

INVESTOR VIEWPOINT

ROBOTS AS A SERVICE

IN BRIEF

Companies and investors embracing a “RaaS” model – robots as a service – will define the coming era of industrial and commercial applications.

COMPANIES TO WATCH

- RedZone Robotics
- Liquid Robotics
- Intuitive Surgical
- ROS Industrial
- Willow Garage
- iRobot Corporation
- Cognex Corporation

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RAAS RISING

By Nathaniel B. Chase, John Abrashkin, Kiel Davis, Rachel Eschle



THE ROBOTS ARE COMING

If there is a central fault of most Robotics industry observations, it is a failure to see the people within the machine. Media and politicians are obsessed with the idea of a “jobless recovery” fueled by automated dustbins replacing the factory worker. Many industry insiders often make a similar, if less obvious, mistake: obsessing over the latest gadgetry. **Our view of the industry is simple (if a bit counter-trend): robots are merely manifestations of the people who build and control them.** Strangely, this seems to be a secret in so far as it is not talked about, and seldom acknowledged openly.

The secret that “robots are people” is important if you are invested in the industry. In the next decade years, a new wave of robotics companies will be coming to market across a broad range of industries. Service robots are expected to grow from ~\$4B to \$10B from 2012 through 2015 or ~35% CAGR (World Robotics Annual Report, 2012). Whether you are investing money, time, or attention to this trend, picking your winners will be important.

So who will win? **We think companies mastering the *Robot-as-a-Service*, or *RaaS*, business model are the likely champions.** Instead of selling hardware, *RaaS* firms “own their fleet” and provide customers a recurring service that is significantly more responsive than long-cycle and capital-intensive purchases. Customers see their costs reduced and needs more tightly addressed while *RaaS* firms benefit from value-based pricing and a faster innovation cycle (rewarding the smart ones and culling the indolent). Already, some emerging robotics firms are using these approaches with early success.

This paper presents our view of *RaaS*, preceded by a discussion of contextual demand and technological trends.

PRODUCTIVITY: DEMAND AND RESPONSE

The companies in the next wave of robotics will be most noticeable in industries traditionally considered to be “niche.” In 2012, nearly 90% of all industry revenue was generated from the Industrial segment, much of which was automotive (~65% of North American business). However, most industry figures point to a doubling of the Service robot contribution, providing \$6B of the \$10B in overall industry growth in the three years through 2015. Our analysis is as follows:

INDUSTRY GROWTH (2012 - 2015)

Market Component	Sales (\$B USD)		Growth	Market Share	
	2012	2015	2013-2015 CAGR	2012	2015
Industrial Unit Sales	\$ 8.7	\$ 10	5%	28%	24%
Industrial Services, Peripherals	\$ 18.5	\$ 21	5%	59%	52%
Industrial Robot Total	\$ 27	\$ 31	5%	87%	76%
Service Robot Total	\$ 4	\$ 10	34%	13%	24%
Total Industry	\$ 31	\$ 41	10%	100%	100%

Source: Maker Capital LLC, World Robotics 2012 Annual Report

This outsized growth in service robots is supported by macro-economic trends favoring productivity solutions that avoid capital expenditure. Private sector profitability appears to have peaked in early 2012 and is now increasingly under pressure (S&P 500, CIQ Data) – we expect to see more large firms looking around for efficiency solutions. At the same time, capital expenditures are at all-time lows, fed by increasing macro uncertainty (see [UBS report, January 2013](#)). Government spending is tight at both the federal and municipal level. Tax hikes and sequestration compromises will only make things worse. If you sell to large enterprises or the public-sector, this all boils down to a simple mandate: *give customers productivity and pay-as-you-go*.

Below, we profile a few trailblazing firms in Infrastructure, Logistics, and Healthcare (all relatively “light” on robotics) as well as the familiar sectors of Manufacturing and Security. Certainly, not all these firms are fully “*RaaS-ified*,” but we see that as the inevitable direction.

Infrastructure

The problem in Infrastructure is old assets. Roads, bridges, tunnels, tracks are generally a government problem – whether directly or indirectly. With an austere capital budget, the old and aging assets are not being replaced. When things break, as they did in the catastrophic failure of the I-35W Mississippi River Bridge

in 2007, or the 2013 I-5 bridge over the Skagit River in Washington state, politicians get a nasty reminder of why you need to fix things. But studies indicate this rarely results in preventive spending, even in the face of 7x to 15x returns on the invested dollar (Healy, Malhortra, August 2009). Estimates indicate there might be \$3.6 trillion in additional funding needed between 2013-2020 to replace or repair failing infrastructure.



Year Founded	1987
Revenue (est.)	\$15 million
Location	Pittsburgh, PA
Website	www.redzone.com
Watch For...	Potential leader in longitudinal data and monitoring services for “just in time” repair/replace
...Smarter Infrastructure Management	

Pipeline inspection products and services for municipalities, contractors, and engineering firms.

Focus on wastewater infrastructure too difficult, dangerous, expensive access by traditional means otherwise.

If scheduled replacement is not always an option, a cheaper just-in-time monitoring and maintenance approach is the next best thing. *RedZone Robotics* is one company executing on this insight. *RedZone* provides sewer-bots that make their way through municipal pipes and identify potential leaks. If they find any anomalies or impending faults, repair crews can fix the problem before it disrupts service – or worse. With the Congressional Budget Office estimating that the U.S. needs to spend between \$13-21B annually on wastewater infrastructure needs in the coming years, municipal infrastructure managers must allocate tight budgets based on the best data available.

Logistics

In the world of moving things, the lack of automation in certain areas of the supply chain is low-hanging fruit. Truck loading, for example, is automated in only ~1% of applications according to *Ancra Systems*, a seller of automation solutions. As shipping expenditures continue to rise automation will offer capacity and speed.

Industrial Perception Inc. (IPI) is a company that sees the challenge of truck loading. Specifically, IPI is developing an optimized unloading solution for back of truck applications. The team, stacked with robot perception and navigation veterans and spun out of [Willow Garage](#), is keen on the fact that most large logistics firms still “pack with people.”

Healthcare

Healthcare has always been a people-intensive field. But with per capita US healthcare costs ~50% higher than

the second highest country (Norway), and increasing public exposure to this cost via expanded government coverage, the need for greater cost efficiency is obvious. *Aethon* is a company working to reduce system costs. The firm provides a platform featuring the TUG, a cart-puller bot, along with an inventory tracking software and implementation services. Best of all, the system is interoperable with old assets – no tracks, wires, or special elevators are required. As the company's early success demonstrates, reducing implementation costs helps significantly (and is increasingly expected).

Industrial and Security

Manufacturing and Security have been the traditional home for most robotics. Demand growth here is a build-out in the lower end of the market. Small and medium size precision manufacturers are implementing point solutions (that do not require a full system overhaul) like the \$22,000 unit from *Universal Robotics* in Denmark. Security applications have bled from military drones to municipal and commercial monitoring solutions, as provided by firms like *AeroVironment* (NASDAQ: AVAV).

Aging Masters

Compare this roster of young firms to industry stalwarts like *Fanuc*, *ABB*, *KUKA*, *Stuabli*, *Kawasaki*, or *Yaskawa* (the "Platinum" suppliers club of the RIA). These incumbents are deeply entrenched, make remarkably similar hardware to their original products from the 70's, and generate most of their margin on implementation and support work. Fundamentally, this came from a focus on in-line efficiencies. Not so in the new generation: the operating theater is the "unstructured environment."

WAR, SOCIAL, AND SOFTWARE

Understanding why these companies are positioned for success now (the past being littered with failed predictions) requires an appreciation of three supporting technology trends in *Sensors*, *Software*, and, most importantly, *Talent*. Behind each trend is a prominent driver that helps explain the timing of this convergence. A decade of war, maturing software applications, and the Great Recession have all come together to support our robotics thesis.

For robotics companies, the palette of *Sensors* available for robotic perception and navigation are orders of magnitude improved over the past decade, thanks both to a decade of technology-intensive military research efforts by the U.S. and its allies, and to the commoditization of "good enough" sensors. The *Kinect* camera system, initially developed for video games, is

now being applied to satellite on-orbit rendezvous and rapid 3D mapping for robot spatial awareness. The improvement in technology and falling prices are combining to create new opportunities for robotics in the home and daily life. For example, the *iRobot Roomba* is now ceding ground to low-cost products from *Neato*, which can map rooms in which they operate – a function that has trickled down from intensive corporate and governmental R&D over the past decade. The R&D efforts are by no means finished – if anything, they will be an important fundamental support to the industry.

On the *Software* side, the application layer of programming is becoming increasingly accessible. In part, this has been helped by the surge of open-source development platforms that have become available over the past five to seven years. *Microsoft Robotics Developer Studio* and *Player/Stage Project*, among other platforms, have enabled bot programmers to more quickly (and cheaply) implement and optimize their operating logic by using existing libraries within a standard operating system. An example of this is the *Robot Operating System (ROS)*, an open-source operating system for software development across heterogenous platforms. ROS grew out of Stanford (SAIL) and found its home in Willow Garage, a research federation that turned out "apps on wheels" and the like. The basic idea is that programmers can now walk into an environment with mixed hardware drivers, and programming languages, and quickly code an integrated product by building off pre-developed libraries using one standard operating system. *ROS Industrial Consortium*, a production-oriented faction, is pushing the platform into traditional operating environments. And beyond the code, *Human-Machine-Interface* evolution (see the *UR* pendant or *Baxter* from *Rethink Robotics*) is now making programming traditional production cells more "drag and drop" than "enter DOS command."

Department of Defense investment in unmanned systems is also paying dividends for robot developers, with a wave of military-inspired autonomous systems now reaching the market. DoD-funded research at institutions such as *Carnegie Mellon's National Robotics Engineering Center* has invested heavily in software for situational awareness, developing algorithms for robots to navigate and engage in unpredictable environments, away from assembly lines.

Finally, the *Talent* landscape is rapidly producing a large and empowered generation of hackers and makers. The 2008 recession helped this by focusing imagination and capital on the challenge of rethinking education. Platforms like *General Assembly*, an a-la-carte education

and co-work space are creating a new (and remarkably more efficient) pathway for interested talents to learn the skills leading directly to their tech interest (and good jobs). The younger generation is leading the charge, but we see older-types trading in their corporate jobs for programming classes. The cultural revolution embodied by the diverse swarm of tech-education ventures like *Codecademy*, *MAKE Magazine*, and *Raspberry Pi* promises a large talent wave coming to the rescue. Anyone who has tried to hire good programming talent will appreciate this demographic story above all else.

These three trends are collectively creating the conditions for niche robotics to proliferate outside the orderly heavy manufacturing environment. Each has lowered the cost of development and deployment significantly – what once required a machine shop fabrication facility and specialized programmers can now be accomplished with a desktop printer, online catalogs and largely pre-developed machine command libraries. Development times are also being reduced – with the increasing availability of materials and components, as well as the accessibility and deepening programming talent bench. These trends are fundamental to the business models we see succeeding.

BY THE HOUR: ROBOTS AS A SERVICE

Demand for productivity services coupled with rapidly decreasing technology hurdles leads us to our view of the dominant business model in the future: *Robot-as-a-Service (RaaS)*. *RaaS* firms will own, maintain, and upgrade their platforms. They will sell clients the value of their services – as an operating expense, not in the capital budget. Customers will gain flexibility and seamless upgrades without big implementation overhauls. In turn, *RaaS* firms will benefit from a recurring revenue stream, faster product iteration, and a closer connection with their product-market fit.

Companies like *Liquid Robotics* are already there. Founded in 2007, *Liquid* has built a wave-powered unmanned marine vessel. Originally, the company was focused on selling hardware – not a workable model. In 2011, the company brought on Bill Vass (former COO, Sun Microsystems) as CEO backed by \$22mm from investors. The pivot was made to a data subscription model – priced against the substitute product (a ship). The economics are profound: Wave Glider can provide access to an array of sensors anywhere in the ocean at a day rate of ~\$2,000; hiring an ocean-rated research vessel to collect the same data might cost 10x to 50x more. The development of an increasingly comprehensive and longitudinal oceanic database is also not likely lost on the company. It seems to be working:

the company reported “low double digit” revenue (\$mm USD) in 2011 and breakeven between 100-160 units (which might be \$30-50mm in sales). The company is also incentivized to continuously lower the total cost of ownership (since they are the fleet owners). For example, in December 2012, a *Liquid* glider completed 12 months and 9,000 miles at sea. Aggressive operating targets like this result in greater reach and utilization rates, reducing maintenance costs and dropping straight to *Liquid*’s bottom-line. This is *RaaS* economics at work.

For credit, the first mention of *RaaS* seems to have been Yinong Chen et al. (2010) in a paper exploring related systems engineering concepts. We hope to contribute a commercial version of *RaaS*, which we see as having six fundamental elements:

- 1. Value-Based Pricing.** By removing a large capital purchasing decision, *RaaS* companies remove the biggest hurdle in robotics: the capital expenditure budgeting and approval process. Typically tasked to conservative FP&A types, customer-developed ROIs have a logical bias for under-estimating the value of a service (and sellers to the opposite). The end result is that sales cycles extend and both parties waste resources on the procurement. Instead of hoping for the target “payback period,” customers implement and realize the economic value immediately.
- 2. Continuous Development Cycles.** An advantage of owning your fleet is you can push upgrades out quickly and in an agile manner. It also offers an opportunity to stay ahead of the competition: if *Liquid* has new data capture functionality, it can push it directly to customers rather than making them wait for the next product cycle. In the short term, point-solutions (i.e., that do not require large systems investments) like *Baxter* from *Rethink Robotics* will likely be early proponents of this; but more complex platforms like *Aethon* are likely to adopt as well.
- 3. Information Network Advantage.** The service model will lend itself to information advantages that scale with time and presence in the market. Data is only useful by comparison. As *RedZone* collects



Sells data services supported by its *Wave Glider* platform, an unmanned, wave-powered, maritime vehicle for ocean operations.

Focused on broad array of ocean-monitoring applications for government, energy, and research customers.

Year Founded	2007
Revenue (est.)	\$15 million
Location	Sunnyvale, CA
Website	www.liquidr.com
Watch For...	Partnership expansion to deploy more data collection instruments on the Glider platform

longitudinal information on pipes, along with associated operational and cost data, the company can continue to provide more value to its customers (e.g., by optimizing delay/repair/replace algorithms).

4. **Total Cost Reductions.** Every bit of cost *RaaS* companies strip from their systems drops to their bottom line (until competitors do the same and pricing catches up). But this is the better system. *RaaS* firms will be the best owners – most customers do not really want to own a fleet they have to finance, maintain, and replace. The efficiencies of “maker-owners” will give leading firms better margins, and customers lower overall costs.
5. **Focus on Customer Service.** Perhaps the most welcome element *RaaS* is a tight integration between the customer and development teams. Traditionally, there has been a divide created by distributor and sales organizations, implementation groups, and long product life-cycles. *RaaS* organizations will feature much closer connection between the builder and the user.
6. **Talent Premium.** Building robots is hard – especially for unstructured environments. Integrating customer insights, hardware, and software is notoriously tricky. Compounded by faster product cycles and increasing competition, this challenge requires an above-normal emphasis on a strong, unified team. If the hardware is great but software bugs, the company fails. More so than in other industries, *RaaS* requires consistently strong execution across a firm. *Baxter*, a robot with impressive marketing and generally underwhelming performance survives today – but tomorrow, shortcomings on product will derail the company.

Now it is important to note: *RaaS* is *explicitly not* systems integration or the “value-added reseller”(VAR) model. The critical difference is where innovation and cost live. Integrators are primarily “innovation takers” and do not drive product development in an integrated and tightly-knit fashion. VARs are by definition mark-up shops; they make money by adding cost (hopefully for value). *RaaS* makes money by driving the innovation agenda, and stripping costs out. In many ways, the two camps are opposite.

THE SOUL OF A NEW MACHINE

Tracy Kidder’s book of the same title ends with a new computer by Data General has just launched – a great success for the company, but leaving its team in shambles. The epilogue closes with the sales team pep-talk, and the author’s closing words:

“It was a different game now. Clearly, the machine no longer belonged to its makers.”

If Data General represented a world of product and market disconnection, the soul of *RaaS* its mirror image: **companies are the development team.**

As product cycles accelerate, competitors strip out cost, and growing firms fight for the best talent, the success of robotics companies will rise and fall based on their ability to sustain the best teams.

Great teams are not simply collections of great people. Integrating materials, components, code, and business logic for niche robotics is tricky business – with more room for translation errors than most products. Leaders have to get culture and processes right from the beginning; these are not luxuries to achieve “at scale.”

This is not new to some industries, and many tech entrepreneurs and investors will find this a platitude. But in a world where the product is so explicitly objectified and celebrated, we feel strongly that it needs repeating.

ON SURVIVAL AND SUCCESS

The Fortune 500, while clearly interested in robotics market opportunities, appear mostly poorly positioned and disinclined to lead the industry toward a *RaaS* model. The level of customization and specialization required to address niche robotics opportunities will inhibit the kind of rapid creation of economies of scale that large scale public enterprises need to justify investment. Many hardware-focused firms will discard *RaaS* as a ‘non-traditional’ business model too risky to pioneer. Product-focused corporations have historically struggled to execute services models effectively, in large part because they lack a firm grasp of what is required from an internal resourcing perspective to support the necessary level of customer responsiveness.

	Year Founded	1995
	Revenue (est.)	\$1 billion
Leading manufacturer of surgical robotics. Sells the <i>da Vinci</i> surgical system: remotely controlled surgical robot for laparoscopy across specialty area with focus on urology and gynecology.	Location	Sunnyvale, CA
	Website	www.intuitivesurgical.com
	Watch For...	Look for service model to appear as a means for Intuitive or competitors to serve lower-end of market.
	<i>...Service model for further growth</i>	

In all likelihood, it will be agile, highly-focused, and entrepreneurial SMBs that will drive the next wave of growth. These are the companies that will move the market forward by developing, testing, and refining *RaaS* business models. They also may also prove to be best able to compete in the new market environment. Start-ups and SMBs arguably offer the kind of culture and work environment necessary to attract and retain teams of creative and highly skilled talent, and tend to lack the bureaucracy that is almost certain to limit the ability of larger organizations to execute on a *RaaS* model. Small and private companies are also more likely to have the patience to succeed, as they lack the quarterly reporting pressure that has come to discourage long-term innovation in the world's largest companies.

But by no means should one count large-caps out. As growth under traditional models slows, corporate leaders are increasingly willing to consider business model innovation as a lever to drive growth. Market leaders in industrial, tech, healthcare and defense markets are watching robotics start-ups closely, and we anticipate a flurry of acquisition activity over the next 3-5 years. As large firms attempt to integrate *RaaS* acquisitions into an existing business, they would be wise to have the *Six Rules of RaaS* pinned to the door – or risk losing the inherent advantages of flexibility, agility, and a strong team. In many cases, our recommendation will be to let larger corporations keep *RaaS* assets as largely independent subsidiaries.

THE PATH FORWARD

On a practical note, we humbly offer six *RaaS Challenges* for anyone investing their time, energy, or money in this space. We recognize not all will be a perfect fit; but test each out and let us know what works.

- 1. Stop Selling Hardware.** *Ask your customers how a service-oriented solution might fit their needs and make life easier from a capital budgeting perspective. The asset backed loan with a service contract should be feasible to finance.*
- 2. Slash Product Development Cycles.** *Ship new product in half the time and tie closer to #5 below (customer service)*
- 3. Own the Data.** *Make it comfortable for your customers to allow you controlled awareness of the data going across your platform; sell it on the collective benefit to all your users and stakeholders.*
- 4. Hire Engineers to Cut Costs.** *Put your best engineers on location to help reduce operating cost for your fleet; this now goes to your bottom line.*

- 5. Put Customer Service in the C-Suite.** *Elevate customer service to the strategic level and install some product development talent on the premise to collect customer and product data for driving product cycles shorter (see #2 above).*
- 6. Go Where No Man Has Gone Before.** *You will need to attract, retain, and motivate the best talent in a fiercely competitive world. Keep your machines “human powered” by putting a flag in a big challenge – leave the smaller goals to others.*

We look forward to seeing *RaaS* firms continue to evolve and gain share in the industry. We welcome your stories and thoughts. ■

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