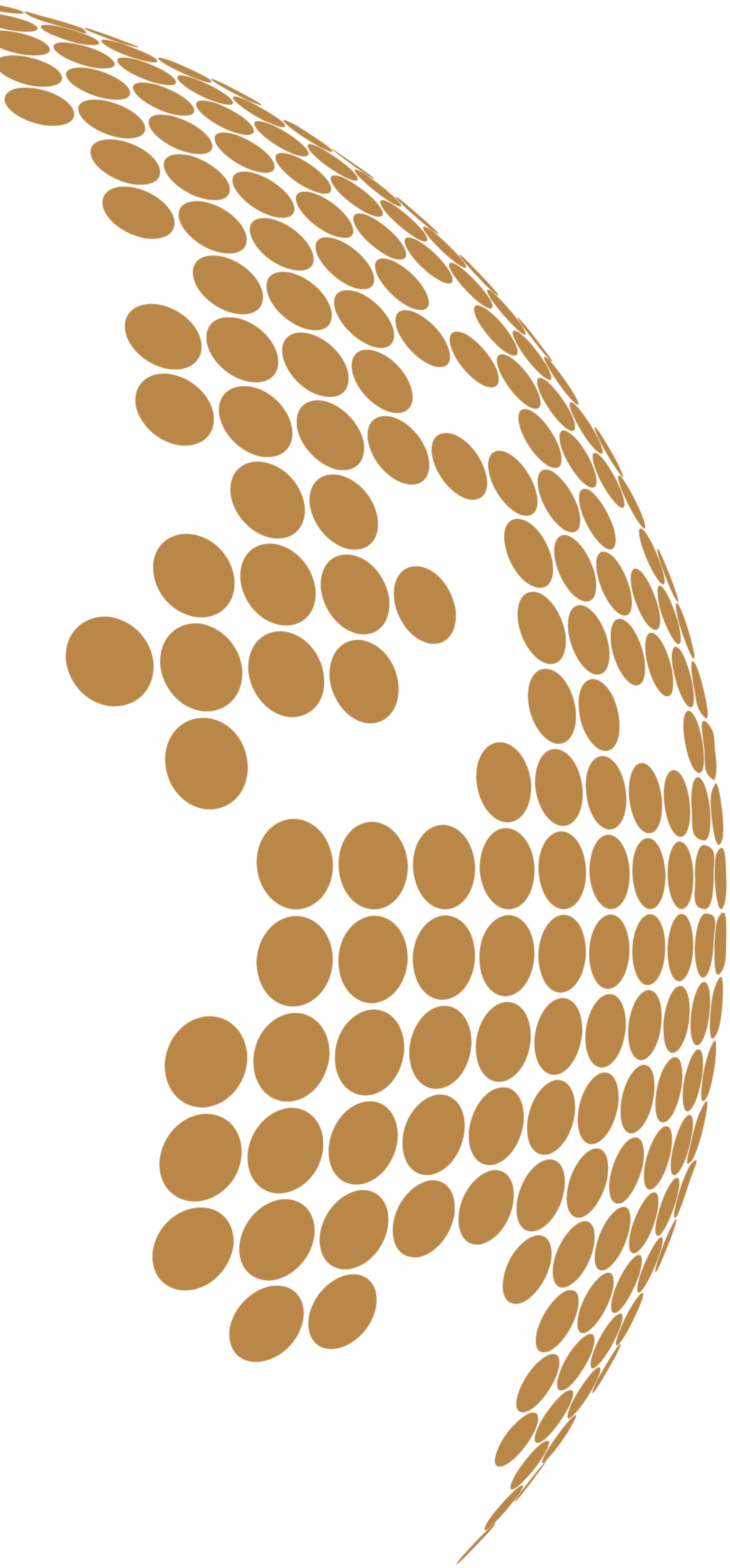

MIT CTL WHITE PAPER

INNOVATIVE OR INCONCLUSIVE? EVALUATING NEW SUPPLY CHAIN IDEAS

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Executive Summary

Even though supply chain innovation (SCI) is a key component of corporate competitiveness, there is no commonly accepted definition of the concept. It is important to address this issue. The pace at which new ideas are introduced has increased markedly over recent decades, and companies cannot afford to be behind the curve because they are unable to effectively evaluate the latest innovations.

The MIT Center for Transportation & Logistics (MIT CTL) has launched a research project to better understand SCI, and to help companies assess the potential of new ideas in terms of their supply chains. The project has developed a working definition of SCI, and is creating a framework for evaluating these concepts.

In this white paper MIT CTL gives a brief description of the initial research findings, and undertakes a basic assessment of three very different innovations that have the potential to reshape supply chains: cloud computing, omni-channel retailing, and 3D printing. Each one is reviewed according to the positive changes in cost, cash, and/or service that result from its introduction, as encapsulated in the working definition of SCI.

Cloud computing is the most advanced in that many supply chain applications are now in use, and the technology is delivering positive results. Omni-channel is not an SCI per se, but its implementation requires a number of supply chain innovations. Developments in 3D printing could revolutionize manufacturing and hence supporting supply chains, but these advances have yet to emerge. In the latter two cases the positive deliverables are still unclear.

The assessment underlines the need for companies to carefully evaluate SCIs, and to avoid being caught up in the hype that often surrounds exciting ideas. Another important lesson is that many SCIs are not original concepts, but reconfigurations of existing innovations.

Introduction

Supply chain innovation (SCI) is a key source of competitive advantage for many companies. Some enterprises such as Wal-Mart and Zara have gained dominant market positions as a direct result of their innovative supply chain models.

Yet SCI is not well understood. There is no clear, commonly accepted definition of the concept; one company's SCI is another company's process improvement.

Does this lack of clarity matter? We argue that it does – particularly in today's fast-changing business environment.

Misjudging a new idea because of uncertainty over its applicability can result in a missed opportunity or wasting resources on a concept that is still years away from fruition. Witness the flawed vision of radio frequency identification (RFID) technology that persuaded many companies to heavily invest in systems prematurely.

MIT CTL has launched a research project to better understand SCI, and to develop a framework that could help companies pursue innovation in their own supply chains.

In this white paper we use some of the preliminary observations of the research, along with interviews of supply chain professionals, to carry out a very basic review of three recent developments that could transform supply chains: cloud computing, omni-channel retailing, and 3D printing.

What is SCI?

Our initial research on SCI shows that in most cases it is confused with – or at least informed by – the idea of product innovation. Yet there are important differences between the two.

While it may be easy to copy a product, for example, the same cannot be said for a process; each application of a process requires some customization and adaption. Also, not all SCIs are equally applicable in all industries. An example is Dell's make-to-order and sell-direct models, which were thought to be worthy of copying when they gained notoriety in the computer industry. But these supply chain models are difficult to apply in, say, a continuous process industry such as steel making. To some extent the advent of the mini mill moves steelmaking in the make-to-order direction, but this has required a great deal of customization to make the approach possible.

Other challenges exist for those attempting to understand SCI. A common misconception is that a true innovation has to be new. Yet many (in fact most, according to the early observations of the MIT CTL research) highly successful innovations in the supply chain field are established ideas that have been redeployed in creative ways.

The nature of SCI raises a number of questions. For instance:

- Is SCI the new method being used, or the application of that method?
- Is the innovation the base technology, or when that base technology moves beyond its invention and is actually applied to produce measurable results?

We argue that an invention creates something from scratch, whereas an innovation creates something new by combining and applying a mix of inventions, existing processes, and/or technologies to achieve a desirable change in performance and capability.

Earlier we referred to RFID, an important development in the supply chain world but one that also amply illustrates the pitfalls of misdiagnosing what an SCI means in practice.

The base technology that makes RFID possible was developed in the 1940s. The first transponder was introduced in 1973, and the first RFID patent was registered in 1983. But these developments were not turned into track and trace applications until the 2000s.

When first introduced as a supply chain application the technology caused much excitement, and some companies rushed to adopt it. But they failed to fully appreciate the conditions necessary for successful applications of RFID, and underestimated the technology's constraints and limitations. Many organizations discovered that although RFID could improve the efficiency of supply chains and might offer new capabilities, the number of suitable applications was far less than originally envisaged. It would take a number of years before actual implementations achieved productive change.

Examples like this should not detract from the importance of SCI, however. Innovating in the supply chain domain has become an important source of improvement for organizations. One research study maintains that competing in process and supply chain is more sustainable than in products. [1] This is because the resources allocated in SCM generate more cost savings and have a greater long-term impact than new product introductions, which tend to be more hit and miss.

This viewpoint is consistent with the description of supply chain innovation provided by Bello et al. (2004), who assert that "supply chain innovations combine developments in information and related technologies with new logistic and marketing procedures to improve operational efficiency and enhance service effectiveness."

To help provide some clarity about the definition, we offer the following based on early observations from our research: *Supply chain innovation is the combining and application of a mix of inventions, existing processes, and technologies in a new way that achieves a desirable change in cost, quality, cash and/or service.*

It is useful to note that the supply chain innovation may be new to a company but not new to the industry; or it could be new to an industry in total. This leads us to suggest that there are two classes of SCI: local and global.

Local SCI occurs at the company or business-to-business level, where the concept is new to the enterprise. A novel cross dock operation may be new to a company, but is not revolutionary in an industry sense, for example. Still, the company does have to adjust and modify internal practices and processes, which is part of the innovation process.

Global SCIs occur more often at the industry level where the innovation is new to all competitors. The research data indicates that many industry-level SCIs have been developed by third parties, and these innovations create an opportunity for change for all competitors. They typically take a long time to mature, but on reaching maturity usually generate large-scale change. Examples include containerization by SeaLand and the introduction of overnight shipping by FedEx.

Let's look at three global-level developments in the context of our working definition of SCI.

Cloud computing (aka Software-as-a-Service or SaaS)

The National Institute of Standards and Technology defines cloud computing as, "a model for enabling convenient, on-demand network access to a shared pool of configurable computing resources (e.g., networks, servers, storage, applications, and services), that can be rapidly provisioned and released with minimal management effort or service provider interaction."[2]

The technology can be deployed as a private, community, public, or hybrid cloud. And the most familiar service model is software-as-a-service, where consumers use the provider's applications that run on a cloud infrastructure.

Time line

Cloud computing has become widely adopted by companies in various disciplines including supply chain management. According to the research firm Gartner, Inc., the public cloud services market is forecast to grow 18.5 percent in 2013 to total $131 billion worldwide, up from $111 billion in 2012.

The concept is by no means new, however. According to some accounts, the term was first coined back in the mid-nineties.[3] And some of the base aspects of cloud technology have been in place a long time. Companies were using centralized computing and storage systems decades ago, for instance. What has changed since then is the relative ease of access and low cost, which make the technology more readily available for broader adoption.

Even within the supply chain domain the idea of a web-based community has been around for some time. A senior supply chain manager in a specialty chemical manufacturer described the introduction of such a system in the bulk tanker business 10 years ago. The system was designed to eliminate the middle-man by enabling companies to communicate with each other virtually. Users exchanged data through this early version of a cloud, and were able to automate documentation such as demurrage statements.

The system was not a success, "but it was a precursor to what we have now (cloud computing)," says the supply chain manager.

Positive Changes

Having evolved to a stage where companies are actively using cloud-based applications, the technology is delivering positive change. Here are some examples.

Supply chain communications and visibility. The capacity of the cloud to create virtual communities of users is one of its most powerful attributes. Participant companies are linked with each other and exchange huge volumes of data, providing near real-time communications. The data is also being used to develop more timely and precise shipment tracking and tracing capabilities.

Before it adopted a cloud-based logistics management system a toy manufacturer had limited visibility into its inbound transportation operations. The company relied on its carriers to provide updates. The network is now being expanded to the organization's entire global freight network. In another example, a chemical company uses its cloud application to negotiate freight rates with more than 28 ocean carriers.

Analytics. The flood of data emanating from cloud-based systems is being used to develop more advanced supply chain analytics. The practitioners we interviewed pointed to a number of examples, including the creation of more detailed carrier scorecards and the predictive modeling of fuel prices and cargo densities across freight networks.

Dynamic routing. Data stored in the cloud is being used to dynamically route shipments. A third-party logistics provider has reduced the number of driver days in its distribution network by using dispatch data from the cloud to re-route drivers in response to changing customer demand, for instance. The advisories can be very detailed; drivers can even be directed where to take right and left turns to minimize transit times.

Risk management. With the benefit of increased supply chain visibility and more sophisticated analytics, companies can be more effective in mitigating supply chain risk. The "100% shipment visibility" afforded by its cloud-based application can improve the management of disruptions such as port strikes, says a leading food products manufacturer. The technology gives decision-makers the information on resource availability and location they need for optimal deployment.

Cloud-based applications could achieve even more as the technology matures. Harnessing the cloud's unparalleled capacity for building user communities to develop cross-industry collaboration is one application area that offers vast potential.

"By making transportation more efficient you make the world smaller," says a senior supply chain manager in the chemicals business. He points to ocean shipping as a mode where the sharing of operational data could achieve paradigm-shifting efficiencies. In the past, companies have resisted the pooling of commercially sensitive information, he says. But cloud-based groups of shippers and carriers, adjudicated by a neutral party, can overcome these barriers (MIT CTL is engaged on a project to improve the efficiency of ocean shipping by analyzing operational data from stakeholders across the industry.)[4]

Another area rich in possibilities is using the cloud to extend the concept of a supply chain control tower. Some leading companies are using control tower systems based on a software-as-a-service model to manage freight networks across countries. It is possible to cut logistics costs by using these systems to create international scorecards and benchmarking initiatives. In the future, these systems may enable shippers and carriers to drill down much further into the performance of multi-country freight networks.

Negatives/Challenges

The sheer volume of data generated by cloud-based supply chain management systems can be a drawback.

"We get a phenomenal amount data on transit times, fuel spend, a whole range of metrics, and it can be overwhelming," says a supply chain manager in a food major products company.

The problem recently persuaded the company to drop the third-party provider of cloud technology it was using. Receiving huge amounts of operational data was not enough, "we want a provider that not only supplies the data, but is also intelligent about the data," says the supply chain manager. An example is pinpointing exceptions and helping the company to identify areas where it can raise efficiency levels. The organization intends to contract with a global freight forwarder to supply this type of service.

Another challenge is providing the global coverage that is fundamental to cloud-enabled control tower systems. This can be difficult when partners across the globe are at different stages of development.

"A carrier may trade under one name but their offices across the world may be very different in terms of their technical sophistication," said a supply chain professional who is using cloud technology to manage international freight flows.

Basic Assessment

Cloud computing is effecting positive change and is having a significant – and quantifiable – impact on the efficiency supply chains. As such, it falls within our definition of SCI.

Omni-channel retailing

Omni-channel retailing is a new retailing/supply chain approach intended to seamlessly link the web, mobile, and bricks-and-mortar channels, so that a buyer can use any combination of these outlets to make purchases. A consumer might opt to order a product via her iPhone, for example, or use a mobile device to research products while shopping in a physical store.

An order can be delivered to the home, or picked up from a location including a store or a locker in a designated outlet.

A senior supply chain executive from a major retail chain suggested that the term "integrated retailing" is more accurate way to describe the concept, "because it provides an environment where the buyer can purchase from any channel."

The integrated term is certainly more understandable than the vague "omni-channel" moniker that is used widely in the retail industry.

A key difference between this innovation and cloud computing is that integrated retailing is enabled by the supply chain; it is not a new development that is being adopted to improve existing operations.

Even so, it is transformative because new supply chain models must be developed in order to make the implementation of integrated retailing possible.

Time line

The idea of integrated retailing has been around for several years, but its component parts – online commerce, shopping via mobile devices, and, of course, bricks-and-mortar outlets – are significantly older to varying degrees.

Still, the model has the lure of a brand new idea. A third-party logistics services provider that advises retailers on the concept explains the reaction of many players in this way. "There is a lot of emotion around this when senior (retail) executives realize how far behind they are. We calm them down and present them with a road map. Sometimes it's an IT road map, or maybe they don't have enough visibility into what inventory is in their stores. We coach them through it."

Positive changes

Compared to cloud computing, where there are established applications with clearly defined benefits (e.g. to improve visibility into inbound shipments arriving a distribution center), the positive SC changes achieved by integrated retailing are in the early stages of development. Some of the examples below are being implemented by retailers.

In-store fulfillment. A key element of the new supply chain model for integrated retailing is in-store fulfillment; using bricks-and-mortar outlets as distribution centers for shipments to online and mobile customers. As a senior supply chain executive from a leading retailing chain points out, "stores are dealing with a different customer, and for us (supply chain management) this means we are delivering to a new address, not to store 1, 2, or 3, but 123 Main Street."

This requires existing supply chains to be reconfigured. There is less room for error or product damage, for example, because delivering to individual consumers is a different proposition than delivering to stores. What value-added services such as special packaging needs for online consumers will stores be required to offer, and how will these impact the competitiveness of the traditional supply chain?

With more channels to choose from consumers are less tolerant of missed buying opportunities, and are more likely to go elsewhere if a product is not available. "There is no substitution anymore," said a supply chain executive from a leading retailer.

What is the optimum number of SKUs a store should stock to serve this new customer base profitably with a minimum of mark downs?

Some retailers are offering integrated services at a select group of outlets so they can generate the sales volumes required to make the multi-channel model pay.

Traditional retailers have developed supply chains that can deliver a wide variety of products, because it is not commercially feasible to build individual supply chains, for say, bathroom fittings and wine glasses. "But it's more complicated with omni-channel," observed the Senior VP of supply chain at a major retailer.

Integrated retailing brings new demand planning challenges that have to be overcome. Consumer buying patterns are more fragmented in this fast-evolving retail world. Take, for example, so-called "sit-back shoppers" who are individuals that might see a product while watching a TV show, and serendipitously order it via a cell phone. These orders often come in between 6pm and 9pm, and the integrated retailer has to decide when to fulfill the order and from where it will be shipped.

The integrated model brings opportunities to leverage inventory more effectively. Seasonal demand for winter coats may be down in Georgia, for instance, but still be high in Maine, and the availability of multiple buying channels gives the seller more options for shifting the inventory to places where the product is still selling. But that requires an agile supply chain, of course.

Express delivery. The need to meet virtual shoppers' appetite for same-day delivery services has sparked fierce competition in the integrated retail space. Again, to a large extent the innovations required to create these services come out of the supply chain domain.

A number of variations on the theme have emerged.

- Amazon is building a network of secure locations for its deliveries. The online giant has an agreement with retailer

7-Eleven to establish lockers in selected stores where customers can pick up their orders.

- Shutl.com originated on the UK, where it offers to deliver orders within one hour to customers who are located within 10 miles of a store. The organization says it is not a high-speed courier service per se, but a technology-driven enterprise that matches local delivery services with demand. The company recently launched a US service. Logistics provider UPS has invested in the system.

- DHL's MyWays service uses a Smartphone application to coordinate deliveries by individuals who happen to be moving through the right locale. "MyWays combines the power of social networks with sustainable mobility within cities to promote the efficient and dynamic delivery of parcels," says DHL.

- Walmart recently announced a service it is developing that uses crowdsourcing to identify customers who are willing to make deliveries on its behalf.

A number of issues need to be resolved. It is unclear whether the Shutl.com model can succeed in the US, for example, where the urban terrain is different to that in the UK. Designating individuals as delivery drivers opens up a number of legal issues, such as who is liable for damages.

But the rush to provide viable same-day services is generating many innovative ideas. One bricks-and-mortar retailer that is offering lockers for an online player commented that the facilities are completely separate entities from its stores, and as such, do not interfere with the their own supply chain operations. Indeed, there are big pluses for the host. The bricks-and-mortar retailer estimates that it will increase foot traffic in its outlets by as much as 8% as people visit the location to pick up their online orders. Also, there is potential for sharing product lines with the online retailer.

Negatives/Challenges

A dilemma for traditional retailers is to what extent the integrated model will undermine the competitive advantages they have developed as bricks-and-mortar players. For example, providing unfamiliar services such as special packaging for online customers might disrupt the supply chain processes that are geared to store-based customers.

Also, it's becoming more difficult to separate online/mobile customers from bricks-and-mortar buyers. In a recent analysts' call the CFO of Macy's admitted that she could not break out sales growth figures for these different channels, because the integrated model it was adopting effectively merged the data.[5]

Basic Assessment

The integrated retail model is being implemented by many retailers, but there is uncertainty over its impact on sales. Supply chains are being developed to support these ventures, but again, are at an early stage of development.

What positive supply chain changes is the model creating? More agility, particularly in inventory management, and reconfiguring distribution networks by, for example, creating more regional DCs to bring inventory closer to customers. One retailer reported that the rigors of the model have required supply chain managers to become more diligent in reducing product damage rates.

The model has spawned some innovative same-day delivery concepts, but in the main, these are in the early development stages too.

Does integrated retailing fit our definition of SCI? It is too early to say, since the positive changes required have yet to be proven.

3D Printing

In the 3D printing process, a digital file of a computer-aided design is sent to a printer that creates the object by depositing successive layers of materials a few microns in thickness. The "ink" from which items are fabricated is made from various materials such as molten plastic.

The 3D printing industry was worth an estimated $1.7 billion in 2011, and is expected to grow to $3.7 billion by 2015[6]

Time Line

The technology has been around for many years, and is well established as a process for making product prototypes.

Over the last several years 3D printing has developed apace in a number of specialized areas such as the manufacture of medical devices and jewelry. More than 90% of in-the-ear hearing aids are made using 3D printing, for example.[7]

Looking ahead, if 3D printing becomes widely adopted as a manufacturing process, it will almost certainly spur supply chain innovations that at present we can only imagine.

The question is: if and when will this happen?

Two years ago MIT CTL published a white paper on 3D printing.[8] Since then the technology has generated huge interest. The cost of the hardware has come down and the range of products made by 3D printers has expanded.

Despite the hype and the promise, however, the number of applications is still relatively limited, and the technology's development in supply chain terms is not a major threat to traditional manufacturing. It is generally accepted that it will be some years before 3D printing is ready for mass manufacturing applications.

Positive Change

As mentioned, in terms of its broader impact in consumer markets, 3D printing is relatively limited. However, companies are making forays into the technology, particularly in industries that use high value parts that lend themselves to being fabricated in this way. And they have demonstrated some positive changes.

A good example is GE Aviation, a unit of GE. In November 2012 the maker of jet engines acquired Morris Technologies and its sister company Rapid Quality Manufacturing, two enterprises that supply components made by additive manufacturing (AM) processes. The acquisition signaled GE Aviation's strategy to adopt AM (AM—additive manufacturing—is an umbrella term for manufacturing processes that make items by adding successive layers of material, 3D Printing being one of these processes) as a core manufacturing technology.

"GE views additive manufacturing as a game-changing, disruptive technology," stated the company. AM will be used to make components for the new Fuel-efficient LEAP jet engine, manufactured by CFM International, a joint company between GE and Safran Group.

The company is focusing on a form of AM called direct metal layer melting, where products are printed using layers of molten metal. Once complete, each item goes through a series of post-steps that can include thermal processing, machining, and final inspection.

According to GE Aviation, it can design and make parts that are lighter than previous designs, thereby saving weight and increasing the fuel efficiency of engines. The company can also lower costs by reducing the number of manufacturing steps needed to produce finished parts. Moreover, some items can be manufactured differently, creating intellectual property and redesign opportunities that are beyond traditional manufacturing processes. There is potential for reducing the number of parts by replacing assemblies with single items, for instance.

CFM has received orders for more than 4,000 LEAP engines. By 2020, well over 100,000 end-use parts in GE/CFM engines will be produced through AM.

GE has decided to keep its AM expertise in-house, as it does with other key technologies such as the production of carbon fiber composite and ceramic matrix composite components. As the company points out, AM methods will become more sophisticated and proprietary as the range of AM-based parts increases. Looking beyond 2020, blades and external mounting hardware could be manufactured additively, along with a variety of parts across all of GE's businesses.

In summary, 3D printing will have a number of applications in the short term.

- Prototyping. This has been around for some years and will continue.

- Specialist consumer items. Bureaus and printing shops will make items such as jewelry to order, and this is expected to continue. There are also applications in business. A custom-made iPhone case can be printed in about hour, for instance.

- Spare parts manufacture is one of the most important applications in the short term. Service engineers can download designs for spare parts and print them from the back of a vehicle.

- Specialized components. As can be seen from the GE Aviation example above, some industries such as aerospace are adopting the technology to produce components. These are not mass production items, however. Also, using AM to improve component designs is a powerful incentive to use the technology.

As the GE example illustrates, companies that develop proprietary designs using AM will want to keep the technology in-house, eliminating the external manufacturing supply chains that they relied on. Will this increase the development of near-shoring and regional manufacturing?

Another supply chain implication is that urgently needed spare parts will not have to be expedited across the globe, but simply printed in situ.

In the medium term other applications could emerge.

- *Digital Warehouse/on site production.* Warehouses could become storage facilities for IP that disseminate products designs to authorized users who make the product on 3D printers.

- *End-of-runway clusters.* 3D printer installations located in or near logistics clusters could provide make-to-order facilities for companies.

- *Universal spare parts catalogue.* Manufacturing facilities equipped with 3D technology could make spare parts on demand, from catalogues of these items.

- *Providers as manufacturers.* The role of third-party logistics providers might change; these entities could become high-speed manufacturing hubs.

- *In store manufacturing.* Imagine the impact on supply chains if retailers located 3D printers in stores to make products such as do-it-yourself tools, rather sourcing these items from suppliers.

Negatives/Challenges

AM has a number of limitations.

- The range of materials that can be used is expanding – machines can now build products from metals and ceramics, for example – but is still relatively limited. Also, using combinations of materials is at an early stage.

- Product lots are limited to around 10,000 units and the process is relatively slow; a complex object can take six to eight hours to print.

- The technology still can't compete with the mass production of even relatively simple components.

- The vision of having a 3D printer in every home may be realized in the long term, but the cost of feedstock and the technical expertise required to operate printers will deter consumers in the short to medium terms.

- Negative perceptions of the technology still have to be overcome. There is a lack of trust in the quality of additively manufactured products – sometimes with justification.

Basic Assessment

To some extent 3D printing mirrors the evolution of RFID. The technology has the potential to be transformational, has been around for some years, and is now being heavily hyped. At the same time, its scope in terms of the number of actual applications is relatively small.

The technology is beginning to create positive change outside of its established prototyping applications, as the GE example illustrates. This could bring major change to supply chains. For example, more efficiently designed components could reduce the demand for certain raw materials, and eliminate some manufacturing contractors from the supply chain.

However, the technology is at the beginning of its evolutionary path. While 3D printing is achieving positive change in some applications, it has yet to exert a major impact on supply chains. As with RFID when the technology first gained notoriety, companies need to be cautious about investing heavily in 3D printing at this stage of its development.

Buyer Beware

The three global innovations described are based on existing technology/market changes that are being reapplied to create innovative ways to make and deliver products.

These innovations – particularly integrated retailing and 3D printing – are attracting much attention, but the supply chain implications are still unclear. They warrant additional scrutiny and careful consideration to identify the potential trajectories and possible applications in future supply chains.

The MIT CTL research on SCI is also at an early stage. However, it is clear that the supply chain community needs better ways to evaluate the real-world potential of innovative applications.

Endnotes

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About Us

MIT CTL has been a world leader in supply chain management research and education for more than three decades. Combining its cutting-edge research with industry relationships, the Center's corporate outreach program turns innovative research into market-winning commercial applications. And in education, MIT is consistently ranked first among business programs in logistics and supply chain management.

For more information, please visit http://ctl.mit.edu.

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