Robotics and the “New” Supply Chain: 2015-2020
Next-gen Supply Chains: Decentralization, Digitization and Robotics
Next-Gen Supply Chains: Decentralization, Digitization, and Robotics

Complex machines that “uncomplicate” supply chains

Labor costs comprise the largest part of a warehouse’s operating expenses, upwards of 50 percent or more.

Inbound Logistics

The price of automated labor compared to human labor has fallen by up to 50 percent since 1990 — a trend that researchers expect to continue.

McKinsey Group

Forecast: $10 billion market for robots that can handle materials better than humans.

Allied Market Research
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“It’s not the strongest of the species that survives, nor the most
talent intelligent, but the one most responsive to change.”
—Charles Darwin
Introduction

“Faster, smaller, cheaper, and local”

“Today’s complex global supply chains are poised to be dismantled,” read the headline a year ago at GigaOM. The article beneath it was a guest editorial by Paul Brody, an IBM VP in IBM’s Global Business Services unit.

Basically, the article’s core stated: “Thanks to the growth of 3D printing, intelligent robots, and open-source hardware, tomorrow’s supply chains will be faster, smaller, cheaper, and local.”

For most anyone running a global supply chain, that headline must have given considerable pause for thought, maybe even relief. Global supply chains are, at best, difficult to run. They are vulnerable to a host of potential problems, foremost of which is their cost.

That there is an alternative brewing somewhere out there that mitigates some or all of a supply-chain’s headaches should be cause for joy with embattled supply-chain managers who have to contend 24x7 with these awkward, problem-prone and wildly expensive behemoths.

A year on, with similar headlines having popped up consistently over all sorts of media, and with the new tools for change rapidly arriving on the scene, industry, for the most part, has been slow to react and to begin early adoption of this “New Supply Chain” movement.

Strangely, some 70 percent of the supply chain leaders IBM spoke with were clueless about this new supply-chain concept, and most admitted that they had no plans to change things for the “rest of the decade.”

“If it ain’t broke, don’t fix it,” seems to be a prevailing mindset. With many organizations still in recovery mode from the Great Recession, such reactions are quite understandable. But the churn of business is not so kind; many supply-chain leaders—who fail to pay attention and react—stand to be blindsided by a revolution they never saw coming.

However, a small but growing number of early adopters, from SMEs to huge multi-nationals, have appeared on the scene and are pioneering these new-look supply chains into what is ramping up to be a paradigm change in the manufacturing, shipping, storage and distribution of just about anything.

I. Brave New World

The need for speed plus...

Behind it all is the need for speed. Global supply chains are being pushed to the max to deliver ever faster from manufacturer to consumer. Former Tesco CEO, Philip Clarke (ousted in July of 2014), said he’s seen nothing like this demand for speed in his over forty years in the business.

Interesting that Clarke’s replacement with Unilever’s Dave Lewis, who will arrive in the fall of 2014, hails from a multi-national that ranks fourth on Gartner’s Top 25 best supply chains for 2014, just behind Apple, Amazon, and McDonald’s.

Couple the need for speed with head-spinning discounting from Wal-Mart and its low-price brethren Carrefour and Tesco, who are also pushing the
Everything has a beginning

In 1952, the U.S. didn’t have a supply-chain worry in the world.

Time magazine that year, in reporting the nation’s $350 billion in gross national product, commented that it was the “greatest material outpouring in its history.” Incredibly, the U.S. produced 52 percent of the world’s mechanical energy and made 65 percent of the world’s manufactured goods. According to the World Bank, the U.S. today produces 18 percent of global manufactured goods.

Adlai Stevenson’s presidential campaign slogan for 1952 was, We Never Had It So Good. Indeed!

World population was 2.6B; U.S. unemployment rate was 3.3 percent; and the DOW was 269. Yes, 269!

Purring away at CBS-TV that fall was America’s first computer, the UNIVAC or (Universal Automatic Computer). UNIVAC famously predicted the result of the 1952 presidential election: with a sample of just 1 percent of the voting population, the computer picked Eisenhower in a landslide while the conventional wisdom favored Stevenson.

That was the beginning of computers entering into our lives.

Four years later, two professors from the University of Chicago coined the term “Information Technology” for an article in the Harvard Business Review titled: Management in the 1980s.

The IT juggernaut had begun. Soon after, people started to lose their jobs.

By 1963, the unemployment rate had spiked to 5.7 percent; there were six million people out of work; and Congressional hearings on “persistent stubborn unemployment” and “Automation” began in earnest. In a special message to the Congress, President Kennedy said: “Large scale unemployment during a recession is bad enough, but large scale unemployment during a period of prosperity would be intolerable.”

Free-market economist and professor at the University of Chicago, Yale Brozen, penned his famous, Automation: The Retreating Catastrophe, in which he tried to state the case for the necessary advance of technology and point out how millions of skilled jobs created by IT overwhelmed the loss of so many unskilled ones.

Here in 2014, all of the foregoing seems all too familiar and discomforting, especially to the millions who lost a job during the Great Recession.

That same year, 1963, in Whitman, MA, about 20 miles from Boston, the Commonwealth Shoe and Leather Company, maker of the famous Bostonian shoe line, left town for good. In pursuit of labor arbitrage, it moved to the Carolinas; then sold itself to C&J Clarks in 1979, and today Bostonians hail from India. That’s over seven thousand miles from the Whitman factory—or a thirty-day voyage by sea.

Bostonian was just a small part of a mass exodus overseas that began the rise of modern supply chains. The production of less expensive goods overseas, coupled with the need to bring them to the U.S. where goods could find customers with enough money to buy them, began a decades-long journey into complexity, fragility and, of course, distance from consumers.

This offshoring in search of low wages for production is unsustainable, but no one knew it at the time, and probably wouldn’t have cared. As Erik Brynjolfsson and Andy McAfee write in their book The Second Machine Age, “offshoring is often only a way station on the road to automation. In the long run, low wages will be no match for Moore’s Law.”

In the 1980s, when supply chains began taking steroids and buffed up global commerce, IT wasn’t there for them as it is today, and consequently business was not going to wait around for Moore’s Law to catch up. Now, however, Moore’s Law has caught up and is powering ahead. IT, in the form of robots and 3D printers, is knocking on the doors of every warehouse and distribution center in the world.

3D printing, intelligent, mobile robotics, and reconfigurable warehouse automation are presenting themselves as the first wave in what’s shaping up to be the Great Return Home. Complex machines will now take on the simplification of supply and demand, and the simplification of supply and demand will become the platform for the “New Supply Chain”.

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envelope with omni-channel retailing, and it is easy to see why automation is
headed into a brave new world where speed and instant inventory availability
are all that matter.

Telling as well, and more to Clarke’s comment on the churn of supply chains,
is the recently released 25th Annual State of Logistics Report from the Council
of Supply Chain Management Professionals (CSCMP), which reveals that “total
U.S. business logistics costs in 2013 rose to $1.39 trillion, a 2.3 percent increase
from the previous year. Logistics as a percent of U.S. gross domestic product
(GDP) declined for the second year in a row [emphasis mine], indicating that
the logistics sector is not keeping pace with the growth in the overall economy.”

In 2012, it was $1.33 trillion or nearly 8.5 percent of GDP. “That $1.33
trillion in total logistics spend,” says Dan Gilmore of Supply Chain Digest,
is 21 percent above the 2009 bottom, but still below the 2007 peak of $1.39
trillion.”

Well, here in 2014, logistics has matched its 2007 peak, yet still lags behind
the growth of the overall economy, according to the CSCMP. That, in effect,
implies that Gartner’s Top 25 are all lagging the economy. So, if the Gartner Top
25 are lagging, where does that put all the others?

The bottom-line concern is that no matter how hard present-day logistics’
systems work, they will never catch up. A situation worse than Alice in
Wonderland who had to run as fast as she could just to keep in place: with
logistics—running as fast as it can—means always lagging behind.

What happens when the economy shakes off more of the Great Recession
and breaks into a sprint? What happens when a supply chain hits a snag like a
natural or geopolitical disaster—even a small one—and the supply chain slows
or even momentarily stops?

What’s at stake?
Charles Darwin was correct: “It’s not the strongest of the species that survives,
nor the most intelligent, but the one most responsive to change.”

What’s at stake? As Darwin put it: Survival. Change is coming lightning fast
to supply chains, pushed seemingly in femtoseconds from online transactions.

By 2016, reports the Boston Consulting Group, “there will be 3 billion
Internet users globally—almost half the world’s population. The Internet
economy will reach $4.2 trillion in the G-20 economies. If it were a national
economy, the Internet economy would rank in the world’s top five, behind only
the U.S., China, Japan, and India, and ahead of Germany.”

Mobile devices—Smartphones and tablets—will account for four out of five
broadband connections by 2016, every one of which will be capable of making
an online order. What will happen when a full 50 percent or 75 percent of the
world’s population is dialing orders from a Smartphone or tablet?

Online retail will comprise 10 percent of all retail sales by 2017, reports
Forrester Research, up from about 8 percent today. That relatively small-
sounding increase is actually a 9 percent compound annual growth rate (CAGR)
from $231 billion in 2012 to $370 billion in 2013.

Exponential growth is taking place and traditional supply chains cannot keep
pace.

Robots, already an emerging fixture in this frenetic landscape, are now,
according to Automation World, “gaining traction against traditional
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automated-guided-vehicle (AGV) and fixed-conveyor solutions.” Additionally, robots have also now become “true options for small- and medium-sized businesses with limited automation skills and budgets.”

II. The Vanguard

Skechers

Poster child of the “New”

Skechers USA (NYSE: SKX) is a good example of an early adopter of “New Supply Chain” automation. In 2011, Skechers built a massive 1.8-million square-foot distribution center in Rancho Belago, CA.

Skechers is the second largest footwear brand in the United States, and annually racks in near $2 billion in sales.

The $250 million structure, located in Southern California’s Inland Empire, east of Los Angeles, is home to the nation’s largest concentration of warehouses. Skechers’ new building on Eucalyptus Avenue near the 60 Freeway, at 2,900 feet long and more than 700 feet wide, is big enough to hold 40 football fields, said Iddo Benzeevi, president of developer Highland Fairview Properties, in an interview with the Los Angeles Times.

Warehouses in the InLand Empire are the first stop for imported goods arriving through the Ports of Los Angeles and Long Beach from Asia, on their way to big-box retailers’ distribution centers and stores nationwide. Nearly half of all imports to the U.S. pass through the region.

The new distribution center enabled Skechers USA to consolidate operations from 1.6 million sq. ft. in six Ontario, Calif. warehouses into a single distribution hub serving the United States and Canada.

“This is the next generation of automation in logistics,” said Benzeevi. “This building has the most advanced building-automation robotics coupled with being the largest green building of its kind in the United States, and probably in the world.”

Skechers retained Wynright, a warehouse technology integrator, to build a robot automation system for storage and retrieval systems (AS/RS), conveyors, pack and hold processes, sorting, and tagging. Enough automated equipment to run “Skechers 70,000 SKUs from order to pallet with practically no human intervention.”

Automating the operation cost Skechers nearly $100 million. Central to that automation is automated storage and retrieval system (AS/RS) from Japan-based Daifuku that lifts shoes to and from densely packed storage racks that stretch to a height of 50 feet.

David Weinberg, Skechers’ COO & CFO, said the building triples the company’s shipping capacity.

Kevin Ambrose, Wynright’s CEO, in a recent interview with Industry Week, elaborated on the results of that automation: “The new facility…can handle up to 17,000 pairs of shoes per hour, more than double the amount handled by hand in the old days. And that number is expected to increase by another 25 percent in the next few years.”
In addition, the new automation system “allowed Skechers to trim its peak production headcount from 1,200 to a slim 500. Off-peak season, that’s down to 300—a 75 percent reduction from pre-robot levels.”

A 75 percent reduction in people! With an ROI for the automation upgrade slated to take up to five years, Skechers will begin reaping the salaries and benefits from 700 workers as its e-commerce sales begin to rise again.

It is said that, because of the level of automation, “human hands will seldom touch merchandise from the time it enters the distribution center until it emerges for pickup at one of 270 truck bays.”

Speed of automation technology will be a high priority as online retail moves toward 10 percent of all retail sales by 2017, one-click e-commerce, omni-channel retailing and Wal-Mart-style low pricing will dramatically continue to reshape logistics and pave the way for even more robots.

Skechers’ embrace of robot automation, as good as it is, only takes place within the four walls of its facility. Robotics can do much more for its supply chain. Transportation, for example.

Skechers’ products are manufactured in China then shipped to the Port of Long Beach, CA from where 40 truckloads of Skechers travel daily the seventy-two miles to the warehouse. That’s a round-trip of 144 miles, with trucks returning empty. Every work week, that’s 200 truckloads; annually, 10,000. That’s a lot of toxic fumes wafting into the skies of Southern California.

Financially, the diesel tab is jaw dropping. With diesel fuel currently $3.89 per gallon in California (week of August 4, 2014; historical high July 1, 2008, $4.76) and Class 8 (18 wheelers) topping out at 6 mpg, 200 weekly round-trips pump up to be $18,672. A year of fifty weeks totals up just short of a million dollars ($933,600).

Of course, that’s only the tip of the iceberg: the total U.S. truck fleet is 1,181,613 of which 178,255 are the diesel-guzzling tractor rigs. PepsiCo alone has over 14,000 big rigs.

“The spike in fuel pricing,” says Jochen Seeba, vice president and COO of Ranger Steel, “and new governmental rules and regulations on insurance coverage for truck drivers made truck transportation very expensive.”

Robotics in the form of autonomous trucks is, of course, the answer to the labor issue. With a third of the nation’s three million truck drivers nearing retirement age, autonomous trucks are a viable substitute.

Running on natural gas, which already fuels some big rigs “with drivers” (e.g. Waste Management and Ryder Systems with CNG trucks; United Parcel Service and AT&T are purchasing Navistar gas-powered trucks), would be a good diesel substitute for both price and hydrocarbons. “At the pump,” reports the Wall Street Journal, “a gallon of diesel often costs more than twice as much as CNG [compressed natural gas], on a diesel-gallon-equivalent basis.”

Are there any autonomous trucks road-ready right now? No; although Daimler reports that its autonomous truck may enter service by 2025. In short, they are at least a decade out, probably more given the legal and insurance hurdles needing to be addressed.

On July 3, 2014, in Magdeburg, Germany, Daimler hosted its “Shaping Future Transportation 2014” conference. The star of the show was “an actual, fully-functioning autonomous truck, a Mercedes Actros tractor-trailer, operating
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at real-world speeds on a special section of the Autobahn outside of Magdeburg.

According to Daimler Trucks’ global head Wolfgang Bernhard, the autonomous system called Highway Pilot is the centerpiece of a whole new concept in freight logistics: the system collects and analyzes data in the overall context of the logistics train and transport system.

It processes data ranging from weather, road conditions, vehicle speed and traffic congestion while navigating, communicating with the shipper, the fleet and other vehicles around the truck and actively interacting with cars and trucks it shares the road with.

The result, Daimler says, “will be freight efficiency levels which would have seemed virtually impossible only a few years ago.”

Daimler is not alone in its quest of autonomous trucking; others have tested what are called “autonomous convoys,” which is a lead truck and driver followed by drones controlled by the leader. Scania Transport Laboratory and Volvo’s “Safe Road Trains for the Environment,” both in Sweden, as well as the Japanese government have also highway-tested “truck platooning” systems.

Although not quite ready to impact the transportation aspects of supply chains, autonomous trucks are the clear alternative. Maybe the only alternative. Globally, those same 10,000 containers shipped to Long Beach originated in China, some 7,000 miles away and were powered to the shores of California “by Category 3 marine diesel engines, which can stand over three stories tall and run the length of two school buses. Auxiliary engines on large ships typically range in size from small portable generators to locomotive-size engines.” Both are significant contributors to air pollution.

Ocean-going autonomous container ships are even further out than autonomous trucks. “Rolls Royce is working on autonomous ships, saying they’d be safer, cheaper and less polluting for the $375 billion shipping industry.”

The point being that the transportation aspects of supply chains—both trailer trucks and trans-oceanic vessels—are robot addressable and represent the only real-world substitute to existing modes of logistics transport. Their singular limitation for now is only that of time.

The U.S. Roadmap for Material Handling & Logistics 2014 positions autonomous trucks as providing a good half dozen qualitative and quantitative benefits that will impact the entire scope of supply-chain transportation:

1. Self-driving and driverless cars and trucks are able to respond more quickly to dynamic driving conditions, which allow vehicles to follow one another more closely. This would have the effect of reducing traffic congestion, due to “tighter convoys” and increased density of flow.
2. Self-driving trucks would not tire or get sleepy, so traffic accidents involving trucks likely would decrease significantly.
3. The truck driver labor crisis would (eventually) be averted, as retiring truck drivers are replaced by technology.
4. Trucks would be able to drive around the clock, thereby extending the reach of a day of transportation and improving logistics service.
5. Extending the geographical reach of a truck would eventually reduce the number of needed warehouses because the same level of service (in days to deliver could be provided by fewer, larger warehouses. Alternatively, companies could provide higher levels of service with the same number
of warehouses. In either case, companies nationwide would have an incentive to reconsider and perhaps redesign their supply chain networks.

6. Finally, the total cost of transportation likely would go down, thus reducing the total landed cost of products on shelves.


Although in the vanguard from the “Old” to the “New Supply Chain”, Skechers has just begun to benefit from robot automation.

Robotics presents itself as a technology with compelling advantages all along the entire supply-chain continuum from manufacturing to customer.

With the astounding advances of 3D printing (additive manufacturing) toward mass customization over mass production, there’s even a blurring of the lines with respect to what’s a factory and what’s a warehouse.

One thing for sure is that Kevin Ambrose will be making more trips to Rancho Belago as more advanced robot technologies and systems arrive on the scene ready to meet Skechers’ future needs.

And whenever he does, he can tote along his company’s own robot division, Wynright Robotics. As a provider of intelligent material handling systems, Wynright (sold to Daifuku (6383:Tokyo) in 2013), is well-positioned for robotics advances into warehouses and distribution centers.

In fact, Wynright recently patented its own robot system for one of the more robot-resistant jobs in logistics: unloading and loading tractor trailers at loading docks. With Skechers’ 270 loading docks still worked by hand, Wynright’s Robotic Truck Unloader/Loader (RTU/L) may soon make an entrance.

**C & S Wholesale Grocers**

**Do-it-yourself automation**

It can be real handy if a logistics’ provider is also owner of a robotics company, as it is with privately held C & S Wholesale Grocers which, according to Bloomberg Business, is world’s largest grocery wholesaler, doing $21.7 billion in 2012, distributing more than 95,000 products to 4,000 supermarkets from Maine to Hawaii from its 54 distribution centers.

The most famous example, of course, is Amazon’s $755 million purchase of Kiva Systems in 2012: The Deal that Shocked Robotics.

In 2009, C & S bought its own robotics developer, Symbotic (formerly called CasePick Systems), and immediately put the new acquisition to work at its 500,000-square-foot distribution center in Newburgh, NY. Taking over 30,000 square feet of that facility, Symbotic erected a four-story cage filled with grocery products through which travel 168 rover robots that look like go-carts. Travelling at 25 mph, the go-cart robots shuttle along at approximately the speed of an Olympic sprinter, working tirelessly through three normal work shifts per day, week in and week out.

**Stihl**

**Ditching the supply chain altogether**

A company need not be an industry behemoth to witness robotics transforming its supply chain. The German chainsaw maker Stihl, ($1.3 billion in sales) (STIHL:GR) with a production facility in Virginia Beach, VA, installed 120 robots and works them 24 hours a day with only seven human co-workers per
shift. Peter Mueller, the VP of U.S. operations says that the cost to produce the chainsaw in the U.S. is only 1.8 percent more than the same Stihl chainsaw produced at the company’s facility in China.

Being closer to its consumer markets and not having to rely on trans-oceanic shipping or the risks of natural disasters like typhoons and earthquakes or even geopolitical events, solves lots of supply-chain headaches for Stihl’s operations. Timing is also convenient because Chinese wages are on a sharp upward slope. That 1.8 percent difference might soon be just a distant memory.

**Rodon Group**  
**Never too small to begin**

Supply chains are not exclusive to mammoth multi-nationals. Good, bad and problematic supply chains come in all sizes, even for small- to medium-size enterprises (SMEs). The advantages of being small are that small can mean more nimble and maybe not as mired in decades’ old systems that offer less and less advantages as the years stream by.

Robot automation for SMEs can mean a new way of keeping a sharp edge on production and distribution while holding the line on prices.

The Rodon Group, about 30 miles northwest of Philadelphia, PA is a small company trying out a single robot. Got to start somewhere. The Rodon Group is an ISO 9001-certified plastic injection molder with a facility about 125,000 square feet located in Hatfield, population 3,300.

The robot is a Baxter from Rethink Robotics. “Baxter” as Industry Week describes him, “has become the poster robot for a whole new category of industrial automation equipment—so called collaborative robots.”

Baxter costs $25,000 and has a lifespan of about three years. That’s dirt cheap for a robot, and the longevity is below average ($250,000 buys a robot with a work life of 15 years). Baxter is slow but steady. The day USA Today interviewed Rondon’s facility manager Tony Hofmann, Baxter had just finished a marathon work session of 2,160 straight hours or 270 8-hour shifts.

Rodon is an injection molding factory that had Baxter “grabbing plastic parts off the line, placing them in a box and separating them with inserts, then counting the items to make sure each box was exactly the same.

At the going rate of $9.00 p/h, Baxter had just racked up the equivalent human paycheck of $19,440.

“Those tasks typically require six employees — two on each shift — and sometimes dust and debris requires that they wear masks. It’s often hard to find willing workers,” said Hofmann. “The work is monotonous, mundane and sometimes dirty.”

For customers who would normally source their plastic parts overseas, here’s Rodon and Baxter offering an alternative that’s priced right.

Rodon advertises cheaper pricing than China plus a few worthy counters to supply-chain risk:
- ✔ JIT delivery vs. 45 days on the water
- ✔ Aggressive lead times
- ✔ Same day order revisions and changes
- ✔ Manufactured under USA laws and regulations
- ✔ OSHA certified
That’s a cool set of advantages available only onshore here in the U.S. Never starting an overseas supply chain offers one immediate benefit. With robot automation helping to keep a lid on production expenses, companies can avoid buying from abroad…and still have a happy bottom line. As Travelers Insurance notes: beware of foreign goods. Supply chain managers need to be aware that “goods produced overseas are still subject to U.S. regulations. That means that if a foreign supplier has questionable labor or environmental standards, a domestic importer could be in violation of U.S. laws simply by purchasing products from suspect suppliers.”

III. Dollars and Productivity: Human vs. Machine

At a Chicago tradeshow, Factory Automation Systems, Atlanta, GA put on an eye-opening demonstration of cost comparisons between human workers and robots: one robot costing $250,000 replaces two workers with combined salaries of $100,000. Result: over the 15-year life of the robot system, the machine yielded $3.5 million in labor and productivity savings.

As a portent of distinct changes shaping up in supply-chain logistics, First Research is forecasting a downturn in traditional materials handling equipment—tools for the “Old” supply chain—from a high point in 2013. “Having deferred purchases throughout the Great Recession, buyers returned to the materials handling marketplace in 2013 with a 2 percent increase over 2012.” Any ongoing gain through 2017 will be modest at best. “Trade growth for material handling equipment manufacturing remains an area of concern because of unstable foreign markets and reduced US demand. Import growth fell nearly 18 percent in 2012 over 2011, while export growth dropped 11 percent year over year.”

Unknown to the clueless 70 percent group interviewed by IBM, the path to the “New Supply Chain” has been bridged and early adopters are slowly taking on the new tools.

Digitization: supply chains, Moore’s Law and innovation

When the modern supply chain was actually modern, circa 1985, Intel’s 80386 microprocessor, introduced in the same year, held 275,000 transistors. In May of that same year the Dow Jones Industrial Average was 1,300. Things have changed.

Today, Intel’s Core i7 processor holds 2.27 billion transistors, or nearly $^{23}$ times as many. The power of exponential growth, like those billions of transistors on the i7, and the level of miniaturization of computing, mean everything for the advance of robotics.

Robots incorporating these new technologies are now punching in for work
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at warehouses and distribution centers, and are performing tasks that heretofore were the sole province of humans.

Basically, Information Technology (IT) is digitizing everything in its path, including supply chains. The only areas in logistics that have escaped going digital are the SKUs—the physical inventory—and the people who handle that physical inventory. They’re next!

It’s only commonsense that if everything is digital or going digital, and human beings are analog, that humans are on the way out. Warehouses and distribution centers will still need lots of people, however, but not handling inventory.

Just think of bank tellers and ATMs: which do you prefer and which do banks prefer that you do business with?

**Profound transformation of logistics**

Now robots and robot automation are closing in on the last two barriers: people are being replaced by robots, and much of physical inventory is being replaced with 3D printing (additive manufacturing). Storing 3D files of the inventory instead of the actual inventory itself will profoundly transform warehousing and distribution centers everywhere.

In many cases, the transformation will blur the lines between manufacturing and warehousing.

Temporarily, to speed up and accommodate human workers, logistics has a few digital/analog workarounds in place like Pick-by-Light systems, which use “light displays to direct operators to specific stock locations. Each product location can have an individual numeric or alphanumeric display with a light, an acknowledgement button, and a digital readout for indicating quantity.”

Other order picking technologies like voice-directed picking; RF handheld devices with scanners for data collection; and visual RF devices—all digital/analog workarounds—are dead-end technologies.

Robots are capable of stepping in and taking over from these short-lived workarounds; and in the process offer added benefits that go way beyond the skill set of even the best human order pickers.

Because robots are mobile computers, they will be able to interact directly with a customer, if necessary using a Siri-type voice to communicate. Robots will be able to circumvent entire back office operations by directly taking customer orders from first interaction straight through to delivery and even confirmation of delivery.

With the aid of the Cloud and Big Data, robots are able to retrieve instant product information with which to communicate purchase advice to customers, even remind customers of their recent purchases or favorite styles—in any language the customer so desires! In an age of social-media-influenced selling, those extra robot benefits will be huge and hugely transformative.

Let’s not get too far ahead of ourselves here with the near-future capabilities of robots, some of which are in use today. We’ll see them again soon enough in this report.

Suffice it to say that humans have no chance of contending with robots and robot automation. And from the degree of difficulty and expense already evident in hiring logistics workers, training them, and recovering productivity after their high turnover rates, it seems humans don't want those jobs anyway.
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- Erik & Andy are correct

  The exponential increase in a chip's transistors, pushed along by Moore's Law, are bringing the power of miniaturized computing to robots…and to every product—computer on a chip; 3D transistors, or nano-scale chips. Even RFID tags are opting for “intelligent” sensing.

  One example to consider is the remarkable recent advances in robot vision systems. Instead of a robot's vision sensors sending data to a remote computer for analysis and decision making, now computing power resident right at the sensor itself is instantaneously interpreting and making decisions for what the robot sees. For example, a tilted SKU, where the barcode is impossible to scan, would be noticed by the robot and automatically righted for scanning.

  Such “sensor intelligence” enables robots greater mobility or the ability to nimbly pick and pack just about anything “they see.” And such capabilities aren’t levelling off anytime soon. Rather, they are increasing…exponentially!

  In many respects robots are the physical extension of IT: think, a Smartphone with mobility and an arm or two.

  The exponential and digital from the above are but two thirds of the future robot scenario brilliantly put forth by Erik Brynjolfsson and Andy McAfee in their book The Second Machine Age.

  The third leg of their thesis is recombinant innovation, an idea they culled from Brian Arthur’s The Nature of Technology. Basically, recombinant innovation is the idea of taking two or more known innovations, and to artfully “recombine” them into a new innovation.

  For instance, GPS, which is used for road directions for vehicles, recombined with Google Maps and Google Street View, go to create the new innovation of a robot navigation and identification system for the interior of a warehouse or distribution center.

  That new third thing enables robots to navigate without any other aid to find product aisles, to identify products and to pick any item to fulfill an order.

IV. Stuff happens!

Eye-opening analysis on supply chains

  Current analyses from nearly a dozen well-respected research organizations have raised warning flags, some dire, that modern supply chains are too long, too complex and too fragile.

  Additionally, the reports point out that supply chains are too expensive, both in terms of cost to operate as well as the cost of recovery after the seemingly omnipresent threat of interruption.

  Numerous surveys have shown that supply chain managers are aware of the risks to their operations, writes Christopher Tang in the International Journal of Logistics Research and Applications, yet few have done anything to prevent or mitigate risk.

  Why is that?

  Gene Long, VP at Chainalytics, ascribes it to the global expansion we've experienced in supply and demand “over the last two decades has just caught up with us.”
Robotics and the “New” Supply Chain: 2015-2020

The recent studies are many but single minded in offering an optimum solution: drastic automation for supply chains. McKinsey, CapGemini, IBM’s Institute for Business Value, MIT Sloan Review, Transport Intelligence, Bain, MIT’s Center for Transportation & Logistics, Gartner, PricewaterhouseCoopers, Motorola, Deutsche Post DHL, and Credit Suisse roll out in exacting detail just what exactly it is that “has just caught up with us” and what needs to be done.

McKinsey’s Building the supply chain of the future is succinct yet emphatic with its solution, which seems to be the consensus opinion from all of the above studies: the pressing need for supply chains takes the shape of “ditching today’s monolithic model in favor of splintered supply chains that dismantle complexity.”

The logistics industry’s own U.S. Roadmap for Material Handling & Logistics 2014, with “more than 100 industry thought leaders” chiming in, echoes the same calls for drastic change sooner rather than later.

“That future,” continues McKinsey’s report, “spurred by a rising tide of global uncertainty and business complexity, is coming sooner than many companies expect.”

It is what it is!

Of course, if you’re running Hewlett-Packard’s gargantuan $65-billion-a-year global supply chain, or larger behemoths like those of Wal-Mart or Unilever, just keeping a long, complex and fragile global supply chain reasonably well oiled and functioning can seem like job enough.

Again, why is that?

One reason could well be simply not knowing: lack of information about what’s happening end to end in most any supply chain and what the consequences of inaction will be seems to be the biggest piece of the looming problem. A Bain survey found that only 25 percent of supply chain managers reported having full information on their supply chains; the rest reported knowing either little to none, or only basic, or selective information. A full 44 percent fell into the little-to-none-to-basic category.

Maybe, these managers are pitted against an impossible task: knowing everything about your supply chain may not be possible. In agreement with that position is Michael ten Hompel, Chair of Materials Handling and Warehousing at TU Dortmund University and managing director at Fraunhofer-Institute of Material Flow and Logistics, thinks so, saying: “The logistics systems in sub-areas are already so complex that the human brain can no longer encompass them.”

Then Gartner piles on saying: “Through 2018, 75 percent of companies will struggle to realize their end-to-end supply chain visibility,” for which Gartner even has created a new six-letter acronym E2ESCV for end-to-end supply chain visibility; to which IDC Manufacturing Insights counters: since most visibility solutions are in functional silos—logistics, manufacturing, procurement, etc.—silo integration has to take place before E2ESCV is even worthwhile.

International logistics, on some levels, might well be reaching its capacity limits, say 25 percent of supply chain managers responding to a Global Delphi Study.
Robotics and the “New” Supply Chain: 2015-2020

Moment-to-moment fragility

Of course, the most obvious supply-chain perils are man-made or natural disasters. One word, Fukushima, tells it all. Unpredictable disasters, including terrorist attacks, wars, earthquakes, economic crises, devaluation of currencies, epidemics like SARS, tsunamis, strikes, computer virus attacks, etc. are all unkind to supply chains.

Two independent studies, one by the Centre for Research on the Epidemiology of Disasters and the other by the world’s largest re-insurer, Munich Re, show historical data indicating that the total number of natural and man-made disasters has risen dramatically over the last 10 years. Moreover, Munich Re reported that the average cost of these disasters has increased by a factor of 10 since the 1960s.

Supply-chain risk is a popularly accepted fear: “Fully 68 percent of global executives responding to a recent McKinsey survey said that supply-chain risk will increase in the coming five years.”

Another critical factor that augers against the modern supply chain is that none are “modern”. Most of these continent-spanning supply systems were built in the late-80s to early-90s when oil was $35 a barrel, when networking was in its infancy, when Moore’s Law was still two decades away from being of any real help to logistics.

Since then, layers of complexity from computer systems to communications have been larded over the original infrastructure; lines of supply have been stretched further, with more hubs and more spokes, more customers and more SKUs added.

In his The Crisis of Complexity, John Mariotti, president and founder of the Enterprise Group, and former president of Rubbermaid Office Products, writes that companies are beginning to realize that complexity is crippling their businesses and destroying profitability, and most can’t see what’s causing the problems. Most, maybe all, he says, don’t even know how much it really costs them to process an order.

V. Tools for Change

How to become “faster, smaller, cheaper and local
3D printing, intelligent robotics & reconfigurable warehouse automation

“No workforce can be paid little enough to make up for the cost of shipping across oceans.”

—Richard D’Aveni, 3D Printing Will Change the World

3D Printing (additive manufacturing)

The 800-lb gorilla in the room. Three things to know:

1. This report separates 3D printing from robotics. However, 3D printing is actually a robotic process and a 3D printer is a robot.

The internationally accepted definition of a 3D printer, which is used in this report, comes from the ASTM International (American Society for
Robotics and the “New” Supply Chain: 2015-2020

Testing and Materials, which is globally recognized as the leader in the development and delivery of international voluntary consensus standards) ASTM International’s consensus definition: “A 3D printer is a limited type of industrial robot that is capable of carrying out an additive process under computer control.”

2. This report also discusses a wide range 3D printer types, beginning with those that utilize a build envelope or chamber (as with 3D Systems and Stratasys products, as well as many others) scaling up to single or multiple robot extruders (as with Lockheed Martin’s “Factory of the Future”).

3. 3D printing is what economists call a “general purpose technology” (GPT), which is a deep technology that cuts across multiple industries: steam, electricity, IT, etc. are GPTs. 3D printing is the latest.

Blurring the lines: warehouse or factory or both?

The rise of the “New Supply Chain” is initially taking place within the four walls of warehouses and distribution centers. Eventually, transportation, both overland and by sea, will be drawn into the transformation as their technologies and regulatory situations evolve. In many respects, the warehouse/distribution center will help define exactly how best transportation will be utilized. But, first things first.

What is a warehouse/distribution center and what is a factory is beginning to blur with the advent of 3D printing. Early adopters like UPS and FedEx are already beginning to test 3D printing capabilities—factories!—at their distribution centers. Others will follow as the impact of 3D printing clarifies.

Some impact areas will be monumental, such as automobile parts, which is nearly ideal for 3D printers to completely absorb. The ramifications of such a conversion of parts warehouses into both parts manufacturing and inventory centers will rock the automotive world with a new method of combined manufacture and storage that could save billions of dollars.

Keeping an inventory for multiple lines of vehicles or inventory to cover statutory limits on older models will all go away. Currently, auto makers are required by law to supply parts for the full warranty period, which can be up to five years or 100,000 miles.

Automakers like GM often sell or license the tooling for parts to aftermarket companies, so one can usually get parts through one supplier or another, says Stephen Spivey, a San Antonio-based analyst with research firm Frost & Sullivan.

Imagine that kind of auto parts boon in the hands of 3D printing? No inventory, no molds, no tooling, no waste in manufacture, no product packaging, no pallet of product headed into inventory or off to a customer.

Only the electronic file for design and fabrication would be archived, with any part capable of being 3D printed on demand in situ.

IBISWorld’s analysis of Global Auto Parts & Accessories Manufacturing shows a global industry with revenue of $2 trillion growing at seven percent annually. The industry manufactures all motor vehicle parts and accessories other than engines, engines parts, batteries, tires, bodies and chassis, and consists of over 24,000 businesses that employ over three million workers.
Robotics and the “New” Supply Chain: 2015-2020

...Its leaders are mega-size enterprises such as Robert Bosch, Denso, Continental, Magna International, and Johnson Controls.

In reality, 3D printing would also have a good shot at producing engine parts, batteries, and tires as well. However, just those numbers from above on the effect of 3D printing disrupting the auto parts and accessories business show the scope and magnitude of what’s ahead for this nascent manufacturing technology. It’s near limitless!

3D printing is a true GPT that can easily impact most anything from medical supplies, to food, to general merchandise.

Twenty miles north of Detroit in Warren, MI, Chrysler Group LLC leases a $35 million auto parts warehouse that covers 1.3 million square feet of space. Over thirty football fields could easily fit within the giant. Hundreds of thousands of dollars are spent annually to ventilate, heat, air condition and light the space to watch over and distribute several million auto parts.

A building that size is nice on the tax rolls of Warren and for the paychecks of its citizens. More than likely, however, its days are numbered. If the Bostonian shoe factory in Whitman, MA jumped to India to save on wages, how long would it take Chrysler to convert the Warren facility to mixed 3D printing with some warehousing, if it could save on rent, taxes, payroll, overhead, and making product only on demand, all in a facility the size of one football field? A heartbeat is all it would take to make that decision.

The disruption of warehouses and distribution centers by 3D printers is barely in its infancy. Expiration of critical patents on 3D printing will push disruption to the extreme. Since the expiration of Chuck Hull’s 1984 Additive Manufacturing patent in 2009, the open source community has embraced 3D printing, leading to rapid innovation and improvements.

From 2009 to 2014 fits the profile of the evolution of 3D printing to date. Expiration of that patent was key. However, fifty-one more critical patents in the industry will expire in the next ten years.

Current 45 percent growth rate would see a $16 billion 3D-printing market by 2018.

“We’ve been more acquisitive lately, especially for talent,” said Doug McMillon, CEO of Wal-Mart Stores, Inc. “And our pace of acquisitions, I think, is going to accelerate. 3D printing is interesting to me. We can use 3D printing over time for replacement parts.”

When mega-retailer Wal-Mart starts toying with the attributes of 3D printing for its business, as well as UPS and Staples, it starts to get mighty clear mighty fast that 3D-printing technology and its predicted 45 percent annual growth rate through 2018 has got everyone’s attention.

**Digitizing and reproducing tangible goods**

“There’s no reason to believe that digitization’s impact on manufacturing will be any less significant than its impact on books, music, and movies. 3D printing is already disrupting business-as-usual in the manufacturing of prosthetics and medical implants,” says Chris Caplice, executive director of MIT’s Center for Transportation & Logistics (CTL).

Once again it’s the familiar drumbeat of IT and Moore’s Law sounding their entrance into a whole new segment of industry and commerce. The same
Robots in supply chain, not just assembly

unrelenting drumbeat since UNIVAC’s picking Eisenhower over Stevenson.

“In the U.S. today, consumer products are typically manufactured offshore, brought in through a handful of ports, and then delivered through a three-tier distribution system,” says Caplice. “Yet the recent trends of decentralization and digitization look like they might really disrupt this design and change the way we’ve been doing supply chain for 20 years. These two trends are feeding into each other, and could dramatically change the way we manufacture and distribute finished products.”

“As applications of the technology expand and prices drop, the first big implication is that more goods will be manufactured at or close to their point of purchase or consumption,” writes Richard D’Aveni, professor of strategy at Dartmouth’s Tuck School of Business in his 3D Printing Will Change the World.

“This might even mean household-level production of some things. (You’ll pay for raw materials and the IP—the software files for any designs you can’t find free on the web.) Short of that, many goods that have relied on the scale efficiencies of large, centralized plants will be produced locally. Even if the per-unit production cost is higher, it will be more than offset by the elimination of shipping and of buffer inventories. “These first-order implications will cause businesses all along the supply, manufacturing, and retailing chains to rethink their strategies and operations. And a second-order implication will have even greater impact. As 3D printing takes hold, the factors that have made China the workshop of the world will lose much of their force.”

3D Systems and Stratasys

Growth rate through 2018: 45 percent?

Until Hewlett-Packard arrives (rumored to enter the 3D sweepstakes (3Q14)), two rivals, 3D Systems and Stratasys, have the field virtually to themselves (20 percent market share for 3D Systems (DDD) versus 54 percent for Stratasys (SSYS)).

Both 3D Systems and Stratasys overlook a playing field filled with enormous potential that is profoundly changing manufacturing as well as warehousing and supply chains.

The playing field

Independent research company Canalys forecasts a scorching 45 percent annual growth rate for 3D printing through 2018, creating a market of over $16 billion.

Tim Shepherd, a senior analyst at Canalys, said in a press release about 3D printing, “It has now moved from a new and much-hyped, but largely unproven, manufacturing process to a technology with the ability to produce real, innovative, complex and robust products.”

Market timing for 3D Systems and Stratasys couldn’t be better. Rivals are gathering. Since the original 3D Systems’ patent expired in 2009, another fifty-one 3D printing patents are scheduled to expire over the next ten years. Other forecasts, while not as generous as Canalys, are still glowing over the rise of 3D printing.

Lux Research estimates the total 3D printing “market will nearly quadruple to $12 billion by 2025,” with leading industries that include aerospace, medical,
Wohlers Associates sees double-digit growth, predicting that the industry would reach $10.8 billion by 2021.

Printers alone, according to Lux Research, will be worth $3.2 billion, while $2 billion will represent formulated materials; $7 billion will come from the value of parts produced.

**The HURCO Effect**

Recombinant innovation in action

Straight out of Brynjolfsson and McAfee (August 5, 2014) came this headline in Robotics Business Review: Hurco Files Patent for Adapter that Turns CNC Machines into 3D Printers.
That headline says it all: Hurco recombined a CNC (computer numerical control) machine and the technology for 3D printing to create a CNC 3D printer.

“It’s a marriage that combines two technologies dear to the heart of many hardware-loving roboticists: the computer numerical control (CNC) machine and the 3D printer,” wrote RBR’s Judith Pfeffer.

The end of the original 3D printing patent wasn’t warm in its grave before Hurco innovated upon it, which indicates that recombinant innovation is at it again, and probably will strike more than just this once in the case of 3D printing. Now the tens of thousands of CNC machines in the world have a chance to get in on additive manufacturing.

Even if the Hurco patent is a dud, someone somewhere will take up the challenge and keep at it until it’s a success.

“We designed an additive manufacturing adapter that, in combination with proprietary Hurco control software, effectively turns a CNC milling machine into a 3D printer,” says Hurco president Gregory Volovic.

“Not everyone is sold on the feasibility of the idea,” wrote Pfeffer, “Many practical issues remain to be solved, as noted by Fabbaloo [article], starting with the fact CNCs are subtractive manufacturing—the opposite of 3D printing, which is additive an manufacturing.”

Factory of the Future

Escaping the build envelope

At some point in time, in order to build large-scale products, 3D printing will need to escape the build envelope or chamber where today everything is fabricated.

Lockheed Martin’s Factory of the Future concept utilizes multiple, large 6-axis articulated robots withextruders mounted on them for depositing large structures.

To each extruder is attached an inline mixing and blending line through which flow a variety of thermoplastic compounds. One robot can apply a tough, weather resistant layer; another robot may apply a layer that conducts heat; another may apply solvent-resistant polymer.

Slade Gardner, a Lockheed Martin fellow, calls the process point-wise composition and control. Multiple robots all working in concert in the building of a single structure.

Pictured here, the point-wise compositing is at work on an aircraft, but it could be as easily set to work depositing parts for a kitchen refrigerator or even a backyard gazebo.

In terms of a supply chain, this capability once again blurs the lines between factory and warehouse.
Intelligent, mobile robotics
Humans need not apply

Not so many years from today when schoolchildren tour warehouses and fulfillment/distribution centers, they will be horrified to learn that humans once worked in them.

Using a Smartphone, their tour guide will place an order and the class will watch as the order is instantly fulfilled from picking to packing to shipping all without human intervention of any kind. The children will be happy to see right before their own eyes that “nice humans” don’t have to do that nasty kind of work.

Their tour guide, holding aloft her Smartphone, will announce that Smartphones were the last straw in banishing people from warehouses. The billions of mobile orders and the need for speed to fulfill those orders was just too much, too great a task for humans.

Value-added robot benefits

If they needed to know, the tour guide could have explained more about that order. She could have said that during her order she could have spoken with the robot order picker, and the robot would be aware of her consumer preferences for almost any product or service. That the robot is a sales advisor as well as order picker. The robot could have suggested related items, and even played advertising messages from manufacturers that offered “special” discounts for those related items.

If the children were interested, the tour guide could have told them that the robot takes and processes the entire order, that the need for a back office for retail sales was unnecessary, that the robot even did the credit card transaction, and that the credit card company also had a “special” offer to make.

In short, intelligent, mobile robots will be much more than order pickers; rather, they will be an integral part of marketing and sales, accounting, and inventory.
De-populating warehouses

With every online retail purchase clicked into existence (2013: $262 billion, 13 percent over 2012, Forrester), we take more and more packages, cases and pallets out of the hands of humans and place their fulfillment into the care of machines.

It’s not robots taking jobs away from human workers, it’s people taking the jobs away.

When it comes to the longevity of humans handling materials in warehouses and distribution centers (DCs), there’s mixed reaction. What is clear is that the trend is decidedly moving away from human workers.

Bruce Stubbs, director of marketing from Intermec, sees employee turnover and difficulty recruiting as huge issues, thereby opening the door to worker alternatives that can plug gaps in automation needs.

Kelly Reed, vice president of material handling integration at Tompkins International, says a lot of “the interest in automation is still being driven by a desire for cost savings, primarily by reducing the size of the distribution center workforce and reducing repetitive strain and other workplace injuries among those workers that remain.”

Others in the industry like Intelligrated vice president Greg Cronin point out that “Baby boomers are retiring, and many of the younger generation aren’t interested in manual labor jobs. Many companies are willing to make capital expenditures today that they weren’t willing to make before to try and offset the labor situation.”

Vice president, Michael Kotecki from Dematic agrees that removing labor from the distribution center is an ongoing quest. Whereas supply chain consultant Kris Bjorson of Jones Lange LaSalle is more blunt, saying that no one can just keep “throwing labor” at automation needs. He feels that retailers are quickly reaching a tipping point whereby in order to make a profit in e-commerce and from same-day delivery that they’ll have to “flip the switch” sooner than later for robot-powered automation.

Although robots are expensive, they are plentiful and available for work; they thrive on repetitive jobs; they never strain themselves or suffer workplace injuries; they can work tirelessly 24/7 for 365 days a year—and can even work in the dark. Their cost to operate, amortized over five years or so, is on par with wages paid to workers in China. And they don’t require medical coverage or time off. That’s hard to beat! In fact, it can’t be beaten.

Talent needed, not brute labor

The real people shortage in warehouses, according to supply chain analyst, Lora Cecere, is not brute labor but talent. There is a shortage of and growing need for logistics technicians; brain power not brawn is what’s trending upwards for humans in warehouse and DC environments.

Consensus opinion, logic and the reality of the workplace seem clear: supply-chain logistics will meet the onslaught of e-commerce, Walmart-style low pricing and omni-channel retailing with brainpower and machines—only.

That’s the future and it’s coming fast.

It’s a future with which Sucharita Mulpuru, vice president and principal analyst at Forrester Research, is all too familiar. She’s Forrester’s point person serving e-business and channel strategy.
Commenting on retail employment in Forbes, she sees e-commerce as a strong jobs creator. “For the first time, we have estimated the total employment in the US that results from the online retail sector. Our estimate is that over 400,000 individuals are employed in some web retailing function, of which more than half are salaried professionals (i.e., all non-fulfillment and non-call center employees).” Notice the exclusion of non-fulfillment and call center employees.

“Furthermore,” she says, “many of these salaried positions have promising long-term career growth trajectories. Given that there are probably about 750,000 such salaried jobs overall in retail (my estimate, approximately 10 percent of the 7.3 million people employed in retail overall), the fact that the e-commerce sector has nearly 200,000 of them is a remarkable testament to the employment impact of this sector.”

Definitely not news to the integrator crowd quoted above was the tenor of the results from a 2014 Motorola survey, From Cost Center to Growth Center: Warehousing 2018. The survey asked “warehouse IT and operational personnel in the manufacturing, retail, wholesale and third party logistics (3PL) market segments to share their thoughts and plans for addressing the new industry realities over the next five years.”

None of the responses were particularly laudatory of human productivity on most any level, which had 70 percent of the respondents opting for alternatives through increased automation.

Inefficiencies and inaccuracies in order picking; need to decrease the impact of labor turnover and chronic shortages of workers, and to reduce training time, especially for new procedures like interleaving; need to increase efficiencies in inbound and outbound handling processes; and redesigning returns management and reverse logistics from one of the least automated, all seem to scream out that humans are in the wrong place at the wrong time.

Incredulously, as other reports have equally pointed out, Motorola’s survey shows that managers of warehouses and distribution centers are reluctant to change old ways. However, the need for speed and churn are finally beginning to wring out agreement: “Survey responses indicated that while about 40 percent of today’s organizations are not currently pursuing increased mechanization to streamline processes, this percentage shrinks to 17 percent by 2018.”

And the Motorola survey, fully in agreement with IDC Manufacturing Insights’ assessment about lack of visibility because of functional silos of information, offers up:

“Today, the reality in many, if not most, warehouse operations is the existence of separate islands of information. The vision for the future is the linkage, integration and consolidation of the Warehouse Management System (WMS) with Enterprise Resource Planning (ERP), the Yard Management System (YMS) and Transportation Management System (TMS). These linkages help remove inefficient information silos, promoting collaboration and increasing the recognition that changes in one process can and will affect others downstream and upstream. For example, changes in packing and staging can affect load plans, trailer drops, routes selection, rates and more. Anticipation of—and response to—these effects is not only crucial to improve warehouse efficiency and productivity, but also to create a more synchronized and agile supply chain.”
Investment money is not the problem

Although warehouses and distribution centers are still spending well on fixed-conveyor systems and sorting automation, until recently, they have shied away from robotics, especially intelligent, mobile robotics.

A total of 22,591 robots valued at $1.39 billion were shipped to companies in North America in 2013, beating the previous record of 20,328 robots valued at $1.29 billion shipped in 2012.

These new records for robotic shipments represent growth of 11 percent in units and 7 percent in dollars. When sales by North American robot suppliers to companies outside North America are included, the totals are 25,772 robots valued at $1.57 billion.

Assemblers, more so than materials handling, are the investment kings as they continue to invest in robots for 2014: robot shipments to North American customers through September totaled 17,645 units valued at $1.1 billion, breaking the previous nine-month record set in 2012 by 14 percent in units and 9 percent in dollars.

According to the 18th Annual Capital Equipment Spending Survey, assembly leads the purchasing of robots by a wide margin. Materials handling lags, and is only lately seen as responding to the realities of the marketplace and the realization that billions of dollars can be wrung from inefficiencies.

In terms of applications for robot orders, increases were seen in assembly (61 percent), material handling (13 percent), and coating and dispensing (5 percent).

It’s not just U.S. manufacturers that are investing in robotics, either. Worldwide, the industrial robotics market has fully recovered from the Great Recession, according to consulting firm Markets and Markets.

The global market for industrial robotics was approximately $25.7 billion in 2012 and is expected to reach $32.8 billion in 2017, representing a compound annual growth rate (CAGR) of 5 percent. In terms of units, shipments of robots will increase from 176,586 machines in 2012 to 234,122 machines in 2017—a CAGR of 5.8 percent.

“There’s no question companies have money to spend. U.S. corporations are currently enjoying the cheapest cost of capital in more than half a century. According to Moody’s, average corporate bond yields are just north of 5 percent. That’s up from 4.5 percent in April, but by historical standards, it’s still dirt cheap. Corporate bond yields haven’t been this consistently low since the mid-1960s.

“The difference is that back then, businesses were actually spending that cheap cash, buying equipment, building factories and hiring workers. Today they’re just hoarding it. The pile of corporate cash on the balance sheets of nonfinancial companies has grown to $1.48 trillion, according to Moody’s. That’s an 81 percent increase since 2006.

“Despite the abundance of cheap money, however, corporations have so far been reluctant to invest in people, plants and equipment. Averaged over the past two years, U.S. nondefense capital goods orders (excluding aircraft) have increased by just 0.3 percent per month. That’s less than half the rate of business investment between 1993 and 1998, when corporate bond yields averaged around 8 percent and borrowing money wasn’t nearly as cheap as today.”
Mercadona (Spain) & Ocado (UK)

Some companies are more than first adopters only, they are drivers of robot automation. Two leaders are Mercadona in Spain and Ocado in the UK.

While Mercadona is savvy about the need for the automation upgrade and brings in a leader like Cimcorp, Ocado brings it all in house.

Mercadona, the Spanish retail company with more than 1,400 supermarkets and a 13.5 percent share of Spain’s total food retail space, has commissioned Finnish robotics specialist Cimcorp Oy (known as Cimcorp) to design and implement a fully automated, robotic order picking system for fresh produce.

Mercadona’s new $86 million logistics center is based on Cimcorp’s “order-processing island” concept:

“The island is self-sufficient, taking care of goods reception; put-away; location of stored items; retrieval planning; picking of crates; sorting and preparation of crates into discrete orders; and loading of the orders onto transport units ready for delivery.”

Commented Markku Vesa, CEO of Cimcorp: “Due to very fast order processing with Cimcorp’s robots, our customers in retail and food & beverage are able to shorten lead times, which is a critical factor for perishable products with limited shelf lives.” In fact, Cimcorp claims that the solution can make order picking six times more efficient than a manual solution and is suitable for a wide variety of applications.

Established in 2000, Ocado (with partnership agreements with Waitrose and Morrisons) is one of Britain’s leading online-only retailers supplying almost 40,000 product lines and serving over 70 percent of British households. The “big four” in UK supermarket chains: Tesco, Asda, Sainsbury’s and Morrisons (combined 74 percent of UK grocery business).

Former Goldman Sachs merchant bankers, Jonathan Faiman, Jason Gissing and Tim Steiner founded the company, which made its first commercial delivery in 2002 (FTSE: OCDO:LN)

When Ocado was founded, its backers realized from the start that off-the-shelf software alone—whether to run its website or its warehouses was far from meeting their needs.

That belief, though, has taken the company into cutting-edge research into robotics, artificial systems, machine learning, simulation and more, as it bids to perfect its systems—and, potentially, to turn the fruits of this research into a platform that it can use to expand or offer as products or services to other retailers.

“We are a technology company, but also a logistics company. We are a retailer and, in the future, as part of being a technology company, we will also be a platform company because that’s effectively what we are building,” says Ocado’s technology director, Paul Clarke.

Reconfigurable warehouse automation

Robotics and moveable conveyor systems

Research and development and testing of reconfigurable warehouse conveyor systems have been ongoing since the 1990s under the heading of Open and Reconfigurable Conveyor Systems or ORCS. However, not much has been done on the implementation of these systems into supply chains, especially enterprise-level supply chains.
Slowly, during the last decade, reconfigurable warehouse conveyor systems have been gaining some renewed market traction over traditional fixed conveyor systems.

Although traditional fixed conveyor systems have been one of the leading factors in lean management over the last two decades, conveyor manufacturers have attempted to respond to ongoing end-users’ needs for maintaining lean flexibility by creating modular conveyor systems. However, modular systems are not reconfigurable systems.

“Most attempts at modular systems fall short in the eyes of engineers,” says Tim Ducey, engineering sales manager at Barry Sales Engineering, Inc. “Once a traditional modular conveyor is taken apart, configuration and integrity are lost forever.”

“One of the fastest ways a conveyor system becomes obsolete is when a new piece of equipment is added to the process,” adds Jill Batka, president, Dynamic Conveyor Corp (manufacturer of “reconfigurable” automation).

“Although many manufacturers identify their conveyor systems as modular, most of their components need substantial alteration, such as cutting and welding to make them adaptable, and once a component has been cut down, there is no way to lengthen it again and that component becomes scrap.”

**Change on the upswing**

The need for more speed and maximum flexibility in an atmosphere of high churn has prompted a reexamination of fixed conveyors. To date, however, most any reexamination and suggested logistics’ solutions have been almost exclusively as scholarly papers in such publications as the International Journal of Computer Integrated Manufacturing, e.g. Dr. Qian Wang et al in *A New Generation of Automated Warehousing Capability*.

Organizations like Dynamic Conveyor Corp provide some capability, but are generally small-scale solutions.

In the offing, large-scale reconfigurable conveyor systems may incorporate the use of robotics as part of the move and reconfigure apparatus. Such robotic assist is now prevalent in the fracking industry where robotics moves multi-ton gas/oil drilling rigs with great precision around small drilling zones as the rigs drill multiple wells.

A transfer of heavy-lift robotics capability into warehouse and distribution center operations might one day become a distinct part of ORCS technology. When necessary to reconfigure, the system’s built-in robotics could move and reorient conveyors to any necessary alignment with great precision.
VI. Robotics Solutions at the Ready

Complex machines that “uncomplicate” supply chains
The journey to the “New Supply Chain” has begun in earnest as a growing number of forward-looking manufacturers are building the tools for today and tomorrow’s logistics chores.

Loading dock: autonomous unloading and loading
- **Egemin Automation**: ATL automated trailer loading vehicles are used to load over-the-road trailers with pallets or other unit loads of virtually any required loading pattern, including mixed-orientation patterns (in conjunction with Mitsubishi Caterpillar Forklifts, Inc.).
- **Teun**: The unmanned PIQR drives into the container, sees the cargo and maps it. Then the machine extracts the products from the container, palletizes them and wraps them, if necessary, with plastic foil. The machine can attach a (barcode) labels and thus prepares the goods for further processing or storage. Every box is checked on volume and weight.
- **Thyssen Krupp**: The ParcelRobot is a system for the fully automated unloading loose, standardized packaged goods from containers and trailer trucks.
  The Parcel Palletizer recognizes the parcel sizes and piles them correctly sorted.
- **Wynright**: Robotic Truck Unloader/Loader (RTU/L) is self-guided and autonomous for the unloading or loading of a variety of products. The RTU utilizes advanced perception technology that allows it to sense and acquire product that has been floor loaded on semi-truck trailers or ocean freight containers.

Autonomous forklift (purpose built)
- **Elettric80**: Freeway is a highly flexible handling system that uses palletization robots, laser-guided vehicles (LGVs), high speed robotic strapping machines (Silkworm) and an autonomous pallet control system.
- **Egemin Automation**: Hybrid Forklift AGVs (with or without driver) automatically pick up and deliver pallets, rolls, carts, containers, and many other transportable loads (in conjunction with Mitsubishi Caterpillar Forklifts, Inc.)

Autonomous forklift (aftermarket kits)
- **INRO Technologies, Ltd**: Robot forklifts operating in warehouses, allowing
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them to function with or without a driver. Founded back in 2005, INRO was spun out from Auckland University and was named Start Up of the Year at the 2008 NZ Incubator Awards.

Kollmorgen: NDC8 is a complete automated vehicle control solution that is application-independent, scalable for use with almost any transport vehicle, and easy to integrate with existing hosts and material handling systems.

Automated Storage and Retrieval Systems (AS/RS)

Schaefer: Schaefer Carousel System (SCS) is a high-speed order-picking grid system using the goods-to-person principle. Up to 1,000 picks per hour, 50 percent higher storage density and a modular system concept.

Symotic: Goods-to-man mobile robot for full case and split case picking. MatrixSelect rovers (mobile robots) store full cases in a dense racked matrix cube. The rovers have the ability to access any product at any location within the cube.

Swisslog: The automated small parts storage system, AutoStore, picks and stores single items and small cases to make better use of available space and increases efficiency at integrated goods-to-person workstations.

Others: Daifuku (acquired Wynright), Dematic, Knapp, Murata, OPEX, Cimcorp

Automated picking system

Schaefer: Robo-Pick (SRP) is a fully-automatic picking system which can be integrated into an existing person-to-goods system. This system picks more than 95% of typical products found in mail-order businesses and achieves picking rates of up to 2,400 picks per hour.

Automated Guided Vehicle (AGV)

Seegrid: Manufactures flexible vision-guided automated guided vehicles (AGVs) and robotic industrial trucks to the material handling industry. Seegrid also provides automated pallet trucks, tow tractors, and “walkie” stackers.

Others: Savant Automation, America In Motion, Ward Systems, JBT Corporation, TecnoFerrari/Prella Technologies

Autonomous tractor-trailer trucks

Volvo Trucks, Daimler (Mercedes Actros tractor-trailer)

3D printers

3D printing or additive manufacturing is a process of making three dimensional solid objects from a digital file. Objects are created by laying down successive layers of material until the entire object is created. Each of these layers can be seen as a thinly sliced horizontal cross-section of the eventual object. Types of 3D processes: Selective laser sintering (SLS); fused deposition modeling (FDM); and stereolithography (SLA).

Select companies: 3D Systems, Stratasys; and Hurco (CNC to 3D adapters)