



Les Echos The Innovator

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In Partnership With Henkel Conference

**TRANSFORMING A
GERMAN GIANT
Q & A WITH HENKEL'S
CHIEF DIGITAL OFFICER**

**DIGITIZING
LOGISTICS
A \$4 TRILLION
OPPORTUNITY**

**GROWING UP DIGITAL
WHAT INDUSTRIAL
COMPANIES CAN LEARN
FROM STARTUPS**

MAN, MACHINE AND THE FACTORIES OF THE FUTURE



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«LES ÉCHOS» DU 5 NOVEMBRE 2018
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● **It was welcome news** to learn that five out of nine of the most advanced factories in the world named by the World Economic Forum and McKinsey are European. The factories were chosen out of an initial list of 1,000. And, as illustrated in the stories in this magazine, there are other signs that Europe is holding its own in the Fourth Industrial Revolution. France's Sigfox is a global powerhouse in Internet of Things connectivity. Germany's arago, backed with an investment of \$55 million from the private equity fund KKR, is offering corporates what it claims is a neutral alternative to AI solutions offered by big American and Chinese platform companies. And big European companies and entrepreneurs are collaborating through Henkel X, an open innovation platform created by Henkel, a 142-year-old maker of chemicals and consumer goods. As members of the Henkel X network gather with Sigfox, arago and other startups in Düsseldorf November 8 and 9, they will be reminded that there is no place for complacency in this fast-paced digital world. As Brent Hoberman, executive chairman and co-founder of Founders Forum and Rob Chapman, CEO of Founders Intelligence write in their guest essay: "Startups have learned discipline from industrial companies. It is time for industrial companies to learn creative chaos from startups."



By Jennifer L. Schenker

Editor-in-Chief, *The Innovator*

THE CHANGING NATURE OF COMPETITIVENESS

● **The changing nature of economic competitiveness** in a world that is becoming increasingly transformed by new, digital technologies is creating a fresh set of challenges for governments and businesses. That is the key finding of the World Economic Forum’s 2018 Global Competitiveness Report. According to the report, which uses a brand new methodology to fully capture the dynamics of the global economy in the Fourth Industrial Revolution, many of the factors that will have the greatest impact in driving competitiveness in the future have never been the focus of major policy decisions in the past. These include idea generation, entrepreneurial culture, openness and agility.

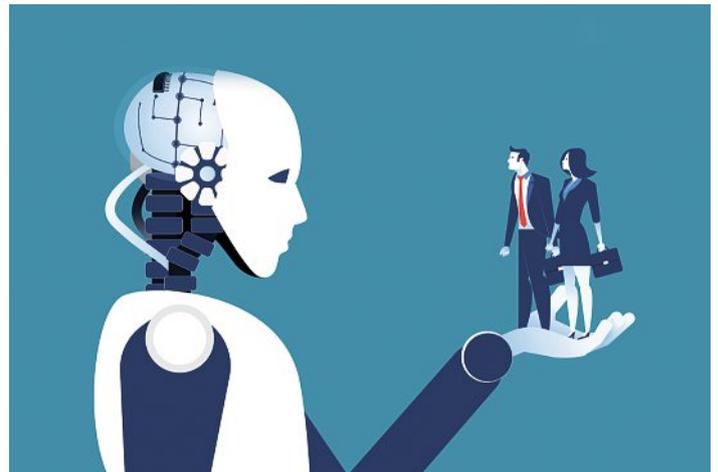
The tool maps the competitiveness landscape of 140 economies through 98 indicators. For each indicator, using a scale from 0 to 100, it indicates how close an economy is to the ideal state or “frontier” of competitiveness. When combining these factors, the United States achieves the best overall performance with a score of 85.6, ahead of Singapore and Germany. The average score for the world is 60, 40 points away from the frontier. One of the report’s most concerning findings is the relative weakness across the board when it comes to mastering the innovation process,

INNOVATION INDEX

1	— Germany	87.5
2	— United States	86.5
3	— Switzerland	82.5
4	— China & Taiwan	80.8
5	— Sweden	79.8
6	— Japan	79.3
7	— United Kingdom	79.2
8	— South Korea	78.2
9	— Netherlands	77.5
10	— Finland	76.3
11	— France	76.1
12	— Denmark	75.4
13	— Canada	75.0
14	— Singapore	75.0
15	— Austria	74.3

Source: World Economic Forum

from idea generation to product commercialization. Some 103 countries scored lower than 50 in this area of the index, which is topped by Germany, followed by the United States and Switzerland. The report notably finds that the attitude toward entrepreneurial risk is the most positive in Israel and tends to be negative in several East Asian economies. Canada has the most diverse workforce and Denmark’s corporate culture is the least hierarchical, both critical factors for driving innovation. ●



HR’S USE OF AI IS GROWING AND SO ARE CONCERNS

● **Some 78% of human resources departments** expect to use machine learning in at least one HR process within two years, according to a new survey conducted by Bain & Company, which polled human resource executives and managers at 500 large companies in the U.S., Germany, and the United Kingdom, including publicly traded and privately owned companies across a broad range of industries from manufacturing to retail to healthcare. Some companies surveyed are already seeing success from using the technology. Unilever, for example, is using AI to help with screening job candidates and the technology has cut the average time it takes to hire new people by 75%, according to Bain. But news of the Bain survey comes as news reports revealed that Amazon had to scrap an AI system that it was using for recruiting purposes because it found it was biased against women candidates. “Everyone wanted this holy grail,” an Amazon executive told Reuters. “They literally wanted it to be an engine where I’m going

to give you 100 resumes, it will spit out the top five, and we’ll hire those.” But the company realized its new system was not rating candidates for software developer jobs and other technical posts in a gender-neutral way. That is because Amazon’s computer models were trained to vet applicants by observing patterns in resumes submitted to the company over a 10-year period. Most came from men, a reflection of male dominance across the tech industry. The Seattle company ultimately disbanded the team by the start of last year because executives lost hope for the project, according to the Reuters report. Amazon’s experiment offers a case study in the limitations of machine learning. It also serves as a cautionary tale to the growing list of large companies including Hilton Worldwide Holdings and Goldman Sachs Group that are looking to automate portions of the hiring process. ●



ACCELERATING CHANGE

● **A group of prominent male business leaders** are stepping up to become Male Champions of Change for a new group called AccelerateHER, which was formed to address the under-representation of women in the technology industry.

AccelerateHER, a part of the Founders Forum group, a private global community of successful technology founders and investors, is working with a network of technology leaders to accelerate change through best practices and promote the value of gender parity. Its work focuses on three core areas: events, strategy and innovation, and Male Champions of Change.

Its global AccelerateHER events shine a light on accomplished female founders, (such as ex-Google and Yahoo executive Marissa Mayer, pictured here) providing the crucial visibility the groups says female founders need to raise capital, access new networks or partner with collaborative companies. The group says it is evaluating and mapping best practices across technology companies, providing partners with guidance and advice on the latest innovative diversity technology. The Male Champions

of Change Global Technology Group is an exclusive, action-based global network of male leaders in technology aiming to accelerate their diversity learning and programs. The leaders are committed to standing up alongside women to share responsibility and reinforce accountability for addressing gender inequality within their organizations and the industry at large. Seventeen global leaders have committed to being Male Champions of Change, including:

- **Steve Demetriou**, Chairman and CEO, Jacobs
- **Mark Read**, CEO, WPP
- **Tony Hall**, Director General, BBC
- **Bob van Dijk**, CEO, Naspers
- **Wendell Brooks**, President, Intel Capital
- **Gavin Patterson**, CEO, BT Group
- **Jonathan Newhouse**, Chairman/CEO, Condé Nast International
- **Ambarish Mitra**, Co-Founder and CEO, Blippar
- **Nagaj Kashyap**, Corporate Vice President and Global Head, M12
- **Rahmyn Kress**, Chief Digital Officer, Henkel and Founder, Henkel X
- **Brent Hoberman** CBE, Co-Founder, Founders Factory/first minute capital/Founders Forum
- **David Jones**, Founder/CEO, You & Mr Jones and One Young World Founder
- **Damian Bradfield**, President, WeTransfer
- **Philippe Chainieux**, CEO, Made.com
- **David Eun**, President, Samsung NEXT and Chief Innovation Officer, Samsung Electronics
- **Frédéric Mazzella**, Co-Founder and President, BlaBlaCar
- **Nicolas Brusson**, Co-Founder and CEO, BlaBlaCar

Each Champion is conducting leadership assessments and focus groups within their organizations leading up to the inaugural Global Tech Group meeting in January 2019 in Davos, Switzerland. The Global Tech Group will meet again in London next June around AccelerateHER's and Founders Forum's flagship events. ●

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THE FACTORIES OF THE FUTURE

— Fourth Industrial Revolution technologies are spurring new techniques and business models.

By Jennifer L. Schenker

● **Haier, a Chinese home appliance manufacturer**, has linked its consumers and suppliers in a mass customization platform that automates each step of production. The automated process allows a customer to personalize orders for appliances such as washing machines or refrigerators then designs the specifics, calls for relevant components from the suppliers, manufactures the appliance as the parts arrive (there are no warehouses), delivers it to the end-user, and arranges for monitoring and service when it is in use.

Welcome to the factory – and the supply chain – of the future. It's digital, it's connected, it's smart, it's flexible, it's customizable. And it's here now. Fourth Industrial Revolution technologies, such as robotics, Internet of Things (IoT), artificial intelligence (AI), augmented reality (AR), robotics and additive manufacturing, are spurring new techniques and business models that are fundamentally transforming the global production systems that have traditionally served as an engine for growth and innovation in economies around the world. Capgemini projects that smart factories have the potential to add \$500 billion to \$1.5 trillion in value to the global economy within five years. And nearly every manufacturing vertical including autos, home appliances, consumer goods, electronics, apparel and pharmaceuticals will be impacted. Here is a glimpse of what the future holds :

Collaborating With Mechanical Co-Workers

The roles of man and machine are changing. For years robots used in factories were stationary and set apart in cages to protect workers. Now they are working side by side with humans. (See the story on pages 32 and 33.)

To keep up, humans are acquiring some new superpowers. Workers who used to have to follow long, complicated paper-based changeover instructions now work more efficiently because they can see each step projected onto a surface using AR technology. (See the story on page 31.) And exoskeletons are being tested to reduce worker injuries and increase productivity. Ford Motor company is deploying them at 15 of its factories around the world. (See the picture.)

Nonetheless, robots are replacing humans in some warehouses and factories. The clothing manufacturer Uniqlo recently replaced 90% of its employees at a warehouse in Tokyo's Ariake district. The robotic system is designed to transfer products delivered to the warehouse by truck, read electronic tags attached to the products and confirm their stock numbers and other information, according to press reports. When shipping, the system wraps products placed on a conveyor belt in cardboard and attaches labels to them. Only a small portion of work at the warehouse needs to be done by humans. Meanwhile, the Chinese phone part maker Changying Precision Technology Company



Ekso Bionics

The merger of man and machine:
A factory worker wearing
an Ekso Bionics exoskeleton

MANUFACTURERS ARE TOP CORPORATE R&D SPENDERS

Trailing 12 months R&D spending (as of 6/16/17)



Source: company filings, Bloomberg
*indicates R&D spending reported annually

has created an unmanned factory. Everything in the factory — from machining equipment to unmanned transport trucks to warehouse equipment — is operated by computer-controlled robots. The technical staff monitors activity of these machines through a central control system, according to a CB Insights report.

Where it once required about 650 workers to keep the factory running, robot arms have cut Changying's human workforce to less than a tenth of that, down to just 60 workers. A general manager said that it aims to reduce that number to 20 in the future, the report says.

Moving From Factory Floor to the Consumer's Door

The factory floor is not the only thing that is changing. The way products get to market is also being transformed. On-demand decentralized modular equipment and custom machines like 3D printers are enabling manufacturers to handle increasing demand for personalized products while moving production closer to consumers. (See the stories on pages 23 and 28-30.)



HOW FOURTH INDUSTRIAL REVOLUTION TECHNOLOGIES ARE CHANGING FACTORIES



ROBOTICS

Factories and warehouses are becoming more and more automated



AUGMENTED REALITY

Technology is making changeovers on production lines and maintenance more efficient



Blockchain, an immutable digital ledger technology, is easing the complexities of integrating suppliers and making the supply chain more transparent, helping businesses like Walmart to more quickly identify problems and avoid recalls. It also gives consumers a means to gain quality assurances, building brand trust. (See the story on pages 40 and 41.) And autonomous ships, vans, trucks and drones are changing last mile delivery. (See the story on pages 46-48.)

The Shift to Outcome-Based Services

As if all of these changes were not enough, manufacturers are increasingly expected to move from providing products to providing outcomes, says Eric Schaeffer, senior managing director and head of industrial practice at Accenture. For example, Michelin, one of the world's largest tire manufacturers, has shifted its business model from selling tires as a product to a service guaranteeing performance. It works like this: Michelin places IoT sensors inside trucks to collect data, like fuel consumption, tire pressure, temperature, speed and location. This data is then processed in a cloud solution and analyzed by Michelin experts, who provide recommendations and training in eco-driving techniques. By encouraging the right handling of the truck equipment, the company can help truck fleet owners reduce fuel consumption by 2.5 liters per 100 kilometers, representing annual savings of €3,200 for long-haul transport travelling over 120,000 km, which works out to reducing total cost of ownership at least 2.1% and CO2 emissions by eight tons. The service helps Michelin achieve higher customer satisfaction, increase loyalty and raise EBITDA margins, according to a World Economic Forum report.

Other manufacturers are starting to sell uptime, i.e. a guarantee that the product sold will be up and working a certain amount of time. If it does as promised the customer will pay an agreed-upon price. If it doesn't the manufacturer pays a penalty.

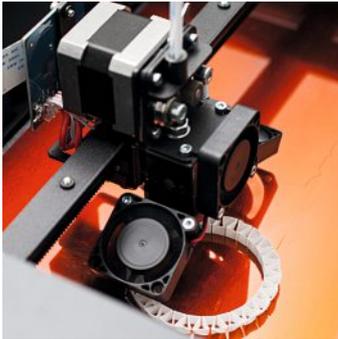
Delivering such outcomes will require new levels of collaboration across an ecosystem of business partners, bringing together players who combine their products and services to meet customer needs, according to a Forum

report prepared with Accenture. Software platforms are expected to emerge that will better facilitate data capture, aggregation and exchange across the ecosystem, helping manufacturers create and monetize new products and services. The big winners will be platform owners and partners who can harness the network effect inherent in these new digital business models to create new kinds of value, the report says.

Going forward "any industrial manufacturer should be part of one or more ecosystems, and this has implications for the way they operate their companies," says Accenture's Schaeffer. "It means having to open up to the outside, but industrial manufacturers are not very comfortable with ecosystems."

A number of other issues still have to be resolved. Cybersecurity remains a serious concern. As machines operating critical infrastructure become connected they become more vulnerable to cyber attacks. (See the story on pages 18, 19.) And a majority of manufacturers have stalled in their efforts to embrace Industry 4.0 technology. A study conducted by the World Economic Forum found that over 70% of manufacturers investing in technologies such as Big Data analytics, artificial intelligence or 3D printing do not take projects beyond the pilot phase.

That is why the Forum is building a network of experts to help, says Helena



ADDITIVE MANUFACTURING

3D printing technology is being used to manufacture everything from orthodontics to airplane parts



ARTIFICIAL INTELLIGENCE

Manufacturers are using AI to reduce equipment downtime, spot production defects, improve the supply chain, and shorten design time



INTERNET OF THINGS

IoT technology allows factory machines to communicate



THE OUTCOME ECONOMY

Manufacturers like tire-maker Michelin are leveraging the technology to sell outcomes as well as products

Leurent, head of future of production at the World Economic Forum. Concluding a year-long study with McKinsey, the Forum named the world's nine most advanced factories in September, recognizing the strides the winners had made in embedding Industry 4.0 technologies. Haier's factory in Qingdao, China was among the winners, as were two other factories in China. A network comprised of the winners was officially launched in September. They have all agreed to share their knowledge with other manufacturing businesses.

Pilot Purgatory

The manufacturing industry could use the help. "There is a reason for the pilot purgatory," says Enno de Boer, partner and head of global manufacturing at McKinsey. "It is literally the complexity they are facing. When you try to move to Industry 4.0 you are immediately confronted with 10 or 12 different technologies that you need to master, from IoT to robotics and AI all the way to blockchain. You not only need to be at the forefront of the art of the possible, in order to drive impact you need to go beyond the technologies and think in use cases. Typically you need 15 to 30 use cases in a single factory. We have clients with over 200 factories so then you

have to multiply that." The process gets bogged down because senior executives decide to start by experimenting so "they say 'let's do robotics, let's do a proof of concept around machine learning' and so on," says Schaeffer of Accenture. "To cover the entire field you could do this forever." Manufacturers need to develop a strategy for digital and figure out how they want to tie it to their business, then put the right architecture and skill sets in place. "I would say manufacturing is the hardest spot on earth, if you want to put together all the technologies – IoT, AI, robotics – all the disciplines and get them all to work seamlessly with your system," says Schaeffer.

That said, "there is a lot of cutting-edge stuff to be done in manufacturing," that can interest top talents such as data scientists and systems engineers, he says. It is up to management to create the environment to attract and keep the right talent. They will not be able to do it all externally, he says, so they will have to build the existing skill sets in their employees and teach them new skills.

"If I have one message it is CEOs really need to understand this, take it seriously and stop tiptoeing around with pilots," says Schaeffer. "It is time to move forward. China is embracing the Fourth Industrial Revolution faster than other regions and the gap is getting bigger." ●

FLEXIBLE MANUFACTURING



Siemens' Chengdu electronics plant.

Going Digital

— Fourth Industrial Revolution technologies enable highly efficient flexible production at Siemens' Chengdu electronics plant.

● **A manufacturing plant in the heart of China's Southwestern Sichuan province owned by German conglomerate Siemens makes Programmable Logic Controllers** that help factories all over the world control and automate their facilities and machinery. It pumps out eight million such devices a year. That equates to about one every two seconds. The ability to efficiently supply the world's factories with over 800 variants of Siemens' SIMATIC controllers and other electronic components hinges on the fact that the plant is not only a consumer of its own equipment but has also successfully implemented a whole array of Fourth Industrial Revolution cutting-edge technologies. Production at Siemens Electronics Works Chengdu (SEWC), which is

controlled by around 700 SIMATIC components, is recorded, monitored, analyzed and optimized digitally. Machines and robots handle some 70% of the value chain independently. Digital twin technology creates a holistic virtual model of the integrated product and production lifecycle – from product design to production planning, engineering, and execution, and service. A fully autonomous logistics system is used during the production execution cycle to ensure a regular supply of materials and components for continuous production, with 100% traceability. A cloud-based Internet of Things (IoT) operating system connects sensors throughout the factory. And flexible technology enables different products to be made on the same production line to increase efficiency. Digitalizing production

has led to greater flexibility, shorter time-to-market, higher efficiency and better quality, enabling a four-fold increase in output and a process quality rate of 99.999%, says SEWC General Manager Li Yongli. It has also earned the Chinese plant recognition as one of the most advanced factories in the world.

Lessons Learned

Nine factories, including SEWC and a Bayer Pharmaceuticals plant in Italy, were recognized in September by The World Economic Forum and McKinsey for their strides toward embedding the technologies of the Fourth Industrial Revolution into modern production, improving operational performance in the process. (See the story about Bayer's factory on page 31.) Like the Bayer Pharmaceuticals plant, the Chengdu plant has agreed to share what it has learned with other manufacturing businesses, to aid the adoption of technologies as part of a new program launched by the Forum.

SEWC's secret for success? "We at Siemens are also going through our own digital transformation in our own factories," says Li. "We are a big manufacturer ourselves, with more than 250 factories worldwide. We not only use our own software and automation tools but also take advantage of the insights we gain in daily usage and take this information back to R&D to continuously optimize our products." SEWC has adopted some of the digitalized production processes that Siemens operates at its electronics plant in Amberg, Germany, where it has been manufacturing SIMATIC Programmable Logic Controllers since 1989. And the Chengdu plant has eagerly

anticipated and embraced new technologies as they develop. "We follow an agile concept and methodology in the R&D and implementation of new technologies; and usually start with pilot projects before scaling up," says Li.

What's more, he says, the plant has taken the necessary steps to help employees and management prepare, both mentally and physically, for going digital. To that end Siemens offers an online program called Apply Digitalization to Our Business Training, to help all employees have a "digital mindset," orient them to the new digital environment and establish one digital language. "We encourage every employee of SEWC to take part in such a training program," says Li. The Chengdu plant also continuously invests in the research and application of future technologies by setting up learning centers. More than 10 technology knowledge-sharing teams have been established at SEWC to impart technical know-how, best practices, and the results of research into cutting-edge technologies to employees. The digital age requires digital talent, says Li.

So factories need to focus not just on how to motivate management but also employees. "Digitalization is a journey rather than a result," he says. "A holistic view is needed to define the long-term roadmap for the digital upgrading of a manufacturing enterprise. Digitalization should not happen independently, but rather have a synergy effect across all departments of the plant and be interpreted and supported by each and every employee of the company." ●

J.L.S.



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Bryan, Garnier & Co has been advising tado^o, Europe's leading climate management company since its early days. This exemplifies our long-term commitment to clients and shareholders to help them meet their objectives. We have helped tado^o over the course of its growth trajectory, raising over \$100 million across several rounds from leading investors in the US and Europe, leveraging our deep understanding of the energy landscape and relationships with strategic and financial sponsors. Keeping in mind the capital structure needs of a high growth company, Bryan, Garnier & Co has raised \$50 million in capital for tado^o from Amazon, E.On, Total, EIC and European Investment Bank.

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Transforming a German Giant

An Interview With Rahmyn KRESS,

Chief Digital Officer and Chairman of The Digital Executive Committee at Henkel.



● **Rahmyn Kress is chief digital officer and chairman of the digital executive committee at Henkel,** a 142-year-old maker of chemicals and consumer goods headquartered in Düsseldorf, Germany.

Prior to joining Henkel, Kress was managing director of technology ecosystems and ventures at the global consultancy Accenture. Kress also served as the CEO of Digiplug, a digital technology company in Paris acquired by Accenture that provided digital services to the world's largest media giants.

Earlier in his career he was executive vice president of physical and digital transformation, supply chain and operations at Universal Music Group. He first gained experience in dealing with exponential change while there, when the first wave of digital disruptions hit the music industry. He recently spoke with Jennifer L. Schenker, The Innovator's editor-in-chief, about Henkel's digital transformation and the launch of Henkel X, a new operating unit and

dedicated platform he designed for Henkel's entrepreneurial journey.

You joined Henkel 17 months ago to lead its digital transformation. Where are you on the trajectory?

R.K.: I think the better way to frame it is to ask "what are the goals that have been set for the journey? And are we executing well and at the right speed?" The first phase of our digital transformation is structured around three core pillars. The first is digital technology. There the question is "Do we have the right tools and capabilities to drive our business forward?" The second pillar concerns our ability to become a more data-driven organization. Are we able to run analytics effectively to have the right visibility on our operations? Can we create digital experiences for consumers and our business partners in B2C and B2B and B2B2C environments? The third pillar centers on digital innovation and our overall strategy. How do we build innovation and eventually transfer

this to our business units? One of the things that is very important to understand is that Henkel has three different business lines: adhesive technologies, beauty care and laundry, and home care.

In all of the business units we have to look at the maturity of the technologies but also the skill sets of the individuals driving the businesses. In the short term the goal is to act as a catalyst of change and use the entire activity as an upskilling exercise.

Have you been able to put the right technologies in place?

R.K.: We agreed across the group at the beginning of the year on the initiatives we would be launching. We selected our global partners for digital technology and data analytics and after that we issued tenders to the market and we started implementing the digital architecture that will get us to where we want to be. That is an ongoing process, a process that you need to continuously fine-tune because technology is always changing. When you deal with data analytics

the most important thing is not the data itself but what are the problems you are looking to solve. What is the data you require to support your hypothesis?

We started that process at the end of 2017. We are now working with our partners on extracting data out of our organization and are ready for our first proof-of-concepts. We have aligned the processes, the governing structures and the operating model across the group globally. So we are at the moment where we have ideated and built, we have tested and now – at the end of the quarter -- we can transfer responsibility for digital tech and data analysis as well as the digital experience for marketing and customer engagement over to all of the business units. It is a tremendous achievement in a relatively short period of time.

What about change management?

R.K.: Digital innovation and the strategy around it is a core initiative that any organization needs to do

“Henkel X is an open innovation platform that distinguishes itself by being very open to collaboration with a number of different players. It is about dropping the guard rail and working and collaborating with others.”

to transform itself. It is about a mindset shift. Many corporates try copying a model where they say “we want to act like a startup.” That is just impossible. Large corporates, while they are undergoing the digital transformation process, have legacy businesses that need to be run and daily challenges that need to be overcome. That doesn’t mean they can’t take what works very well at startups and identify how to obtain an innovation culture by following their own path. That is what led to my thinking in creating Henkel X in February.

What is Henkel X?

RK: Henkel X is an open innovation platform that distinguishes itself by being very open to collaboration with a number of different players. It is about dropping the guard rail and working and collaborating with others. That is one of the biggest changes for an organization – the shift from thinking about products to thinking about services and marketplaces. To stop thinking about competitors and

start thinking about collaboration and peers. Henkel X helps us to achieve that through three “e’s”: it is about creating an ecosystem; it is about creating experiences to foster new ways of thinking, and different types of activities and formats that foster innovation; and it is about experimentation, i.e. new ways of working. From those three pillars we are building a number of different products and programs.

Our Henkel X Mentor program is one of the areas. The members of the Henkel X mentorship club are the brightest minds in entrepreneurship and industrial thought leadership with diverse backgrounds. Mentorship Days offer a unique chance for our internal colleagues to discuss entrepreneurial ideas with these mentors, get their advice on a current business challenge or have an exchange on any digital topic that they are currently facing. We attracted over 100 mentors in only three months. For our first mentorship day one-third of the mentors flew in from all

over the world and Henkel employees from all different levels got to talk and share experiences with them. In addition to the mentorship club we have also introduced partnerships with academic institutes of entrepreneurship such as ESCP, a top business school in Europe, which allow us to present business challenges which the faculty then take on board. We will have further partnerships in Europe and the U.S. to announce soon. We are a founding partner of AccelerateHER, an initiative in which males in leading positions step up to encourage more women in technology. I have been very privileged to be elected to become an active member of the World Economic Forum’s platform economy initiative that focuses on the importance of that for Europe and its businesses and its overall future economy.

We have partnered with the Founders Forum to bring – for the first time – their conference to Germany to encourage founders and C-Suite executives from big corporates to work together. Our “experience” initiatives include regular fireside chats and briefings with mentors and industry leaders. So far we have had seven, and from there we have launched 18 ongoing live projects in which our business units are working together with startups to build proof-of-concepts. We have launched our first live version of the Henkel app which our employees can access on their mobile phone and tablets for daily news or information on innovation topics and we have done a number of other things that allow us to get digital feedback from our employees.

When it comes to experimentation we are working with H-FARM [a global innovation hub on the outskirts of Venice, Italy that combines innovation, entrepreneurship and education]. H-FARM allows us to tap into a global network of startups and it gives us a place – outside of our own environment – to go with our

partners and employees to innovate cooperatively and build MVPs [minimal viable products], new business opportunities and services. It helps us install a mindset of build, measure and learn.

Last, but certainly not least, I have taken over the responsibility of driving the Henkel venture business, together with the business units, to look at what does venture really mean for a corporate and set the right level of expectations.

Where do you go from here?

RK: My focus will shift in 2019 to future opportunities in marketplaces and platforms, in deep tech and in new digital technologies with a focus on retail B2B2C and B2C environments that are not asset-based. To make that plain it will be all about, on a daily basis, how to identify areas that could disrupt Henkel’s business as we know it today. My job as CDO will be to become the Chief Disruption Officer so that instead of being disrupted we can anticipate and build and invest in new areas and turn the threat of being disrupted into a proactive “innovate or disrupt from within” culture.

What advice do you have for other corporates?

RK: No matter how visible it is for those of us who have been involved in digital transformation for a while, you should never underestimate that it is still very new to many and therefore you should not ignore the fear and discomfort of people. It is very important therefore to be very plainspoken in your communications and inclusive. It is paramount to bring as many people on board as possible. The second point is that the biggest and the most important part of digital transformation is culture and the cultural change required, which includes different ways of working and giving more responsibility to individuals so that they really feel empowered to make a difference and be a part of the change. ●

J.L.S.

Why Henkel Adhesive Technologies is Sticking With Startups

— The €9.38 billion unit is teaming with entrepreneurs to build new businesses in advanced materials.



● **In the Silicon Valley it is sometimes hard to differentiate the venture capitalists from the entrepreneurs.** Both often wear hoodies and Allbirds sneakers and are obsessed with what's trending. That's not the case at Henkel Ventures, the venture capital arm of the 142-year old German conglomerate, which specializes in adhesives, laundry and home care and beauty products. "We don't do cool or hip," says Paolo Bavaj, head of corporate venturing at Henkel Adhesive Technologies.

It all depends on one's perspective. In the movie about the making of Facebook the character based on the American Internet entrepreneur Sean Parker famously says "You know what's cool? A billion dollars."

The adhesives business unit, which makes adhesives, sealants and functional coatings for consumers, craftsmen and industrial applications, reported revenues of €9.38 billion in 2017, representing 47% of Henkel's total company sales. And Bavaj's mandate is to build new businesses in advanced materials for the adhesives business that could have a turnover of hundreds of millions of euros in five to eight years.

To feed those efforts with the right technologies Henkel Adhesive Technologies conducts its own R&D but is also reaching out to universities and startups. When Bavaj first started interacting with entrepreneurs in early 2014, "I was impressed at how scientifically savvy the people in the startups were," he says. "They were doing things that we would never be able to do ourselves." Henkel created its own company-wide venture fund in 2016, setting aside a total of €150 million for direct investments by all of its business units between 2016 and 2020. As a first step, Henkel invested in the following venture capital funds: China Materialia, which specializes in investing in advanced materials startups in China and adjacent Asian markets; Emerald

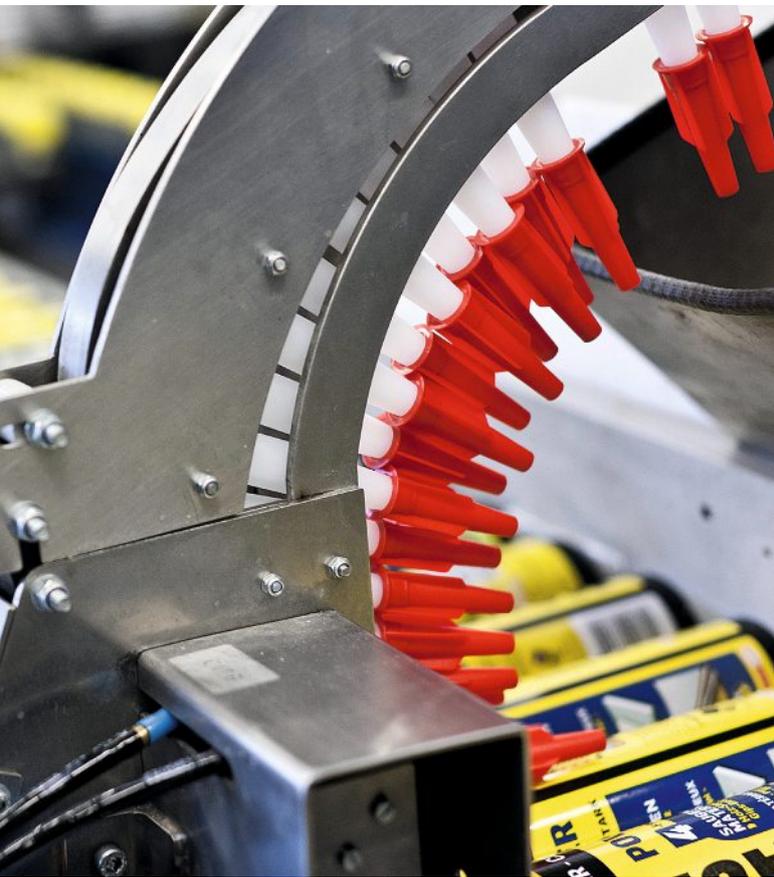
Technology Ventures, which has offices in Zurich, Switzerland and Toronto, Canada, and focuses on industrial innovation, including advanced materials; Pangaea Ventures, an advanced materials fund which has offices in the U.S. and Canada; and Firstminute Capital, a pan-European seed fund.

New Markets

Through these four funds Henkel's adhesive business has access to 2,500 startups. "We check which ones are strategic to our core business, usually around 200 per year, and we do detailed evaluations of 50," says Bavaj. So far Henkel Adhesives Technologies has invested in five startups.

Among them is Israel's Copprint Technologies, which is in the field of printed electronics, one of the key areas in which Henkel Adhesive Technologies is searching for innovations. Copprint, an advanced materials startup, has developed a novel technology for producing conductive copper inks that has the potential to replace silver-based ink methods and provide substantial cost benefits for a variety of printed electronics applications. Based on the increasing demand for printed electronics, the market for conductive inks is projected to reach \$2.8 billion by 2020, according to a recent IDTechEx research report. Copper-based technologies have the potential to significantly reduce costs. Today all solutions are still silver-based due to technical challenges such as copper oxidation and expensive production processes.

"Copprint has found a way to switch from silver to copper inks," says Bavaj. "Silver is super expensive so if you can incorporate copper-based tech you can substantially lower the cost of ink." Copprint has demonstrated that its copper ink can be applied without oxidation and it has already achieved



**Production of adhesives
at a Henkel factory**

technical product qualifications for printed RFID (radio frequency identification) antennas. Such antennas are part of RFID tags that use electromagnetic fields to automatically identify and track objects such as products moving through a supply chain. Copprint says its printed RFID antennas offer significant advantages in costs and sustainability compared to other existing methods. In addition to RFID and near field communication (NFC) antennas, its technology has the potential to be used in a broad variety of applications such as 3D-printed electronics, wearables and smart clothing. “The applications are huge,” says Bavaj. “For example, this new type of ink could be used for printing electronics systems used in next generation photovoltaics, allowing us to enter into market segments that were not available to us before.” When Henkel takes equity stakes in startups it usually

takes less than 20%. “Startups that accept money from Henkel expect something else beside the money,” says Bavaj. “They want access to our footprint, our brand, our market channels and our customer base.” Henkel Adhesive Technologies is well-positioned to help the startups it works with to scale, says Bavaj. It has 6,500 technical sales people on the ground and hooks into big industries such as automotive. “Very often large automotive OEMs are reluctant to embrace cool tech from a young startup because they are afraid the company could disappear in a few months,” he says. “But if Henkel is behind the company as an investor it gives big clients some sort of security. This is why our brand is so important for them.”

Henkel Adhesive Technologies only invests in an operating company if there is sign-off from a relevant operating unit. “We always involve them in evaluating a startup because they need to provide the resources to help the startups scale up,” he says. “If they are not excited about a particular investment it won’t work.” When the unit works with startup companies “we work as closely with them as necessary and as loose as possible,” says Bavaj. “We don’t want to tie them too tightly to Henkel because we recognize that they have their own business and their own way of working. The point is we want to support them but if we interfere too much it will be the end of that startup company.” The unit does not always take equity stakes. It has collaboration agreements with some 35 startups. “Some of them are not looking for money and it is more about rolling their products out to our customers or really jointly developing a new technology,” he says.

Regardless of the arrangement, he says the goal is to develop new lines of business for Henkel Adhesive Technologies out of startups’ technologies that look poised to be profitable and stick.

J.L.S.

EXAMPLES OF STARTUPS WORKING WITH HENKEL

COPPRINT TECHNOLOGIES ISRAEL

WHAT IT DOES: A copper-based ink platform for printed electronics.

www.copprint.com

KRIYA MATERIALS THE NETHERLANDS

WHAT IT DOES: Nanoparticle-based coatings that can be used for a variety of applications, including flexible film and glass.

www.kriya-materials.com

NBD NANO UNITED STATES

WHAT IT DOES: Nano-materials that can repel water and oil on a variety of services such as glass, plastics, leather and fabrics.

www.nbdnano.com

Manufacturing the Future of Laundry and Home Care

— Pilot first, then roll out fast globally.

● **In 1876 Fritz Henkel founded the company Henkel & Cie in Aachen, Germany.** The company's first product was a laundry detergent based on sodium silicate called "Universal-Waschmittel" (universal detergent). Today Henkel's detergents are used worldwide to do about 25 billion wash loads annually. The consumer goods business has grown into a globally active unit with well-known brands, such as Persil, Purex and Pril, and encompasses not just laundry detergents but laundry additives, dishwashing products, hard surface cleaners, toilet care, air care and insect control products.

These products — a €6.6 billion business — are produced in 31 factories around the world that are filled with legacy equipment. So what is the cleanest way to digitize all of these plants? "We have deployed already on a global scale but we don't have one single lighthouse factory," says Dirk Holbach, senior vice president of Laundry & Home Care and managing director of Henkel's global supply chain. "Our approach is broader. When we find something interesting we pilot it in two, three or four sites and if it works then we scale-up fast globally."

The approach is structured around a "4+1" strategy that Holbach believes can help the company's supply chain become "faster, better and cheaper": Analytics, robotics/automation, sensors and visualization plus end-to-end connectivity. "We are trying a lot of things," says Holbach. "The speed of change is so fast we can't always bet on the right horse. We have to fail also and not get lost in all the opportunities, so we are going with a portfolio approach. This portfolio of application is constantly reviewed and adjusted over time." The digitization process began in 2013 when the company started systematically connecting all of its sites. The digital backbone extracts data about the production process worldwide, giving the company insights that it uses to build applications. The unit is using machine learning to

improve processes continuously. And, legacy controller equipment is being upgraded so that factory printers can produce serialized codes, using an app that tells the company where a product is produced, which line, which warehouse and for which customers. "At the moment eight printers in our European factories are testing this and we plan to roll it out to more than 200 production lines by the end of 2020," says Holbach. The company is experimenting with 3D printing in the production of its home care products and with augmented reality (AR). AR is being tested in factories in Spain and North America for changing products on production lines and maintenance. Using AR headsets to digitize paper-based instructions is expected to reduce defect rates, decrease training times and increase yield. But "digitizing all of these different steps in the system takes a lot of effort, money and resources for rather incremental benefits," says Holbach. "At the moment it is not yet at the very top of our list."

Some 1,600 people working in Laundry & Home Care are using cloud-based, end-to-end analytics to visualize the supply chain. Machine learning algorithms are being used to improve demand forecasting capabilities. The business unit is also testing digital twinning technology that involves creating a digital replica of physical objects. It has run one pilot in the U.S. where it operates some of its largest factories.

Holbach says Laundry & Home Care is not yet ready to embrace digital twinning on a grand scale. "You have to pay six or seven digits just to license the technology and then pay seven-digit amounts to digitize a large number of factories, so you need to have a real business case," he says. "If you are building a completely new digital plant for millions of dollars then the investment for a digital twin is worth it, but we don't see the margin of benefit for this technology at the moment. We are not pursuing this actively because we think a smart startup will come along and figure out a faster and cheaper way to digitize." The Laundry & Home Care unit regularly works with startups. (See examples below.) "We are using a good mix of traditional big industry players but also newcomers," Holbach says.

Change from the Bottom-Up

But going digital "is not only about buying technology and putting it somewhere, we have to take the entire organization along," he says. "It is a big change-management endeavor. It is one of the reasons we don't have single lighthouse factories. We want to involve as many as possible. You can't do this top down. You have to have a bottom-up process that comes with training and skills assessment because the jobs of people will change. We usually recruit mechanical engineers, now it is more and more about systems and data analysts. We also need more systems engineers. We are hiring for these profiles but many others are too, so you have to be creative about how to engage good people."

Earlier industrial revolutions took several decades to fully materialize, notes Holbach. This one will happen faster but it is likely to take more than a decade. "I personally believe we have way more to learn," he says. "We are only at the beginning of what technology can bring us." ●

J.L.S.

The production of Somat dishwashing soap at a Henkel plant.



AT A GLANCE: HENKEL'S LAUNDRY & HOME CARE BUSINESS

The company's first product in 1876 was a laundry detergent. Today Henkel's detergent washes about 25 billion loads annually

- The consumer goods business includes well-known brands Persil, Pirex or Pril, and also encompasses laundry additives, dishwashing products, hard surface cleaners, toilet care, air care and insect control products.
- The Persil brand, sold in more than 50 countries globally, generated sales of more than €1 billion in 2017.
- Total sales generated by the Laundry & Home Care business were €6.651 billion in 2017.
- The proportion of sales from products successfully launched in the last three years was around 45%.
- 19% of Henkel's 53,000 Henkel employees worldwide work in Laundry & Home Care
- Laundry & Home Care represents 33% of Henkel group sales (47% come from Adhesive Technologies, 19% from Beauty Care)
- The Laundry & Homecare unit operates 31 factories worldwide

EXAMPLES OF STARTUPS WORKING WITH HENKEL

MICRO-BIOLYTICS GERMANY

WHAT IT DOES: Patented process digitizes liquid substances such as detergents while they are being produced. Data collected provides fast, reliable information on changes and impurities.

<https://micro-biolytics.com>

DOKS INNOVATION GERMANY

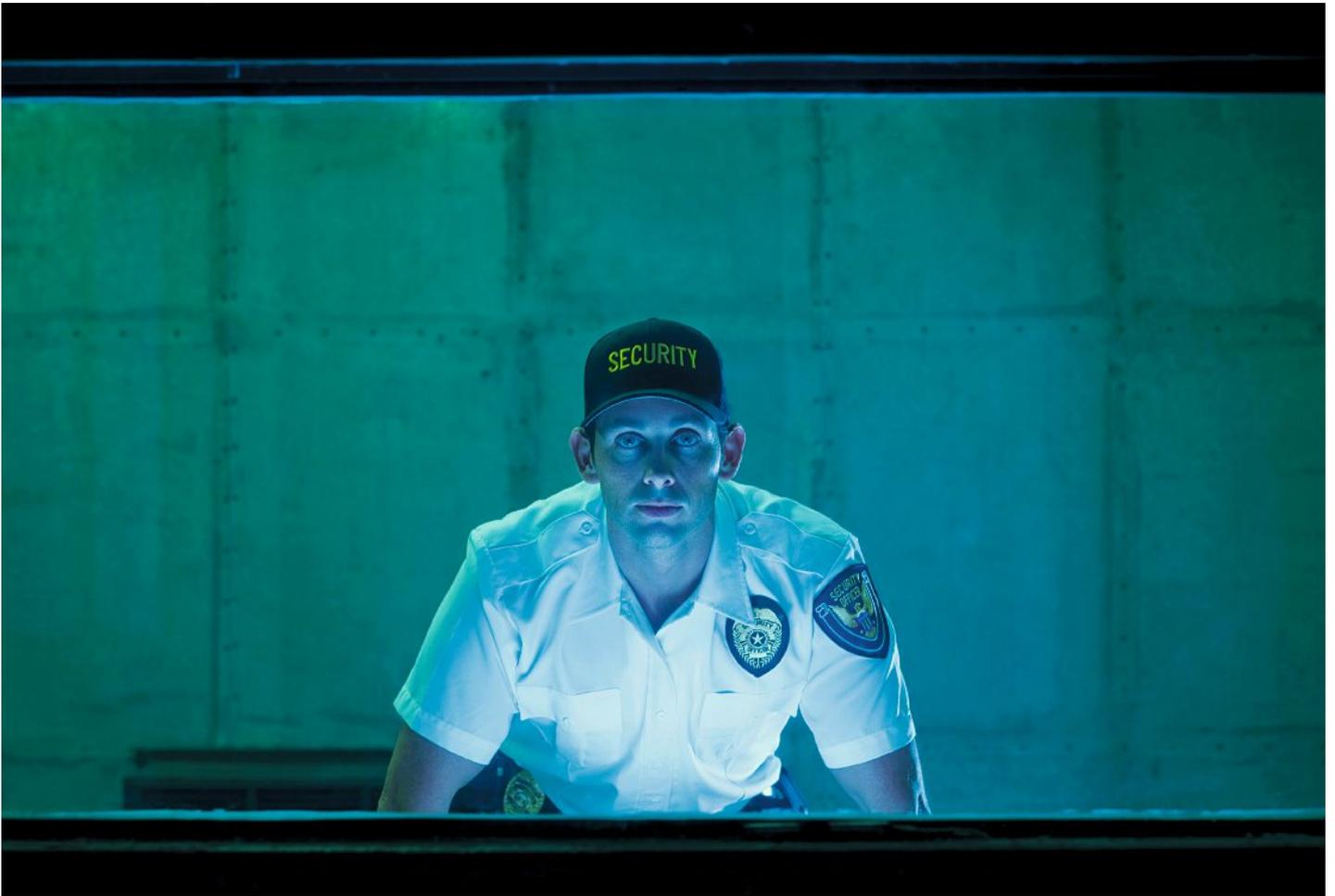
WHAT IT DOES: Automated stock-taking and inventory management based on smart multi-sensors and different autonomous carrier vehicles such as drones. Henkel is testing the technology in Serbia and Spain.

<https://www.doks-innovation.com>

ONE LOGIC GERMANY

WHAT IT DOES: Provides a data science platform and data analysis experts to improve forecasting.

<https://www.onelogic.de>



En Garde

— Industrial control systems are an easy, tantalizing target for hackers.

● **In 2017 NotPetya ransomware caused an estimated \$10 billion in damage as it shut down ports**, disrupted shipping, infected factories and hit power grids. Such havoc is entirely predictable. The Industrial Internet of Things (IIoT) is expected to transform manufacturing, energy, agriculture, transportation and other industrial sectors of the economy that, together, account for nearly two-thirds of the global gross domestic product. Unfortunately, many of these companies are unprepared for the potential risk and liability that may be brought on by connecting new technologies with old-world systems, including new threats to public safety, physical harm, and catastrophic

systemic attacks on shared public infrastructure, says a World Economic Forum report on secure market incentives for IoT.

As today's economy continues to prioritize time-to-market and the profitability of solutions over security, the threat of serious physical, financial and institutional harm grows, making factories and other types of critical infrastructure an increasingly tantalizing target for state-sponsored hackers, cybercriminals and political activists. "There is more and more need for security," says Philippe Duluc, chief technology officer, big data and security, at ATOS, the European IT services giant. "The surface of attack is increasing every day because we have this convergence between IT and objects. And with this evolution of global interaction we have more and more risks." Just how big the risk is can be hard to quantify. But in September, Germany's digital association Bitkom released a study that gives a troubling window into the magnitude of the problem. It revealed that 66% of the country's manufacturers have already been hit by some kind of cyberattack, resulting in \$50 billion in losses to the German economy.

Groups like Bitkom are calling on manufacturers to take such threats seriously. As networks expand and more objects get connected, the ripples from any attack can spread rapidly. Yet it's easy to overlook such dangers. Manufacturers look out over factory floors filled with machines and control systems that in some cases have been in place for decades and are dazzled by the potential to revolutionize that equipment by packing everything full of sensors, installing robots, harvesting rich data sets, and using artificial intelligence to optimize it all. The problem, say security experts, is that the old equipment never

required much security, since it was manually operated, or only connected via internal networks. Critical infrastructure providers such as factories are then adding sensors, robots, or other types of IoT equipment that also lack basic security, introducing yet more weak entry points for hackers. “When you have a large volume of operating systems, it creates vulnerabilities,” says Adam Kujawa, director of malware intelligence at Malwarebytes.

The older Industrial Control Systems, or ICS, make the security industry especially nervous. ICS refers to the technology that triggers a machine to perform a task or operate in some way. Such controls were at the center of an infamous hack on a steel mill that Germany’s federal agency for digital security disclosed in great detail four years ago.

In that case, hackers launched the attack by sending “phishing” emails that looked legitimate, but which included an attachment that installed malware when opened. This got them into the office network, and from there they were able to navigate into the software inside the steel mill. Once there, they seized the control systems and were able to stop a blast furnace from activating security settings, which caused systems to fail and damaged the mill. Those tactics have evolved, leading to the more recent attack that shut down a Middle East plant late last year. Security firms said they detected a piece of malware called TRISIS that was optimized to attack ICS. While other attacks had targeted controls, TRISIS targeted the safety systems, meaning that the systems that might trigger alarms or emergency shutdowns had been compromised.

Mitigating Mischief

More than two dozen companies, governments, organizations and universities have been collaborating with the World Economic Forum to co-design the Industrial IoT Safety and Security Protocol. This first-of-its-kind policy framework generates an understanding of how insurance might facilitate the improvement of IIoT security design, implementation and maintenance practices. It also sets forth a universal set of security best practices that should be incorporated in all IIoT deployments. The next steps are to pilot these incentive structures with governments, insurance firms and other private sector companies, refine the underlying operating models, and then share these outcomes to scale-up adoption internationally and across sectors. In the meantime this complex security puzzle has led traditional cybersecurity

leaders to develop specific solutions and expertise for Industry 4.0. Trend Micro of Japan, for example, offers extensive guidance to industrial customers on how to design their networks to limit access and potential fallout by segregating some operations. The company has also developed computing equipment that can be installed on ICS networks to monitor traffic as well as software to continually scan for vulnerabilities and mischief.

“The exponential growth of highly-available wireless networks coupled with an equal growing market of cheap and commercially available IoT devices is changing the risk equation,” says Ed Cabrera, the chief cybersecurity officer for Trend Micro. “The threat landscape is changing, making it more profitable for cybercriminals to hold factory floors and hospitals for ransom.” Unfortunately, cybersecurity firms face the challenge of explaining these issues to executives in industries where the knowledge base and experience is low. Christian Polster, chief strategy officer for the Vienna-based cybersecurity firm RadarServices, says the company has developed a wide-ranging platform that allows industrial customers to monitor operational and informational technology from a single security center. But reactions vary widely when Polster explains to a factory owner why such a comprehensive approach is needed. “Very often they are in the stage where they say they have a scanner and a firewall, and that’s it,” Polster said. “And then it’s very hard to convince them. But if they have a CIO and compliance programs, then it’s a signal that they are on their way to understanding what they need to do.”

Urgency may be growing as Industry 4.0 adoption accelerates. San Francisco-based Nozomi Networks was founded in 2013 to focus specifically on industrial security. It has developed a comprehensive industrial security platform that monitors all aspects of the network for vulnerabilities and malicious traffic, and pulls it all together into a central management console. The company has raised \$54 million in venture capital, including a new round of \$30 million at the end of September. Investors were no doubt responding to the huge market opportunity.

“Next year is going to be the first mainstream year for industrial cybersecurity,” says Edgard Capdevielle, Nozomi’s president and CEO. “We have passed the tipping point. People want more integration and a lot more intelligence in the production process, which creates more risk. Everyone has to care about security. If it’s connected, it’s exposed.”

Chris O’Brien

INDUSTRIAL CYBERSECURITY STARTUPS TO WATCH

NOZOMI NETWORKS UNITED STATES

WHAT IT DOES: Monitors networks which blend Industry 4.0 connectivity with traditional machinery controls. Its SCADAguardian appliance scans IT and operational technology networks for unusual traffic, pulling data into its Central Management Console.

www.nozominetworks.com

CLAROTY UNITED STATES

WHAT IT DOES: Specializes in security software to protect critical infrastructure such as electric grids, transportation networks and factory floors from cyber attacks. Customers include electric utilities, oil and gas companies, chemical manufacturers, water companies, and manufacturers.

www.claroty.com

CYBERX UNITED STATES

WHAT IT DOES: Provides an industrial cybersecurity platform for ongoing risk assessment that has the ability to detect unusual traffic sent between two machines, or M2M. Behavior analytics model industrial control systems to determine whether there is suspicious activity.

www.cyberx-labs.com

Fast Fashion Takes on a Whole New Meaning

— Going forward, robots will speedily make custom orders for people in the color, shape and size they want.

● **The clothing retailers Zara, Forever 21 and H&M improved supply chain management**, famously reducing product cycle times from nine months to nine weeks. It is called Fast Fashion – or in industrial parlance just-in-time – which means the fabric from the mill doesn't sit in a warehouse but shows up at the factory precisely when it is needed.

Bombshell, which claims to be the world's first fully-programmable clothes factory designed to deliver customized garments, cuts nine weeks to nine hours. It is an example of how traditional business-to-consumer manufacturing is set to shift to faster, more-personalized manufacturing, largely driven by consumer demands.

"We literally never make a product until someone clicks 'buy now' and tells us what color they want. Usually, within 24 hours it is on its way to you. That's the model," says Pablos Holman, a hacker, inventor and futurist. He now works for former Microsoft Chief Technology Officer Nathan Myhrvold at the Intellectual Ventures Laboratory on the West Coast of the U.S., where a wide variety of futuristic invention projects are under way. Holman built Bombshell a little over five years ago on his own time and on his own dime – to prove it was possible and would likely be the future of manufacturing. Holman's hunch proved to be prescient. Customized manufacturing is moving from possible to probable and looks poised to disrupt the \$2 trillion apparel industry as well as the production of many other goods. Jack Ma, executive chairman of Alibaba, calls it "the new

manufacturing." "In the past, it would be impressive if an assembly line could produce 2,000 of the same garments in five minutes," Ma said in a speech in September during Alibaba's annual cloud computing conference in Hangzhou, China. "Today onwards, making 2,000 different garments in five minutes will be more impressive," Ma said, adding that modern consumers aren't satisfied with mass-market fashion and are demanding unique outfits.

Closely related to Alibaba's New Retail strategy, a consumer-centric approach that merges online with offline for seamless shopping experiences, New Manufacturing will greatly impact traditional manufacturers in the next 10 to 15 years, Ma said. "New Retail seeks to redefine the retail sector," Ma said in his speech. He added that new manufacturing "will soon bring a wave of threats and opportunities to the manufacturing industry in China, and around the world. We must be prepared."

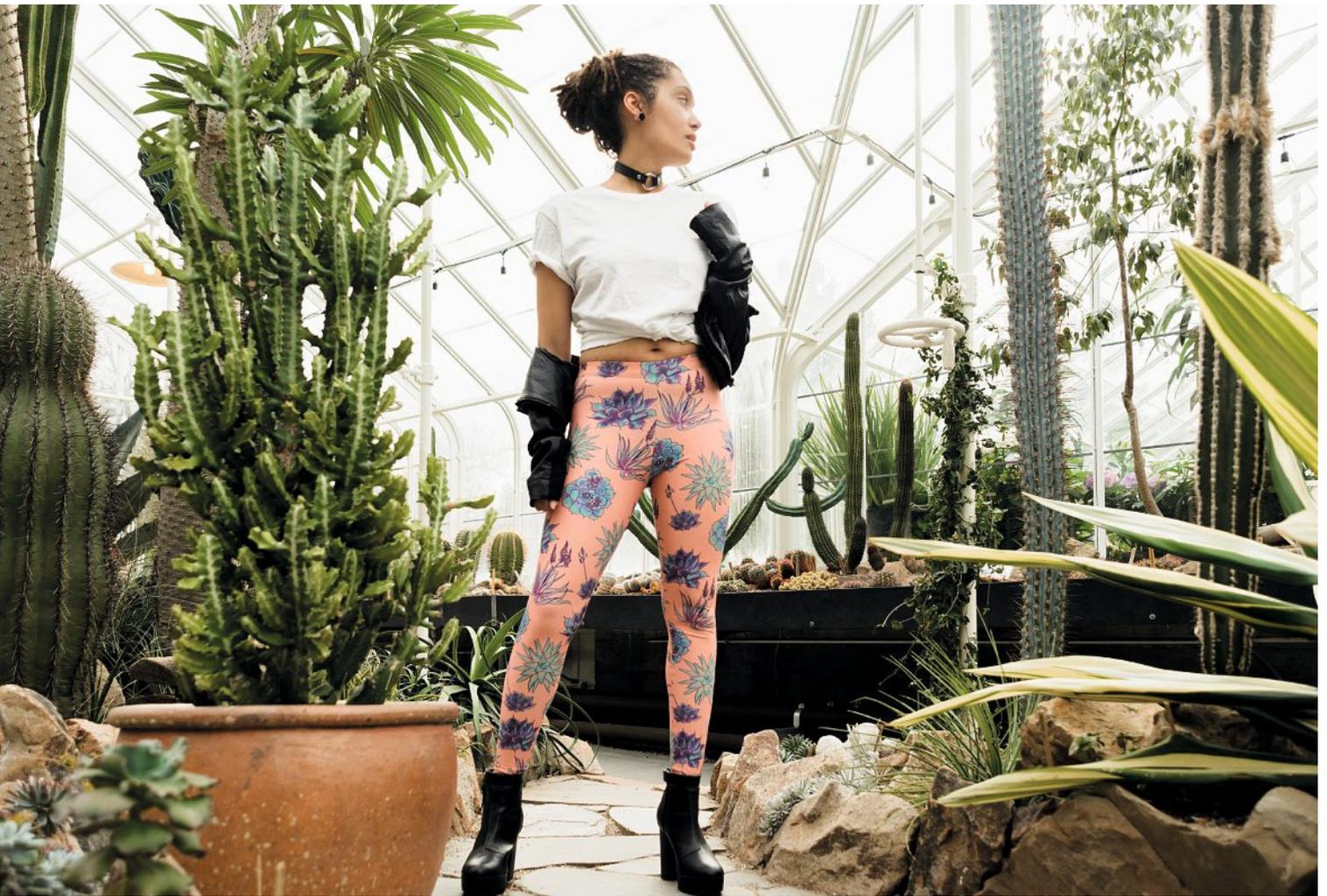
According to Ma, the lines between different industries will be increasingly blurred, and the manufacturing, tech and service sectors will become more interconnected. "You can't have one without the other," he was quoted as saying. "Data analysts and algorithm engineers of the future will not be working in-house at Internet companies, but in manufacturing facilities."

Upending an Entire Industry

Holman is blunt about why he launched Bombshell: "We started the company to upend an entire industry." "That is what disruption is," he says. In Silicon Valley the attitude is "we are not going to try and fix your industry. We are going to start from scratch and we are going to create a parallel industry using all the superpowers we get from our computers." The apparel manufacturing industry is ripe for disruption, he says. "When we show Bombshell [to traditional retailers] they all wish they had this company," says Holman. The reason? Inventory management. "They all have to guess nine months ahead what will sell and send back orders to China. And they always guess wrong," he says. That leads to liquidation sales, which "devalues their brands." On the other hand, if they don't order enough, "they are spending money to market things that have sold out... The winners are the companies that have lost the least."

Bombshell uses micro-production technology to make only one customized product so no one is expecting it to overtake the likes of Zara or H&M anytime soon. But the fact that it can make customized products from quality fabric and turn them around in a day at a price within reach for many people underscores the changes that Industry 4.0 will bring.

Bombshell automates a lot of what both factories and retailers do. Patterns uploaded by designers go on sale online within one hour. People still do the sewing but Holman suspects that will not be the case for long. For the moment producers of robots are focusing on automating high-value tasks



A model wears made-to-order leggings produced by U.S.-based Bombsheller, which claims to be the world's first fully-programmable clothes factory designed to deliver customized garments.

like surgery. But, he says it makes more sense to focus on automating sewing. “It is a two trillion dollar industry and nearly every human on Earth will come back every year for something new,” he says. Going forward, robots will increasingly make custom orders for people in the color, shape and size they want, he says.

Customization is Coming

That’s radically different from the way manufacturing is done right now. But soon, say pundits, no manufacturer anywhere in the world will be unaffected by Industry 4.0. This new industrial revolution is driven by changes in consumer expectations – they want customizable products delivered in Internet time – as well as the convergence of new technologies such as The Internet of Things, collaborative robotics, 3D printing and the cloud, together with the emergence of new business models. To remain

competitive industry observers say factories will have to accommodate custom designs and be able to make rapid changes to the products being produced. To do that they will have to: use the Internet of Things and other technologies to digitize the entire process; reduce time to market; integrate their supplier and production networks through Internet-based product lifecycle management so that employees throughout the network can collaborate; have semi-autonomous robots working alongside humans to accelerate production while ensuring quality; and analyze data collected about customers to offer a plethora of new digital services. “Customization is a key trend,” says Olivier Scalabre, a senior partner and managing director at the Boston Consulting Group (BCG). “And with new Industry 4.0 manufacturing it will be possible to satisfy this demand.”

Early examples include Adidas’ high-tech Speedfactory, which uses automation and 3D printing technology to support small-batch production of customized running shoes tailored to consumers near the production sites. The first Speedfactory was opened in Ansbach, Germany in early 2017, and another has since opened in the U.S. Clothes and shoes are not the only items being personalized. BCG has opened 10 innovation centers around the world to showcase how production lines will change. Among them is a facility near Paris that produces customizable scooters. “We are doing this





A robot holds a customized shoe in an Adidas Speedfactory

“In the past, it would be impressive if an assembly line could produce 2,000 of the same garments in five minutes. Today onwards, making 2,000 different garments in five minutes will be more impressive.”

to demonstrate the impact of Industry 4.0 to our clients,” says Scalabre. During the third industrial revolution factories were designed according to a few guiding principles: make a lot of one product and get better and better at doing it while decreasing costs. The objective was to specialize factories by product and move them offshore, where labor costs are less expensive. So the world ended up with mega factories, specialized by product, far away from consumer markets.

Technology is changing that. In the old system, switching a production line from one product to another required stopping the line, cleaning it, and resetting all the tools and the parameters. Thanks to collaborative robots and augmented reality tools, manufacturers can switch products at almost no cost, Scalabre says. What’s more, the introduction of IoT and digital twinning can boost productivity by 20% to 30%. Manufacturers now have a lot more flexibility. They don’t need to go offshore to obtain productivity gains because the new factories are much smaller so they can be closer to consumer markets. All this means that whereas products were once made to specifications, now they can be made to order, says Scalabre, driving the trend toward personalization.

Take beauty products. Now, a consumer can go into a shop, have their skin analyzed and order a special blend that a small, nearby factory delivers within a few hours. Or running shoes. Consumers can go into a Nike or Adidas store, have a 3D model made of their feet and order customized 3D-printed sneakers. While today such orders only represent a small percentage of global production there is a clear demand from consumers for “my cream, my shoes, my clothing,” Scalabre says. “Every industrial company that is making a choice about a design of a new factory in the

next 10 years is basically thinking about this at this very moment,’ he says. “There will not be 100% mass customization – it will likely impact maybe 15% to 30% of the market -- but it is happening. The traditional value chain will be broken apart and all the downstream manufacturers will move closer to the consumer market.”

China is among the fastest to embrace Industry 4.0 technologies, says Scalabre. “It will be one of the few countries in the world that will lead the way,” he says. “It will no longer be the factory of the world. It will build local factories for local customers.” Given that the next billion consumers in China are projected to inject more growth into the economy in the next five years than the top five mature European markets together, targeting their home market will make economic sense.

A Lesson in Disruption

So what can other industries learn from the disruption of manufacturing? “You may not care at all about apparel but you should consider this as a roadmap for technology-based disruption,” says Bombsheller founder Holman. “If we have surgical robots and self-driving cars then we will have self-driving sewing machines that allow us to re-engineer the apparel industry. That is what we are trying to show people.”

He warns industry leaders, “you are not immune. Don’t fixate on sewing machines because with the adoption of machine learning there will be something analogous in your industry and people you never heard of who have just dropped out of college will do an end-run around you.” ●

J.L.S.

Factory -in-a-Box

— Nokia and its partners are offering an agile – and portable – form of Industry 4.0 production.

● **Traditional manufacturers are under market pressure to work faster and be more flexible at the same time they are making the slow,** and sometimes painful, transition to digital. Enter Nokia's Factory-in-a-Box, which turns cargo containers into mini-manufacturing sites, replete with high-speed Internet of Things (IoT) connectivity, robotic assembly and other Industry 4.0 technologies. The factory-in-a-box can be packed, transported and brought into service at a new location within a matter of hours. Research firm Gartner calls it "a creative way to decentralize manufacturing capacity into smaller, portable sites supported by an ecosystem of partners." Nokia's idea originated as it looked toward the supply chain of the future, with the introduction of robotics, IoT solutions, and the cloud. It is part of Nokia's Conscious Factory project, the company's vision of how factories and networks should work together, says Johannes Giloth, senior vice president of global operations and chief procurement officer at Nokia. The project was accelerated

with the launch of Nokia's Digital Creativity Lab in Munich, Germany, toward the end of 2017. The final step in the proof of concept was the creation of a moveable mini electronics factory that was able to complete the full manufacturing of a printed circuit board as well as robotic assembly and testing. A Nokia-led group – which includes Factory-in-a-Box partners Beta Layout, DHL, Fuji, HARTING, Isel, Isolec, MTEK Consulting, Mycronic, Rehm Thermal Systems, Viscom and 42Q – showcased this application at Hannover Messe, a German industrial technology trade show, in April.

Industry Agnostic

Manufacturing inside the containers is not limited to making electronics, says Giloth. "We started with electronics due to the specific needs of that industry but the Factory-in-a-Box is industry agnostic," he says. Manufacturers can't use the portable factories for die casting, a metal casting process that involves forcing molten metal under high pressure into a mold, but they can make



A robotic assembly line inside Nokia's Factory-in-a-Box

anything that requires 3D printers to be connected together.

"There are endless use cases," Giloth says. Among them:

- Assembly in country of origin: A container can be driven or shipped to a location, build the required volume locally, and then be moved again.
- New product introduction: Time to market is a competitive advantage. The Factory-in-a-Box can be used for fast prototyping of new products and quick fixes, services that could appeal to startups as well as traditional manufacturers. When they are ready for mass production, they can go elsewhere.
- Disaster recovery: When a natural or man-made disaster strikes a

business a portable plant can help deliver critical customer orders.

- Ramping up and down: Factory-in-a-box can be a handy standby solution, helping enhance capacity when needed.
- Training: The portable unit can be used to train factory workers.
- Limited trials: Universities could use the mobile units for specific projects or experiments.

The containers are Lego-like so manufacturers can easily configure more than one on-site. Pricing depends on use cases, Giloth says. Nokia expects that big manufacturers like FoxConn or Flextronics might be interested in buying 10 or more of the portable factories and keep them on hand to enhance capacity as needed, Giloth says. Smaller manufacturers, startups or universities are likely to rent them. The rental fee will depend on what kind of equipment and connectivity is required for particular applications. Giloth says Nokia expects to sign its first commercial contracts for its Factory-in-a-Box in the coming months. ●

KONUX GERMANY



WHAT IT DOES: Offers an end-to-end Industrial Internet of Things solution combining smart sensors and AI-based analytics to enable predictive maintenance for industrial and rail companies. It raised \$20 million series B financing last April.

www.konux.com

MAANA UNITED STATES



WHAT IT DOES: Maana's knowledge graph, coupled with advanced AI algorithms, semantic search and deep learning, help industrial companies make faster and more relevant decisions. Investors include Shell, Aramco and Intel Capital.

www.maana.io

FETCH ROBOTICS UNITED STATES



WHAT IT DOES: Develops autonomous mobile robots that provide on-demand automation for warehouses, factories and distribution sectors. Cloud-based software allows robots to be operational within 24 hours. SoftBank and Sway Ventures are among its investors.

www.fetchrobotics.com

CARBON 3D UNITED STATES



WHAT IT DOES: This 3D printing company has developed a system of connected manufacturing unit operations that enables repetitive manufacturing of end-use products at any scale. Its technology is used to produce Adidas' 3D sneakers as well as electronics, industrial components and medical devices.

www.carbon3d.com

FOGHORN SYSTEMS UNITED STATES



WHAT IT DOES: An Internet of Things application platform for remote monitoring and diagnostics, predictive maintenance, anomaly detection, alarm management, and asset and yield optimization solutions. It targets the manufacturing, mining, energy and utilities, transportation, healthcare, retail, oil and gas, and aviation industries.

www.foghorn.io

SEEGRID UNITED STATES



WHAT IT DOES: Self-driving, vision-guided robots that handle and deliver materials for warehouses, factories and the distribution sector. Clients include Amazon, GM, Whirlpool, Boeing, Jaguar, BMW and Daimler.

www.seegrid.com

3DSIGNALS ISRAEL



WHAT IT DOES: Developed a predictive maintenance platform using acoustics. Hardware that includes wireless ultrasonic sensors is mounted near industrial rotating equipment. Its software technology collects and processes the sound signals in order to detect issues before machines break down. Global research firm Gartner named it a cool vendor in June of this year.

www.3dsig.com

SCADAFENCE ISRAEL



WHAT IT DOES: Protects Industrial IoT/Industry 4.0 networks from cyber threats. Customers include Global Fortune 500 companies in the automotive, pharmaceutical, chemical and energy industries.

www.scadafence.com

TULIP UNITED STATES



WHAT IT DOES: It has developed a manufacturing app platform that introduces Industrial Internet of Things (IIoT) and advanced analytics into the workflow. An intuitive drag and drop interface lets process engineers build apps, connect to the IIoT, integrate with their systems and collect real-time data, without having to write any code.

www.tulip.co

MNUBO CANADA



WHAT IT DOES: Developed an IIoT insights platform that helps companies rapidly transform their connected equipment data into actionable business outcomes. Investors include HSB Group, a part of Munich Re.

www.mnubo.com

DESKTOP METAL UNITED STATES



WHAT IT DOES: Developed a 3D-printing system that can mass produce metal components, allowing teams to go directly from computer-aided design to rapid prototyping and volume production.

www.desktopmetal.com

TOP 25 INDUSTRIAL INTERNET STARTUPS TO WATCH

COMMONSENSE ROBOTICS ISRAEL



WHAT IT DOES: Develops urban warehouses and operates the sites with autonomous mobile robots and a cloud-based software. The idea is to enable retailers to more easily deliver products in city centers. It recently launched its first automated center in Tel-Aviv.

www.cs-robotics.com

UPSKILL UNITED STATES



WHAT IT DOES: UpSkill has developed Skylight, an augmented reality platform for industrial use that promises to cut production time by 25% and reduce errors to nearly zero. Customers include Boeing and GE.

www.upskill.io

ELECTRIC IMP UNITED STATES



WHAT IT DOES: A hard-and-software platform-as-a-service purpose-built for the Internet of Things that enables commercial and industrial applications. The aim is to empower manufacturers to manage and quickly scale their connected products and services to millions of users.

www.electricimp.com

PROGLOVE GERMANY



WHAT IT DOES: Connected gloves that enable manufacturing and logistics staff to work and scan products at the same time. Its integrated user-friendly scanner enables users to gain time as they work. Clients include BMW, Thyssenkrupp and Lufthansa.

www.proglove.de

ACTILITY FRANCE



WHAT IT DOES: Manages Internet of Things connectivity for large corporate clients. Actility's low-power, wide-area networking technology allows long-range communications between connected devices while promising to optimize both costs and power-consumption requirements.

www.actility.com

SEEBO ISRAEL



WHAT IT DOES: Process-based Industrial AI solutions for predicting and preventing manufacturing disruptions. Customers include Decathlon and Ralph Lauren.

www.seebo.com

UWINLOC FRANCE



WHAT IT DOES: The Toulouse-based startup created an indoor location system that tracks large volumes of assets with connected battery-less tags. Applications include manufacturing, healthcare, logistics and e-commerce. In July it won a Volkswagen and Siemens Startup challenge.

www.uwinloc.com

PRESENTO ISRAEL



WHAT IT DOES: Uses AI and machine learning to deliver predictive analytics for industrial systems. Its technology collects data at high speed and provides real-time asset failure predictions based on the monitoring of sensor signal data in the cloud.

www.presenso.com

KITOV SYSTEMS ISRAEL



WHAT IT DOES: Uses computer vision, AI, advanced robotics and Big Data analytics to conduct visual inspection of industrial manufacturing plants. It just raised \$10 million in a Series A round, led by HAHN Group.

www.kitovsystems.com

NEXDEFENSE UNITED STATES



WHAT IT DOES: Originally funded by the U.S. Department of Energy, it develops cyber security software for automation and control systems used in factories or energy grids. Utilities and companies in the oil and gas, defense, manufacturing, water/wastewater and pharmaceuticals industries use its technology.

www.nexdefense.com

SIGFOX FRANCE



WHAT IT DOES: A leading global, low-power, wide-area network that powers the Internet of Things by enabling objects to communicate. The company is about to launch a new service for tracking objects based on battery-less stickers and hotspots called Bubbles.

www.sigfox.com/en

ELEMENTAL MACHINES UNITED STATES



WHAT IT DOES: This spinoff of MIT uses the cloud, Internet of Things and machine learning technology to model and understand how processes in a laboratory or factory work. It then uses that knowledge to help obtain consistent, repeatable results, saving companies time and money.

www.elementalmachines.io

CLAROTY UNITED STATES



WHAT IT DOES: Specializes in security software to protect critical infrastructure such as electric grids, transportation networks and factory floors from cyber attacks. Customers include electric utilities, oil and gas companies, chemical manufacturers, water companies and manufacturers.

www.claroty.com

MOV. AI PORTUGAL



WHAT IT DOES: A software framework for mobile robots used in warehouses and on production lines. Features such as easy mapping, autonomous navigation and obstacle avoidance enable industry-grade deployment of robot fleets.

www.mov.ai

By Esther Attias

A contributing writer at The Innovator. Attias works as a freelance journalist for Les Echos and Les Echos START

Waze for Factories

— The slightest variable can lead to batch yield issues in factories and R&D labs. Elemental Machines is using a combination of Internet of Things and machine learning to ensure consistent outcomes.

● **Serial entrepreneur Sridhar Iyengar's first exposure to quality control problems in manufacturing came not long after founding his first company, AgaMatrix.** The startup, which counted the French drug maker Sanofi among its customers, specialized in disposable test strips to calculate the blood glucose levels of people with diabetes or hypoglycemia. It contracted with a factory to make several million strips a day but quickly ran into batch yield issues. "I spent 53 nights in 52 weeks in the same hotel in South Korea trying to fix the problem," remembers Iyengar. He and his co-founder gathered all the data from the contractor, augmented that with sensors in the factory, and built their own dashboard and prediction algorithms. The yield went up to virtually 100%, he says. "We were able to predict the quality of output two to three months in advance and if we saw a high risk we were able to use our own tech tools to pinpoint where the issues were," says Iyengar. That helped the company snag CVS, a large U.S.

drugstore chain, as a customer. AgaMatrix went on to create the first medical device (a glucose meter) that could be plugged into an iPhone, and was bought out by Sanofi. Next, Iyengar founded Misfit Wearables, together with John Sculley, the ex-CEO of Apple. The company's health trackers created a data-rich, globally distributed sensor network. For Iyengar it was an "aha" moment. Why not create a Fitbit for machines and use that data to improve the yield of R&D trials in biotech and life sciences as well as manufacturing anything requiring precision and repeatable results?

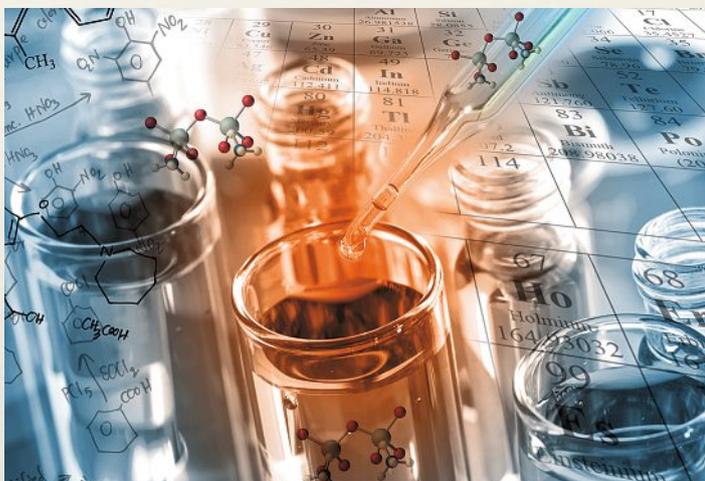
No Waste, High Yield

So, Iyengar founded Elemental Machines, which uses the cloud, Internet of Things and machine learning technology to model and understand how processes in a laboratory or factory work and then use that knowledge to help obtain consistent, repeatable results, saving companies time and money. The

Boston-based startup pulls data out of machines that aren't currently connected to anything, collates it with data from equipment that is already monitored, analyzes what is happening in real time and displays it on dashboards. The company, which has so far raised \$11.5 million, has 100 customers ranging from small startups to big pharmaceutical, petrochemical and food manufacturers. "We are building the hardware and software tools that allow companies to model and understand how complex processes work and very rapidly zero in on what went wrong, or right," says Iyengar. "If things are done correctly there is no waste and high yield, and it can also help prevent drugs and other products from being recalled."

When valves or other parts fail machines don't always automatically report the error. Many times errors are only discovered after a beta trial, which can cost hundreds of thousands of dollars, says Iyengar. Take the case of a synthetic biology company, one of Elemental Machine's customers.





"We are building the hardware and software tools that allow companies to model and understand how complex processes work."

When it grows cells it warms them to 37 degrees celsius and the flasks are gently shaken to both blend and aerate the cell mixture.

"The company was consistently getting bad results and couldn't figure out why," says Iyengar. Finally, they discovered that a tiny screw was loose in one of the machines that

shakes the mixtures. The shaking vibrations and the rate of aeration were a little bit different so the cells grew at a different rate, expressed themselves differently, impacting the purity rate. "It took them months to figure this out," says Iyengar. "Now they are using our technology to measure all the variables that may

affect their yields and outcomes." Earlier this month Elemental Machines announced it is partnering with PerkinElmer to allow scientists, as well as lab and facilities managers, to access information at any time from a computer or mobile device about what is happening inside their laboratories and be notified of

potential problems when conditions change. While Elemental Machines started by focusing on helping R&D laboratories control variables it has since branched out into manufacturing. One of its manufacturing customers, a materials science company, was not measuring temperature, humidity or light in the areas where it was mixing chemicals.

"Turns out the microclimate made a huge difference," says Iyengar. Now the manufacturer is using the startup's technology to measure those elements and analyze the data.

Turn-by-Turn Navigation

Iyengar sees many more applications for the technology. "Now that we have a way to collect and analyze all of this data it allows us to generate a numerical representation of quality and use that to train our models on the way the process is actually run," he says. While it is still early days, Iyengar says he believes it will be possible to develop a system for R&D trials and manufacturing that would operate much the same as Waze, a GPS navigation software that works on smartphones and tablets to provide drivers with turn-by-turn navigation information.

Elemental Machines' "Waze for factories" could prove crucial not just to traditional R&D labs and manufacturers but to a variety of emerging fields, such as personalized medicine and next generation materials like lab-grown leather and meat, where precise and repeatable results are crucial, he says. ●

J.L.S.



How 3D Printing is Impacting Manufacturing

— The technology is being used to manufacture everything from orthodontic devices to cars and rocket engines.

By Chris O'Brien

● **MakerBot was among the first to develop desktop versions of 3D printers** that put additive manufacturing within reach of a new generation of entrepreneurs and product developers. Initially it saw sales grow fast but they hit a wall when widespread consumer interest failed to materialize. Stratasys, a leader of industrial additive manufacturing, acquired it in 2013 for \$604 million. That's not surprising because the industrial space is where analysts believe the real potential of 3D printing lies. Research firm Gartner projects that by 2021 at least 40% of factories will embrace some kind of

additive manufacturing technology, the term used to refer to industrial 3D printing. Some 1,768 metal additive manufacturing systems were sold in 2017, up 80% from 2016, according to 3D printing analyst firm Wohlers Associates. The 2018 report notes there were 135 companies selling industrial 3D printing systems in 2017, up from 97 the previous year.

Demand is particularly strong in industries such as medical devices, automotive, aerospace, defense and heavy industrial equipment. Align Technology, the orthodontic company that makes Invisalign aligners and retainers, a popular alternative to braces, manufactures every unit using a 3D printing process. Last year Local Motors, a design startup, began 3D printing its self-driving shuttle Olli at its Knoxville microfactory. The company says 3D printing will cost half as much as traditional production while allowing it to customize each shuttle to fit the needs of customers.

SpaceX, founded by Silicon Valley entrepreneur Elon Musk, has created the engine chamber for its SuperDraco rocket by 3D printing it from an alloy that combines nickel and iron. The company said 3D printing allowed it to dramatically reduce the time from designing to manufacturing the chamber. At the more fantastic end of the spectrum, the European Space Agency has announced it will create a village on the moon by placing 3D printers there to "print" the various structures.

The Prospect of Lower Cost, Greater Flexibility and Imaginative Designs

3D printing has existed in some form for decades. Using plastics, resin or metal, a machine reads a computer-design pattern and places layer upon layer of material to create a three-dimensional object. As early as the 1980s, large companies were turning to costly industrial 3D printing for

Airbus' 3D printed mini plane THOR was designed to test the ability to use additive manufacturing in aeronautics. All the parts except for the engine were made by a 3D printer,
Photo courtesy of Airbus.

prototyping. Later, in the '90s, 3D printing allowed mass customization of items such as hearing aids.

Over the past decade advances in material science and design software, coupled with the falling cost of tools to power industrial printers, have put the technology within reach of more corporate customers. The draw is the tantalizing prospect of lower costs, greater flexibility and customization, and imaginative new designs. Manufacturers eager to transition to industrial 3D printing still face barriers such as material limitations, regulations, and a lack of awareness among industrial designers. But producers who are among the first to find ways to overcome those challenges could gain a major manufacturing advantage in the years to come. "When using it correctly, 3D printing can save money, reduce time to market, and result in higher quality products," says Wohlers Associates President Terry Wohlers. "Using it for production volumes can result in new types of products and businesses." The opportunities inspired the Obama administration to make additive manufacturing a critical part of the \$1 billion plan announced in 2016 to revitalize the American manufacturing economy. That initiative included creating the National Additive Manufacturing Innovation Institute (NAMII) in Youngstown, Ohio to encourage further development of and investment in this technology. But a growing number of private industry players are making sizable investments on their own.

Airbus Helps Industrial 3D Printing Take-Off

Aeronautics giant Airbus has even created a position called Innovations' ALM (Additive Layer Manufacturing) Roadmap Leader to spearhead its aggressive efforts, which include opening a material research laboratory near Munich that focuses in part on additive manufacturing.

Since that lab opened two years ago, Airbus has outfitted one of its airplanes with a titanium 3D-printed bracket in the section between the wings and engines. It has also installed several other 3D printed products in various planes. The company's Defense and Space Division in the U.K. has developed aluminum 3D printed components for its satellites. And APWorks, Airbus' 3D printing subsidiary, has even built an electric motorcycle, called Light Rider, made primarily from 3D-printed components including hollowed frames that are super strong and lightweight. More widespread 3-D printing could massively reduce wasted material, generate big fuel savings with lighter aircraft and vehicles, and reduce the cost of replacement parts which could be created on-demand rather than built in bulk and stored. "There are about 1,000 parts manufactured within an aircraft," says Gartner analyst Pete Basiliere. "It really adds up."

Chain Reaction

GE has also invested heavily in additive manufacturing, pumping a reported \$1 billion into projects that span its business lines. One notable initiative is a project to design 3D printed replacement parts for nuclear power

"3D printing can save money, reduce time to market, and result in higher-quality products."

plants. In 2016, GE Hitachi Nuclear Energy was selected by the U.S. Department of Energy to spearhead this \$2 million project. Fran Bolger, GE Hitachi's Manager of New Product Introduction, says the nuclear group will try to take advantage of additive manufacturing already used in the conglomerate's other businesses. With the nuclear project though, any new 3D printed part would have to be reviewed by energy regulators before it could be deployed. Still, optimism about 3D printing runs high at GE. "We have to find the right opportunities and the right level of cost," Bolger says. "The more complex the part is, the more savings you can potentially get. There is work to be done in terms of qualifying the material in a highly regulated industry. But we're starting to think about applications where we can deploy it."

An Opportunity for Startups

The surge in additive manufacturing has attracted a growing number of entrepreneurs who are tackling issues like developing printers for different industries, as well as new materials, services and design software. "When we started in 2013, we felt 3D printing was an amazing technology," says Stephan Kuehr, CEO of 3Yourmind, a Berlin-based startup. "But the tools you needed to access the printers were way too complicated." The company, which has created a platform to streamline 3D from the design stage to analyzing materials and powering the printers, has raised \$13 million in venture capital. Industrial 3D printing startups have attracted \$1 billion in venture capital across 133 deals since 2013, according to research firm CB Insights. A large chunk is coming from corporations. GE Ventures, for instance, has made six investments while its corporate parent has acquired



THE FACTORIES OF THE FUTURE



three related startups. BMW invested in 3D printing startups Desktop Metal, Carbon and Xometry. Siemens, the Germany-based industrial giant, has also been active, investing in startup Markforged and acquiring Materials Solution.

Siemens' and Henkel's Roles in the Market

Siemens sits at an interesting crossroads in the additive manufacturing movement. While the company sells a wide range of software and services, including additive manufacturing solutions, to other manufacturers to help them reinvent their factories, Siemens also uses additive manufacturing across a wide range of its own businesses. The company announced earlier this year it was investing \$35 million in a new manufacturing facility in the U.K. focused on materials solutions. The facility will produce components for aerospace, automotive and other industries. Yet Siemens still has plenty of challenges, says Heinz Neubert, who oversees additive manufacturing there. The skills needed to design and conceive of 3D-printed products are still in short supply. So Siemens created an internal design lab to help different divisions navigate the development process. Neubert notes that the technology is advancing so rapidly that adapting and staying current represents a major challenge for manufacturers accustomed to evolutions that took decades.

"Every year the machines are changing a lot," he says. "You're not talking about drilling machines which might remain the same for years. In additive manufacturing, there is a tremendous amount of innovation happening right now." Other industrial players remain worried about the initial costs involved, unsure if the promised savings or design breakthroughs will really materialize. The sprawling range of software, machines and materials can



Local Motors, a design startup, began 3D printing its self-driving shuttle Olli at its Knoxville microfactory.

Photo courtesy of Local Motors.

also seem daunting. And Gartner's Basiliere said there is still a limited choice of materials that can be used in additive manufacturing. To address that, Henkel, the German chemical and consumer goods giant, earlier this year announced new 3D Printing material solutions for industrial manufacturing. The materials, such as acrylic, silicone, epoxy and polyurethane adhesives, will increase the possible uses for additive manufacturing. The company is also working to create customized materials for customers' specific needs.

Enormous Opportunity

For Pat Dunne, vice president of advanced application development at Rock Hill, South Carolina-based 3D Systems, this frenzy of activity and interest in additive manufacturing is the realization of a dream. Founded in 1986, 3D Systems was a true pioneer of 3D printers. Today, it provides additive manufacturing systems used to produce artificial teeth, dentures, orthodontics, race car parts, replacement components for vintage autos, and even some parts of the Mars Exhibition Rover.

For now, Dunne says his biggest challenge is educating industrial clients about the potential. "As more and more designers become aware of the capability to use this to engineer products in a new way, that's what's really going to drive adoption," he says.

ADDITIVE MANUFACTURING STARTUPS TO WATCH

3YOURMIND GERMANY

WHAT IT DOES: Created a platform to streamline 3D printing by speeding up the workflow, from design to analyzing materials to powering the printers. The goal is to make 3D printing more efficient and accessible to all team members.

www.3yourmind.com

DESKTOP METAL UNITED STATES

WHAT IT DOES: HSystem can print 3D metal prototypes or small batches of products. A larger version promises to print metals at a pace and scale to replace traditional manufacturing methods.

www.desktopmetal.com

CARBON 3D UNITED STATES

WHAT IT DOES: Developed a 3D printing alternative that uses light and oxygen to allow users to produce products from resin. The company says its combination of hardware and software allows for more economical printing at a larger scale.

www.carbon3d.com

Using Data as an Asset

— A plant run by Bayer’s Pharmaceuticals division in Italy is considered one of the world’s most advanced factories.



A worker at the Garbagnate plant using augmented reality technology to reduce changeover times when switching product lines.

● **Bayer’s pharmaceuticals division**, like units of most big corporations, generates lots of data but, until recently, managed to leverage only a small amount of it. Thanks to a pilot project – part of the company’s Advancing Digital transformation initiative – it’s making better use of data, and its plant in Garbagnate, Italy has become a “lighthouse” factory teaching others how to do the same. The plant, which produces and packages pills, was named one of the most advanced factories in the world in September by the World Economic Forum and McKinsey. Nine factories were recognized for their strides toward embedding the technologies of the Fourth Industrial Revolution into modern production, improving operational performance in the process. The Garbagnate pilot, which was launched in September 2017, uses machine learning and analytics to increase operational efficiency; a digital twin (digital replica technology) for

employee laboratory scheduling, and augmented reality (AR) devices to reduce changeover times when switching product lines. In each case the front-end applications are connected to 15 data sources and integrated into the plant’s IT infrastructure. Ongoing operations are now more transparent to employees on the factory floor and they get real-time updates on performance, helping them make smarter decisions, react faster and utilize resources more efficiently, says Hans-Walter Hoehl, head of efficiency, innovation and projects within the product supply unit at Bayer’s pharmaceuticals division. “The first results are very promising,” says Hoehl. “In certain areas, such as coating tablets, we could further optimize the manufacturing process and eliminate root causes for potential variations. Bayer’s pharmaceuticals division plans to roll out the digital initiatives to other major sites in the near future. And, it has agreed to share what it has learned with other

manufacturing businesses, to aid the adoption of technologies, as part of a new program launched by the World Economic Forum. The aim of the program is to build a network of the most advanced manufacturers to address problems confronting industries when they invest in advanced technologies. Earlier work by the Forum found that over 70% of companies do not take pilots beyond the implementation stage due to unsuccessful implementation strategies. Digitizing factories goes far beyond implementing technology. “When there is much more available data it also requires a change in the culture of decision-making,” says Hoehl.

Making the Most of Data

Data scientists played a key role in digitizing Bayer Pharmaceutical’s plant by developing the algorithms that turn data into useful insights to enable more efficient production of drugs. Three steps were required to develop the algorithms. First, the data had to

be prepared: different data sources need to be “cleaned” and connected to be applicable for advanced analytics. Next, the algorithms had to be set up through a modeling process. Different machine learning techniques were implemented to enable the algorithms to make predictions. Finally, the company needed to figure out how to visualize the insights in ways that employees on the factory floor could interpret easily.

That is where technologies like the digital twin come in. A machine learning-powered digital replica of a laboratory now takes care of employee scheduling to maximize efficiency. “Output increased by 40% and people love it because it makes their work better and easier,” says Hoehl. “We want to make this readily available to labs across the whole network.”

AR, another visualization tool, is helping significantly reduce the time it usually takes to change from producing one product to another, increasing the utilization of factory machines, says Hoehl. Not only was the production time reduced but employees no longer have to follow lengthy, complicated paper-based instructions, he says. That is not to say that digitizing a factory is without challenges. Structuring the data and putting the necessary connectivity in place is a lengthy process but competition for skilled data scientists is fierce. Digital transformation also requires lots of employee training. Internal experts on quality control, packaging and engineering need to be an integral part of the process and managers must learn to make decisions based on data rather than on prior experience only. Hoehl’s advice to factories embarking on a digital journey? “Start by designing use cases for the technology and then select a partner that can help you rather than trying to do everything on your own.” ●

J.L.S.

Man and Machine

— Robots are increasingly working next to humans, raising efficiency in warehouses, factories and labs.

By Chris O'Brien

The Panda is a collaborative robotic arm designed by Munich-based Franka Emika to perform repetitive tasks that it can be taught by pushing a few buttons on its arm.

● **At a warehouse in the French city of Bordeaux,** Skypod, a robot created by startup Exotec Solutions, carries a bin that can hold up to 30 kilograms as it wheels around using a laser scanner for navigation. When it reaches inventory racks, it grabs onto rails and glides upward until it finds the correct shelf to retrieve the merchandise. The Skypod then zips to a conveyor belt where a human uses a scanner to verify the goods. These robots save physical wear and tear on employees, who walk an average of 15 kilometers a day fetching goods. The robots can retrieve 400 items per hour, compared to 80 for humans. They also allow French ecommerce retailer Cdiscount, which is trying to transform its logistics to stay ahead of competitors, to build shelves higher and pack items much

closer together, making better use of space in its existing warehouses.

Vincent Valloir, head of supply chain planning and innovation for Cdiscount, says using Exotec Solution's robots is helping it avoid the expense of building additional warehouse space. It is also increasing the number of same-day deliveries it can handle, by improving order processing speed. But, rather than replacing employees with robots, the company is redefining their roles, training them to do new tasks such as managing the robotic systems or monitoring digital systems.

"This innovation changes the approach and the roles of everyone in the organization," says Valloir.

For several decades, talk of automation has conjured a bleak vision of a future in which robots steal jobs from workers as machines battle humans for economic dominance. But, as the Cdiscount example illustrates, the emerging reality is a picture of cooperation, rather than conflict, as robots and people increasingly work side-by-side in warehouses, factories and labs.

As at Cdiscount, robots are fetching inventory in warehouses to speed



“There is a real synergy between robots and employees.”

fulfillment. They're also being installed in production facilities to perform a growing range of tedious, repetitive tasks. And in some cases, they're even being attached to humans in the form of exoskeletons to help with lifting and avoiding injuries.

“Robots allow enterprises to be more competitive and to run better, especially small and medium-sized businesses,” says Adrien Poinssot, Universal Robot's sales development manager for France. “And if the work goes better, the company hires more people. There is a real synergy between robots and employees.” Robots have been part of manufacturing for decades, primarily used in heavy production lines for things like automobiles. Early models were considered hazardous to humans and some had to be caged. And their size and cost meant they only made economic sense for such massive operations. Over the past decade, things have changed dramatically.

According to the International Federation of Robotics' latest annual report, global annual sales of industrial robots grew to 387,000 units in 2017, up from 294,300 the previous year. That includes 69,000 robots installed for use in logistics, up from 26,300 in 2016, making adoption of robots in this sector one of the highest for any sector. Overall, robot sales are projected to rise to 630,000 annually in 2021, benefitting established industrial robot-makers such as Germany's KUKA (now owned by Chinese electrical appliance manufacturer Midea), as well as a host of new players.

The market is not without casualties. Rethink Robotics of Boston, which was co-founded by Rodney Brooks, an Australian robotics pioneer, announced in early October it would shut down. Its robots were intended to usher in a new age of automation; one where machines would work safely next to humans, rather than be confined to their own sections on the factory floor. That trend looks here to stay even though Rethink Robotics couldn't get enough market traction.

Filling the Fulfillment Gap

A seminal moment in industrial robotics came in 2012 when Amazon acquired Kiva Systems for \$775 million. Kiva had emerged as a leader in the robotics revolution, having developed an inventory management system that allowed machines to roam a warehouse, find goods, and then bring them to a human packer waiting in front of a delivery truck. The acquisition gave rise to Amazon Robotics, a Massachusetts-based company that manufactures mobile robotic fulfillment systems. It now reportedly has produced more than 100,000 robots used in the e-commerce giant's fulfillment centers. The acquisition created a void because Kiva is no longer selling its robots to anyone else. As a result, a large number of startups have rushed

to fill that gap. Among them is Los Angeles-based inVia Robotics, which has designed a warehouse robotics platform for e-commerce distribution centers and other fulfillment facilities. Founded in 2015, the company, which has raised \$29 million in venture capital, says its inVia Picker autonomous mobile robots can help clients increase fulfillment by as much as 500%. “Warehouse automation is critical for retail businesses to streamline workflows, increase throughput and keep up with consumer demand,” says Lior Elazary, the company's co-founder and CEO.

The founders of Lille-based Exotec Solutions saw a similar opening. Founded in 2015, the company has raised \$21 million in venture capital for its robotic fleet of order preparation robots, which it co-designed with Cdiscount. Exotec Solutions CEO Romain Moulin says such systems are quickly moving from being considered a novelty to an essential tool for all warehouses. “The demand from the market is huge,” Moulin says. “And it's going to play a big role in leveling the playing field for everyone.”

Beyond just finding and moving items, robots are increasingly being employed to perform straightforward chores like packing boxes and doing some basic assembly of components.

For example, Munich-based Franka Emika, which was founded in 2016, makes Panda, a collaborative robot designed to be easy to use out of the box. (See the photo on pages 32 and 33.) The Panda can be programmed to perform tasks by pushing several buttons on the arm while guiding it through a series of maneuvers to “teach” it the process.

The most well-known player is Universal Robots of Denmark, which has become a leader in “cobots,” robots designed to physically interact with humans in a shared workspace. Launched in 2005, the founders of the Danish company wanted to find a way to make large industrial robotic



ADDITIVE MANUFACTURING



systems more accessible to small and medium businesses and manufacturers. Today, the company sells three models of cobots, ranging from a table-top version for light assembly to a large version designed for packaging and placing items on pallets. The cobots can handle painting, assembling, and attaching labels, among other tasks. Most importantly, the cobots are relatively simple to set up and can be reprogrammed for different jobs as a business evolves. The company, which was acquired by Teradyne in 2015, has sold 25,000 cobots. “More and more there is a need to produce the right product at the right moment,” says Universal’s Poinssot. “The collaborative robot is one of the bricks of this new industry.”

Poinssot says the company is continuing to try to expand the market through an online digital learning platform called Universal Robots Academy as well as an online marketplace that sells accessories from third-party developers. As with logistics robots, Poinssot says a big part of the appeal is relieving employees of the most dreary, repetitive parts of their jobs. It’s that focus on employee well-being that is a driving force behind another brand of machines that augment workers: Exoskeletons.

Suiting Up

ABI Research has projected that sales of exoskeletons will grow from 5,000 units in 2017 to more than 100,000 in 2025. Strapped to the outside of employees’ bodies, exoskeletons vary in design and sophistication. Some contain enough sophisticated computing to justify the use of the term robotics, serving as a kind of merger between man and machine.

For instance, LG recently announced it was developing the CLOi SuitBot, an exoskeleton designed to reduce strain on human workers. Employees strap it around their legs and lower back and the wearable robot automatically adjusts itself as it senses a wearer’s movement. It can also connect to other LG service robots, becoming a part of a network of automated devices. One of the first companies in this field was Ekso Bionics of Richmond,



The inVia Picker grabs items from warehouse shelves at a far greater pace than humans, increasing efficiency and freeing people for other tasks.

Photo courtesy of inVia Robotics.

California. The company originally got its start designing exoskeletons for the military and then moved into medical versions to help disabled patients. Ekso more recently began getting inquiries from industry and manufacturing. While companies have been focused on making workplaces safer, reducing the number of accidents, they still want solutions to protect employees from the long-term injuries that could prevent them from doing repetitive or heavy work. In 2015, the EksoVest for industry was introduced. The passive device uses gas-filled springs to give employees a boost rather than using any electronics. As the number of workplace injuries drops, “companies are turning their attention to quieter problems like ergonomic issues,” says Zach Haas, senior product manager for EksoWorks. “This is something that occurs when someone is doing their job absolutely correctly.” This past summer Ford announced it would roll out EksoVests to employees in 15 factories around the world. The company says it wants to reduce the physical toll on employees from tasks like holding power tools over their heads all day. Haas says this is just one indication that exoskeletons that augment human capabilities are on their way to becoming standard equipment.

“There was a time when people didn’t wear hard hats at construction sites,” he says. “Now that’s standard. I think it will be the same for this. We’re having a hard time keeping up with the demand.”

INDUSTRIAL ROBOTIC STARTUPS TO WATCH

COMMONSENSE ROBOTICS ISRAEL

WHAT IT DOES: Building a system for autonomous sorting and shipping using a combination of robotic sorting systems and artificial intelligence software to prepare orders.

www.cs-robotics.com

INVIA ROBOTICS UNITED STATES

WHAT IT DOES: Robotics-as-a-service platform provides ecommerce fulfillment centers with warehouse automation technologies. The InVia Picker retrieves goods from shelves and carries them to humans.

www.inviarobotics.com

EXOTEC SOLUTIONS FRANCE

WHAT IT DOES: Designed an inventory system that uses autonomous robots and specially designed shelving to make warehouses more efficient. The robots roam the warehouse and then slide up rails on shelves to find items.

www.exotecolutions.com

An App Store for the Factory Floor

— A U.S. startup brings people, machines and processes together for large and small manufacturers with its platform-as-a-service offering.



● **Despite all the hype around Industry 4.0, manufacturing is still a paper-based world.** Most of the workforce still relies on paper-based instructions and operating procedures while managers collect data manually on paper and whiteboards. Now there are apps for that. Tulip, a spin-out of the Massachusetts Institute of Technology (MIT), has developed a manufacturing app platform that introduces Industrial Internet of Things (IoT) and advanced analytics into the workflow. An intuitive drag and drop interface lets process engineers build

apps, connect to the IoT, integrate with their systems and collect real-time data, without writing any code. Global manufacturers across multiple industries, including electronics, aerospace and defense, medical devices, footwear, pharmaceuticals, and contract manufacturing, are already using Tulip's app platform. And Tulip recently announced it is teaming with Bosch Rexroth on an IOT-enabled "smart" workstation for the factory floor, which combines Bosch's manual production app platform. The workstations are

built to order and can be retrofitted with hardware and software for a factory's specific needs.

Initial success with large manufacturers prompted Tulip to introduce what it says is the industry's first platform-as-a-service, allowing manufacturers of all sizes to start using the service directly from any Web browser. The monthly plans, priced at \$95 and \$195, also include access to Tulip's "app store", a manufacturing app library comprised of customizable real-world apps. There's a 30-day free trial for all apps, which the company says is unique in the industry. So far the library includes over 25 apps that are ready to use or customize around major use cases such as work instructions, quality, lean manufacturing, machine monitoring, production visibility, training and auditing.

Manufacturers using Tulip have reduced defect rates by up to 98%, cut training times by over 90%, and increased yield, says Natan Linder, the company's CEO and co-founder.

Thales, a French conglomerate that builds electrical systems and provides services for the aerospace, defense, transportation and security markets, is one of Tulip's customers. It began with two employees using Tulip's

technology to digitize what had been 30 pages of assembly instructions at an aviation factory near Tours, France. With Tulip's technology each step is now presented onto the work space, turning it into an immersive IoT experience.

Additionally, every movement of the worker and all the surrounding conditions are measured using IoT technology.

That's important because certain conditions and parameters have to be validated before a worker can go to the next step, says Fabrice Danigo, methodology and digital transformation manager for Thales' Avionics. He says that during a year-long test employees were able to work faster, saving 15 minutes per hour, and Thales could measure variables at each step, averting problems before they happened.

Based on the success of the proof-of-concept trial, Thales plans to introduce Tulip apps at its five avionics plants, four in France and one in Singapore. The roll-out will take a year, says Danigo, the time needed for Thales, with Tulip's help, to migrate the solutions and transform all its manual processes into interactive ones.

Tulip, which was named a 2018 World Economic Forum Technology Pioneer, a Gartner Cool Vendor, IDC Innovator, and Frost and Sullivan Entrepreneurial Company of the Year, is "ramping up as fast as we can as we are expecting our business to grow very quickly in the months to come," says Linder. "There is huge demand from manufacturers to change the way they work. The technology is here now, simple to use, relatively affordable and can be deployed overnight."

● J.L.S.

INDUSTRIAL INTERNET OF THINGS

Everything is Connected

— The Industrial Internet of Things links the machines, factories and infrastructure that drive business.

● **In the next 10 years, the Internet of Things revolution is expected to dramatically alter manufacturing,** energy, agriculture, transportation and other industrial sectors of the economy which, together, account for nearly two-thirds of the global gross domestic product (GDP).

It combines the global reach of the Internet with a new ability to directly control the physical world, including the machines, factories and infrastructure that define the modern landscape, says a World Economic Forum report. It will also fundamentally transform how people will work through new interactions between humans and machines. Dubbed the Industrial Internet of Things or IIoT, this latest wave of technological change “will bring unprecedented opportunities, along with new risks, to business and society,” says the report.

As more connected devices come online and new services are developed for them, many important questions remain, including how the IIoT will impact existing industries, value chains, business models and workforces. That is where the Industrial Internet Consortium comes in. The IIC is building testbeds that cost in the \$10 million to \$50 million range, to explore new technologies, new applications, new products, new services and new processes and rigorously test them to establish their viability before coming to market, says Richard Soley, the IIC’s executive director. The testbeds represent the multiple use cases for the Industrial Internet of Things. They include smart buildings in Japan, a smart city in Ireland, an energy grid project in California and an agriculture site in India.

The smart city project in County Cork, Ireland focuses on ambulance management. The service allows National Healthcare Service data to be uploaded directly into ambulances and for paramedics to transmit live



information from the ambulance back to the National Healthcare Service. “I am pretty sure we save lives,” says Soley.

The smart building testbed connects some 35,000 sensors that collect 300 Terabytes of data a year. The project aims to determine if the data can be used to both make people more comfortable and lower the maintenance costs of the building, he says.

Improving Order Fulfillment

In October the IIC announced results and updates to a Smart Factory Testbed that is operational at two sites in Germany and at two sites in South Korea. The testbed’s network of factories allows manufacturers who want to improve order fulfillment and create new businesses to assign flexible production resources across multiple sites, according to an IIC announcement. The testbed also allows factories to use “plug and work” functions and data analytics.

Also in October its Track & Trace Testbed generated the requirements for a new IIoT standard for tracking and tracing assets.



**Electric grids, cars
and smart buildings are
being connected
by the Industrial Internet of Things**

“The testbeds [...] include smart buildings in Japan, a smart city in Ireland, an energy grid project in California and an agriculture site in India.”

Through its work on that testbed a need emerged for the manufacturers of sensors to be able to agree on a way to publish the required interpretation of the data that they produce via an Electronic Data Sheet. The testbed, led by Bosch with the IIC member participants Cisco and SAP, developed the requirements from a logistics use case, which gathers data from transport-related assets to ensure transport-service-level agreements are met and logistics chains optimized.

The IIC has also just set up a new interface and web-based tool that guides users through the analysis and planning of their own IIoT projects. Soley is also a member of the executive board of the IOTA Foundation (along with Johann Jungwirth, Volkswagen’s chief digital officer), which

bills itself as the first open-source distributed ledger – a type of blockchain technology that is being built to power the IoT with fee-free microtransactions that guard the integrity of the data.

The foundation, which is based in Germany, aims to help big corporates use blockchain technology to create new business models and new revenue streams. “We don’t yet have any IOTA test beds but a couple are being designed,” says Soley.

As blockchain adoption has increased over the last decade, early adopters have been hit with sluggish transaction times and skyrocketing fees. IOTA says its technology better positions it to speedily handle large volumes. Its distributed ledger does not consist of transactions grouped into blocks and stored in sequential chains, but as a stream of individual transactions entangled together called The Tangle.

Enabling the Emerging IIoT

The main focus of IOTA is to enable the emerging IIoT, according to the foundation. But it says it also plans to be the transaction settlement and data integrity layer for the “Internet of Everything.” This includes smart cities, smart grids, infrastructure, supply chain, financial services, peer-to-peer payments and insurance. It is just one example of how new entrants are attacking the needs of industry by developing sensors, cloud platforms, networking infrastructure, as well as machine learning software to transport or extract insights from the deluge of data that is now emanating from the world’s machines.

J.L.S.

Ignoring The Herd

— Sigfox is pioneering new ways to track assets with Bubbles and stickers

● **France's Sigfox made headlines in 2014** when it pierced the ears of cows in the Pyrenees so that tiny modems could be inserted and their whereabouts tracked via its dedicated Internet of Things cellular network. The info was transmitted to researchers studying the moving patterns of herds, an application that was considered novel at the time. Fast forward four years and Sigfox's Low-Power Wide-Area network "connectivity" has been extended to millions of objects in over 50 countries. It's rooftop base stations, which serve as transmitters, cover about one billion people. "With Sigfox you can move from Johannesburg to New York to Singapore and always be on the same network," says CEO and Co-Founder Ludovic Le Moan, a scheduled speaker at the Founders Forum x Industry In Partnership With Henkel Conference in Düsseldorf on November 8 and 9.

Early next year Sigfox plans to launch a fourth satellite. "This way we will have a full constellation of satellites that will complement the ground network that we are rolling out," he says. "If

we want to cover the whole planet we cannot rely only on ground antennas."

Sigfox is gearing up for asset tracking, which Le Moan considers "the biggest opportunity now for IoT."

Bubbles and Stickers

The French startup, which is headquartered near Toulouse, recently announced a new movable hardware transceiver called a Bubble which serves as a hot spot. The Bubble uses Sigfox's low-power wide-area network to connect to the cloud instead of GPS, WiFi or Bluetooth technologies. "We have a simple vision," says Le Moan. "You take data, you send data over the air, and our many antennas will catch the data. The fact that there is no connection necessary makes us unique."

The Bubbles communicate with state-of-the-art battery-free stickers Sigfox has developed that can be attached to everything from a suitcase at an airport to goods in a factory that need to be inventoried.

Le Moan says the stickers aim to replace radio frequency identification

The Bubbles communicate with state-of-the-art battery-free stickers Sigfox has developed that can be attached to everything from a suitcase at an airport to goods in a factory that need to be inventoried.

(RFID) tags which were heralded as a high-tech way of tracking goods in stores and in supply chains but have fallen out of favor because they use a lot of power, only operate at short range and when grouped close together can cause interference with each other. He says Sigfox's stickers can track assets without any of those side effects.

"The challenge of IoT is the cost of

solutions," says Le Moan, "because there is a need to transfer data at the lowest possible cost." Services can then be built around it. For example, Sigfox sensors currently track Michelin tires from the factory to the end-customer. The concept of Bubbles is a new way for customers to know where the device is, he says, "When you cross the path of a Bubble with a sticker tracking device, like at an airport, the sticker on your luggage will know that it is passing by a Bubble it trusts, says Le Moan. He says he believes it will be possible to get the cost of the sticker down to three cents or less, since they are battery-free. "There are many, many ideas to link what we are doing with blockchain," says Le Moan. For example, he says, if you want to be assured that your luggage will not be opened when you leave it at the airport, an insurance company could give a consumer a guarantee. Attaching blockchain applications to the data in our network is something that makes sense. But, he says, the company will stick to tracking goods, including "moo-vable" assets. ●

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How Blockchain is Changing Supply Chain Management

— The technology is adding transparency and efficiency to a system that still runs on phone calls and handshakes.

by Chris O'Brien

● **The industries that power the global supply chain have stubbornly resisted radical change for decades despite being plagued by fraud, buried under mountains of paper, and suffering mind-boggling inefficiencies.** This conservatism makes their sudden love affair with blockchain technology one of the crypto era's most surprising twists. IBM and shipping giant Maersk have teamed up to develop an industry-wide blockchain platform they believe can finally modernize an industry that still often runs on phone calls and handshakes. Retailers like Carrefour and Walmart have

embraced blockchain as a way to make their supply chains more transparent in order to build more trust with customers. A host of startups have seized on this trend to demonstrate that blockchain is more than just the foundation for cryptocurrency.

The technology serves as an immutable distributed ledger that allows an almost limitless number of participants to record transactions. It is perfect for supply chains because the transactions are transparent to everyone on the platform, allowing for easy verification and a high degree of trust and security. Any change to the record has to have the agreement of all parties. "Global supply chains are some of the most complex, multi-party ecosystems in the economic landscape today," says Maersk's Mike White, who heads the TradeLens blockchain project the company is co-developing with IBM. "Blockchain is one of the technologies that really changes the game."

The blockchain revolution is coming just in time for supply chains. A study by Transparency Market Research projects that the value of goods moving across the supply chain will almost double from \$8 trillion in 2016 to \$15.5 trillion in 2023.

The projected growth is likely to strain the capacity of shippers but building more ships, ports or other infrastructure can be a costly and risky proposition. Blockchain is appealing because it makes existing resources more efficient. Today, a product moving across the globe could involve 200 separate exchanges of data or paperwork and pass through 30 different parties as it moves from factory, to warehouse, to port, to customs, to a ship, and so on. These transfers are still often marked on paper, arranged by phone calls, verified with a handshake, or maybe typed into a spreadsheet. When something gets lost, or broken, or delayed, there is virtually no way for a

company or consumer to know why. “We’re trying to address one of the big challenges of the movement of cargo, which is the lack of visibility of a container at any given time,” says Todd Scott, IBM’s vice president of blockchain global trade.

That led to IBM’s official announcement of TradeLens with Maersk earlier this year. Maersk and IBM began exploring development of a blockchain service in 2016 before officially announcing TradeLens in August. The companies say 94 organizations have agreed to participate, including shipping companies, ports, customs agencies, freight forwarders and trucking companies. In some cases, the partners say the shipping time for items was reduced by 40%, while the query time about the location of a cargo item was reduced from 10 steps to one.

“What’s interesting to me is the breadth of participation across all parts of the ecosystem,” says White of Maersk. “It shows me the market is ready, the industry is ready to embrace a solution.”

While TradeLens has gotten the most attention, it’s not the only effort. Last year, a group of logistics veterans founded ShipChain, which is developing a supply chain platform on a type of blockchain technology called Ethereum with a goal of bringing together all links of the supply chain. Scheduled for release later this year, the company’s platform will create smart contracts designed to automate all recordkeeping. This will allow users to arrange payments once a contract is fulfilled and verified. To fund its development ShipChain raised \$30 million earlier this year through an initial coin offering (ICO), the cryptocurrency world’s rough equivalent to an initial public offering.

“With blockchain, there’s a unified, single layer of trust,” says ShipChain CEO John Monarch. “Right now, that doesn’t exist... there’s no way to verify anything.”

Building Consumer Trust

London-based Provenance is taking a different tack. The company grew out of research Jessi Baker conducted for her PhD in computer science. She became one of the first people to use blockchain for the supply chain as part of her research. Since then, Baker has worked with non-profits to

develop pilot projects such as a program to verify that fishermen are meeting social sustainability goals when they catch tuna.

In shifting to building a for-profit company, Baker decided to focus on trust between brands and consumers. Provenance offers a platform that blends blockchain, mobile, and social technologies to allow companies to show consumers a product’s entire journey. Such a system can offer proof, for example, that the beef you are eating really comes from Argentina, and not from Scotland, which reported an outbreak of mad cow disease in October. Consumers can contribute comments, reviews, or personal stories that are verified and attached.

The reason companies are becoming Provenance clients is “they want to be trusted by their customers,” says Baker.

Trust is also at the heart of the IBM Food Trust project, another of the tech company’s major blockchain efforts. This was developed in tandem with Walmart, and was motivated by an outbreak of E.coli in prepared lettuce a few years ago. A massive recall was ordered in large part because officials couldn’t determine the origin of the contaminated lettuce or where it was distributed.

With the IBM Food Trust, companies can track every item of food from farm to table. Following another E.coli outbreak in the U.S. lettuce supply this year that is linked to the deaths of five people, Walmart recently told all suppliers of leafy greens they must have blockchain technology in place by next year if they want to continue working with the company. The company said it would offer guidance, resources and training to help suppliers onboard to the IBM Food Trust platform.

French retailer Carrefour announced in October it was joining the IBM Food Trust. Carrefour stated that it will continue to use a blockchain platform it developed itself when dealing with smaller, local suppliers. But it makes sense to join the IBM program to work with bigger, international brands, says Emmanuel Delerm, director of Carrefour’s blockchain program.

Carrefour says it is embracing blockchain to promote trust with end-consumers. “This traceability and this visibility is really a way to say to customers that we really want to share this with you and show we care,” says Delerm. ●

BLOCKCHAIN FOR SUPPLY CHAIN STARTUPS TO WATCH

SHIPCHAIN UNITED STATES

WHAT IT DOES: Building a blockchain platform to improve tracking items across the entire supply chain. It will blend blockchain with an API to allow various participants to connect their records to the platform.

www.shipchain.io

PROVENANCE UNITED KINGDOM

WHAT IT DOES: Using a combination of mobile, APIs, and blockchain, it is creating a platform that reveals a product’s journey while allowing consumers to attach verifiable stories and experiences.

www.provenance.org

CARGOX SLOVENIA

WHAT IT DOES: Introducing documents based on Ethereum blockchain technology to replace paper Bill of Lading, the document ports issue for every container. It is critical to the industry, but dependence on physical documents creates a slow and inefficient process.

www.cargox.io

Going Digital

— A German startup is helping European utilities offer new types of services to customers.

● **Tado, a German startup that makes smart thermostats, is helping energy companies offer new kinds of digital services to their customers.**

The startup's smart thermostat has been engineered to be able to connect to a heating system's digital serial interface. Through Tado, utilities can monitor the health of a house's boiler remotely and collect diagnostics that can be used by engineers or repairmen.

And Tado, a competitor to Nest, a smart thermostat company acquired by Google in 2014 for \$3.2 billion, has ambitious plans to do more with utilities.

The company – which has just raised a new \$50 million round of financing from Amazon, the French energy company Total, the UK energy company E.ON, EIC and the European Investment Bank – has so far struck partnership deals with 30 energy companies.

The deals are helping utilities increase customer retention, says Tado's co-founder and managing director, Christian Deilmann.

The deregulation of the energy sector in Europe is leading to high customer churn. "With much more competition coming onto the market people really start to switch providers based on price," he says. "In the UK a quarter of the people switch providers every year. If it is just about buying a cubic meter of gas or some kilowatts of electricity they don't care where there energy is coming from." Tado helps utilities offer a more holistic service and build a much stronger customer relationship, says Deilmann. Under the partnership deals, Tado delivers the maintenance data to the utility company so that it knows when there is a problem in a household and what is broken, and Tado even calculates how much time it might take to repair it. With maintenance contracts that are not based on digital



data, some 50% of the time that repairmen show up to fix something they end up having to order a part from a wholesaler and come back a second time. "With Tado the first-time fix rate is 95% because the engineer knows up front what is wrong," says Deilmann.

The heating system has 120 codes and an error code is transmitted anytime there is a fault somewhere. "If the repairman knows your pump is broken and shows up the first time with a spare part it gives your customer a very good feeling," he says.

Tado and the energy companies split revenues from the service. "We really want to back this up with more services," Deilmann says. It's a good bet that at least one of the new services will be voice-based and work on Alexa, Amazon's cloud-based service, which is available on tens of millions of devices. People who are used to controlling temperature through their phone are also likely to want to control by voice, "therefore there is a strong correlation and it is very interesting to them," Deilmann says. Amazon likes smart-home customers because research shows that the engagement rate goes up by a factor of four when there are daily interactions.

Helping to Balance the Grid

The smart thermostat business is part of a booming sector. Gartner forecasts that consumers and businesses will be spending almost \$3 trillion on connected devices such as smart-home hardware by 2020.

Around a third of all global energy consumption goes to the heating and cooling of buildings. Smarter technologies allow more efficient control and can save up to 31% of that energy. But Tado wants to do more with



Tado's intelligent thermostat devices allow consumers to control the temperature in their homes. Utilities can tap into the devices to monitor the health of consumers' home heating systems in order to provide more efficient maintenance services.

TADO'S UTILITY CUSTOMERS INCLUDE :

- **E.ON** UK, Germany and Italy
- **SSE** UK
- **Naturgy** Spain
- **Essent** Belgium
- **OVO Energy** UK
- **Badenova** Germany
- **Vattenfall** Germany
- **Nuon** Netherlands
- **Energie Oberösterreich** Austria
- **IREN Mercato** Italy

“Gartner forecasts that by 2020 consumers and businesses will be spending almost \$3 trillion on connected devices such as smart-home hardware.”

its smart thermostats than help fix boilers and enable consumers to say “Alexa, turn down the heat in the living room.” It wants to help balance the grid.

Heating or air conditioning systems are the largest consumers of energy in buildings, says Deilmann. “The good thing is that there is some flexibility in the heating and AC systems and this flexibility is of value to the energy grid, especially in areas where you have production in solar and wind.”

A shift of 20% of energy – while keeping to the boundaries of what

constitutes a level of comfort in homes – amounts to a lot of energy when you add up all the buildings in the country, says Deilmann. “It is not ideal when you have to think about what time you should load the dishwasher but in our case it is really using flexibility assets in the background without having any effect on the comfort level.” . “It is a massive market. It has huge potential and we want to grab it.” ●

J.L.S.

The Strategic Implications of AI

— Can a European AI company help corporates take on the likes of Google, Amazon, Facebook and Alibaba?

● **The German artificial intelligence (AI) guru Chris Boos has a message for executives at big corporates.** If you are worried about being disrupted by so-called platform companies – Amazon, Google, Facebook, Amazon, Alibaba, Baidu – you should be. All of the big platform players have a General AI platform and are working to make it more versatile every day.

General AIs are built from multiple algorithms that are designed to offset the limitations of individual algorithms and enable the AI to tackle different tasks while learning on the fly. These AI are usually built on top of large data pools acting as a kind of world description. Every time a new field is added, the AI's "world" gets bigger and it has an exponentially better learning curve. The very clear goal of these General AIs is to disrupt business in any vertical, says Boos, the CEO and founder of the AI company arago and a scheduled speaker at the Founders Forum x Industry in Partnership with Henkel conference in Düsseldorf November 7 to 9.

"It makes sense to partner with these platforms in business areas that are no longer strategic because they will give the best result possible," he says. "But it is suicidal to work with them in any part of the business that is strategic or core because as soon as they own the knowledge and data they will reimplement the business model."

Arago claims to be the only neutral General AI platform built for established enterprises. "We want corporates to succeed in competing with the platforms

and we give them the technology to fight with the same gear as they do," says Boos. Boos, a member of the digital council consulting the German federal government, has been working on AI technology for more than 25 years. He launched arago in 1995.

And he knows what it is like to go head-to-head with Google. He has been doing it for years. Arago helps businesses manage and automate every process within a company, from IT operations to business processes and transactions. Its AI platform HIRO uses reasoning and a knowledge-based problem-solving engine to deliver enterprise automation solutions to clients such as UBS, Lufthansa Technik, SAP and Klöckner.

The company, which raised \$55 million in 2014 from the private equity firm KKR, was named in 2017 as a leader in semantic intelligence by the research firm Frost & Sullivan. Arago is on a mission to dispel misconceptions about AI, which Boos says can lead to dramatic mistakes.

For starters, AIs do not "understand" anything about the world. "If an AI is a good chess player, that does not mean it also is an analytical thinker," he says. "Similarly, if an AI can answer Jeopardy [questions] it does not mean it can listen to a board conversation and make sense of it."

Businesses need to recognize the different flavors of AI and the consequences of adopting them, he says. Narrow AI, an alternative to General AI, typically uses one algorithm to solve a particular problem. There are major limitations to this approach. Applying machine learning to a problem means having a dataset to explain to the machine what desirable results are. If that is possible the machine will find optimal solutions for problems in that space. But the more complex the problem, the more data one needs to describe the current situation. Most real-life problems are too complex for this type of machine learning, Boos says.

General AIs are the only way to automate entire businesses and allow for completely new business models, says Boos. But all General AIs operated by big platforms are used to disrupt every sector that they can. That is where arago comes in.

Boos argues that it is important to have an alternative to the big disruptors. Arago only competes on AI and has no intention of entering into any other sector, he says.

Automating the Future

The way to think about AI is to realize that it is not about pattern matching or prediction. "It is all about automation," says Boos. "But not the kind of automation we are used to. AI is about dramatically increasing productivity without the need to leverage economies of scale. That means AI is the end of the era of industrialization."

● J.L.S.



"AI is about dramatically increasing productivity without the need to leverage economies of scale. That means AI is the end of the era of industrialization."

Chris Boos,
arago CEO and Founder

A \$4 Trillion Opportunity

— A digitally-optimized logistics industry could add huge value to the world economy.

By Chris O'Brien

● **From the time a product leaves a factory in some distant corner of the world to the moment it reaches your doorstep,** it uses a dizzying number of services, with dozens of companies exchanging hundreds of different data points. It is a remarkable journey made even more epic by the fact that so many logistics services remain in a digital dark age, completing transactions via phone, paper and fax machine.

No wonder logistics companies are being targeted from all sides for massive disruption. Startups as well as some of the world's biggest corporates are marshalling financial and technical resources to transform logistics through the use of autonomous cargo ships, Uber-like shipping platforms, artificial intelligence-driven warehouses, delivery drones and modular self-driving delivery vehicles.

These sweeping efforts have the potential to accelerate the delivery of just about every good, reduce delivery times, shrink costs, and eliminate waste. Yet this momentum is being sapped by a vast legacy infrastructure that is so antiquated that it's hard for companies to transition into this new world. The challenge for participants in the logistics revolution is to get all the pieces to align to deliver the promised benefits.

The World Economic Forum estimates that an average of 85 million packages or documents are shipped every day. The system is coming under strain as fuel prices rise and consumers come to expect fast delivery of any product at any time. This requires a flexibility and agility that is simply impossible for many logistics players, according to a recent study co-authored by Shanton Wilcox, Partner & Manufacturing Segment Head for Infosys Consulting. Most shippers understand the need for agility but, the report says, 42% haven't made changes in the past five years. "A lot of the basics are broken, and the foundation is just not there to allow them to get where they want to be," Wilcox says. Frustrated by the slow pace of change, e-commerce giant Amazon has registered itself as a freight forwarder, allowing it to help partners manage the regulations and logistics associated with international

shipping. The company is also experimenting with things like an on-demand delivery service dubbed "Amazon Flex," an Amazon Air fleet of planes, and a Delivery Service Partner program for franchise delivery businesses. It has also built 744 operational facilities around the world and ordered 20,000 Mercedes-Benz vans that it plans to use as part of a leasing program targeting small businesses.

Brian Solis, a principal analyst at the Altimeter research firm, says retailers and logistics players have no choice but to adapt. "You as a consumer are being constantly taught to expect immediacy and personalization," Solis said. "You're constantly wanting something more and faster and better. Everything is being reinvented to cater to this accidental narcissist. No matter what business you're in, this is happening."

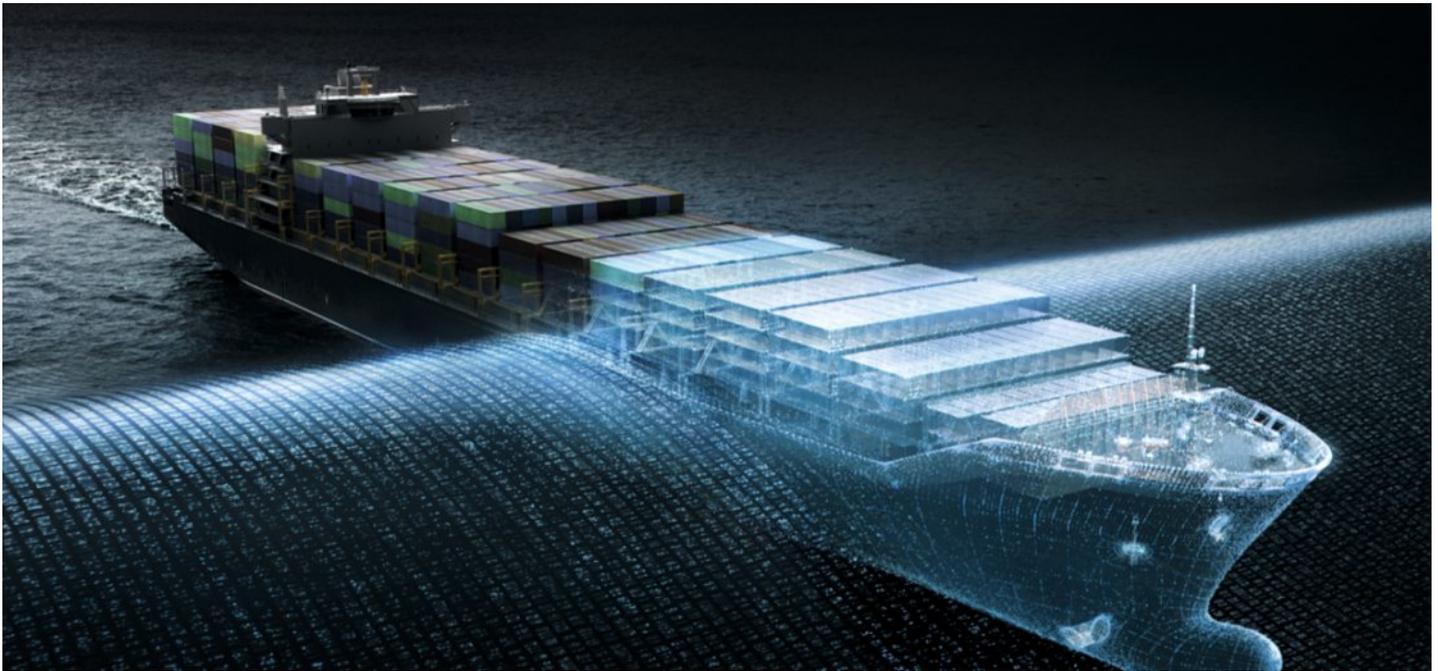
The World Economic Forum has tried to sound the alarm, urging logistics companies to move faster or risk squandering a massive economic opportunity. With e-commerce penetration projected to grow from 7% in 2015 to 17% in 2025, the Forum says a digitally-optimized logistics industry could add \$4 trillion in value to the world economy. "Logistics has introduced digital innovations at a slower pace than some other industries," says a Forum report. "This slower rate...brings enormous risks that, if ignored, could be potentially catastrophic for even the biggest established players in the business." Indeed, there is a growing list of new entrants in areas such as shipping, warehousing and delivery with big ambitions.

SHIPPING: Making it Easy, Transparent and Efficient

Israeli entrepreneur Zvi Schreiber got the idea to disrupt the world of international freight shipping when, as a manager of an electronics company, he spent days calling shipping agents, trying to get price quotes.

The experience inspired him to found Tel Aviv-based Freightos in 2012, which has since raised \$92 million in venture capital. Its fundamental mission is to make freight booking as easy as ordering an Uber. But so few shippers have even basic digital tools that Freightos in 2013 launched AcceleRate, a cloud-based service that allowed freight companies to digitize and centralize their internal information. Since then Freightos has launched a marketplace that lets adopters share their prices and book services across the Web. Making booking faster and more transparent helps ensure capacity on ships is being efficiently used, Schreiber says.

Rather than try to draw industry players into the modern world, Berlin-based FreightHub became a freight forwarder itself and entered directly into the business of shipping. Via its Web-based platform, customers - including small and medium-sized businesses - can book shipping. FreightHub, which has raised \$23 million in venture capital, helps arrange the entire process through a network of agents, says CEO and co-founder Ferry Heilemann. Other startups such as Flexport, which has raised \$300 million, and Fleet, are also entering the freight forwarding business. "People think it's too complicated and that startups can't tackle that," says Heilemann, a scheduled speaker at Founders Forum x Industry in Partnership with Henkel conference



Rolls-Royce has partnered with Intel to build autonomous cargo ships that promise to bring savings and efficiency to an often clunky logistics industry.

Courtesy Intel/Rolls-Royce

in Dusseldorf, November 7-9. “But that’s what they used to say about fintech startups and the financial industry.” Disruptions from startups are forcing stalwarts to adapt. Shipping giant Maersk’s freight-forwarding unit Damco launched a digital platform last year called “Twillie” Likewise, freight forwarder DHL earlier this year released MySupplyChain, a software and service designed to allow for greater tracking of shipments as well as enhanced data analytics. Even vessels are getting an overhaul. U.K.-based Rolls-Royce is developing autonomous and remote-controlled cargo ships that it hopes to deploy by 2025. The autonomous system is being developed at the company’s R&D centers in Finland and Norway. According to the United Nations, about 90% of the world’s trade is carried over the seas, and Rolls-Royce believes autonomous fleets of ships can increase safety and efficiency.

“We’ve proven a lot of the technology that’s required,” says Kevin Daffey, Director of Engineering, Technology and Ship Intelligence at Rolls-Royce. “Now it’s about convincing businesses that there’s a business case and that it can revolutionize their business model.”

Still, it’s an enormous undertaking to equip ships with the array of visual

sensors and cameras needed, plus the servers necessary to process the data in real-time, which could be as much as one terabyte per day per ship.

WAREHOUSES: From Clunky To Instant Fulfillment

Once merchandise clears a port, it is almost guaranteed to pass through one or more warehouses as it winds its way to a home or business. The traditional, clunky methods of inventory distribution, fulfillment, and preparation for delivery create another painful bottleneck.

Traditional players are taking steps to change that. For example, United Parcel Service has announced it is developing an analytics and machine learning project to better leverage the vast amounts of data it generates to create better predictive tools and better manage storage and capacity across its warehouses and vehicle fleets. And, to remain competitive, French retailer Cdiscount, founded almost 20 years ago in Bordeaux, created its own in-house lab called “The Warehouse.” It brings in startups that can help it make



LOGISTICS STARTUPS TO WATCH

FREIGHTOS ISRAEL

WHAT IT DOES: Runs an online international freight marketplace, trying to make booking shipping as easy as ordering an Uber. It also offers a cloud-based service called AcceleRate to help logistics customers centralize and digitize data such as rates.

www.freightos.com

FREIGHTHUB GERMANY

WHAT IT DOES: An official freight forwarder, it can arrange all details and paperwork connected to shipping goods internationally. Its online platform helps organize all aspects of the logistics chain, including quotes, booking, managing documents, and tracing goods as they travel.

<https://oceanprotocol.com>

FLEXPORST UNITED STATES

WHAT IT DOES: A full-service air and ocean freight forwarder. Its platform offers an end-to-end service for logistics teams, delivering real-time tracking, structured data, and shipment-specific communication.

www.flexport.com



better use of data and robotics in its warehouses, better manage peak sales cycles and improve delivery via technologies such as autonomous vehicles. For companies who don't have the resources or expertise Mumbai-based Fractal Analytics has developed algorithms and artificial intelligence to more accurately predict inventory needs and management. In one case, a customer was able to save \$5 million by reducing the inventory it kept on hand, says the company. That kind of smarter fulfillment also allows such warehouses to be more responsive to on-demand orders.

Other startups are trying to reinvent the very concept of a warehouse. Israel's Commonsense Robotics just recently launched a 6,000 square-foot micro-fulfillment center in downtown Tel Aviv that provides autonomous sorting and shipping. Using a mix of robotics, AI and humans, the company can more efficiently use its tiny warehouse to deliver goods in city centers. Chaldal is going one step further, by using robotics and AI to create networks of single room "nano-warehouses" in crowded developing cities like Dhaka, Bangladesh, where it is based, to do on-demand fulfillment. And Austria-based Logsta launched last year to create warehouses that are at the center of a service that helps small businesses with everything from learning how to get their products into Web-based marketplaces like Amazon to helping arrange all aspects of shipping and last-mile delivery.

Transforming warehouses is critical for businesses to stay competitive as last-mile delivery options explode. In the U.S. alone companies like grocery-delivery service Instacart, which just raised \$600 million in venture capital, and Postmates, which now offers delivery of food and goods in 550 cities, are making instant fulfillment the default expectation.

Transforming the Last Mile

For many consumers, much of the logistics revolution looks like a young college student furiously pedaling a bicycle around city streets carrying a larger Deliveroo or Uber Eats insulated backpack. While this analog solution is indeed fueling an ecommerce expansion, the mobility industry has far more ambitious plans to reimagine this end of logistics.

Amazon has been experimenting with drone technology, as has China's JD.com, which has been delivering small packages to remote areas. Meanwhile, Israel's Flytrex struck a drone delivery partnership with Icelandic ecommerce startup AHA in August 2017. Mostly, the packages tend to be smaller goods, like food, or new smartphones. Currently, AHA is approved to fly 13 routes around Reykjavik.

But drones are still often limited to one item under a certain size. A wide range of automotive makers believe they can have an even bigger impact on logistics by introducing fleets of self-driving trucks for long-haul shipping and autonomous vans for last-mile deliveries. Volvo Trucks recently introduced



Boxes are lifted into a prototype of Renault's EZ-Pro, an electric self-driving modular van that can be adapted to different sizes for last-mile delivery to homes and businesses.

Courtesy of Renault

Vera, a self-driving truck concept for well-defined routes in limited spaces such as ports or warehouse districts that could carry freight. Vera is a truck tractor that can pull a trailer but has no cab for a human. Mercedes-Benz Vans is taking a hybrid strategy, creating a self-driving platform called "Vision URBANETIC" that offers one module for carrying people and another that can hold ten pallets of goods. Renault, meanwhile is developing its own modular, self-driving delivery pod called "EZ-Pro." These can be reconfigured with different pods and run separately, or in a platoon. In some cases, a human could ride along to carry the packages from the pod to the customer. Startups are also targeting the opportunity. According to CB Insights, trucking-related startups raised more than \$1 billion in 2017, up from the \$763 million invested in 2016. Each of these investments is building toward the larger logistics revolution by creating delivery networks that will expand the types of goods merchants can send on-demand, says Paul Asel, a managing partner at Nokia Growth Partners in San Francisco, which has invested in Peloton, a startup developing autonomous systems for long-haul trucks. As more vehicles become autonomous, and more inefficiencies are eliminated across logistics, consumers will reap enormous benefits.

"We believe as the marginal cost of delivering goods and services declines, there will be a lot more services that people choose to use in terms of last-mile delivery," Asel says, "As soon as you start thinking through the ripple effect of this, it really becomes exciting."



By Brent Hoberman
Executive Chairman and
Co-founder, Founders Forum



Rob Chapman
CEO of Founders Intelligence

What Can Startups Teach Industrial Companies?

● **Does your company play? With data? With ideas? With technology?** Many of the most valuable companies and technologies arise from amateur enthusiasts having a go at something no industry professional, no matter how well funded, would attempt. The offices of the most successful startups feel like creative chaos, an atmosphere corporations can't tolerate.

But if industry leaders can't find a way to access this unstructured energy, their companies are unlikely to be the leaders of the next breakthrough industries. They put at risk their leadership positions in their own industries if they don't make the transition to becoming technology companies.

For example, for years people have been hailing the transformation that the Internet of Things will have on business and society. Businesses have connected millions of sensors but use them only for marginal optimization or command and control. Transformational use cases are out there, but they aren't likely to be invented by the engineer at headquarters. Instead, hackers trying to solve something important for a customer will create them when they combine data from 15 sensors from 15 different companies. Today though, almost no industrial company has truly opened its data and processes to allow this play, this opportunity.

This is the biggest lesson industrial giants can learn from the philosophy of consumer technology companies. Develop platforms that allow others to experiment, create and play. Watch carefully what is successful and help scale the most promising. If you try to control everything you are limited to the (often brilliant) minds of the teams who work for you. If you open your data or your platform to others, you remove those limits and gain 100x more brilliant minds to solve problems for your customers. Opening to the outside is new and uncomfortable, but essential. Industrial companies have been designed to optimize a set of processes and technologies to do something highly efficient and no sensible CEO will allow those to be disturbed for a high-risk idea. This is why the play-spaces need to be as separate as possible but as integrated as necessary to assure autonomy and freedom while also allowing the core business to provide the data

and market access to scale the innovation. Large industrial companies can learn from all three advantages startups have when it comes to playing and experimentation:

Focus: Startups don't have the resources to solve everything, so they go after one thing really well. Because of this their teams maintain an end-to-end view of the problem to be solved, avoiding the fragmentation of working separately on different parts of the problem. Many clients we work with add big teams to a project and include many who aren't directly invested in the product's success. To avoid that Amazon Chairman and CEO Jeff Bezos has the two pizza rule – never have a team working on a problem that needs to order more than two pizzas.

Closeness: Successful startups understand their customers in detail and solve a very particular and acute real-world problem. Their mission in the early days is to gather as much data as possible on the problem and its solution during their short funding window. This brings them naturally close to their customer, as the customer is the only source of validation. And the only source of survival.

Integration: When something is genuinely new, start-ups need to control the end-to-end process to solve a customer pain point. It is only once the proposition is at scale and the value chain becomes commoditized that companies begin to modularize and eventually create platforms to allow the next wave of innovation. Tesla is a perfect example of a company that managed to get a differentiated product to market years before others by controlling the core technology. Boom, a maker of supersonic jets, is doing the same in aviation. Startups have learned discipline from industrial companies: the lean methodology has been translated to the startup world and is now gospel. It is time for industrial companies to learn creative chaos from startups. ●

Founders Intelligence (FI) helps large companies such as Shell, Visa, Henkel and Fannie Mae to benefit from the new ideas, technologies and business models that will transform their industries. FI is a part of Founders Forum, a private network of some of the world's most successful founders.

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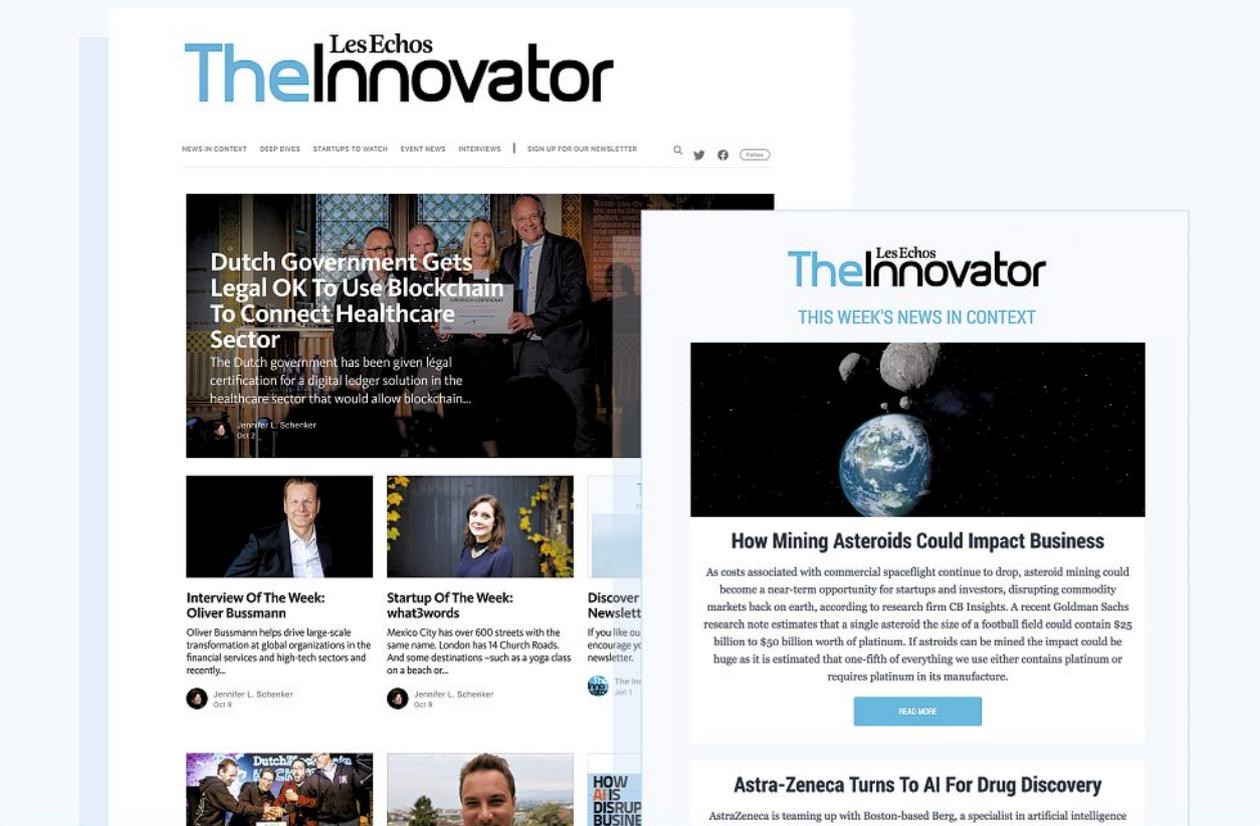
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