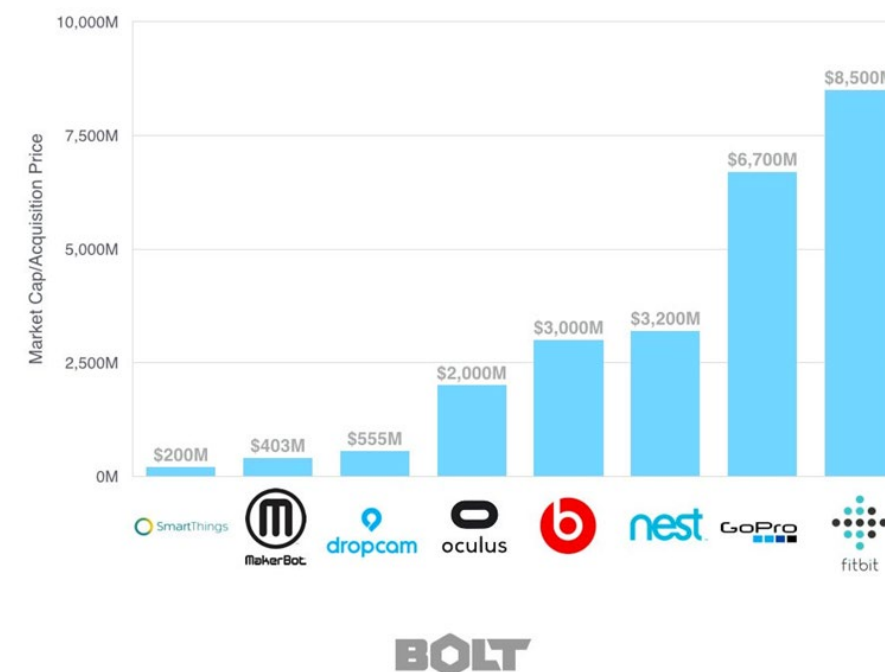


Figure 2. Quintero, C. (2015, September 14). Who Invests in Hardware Startups?

While both hardware and robotic investments are growing each year, they still lag behind the percent of investments in less-risky segments of internet-specific (25% in 2014) and software companies (41% in 2014) according to PwC 2014 venture capital data.⁷ In stark contrast to these high percentages, only .07% of the \$48.3 billion VC funding went to robotics. Comparing the hardware-based robotic companies to those in software and internet-services, the investments in the latter are less risky and have the ability to grow and scale quickly with less upfront investment. Although some investors are willing to take risks and bet on the future of robotics, the funding of millions of dollars pales in comparison to the billions being poured into other sectors.⁸

With less than 1% of VC going into the robotics industry, it begs the question: Why are venture capitalists skittish when it comes to robots? It boils down to perceived risk. William Santana Li, CEO of Knightscope, observes that most VCs believe

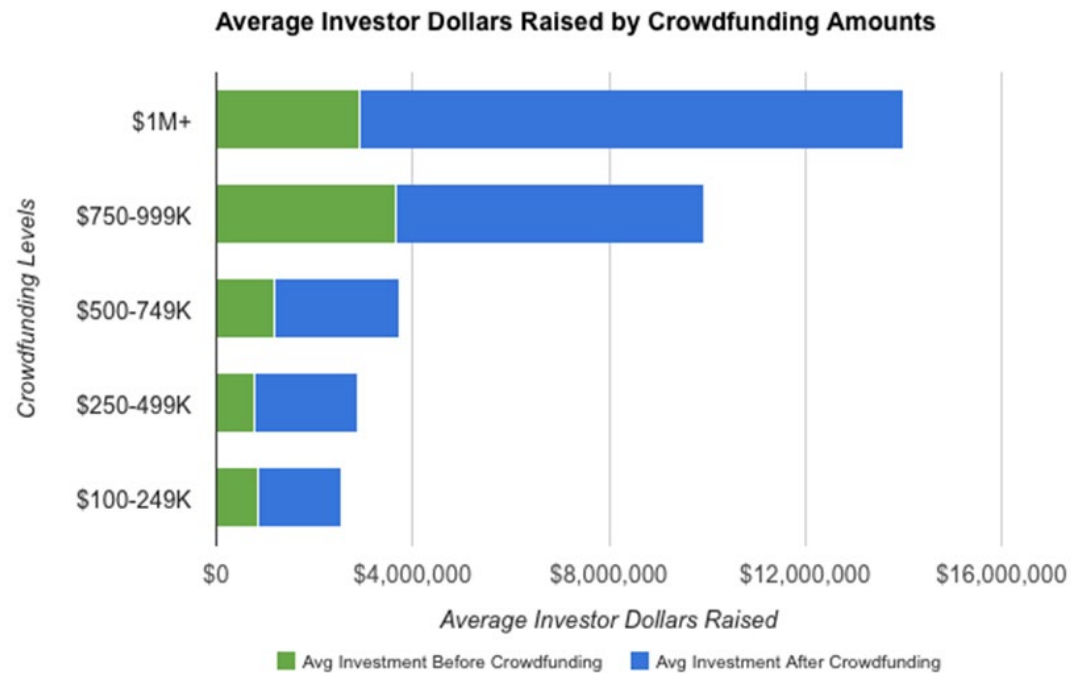


Figure 3. Witheiler, M. (2014, December 14). Raising More Than \$750K In Hardware Crowdfunding. Retrieved November 2, 2015.

“Hardware is too hard.” It requires expensive investments that appear risky when you consider that many emerging startups run on the fuel of hungry, yet relatively inexperienced entrepreneurs. And those who do have experience are unlikely to have developed the expertise needed to build a sustainable and scalable manufacturing operation.

For entrepreneurs and visionaries who see the possibilities of robotics, the constant struggle to receive funding can discourage the development of disruptive robotic solutions. Ironically, the challenge of receiving VC backing can encourage the best and brightest to shy away from the funding struggle: Peter Thiel observes, “We wanted flying cars, instead we got 140 characters.” The perseverant founder William Santana continues to motivate entrepreneurs, “Tune out the naysayers who will just keep talking because building something is “too hard.” Ignore the noise, focus on your mission and

deliver results.”

While hardware may be hard, there is a way to play it smart. The value of strategic investors and partners should not be underestimated. In what many consider to be an overly risky environment, strategics can provide the expertise needed to help accelerate robotics companies. Strategics with strong legacies in hardware bring operations infrastructure, knowledge, and foresight to help emerging startups commercialize. Furthermore, these strategics can de-risk the most challenging components of starting a hardware company, including the servicing, deployment, design for servicing, maintenance, manufacturing, and distribution. With Konica Minolta Business Innovation Center (BIC) as a strategic partner, Steve Cousins, CEO of Savioke, notes that they “gain a strong services infrastructure, capabilities, global reach, and scale.” Having a strong strategic investor or partner allows the Savioke team to focus on putting more



Robotic Investments & The Value of Strategics



Total VC2014
\$48.3billion

Robotic VC2014
\$341.3million

only 0.7% of 2014 VC investments were in robotic startups

Why Are VCs Shy Around Robotics? Because Hardware is “Hard”* ... But Strategics Can Help

Strategic Partners and Investors can provide expertise in:



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Deployment



Maintenance



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Relay robots into the world without having to worry about scaling to support their growing customer base.

Like any true partnership, the benefits flow both ways. Corporate strategics understand the necessity of staying innovative in today's competitive market. At the Konica Minolta Business Innovation Center, "We are transforming Konica Minolta's core business by focusing on industries that provide our customers the tools they need to stay ahead of the curve" says Ekta Sahasi, VP Konica Minolta BIC. The desire to access these disruptive industries like robotics, offers a strong incentive to ensure the investment companies become best in class. Unlike some venture capitalist firms, corporate strategics are investing in products that align with *both* the strategy of their business *and* are poised to produce financial returns. By aligning the success of the emerging companies with the strategy of the business, corporate strategics are especially invested in the success of the emerging company.

There are many ways to connect with strategic investors. At Konica Minolta Business Innovation Center, we partner with emerging startups through investments, partnerships, co-development, and mentorships. We have invested in Knightscope, an autonomous crime-detecting robot that aims to reduce

crime by empowering the community with data and security. Through our partnership with Savioke, an autonomous robot for the services industry, we have installed robots in hotels and created a service model to help scale. We also co-develop with our robotic industry companies to integrate complementary technology from our platform. For instance, we are working to have Sigsense, a maintenance-detecting software, to integrate their product into robots in order to predict maintenance needs. Finally, we have worked with accelerators such as Plug and Play to identify and mentor the emerging robotic startups.

Konica Minolta is supporting the development of the robotic solutions that will transform the future. If you are an entrepreneur, investor, accelerator, or enthusiast, say hello and join our journey! ■

¹ Venture Capital (VC) Funding for Robotics in 2014 | Hizook. (n.d.). Retrieved November 2, 2015.

² Deyle, T. (2015, January 20). Venture Capital (VC) Funding for Robotics in 2014 | Hizook. Retrieved November 2, 2015.

³ Quintero, C. (2015, September 14). Who Invests in Hardware Startups? - Bolt Blog. Retrieved November 2, 2015.

⁴ Crowe, S. (2015, February 13). 10 Most Funded Kickstarter Robots Ever - Robotics Trends. Retrieved November 2, 2015.

⁵ Witheiler, M. (2014, December 14). Raising More Than \$750K In Hardware Crowdfunding. Retrieved November 2, 2015.

⁶ Keay, A., & Komissarova, V. (2014, February 26). Valery Komissarova on when investing in robots is the right move. Retrieved November 2, 2015.

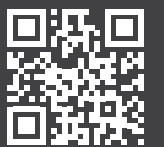
⁷ Kokalitcheva, K. (2015, January 17). VCs invested \$48.3B in 2014, highest level since 2000. Retrieved November 2, 2015.

⁸ Quintero, C. (2015, September 14). Who Invests in Hardware Startups? - Bolt Blog. Retrieved November 2, 2015.

Lynx mobile robot platform can be adapted for many applications.



Adept Technology, Inc.

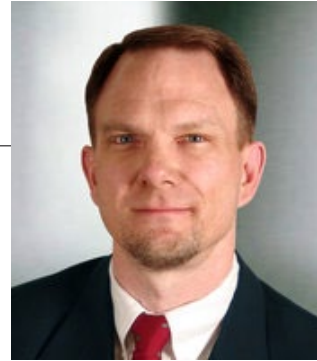


Adept Technology, Inc. (NASDAQ: ADEP) is a global provider of intelligent vision-guided robotics systems, autonomous mobile robot solutions and services. Founded in 1983 and headquartered in Pleasanton, California, Adept is the largest U.S.-based manufacturer of industrial robots. On October 23, 2015, Adept was acquired by and became a wholly owned subsidiary of OMRON Corporation, a global automation manufacturer of sensing and control technology based in Japan. Product lines include SCARA, parallel, and six-axis robots; linear modules; mobile robots; machine controllers for robotics and other flexible automation equipment; machine vision; and software. The company's core markets include manufacturing, warehouse/logistics, electronics, semiconductor and food.

Adept distributes and supports its products worldwide both directly and through channel partners. Around the globe, more than 68,000 robotic systems are installed with either Adept robots or robot controllers.

In 2010, Adept acquired MobileRobots, Inc., a strategic move positioning the multinational to explore commercial and industrial applications for the burgeoning mobile robots market. The flagship of its mobile robots product line is the Lynx® Autonomous Intelligent Vehicle (AIV) ([video](#)), which serves as the mobile platform for various payload solutions incorporating robotic manipulators, shelving systems, cart transportation and channel partners' human machine interface technologies. The majority of Adept's customer base for its mobile robots is in the industrial sector, including manufacturing, warehousing and logistics, and semiconductor fabs. Emerging and still evolving markets in the service robotics sector include hospitality and healthcare.

Interview with Michael Oitzman, Sr. Product Line Manager, Mobile Robots *edited for clarity*



Michael Oitzman

What are the current markets and types of applications for Adept mobile robots in the service robotics sector?

Service robotics is a small, emerging part of our main target markets (manufacturing, warehouse/logistics and semiconductor). We have begun to explore this market space through several partners that have deep market knowledge and established customer relationships. We are finding that the Lynx platform is flexible enough to address many growth opportunities in this space.

Hospitality

I want to start with Techmetics because it's been an interesting relationship. We built and designed the Lynx to be an OEM platform for customers and partners to white label our solution, to take our technology and build onto that base with an application payload on top of it. That's exactly what Techmetics has done.

Techmetics' forte is in point-of-sale systems. That's the technology that they've had for many years; these are systems for ordering and paying for food. The natural extension for them is robotic delivery. This fall they're going to start installing multiple robots into their customer base to be robotic waiters (called Techi, as seen in this [video](#)). That will be the first application that they deploy. I think it's a very interesting opportunity because the Lynx technology fits so well into that space because of its unique ability to navigate safely and reliably through very dynamic environments.

So we're excited about that, and then the same thing with their robotic butler in hotels ([video](#)). There's a lot of opportunity in Southeast Asia, especially in Singapore, which is where they are launching. Reduction of labor costs is a large focus in Singapore. The Singapore government

has provided some funding to get them started in this application. Employers can replace the manpower of three servers with the Techi robot and have an ROI of less than a year.

With Techmetics, they have a couple of interesting applications that they are bringing to market and we're going to see them grow over this coming year. We're very excited about supporting them going forward.

Healthcare

We've also developed the Lynx Courier AIV, which is a vehicle that we sell completely configured. It's available in either an enclosed or open configuration. The vehicle includes sliding shelves for holding the cargo. We designed that vehicle for hospitals, for carrying lab samples or for moving materials from the pharmacy out to the wards. That was an evolution with our friends at Swisslog. We're continuing to work on the next generation of vehicles deploying to hospitals. Regionally, we're also working with new partners such as the Lamson Group in Australia to go after healthcare applications in those markets ([video](#)).

An Adept press release referred to the first commercial use of its mobile robots as far back as 2010. Was that this partnership with Swisslog?

Yes, that was the prior generation. Before the Lynx, we had the MT-400. When we acquired MobileRobots, the MT-400 was the first generation Industrial Mobile Robot. Then we

created a couple of application payloads on top of that vehicle, one of which is the Courier generation. That's what Swisslog incorporated into their OEM product (RoboCourier®, as seen in this [video](#)).

Then two years ago when we released the Lynx, it was an entirely new design optimized for high reliability and flexibility. The software also evolved during those years. From this newer generation of the OEM platform we created the Lynx [Handler SEMI](#), which is the semiconductor-specific vehicle. The Lynx Handler incorporates a collaborative SCARA robot on top of the Lynx mobile base. Our largest installed base right now is into the semiconductor industry. That's where we matured the fleet management solution (Adept's software tool for managing multiple robots is called Enterprise Manager).

Outside of manufacturing and logistics, those are the service applications that we have in terms of what I can talk to you about now.

How did these markets evolve or how did Adept choose these service market areas for concentration?

Our focus has been primarily on our three target markets as I mentioned. We wanted to get the operation and reliability in terms of the core navigation, safety, mapping and programming technology to meet the demands of these markets. Our partners in the service industry saw the performance of our Lynx product and realized that it was a great platform for their application space. They quickly adopted the technology and began to share the new capabilities with their customers.

Do these partners come to you or is it the other way around?

It's a bit of both. We look strategically for the right opportunities and then we have partners that have



Techi is a new service robot configured to serve food in restaurants.

What is a typical day like for the robot working in a hospital?

The hospital Couriers operate throughout the day, making deliveries as needed. When the robots aren't driving, they'll sit and charge to make sure that they are ready to go. That's a pretty straightforward application for the Enterprise Manager, where there's more than one vehicle operating and they're running routes to a variety of pick-up and drop-off points.

come to us because they love our platform and don't want to re-engineer everything. For those partners, like Techmetics, our advantage is what can be put on top of our solid platform.

How does the robot learn the routes and understand the layout of the hospital?

This is part of the core technology. Our mapping technology is done using the vehicle, so you just have to walk the robot around the facility once. You simply show the robot every place it could potentially drive, and we use the drive navigation laser to do the mapping. Then we generate an accurate facility map, which will be used by all of the robots for path planning and navigation.

Here's the interesting part about the Lynx Enterprise Manager solution – all the robots in the fleet share the same map, so when you edit the map for any reason all of the Lynx units are automatically updated with the new information. They're all on Wi-Fi. That's how the robots communicate with the Enterprise Manager.

Then on the map you designate the areas that are forbidden, where you don't want the robot to drive. If you never want the robot to drive down a certain hallway, you put a forbidden zone there and the robot will never enter that spot. Or you can assign one-way aisles, so the robot will always drive in one direction in this aisle. Or you can designate two-way directional sections where the robot will hug the right or the left side of the aisle, or follow any preferred traffic pattern.

Who usually does that programming or tweaking?

The Lynx software interface is designed to be very intuitive and is easy for the end user to configure. Typically one or two end users attend a short training course.

Once you set up the map, the robots are then on their own to decide how they get from point A to point B based on the map features. So the robot will path plan through the facility and then if an obstacle appears in the path of the robot, for example, a door is shut or there's a gurney parked in the way, or if there's a bunch of boxes or a

ladder, or anything that's temporary that it might encounter, the robot will see that with its drive laser and will path plan an alternative route around the facility based on the definition of all the map features.

Enterprise Manager is required anytime you have two or more mobile robots operating in the same workspace. With Enterprise Manager in place, when both of those vehicles need to cross each other's path, it will inform the other robot that there is a robot ahead and it's going to go to its right, so you need to go to your right and drive around it. It will have a much faster and cleaner path planning without having to stop temporarily. And at intersections Enterprise Manager will give one robot the right of way. That sort of algorithmic decision making is built into Enterprise Manager to help the fleet be more efficient.

What other types of onboard technology support the robot's performance?

One thing about our platform, because our primary markets are in industrial and warehousing, everything on our system is hardened for that environment. We're perfectly comfortable taking it out of the warehouse and putting it into another environment with humans, where maybe the regulations aren't as developed as they are in the warehouse or on the manufacturing floor. There's no one else on the market today that's using that level of technology in service robotics.

Lynx is a collaborative robot, interacting safely alongside people. We've designed the system with all the safety sensors and control architecture that make the system collaborative.

Then you have a sonar package on the front and the back of the robot for looking at things that might appear in its path. We have the option to include vertical lasers as well. That means we can put a vertical light curtain around the sides of the payload. The worst obstacle for a mobile robot



The Lynx Enterprise Manager fleet management software coordinates multiple robots' jobs.

would be a table where it only sees the legs and thinks it could navigate between those legs. Yet potentially you could have the payload located at the tabletop level. In that case, the vertical lasers would be able to spot that tabletop.

We have a very unique solution in something we call Acuity. Acuity is the option we developed because LIDAR (Light Detection and Ranging, or laser radar) by itself is not capable of operating successfully in a complex, dynamic environment. Any mobile robot using LIDAR and SLAM (Simultaneous Localization and Mapping) can get lost if the route is too different from the reference map that it's using to navigate. With Acuity we use an upward-facing camera placed on top of the vehicle for a 120-degree view. The vehicle looks up at the lights in the ceiling and uses those lights to triangulate its position. As it drives, it keeps looking for the next set of lights to come into view and it uses that to keep it localized in the world.

The vehicle itself has digital I/O and analog I/O so we're able to control active elements on the payload. We also provide electrical power at various regulated voltages supplied from

the robot's battery. That's actually how we power the robots that are running on top of our semiconductor applications. In addition to the robots, in the payload section, people are putting PLCs there. Tech (the hospitality robot) has the little tablet with its eyes, and that tablet communicates with the robot core to anticipate where it's driving.

What kind of feedback have you received from customers/end users?

The units we have deployed are all performing very well. It is interesting to see our customers give the robots individual names and almost treat them as fellow employees! The advanced navigation capability really allows these robots to operate autonomously without any interaction or support. If we go back to the warehousing and manufacturing, we have some very happy customers that are just thrilled with the technology and what it's been able to do. I think our newest service industry customers will see that same sort of value.

How do these robots provide value in each application? Typical return on investment?

We're trying to design a solution that can give customers an ROI in a year. Tech is replacing waiters. They're reducing the staff and then all the overhead costs of hiring and training that labor. Singapore is also a high-tech market. They're used to having high-tech gadgets, so I think there's a bit of novelty to it as well.

In the hospital environment, it's about making people more productive so they can focus on more value-added tasks. There are also intangibles about predictability and traceability. Things are sent from one point to another and it is guaranteed that they are going to arrive intact and on time.

How significant of a role does Adept's experience in the industrial sector play in the service sector and what have you learned from the industrial sector that you can apply to the service area?

The semiconductor market is extremely demanding, because time is money in a fab. Those robots run 24 hours a day, 7 days a week. They don't even have time to charge the batteries on the robots. They swamp out the batteries between shifts. So from a systems stress standpoint, the fabs have been a true test of industrial reliability and have resulted in a robust product platform. Every other customer that's come afterwards is now gaining the advantage of having worked through those situations in the fabs. We've learned a lot from those robots being deployed, so we've improved the reliability of the robots.

I think that's a key buying criteria for those partners because they know that we design and build robust solutions. We have solutions that are designed and engineered to function in the industrial world and we're bringing them into the consumer space where, if we have a partner

What are the main differences or new challenges you're encountering in the service area?

The Lynx software for me is the enabler for service industry applications. The software will likely require specific capabilities that will need to evolve to get better across all these markets.

Does Adept's reputation precede it or do you sometimes feel like a startup?

We have the advantage of taking the relatively new technology of mobile robots and leveraging our deep knowledge and experience of fixed industrial robotics and automation. We are trying to innovate at a very fast pace to address market demand. We're growing the technology quickly and are working to be more nimble in terms of how we can design and evolve the market. I think Tech is a great example. That opportunity came to us and we said what can we do to help these guys with their vision. Here's a partner that has all of the rest of the pieces put together, so it was the perfect partnership for us. Now they will take it to market in Southeast Asia and beyond.

Looking forward, what are you envisioning for Adept mobile robots?

I think it's pretty intuitive if you look at our existing product line of fixed robots and the mobile robots. When I look at the next generation of mobile robots and the convergence of putting mobile manipulators on top of the vehicle, which is where everyone is looking to go, I think we're a uniquely qualified organization because we have both assets in our portfolio, fixed robots and mobile robots. It's a natural extension of our key core capabilities and a great place for us to drive towards. ■

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Survey of Robotics in Silicon Valley 2014

Robotics is no longer a secret and the investments keep coming. Silicon Valley Robotics has just released its annual snapshot on the state of robotics in Silicon Valley. The report is a combination of qualitative interviews with the CEOs, founders or directors of 30 robotics technology companies and analysis of publicly available funding data for a broad range of robotics companies, both in Silicon Valley and beyond.

[PURCHASE 2014 ROBOTICS SURVEY](#)

As well as networking events, **COMPANY membership includes directory listings, job fairs, investor forums and demo days.** **COMPANIES** can be either a local robotics technology company eligible for **FULL SVR MEMBERSHIP** or an affiliated company eligible for **GLOBAL PARTNERSHIP**. (Level depends on size/type of company.)

Are you a locally based robotics technology company? Do you have an office in California? Do you conduct business in the Bay Area? You are eligible to be an **SVR MEMBER**, which allows you to nominate directors for Silicon Valley Robotics board.

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