

# 3D Printing Package

## 2014

eft has rounded up their most recent research to provide you with a snapshot into the potential impact of 3D printing on the logistics and supply chain industry

This package includes:

- Opinion pieces from the experts on this game-changing phenomenon
- 3 presentations and video interviews exploring the biggest challenges and opportunities related to 3D printing
- Insight and analysis from the recent 3D printing survey of over 250 supply chain and logistic executives

This research was conducted in conjunction with the 12th Annual 3PL Summit & Chief Supply Chain Officer Forum, taking place in Amsterdam, November 18-20



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## I. Introduction

By Dr Steve Brady, CEO, Supply Chain Innovations Today



Depending on what you read, or who you listen to, 3D printing is either the definition of [disruptive technologies](#) or just another in a long line of [over-hyped technologies](#). There is (as in most conversations about anything) a bit of truth in all of this. As with any new technology the opportunities seem endless and the paths to innovation unlimited. We are certainly seeing a growth in the market, with 3D printing finding its way out of the labs and manufacturing floors and into homes with the Makers movement. We are even seeing the addition of 3D printers at Amazon with their new “[Amazon 3D printing store](#)” and at select [Staples office supply stores](#) in the US. But are we really seeing a transformation, or simply falling into the trap of hype?

Gartner has developed what they are labeling as “the Hype Cycle.” This model explains in a sense why some technologies seem to disappear for 10 or 15 years, only to “suddenly” re-appear to great fanfare and success. The challenge faced with 3D printing is to determine where this technology is in this model, and more importantly, where your company wants to start engaging with the technology in this curve.

In their model, they have identified 5 phases that technologies go through in reaching widespread adoption and productivity. According to their model, there is 1) a technology trigger, then 2) peak inflated expectations. This is “the hype” that gets the media attention and has many writing about how the technology of the day will truly “change the world.” Companies of all sizes may jump in, and often there are numerous small startups brimming with promise and expectations.

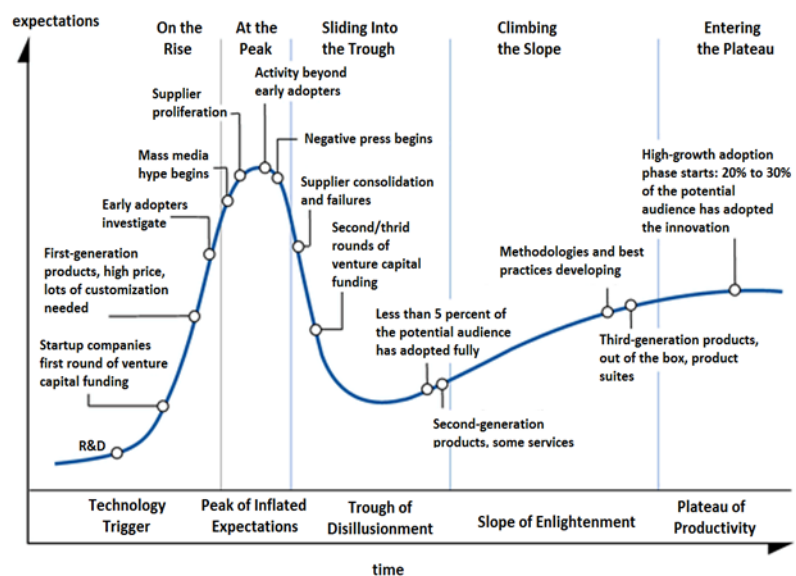


Figure 1 "Hype-Cycle-General" by NeedCokeNow - Own work. Licensed under Creative Commons Attribution-Share

Of course, most of those stories are more promise than ability, and when the technology doesn't deliver quickly the technology then enters the third phase, the 3) Trough of Disillusionment. In this third phase the bubble of expectations has burst. One might even start reading truly negative stories about the technology, questioning whether it could ever truly deliver on its promise. Many start-ups fail, and larger companies will abandon the technology as a “failed experiment.” But still, some remain.

The fourth phase, the “Slope of Enlightenment” is where the second and third generation of the technology is developed. Once the hype is gone, the remaining technologists work in relative anonymity perfecting their technology and their craft. It is in this enlightenment phase that the technology can be seen as delivering its true potential. Once the most effective applications for the technology have been developed and implemented the 5<sup>th</sup> stage, the “Plateau of Productivity” is achieved. From here the next wave of “future uses” and true imagination can be born.

Where is 3D printing along this curve? Depending on what applications you are considering, and what sources you read, 3D printing is either on the peak of hype, or firmly in the “plateau of productivity.” There is certainly a lot of press surrounding the introduction of 3D printers, using plastics, into price-points making these printers seem a lot like the introduction of ink-jet and laser printers to the home. And certainly, we find that just as with the 2D printing market the technologies making their way into the home have been demonstrated to work on an industrial scale. But generally speaking, while the 2D printers we introduced in the home allowed the production of nearly identical products to what a professional printer could provide, we are still faced with the inability of a home-based 3D printer to deliver a final, finished product.

3D printing finds its niche of productivity in manufacturing now as a tool for rapid prototyping and for manufacturing specialized parts in low production runs. For now, this is where we can find that 3D printing can truly transform the manufacturing space.

Given that 3D printing is “additive” rather than “subtractive” manufacturing it has the potential to be the “ultimate green machine.” By only using enough materials to make the product the 3D printing process removes waste. If you have ever watched a lathe working on a wooden, plastic, or metal, piece you can see how much waste there is in the materials as the shavings fly off. Of course, the metal or plastic can be collected, melted down, and reused, but each of those steps requires additional energy.

3D printing can also transform the manufacturing space through the obvious ability to develop prototypes quickly and thus assess the “form, fit, and function” of new parts. This tool truly allows for rapid prototyping providing the opportunity to make adjustments to designs, test out those adjustments, and quickly iterate to find the best approach. In an era where many product cycles are measured in months rather than years the ability to quickly design, test, and improve a product is critical.

Great progress has been made in the materials used in 3D printing. While we are seeing plastics used in the printers in the home the printers used in industrial processes cover a wide range of materials ranging from plastics, waxes, ceramics, and now metals. Some printers even mix the mediums used. By using wax in the printing process, these printers are capable of designing fully functional moving parts, simply by melting the wax away leaving freely moving joints and bearings.

3D printing even integrates into existing manufacturing processes, improving the quality of products made through traditional means such as injection molding. Since additive manufacturing involves building up a product layer upon layer, designers can now introduce “conformal cooling” channels to ensure an even cooling of the materials improving the quality of the final product. Siegfried Mayer wrote for Plasticstoday.com in 2009 that:

“Growing numbers of injection molders are discovering the advantages of using conformal cooling channels that follow the shape of the cavity and core, reach hot spots, and promote temperature uniformity in the plastic materials being molded. These molders are seeing striking results: shortened cycle times, improved plastic part quality, and—above all—cost reductions.” <http://www.plasticstoday.com/imm/articles/tooling-conformal-cooling-1209>

As you read through this packet, consider your business, your processes, and consider how 3D printing could perhaps transform your activities. Remember, as with conformal cooling, sometimes the most effective, and efficient, application of a technology isn't a new product at all—but a better way of looking at what you are already doing.

## II. 3D Printing

By Chuck Intrieri

First of all ‘What is 3D Printing and What is the Outlook of the Application in Manufacturing?’

As we noted in our [top issues in American Manufacturing series](#), 3D printing is a key trend and applications manufacturers are paying attention to over the next decade. Currently around 28% of the money spent on printing things is for final products, according to [Terry Wohlers, who runs a research firm specializing in the field](#). He predicts that this will rise to just over 50% by 2016 and to more than 80% by 2020.

The process of 3D printing, **sometimes called additive manufacturing**, is a slow procedure in which a printer reads a digital blueprint and methodically drops building material according to a set of instructions, creating a final product that’s built up tiny layer by tiny layer. The printers are capable of producing extremely detailed and intricate levels of design that can be difficult or impractical to create with other methods.

Some are saying that 3D Printing will be “the next industrial revolution” says Doug Angus-Lee, rapid prototype account manager with Javelin Technologies, an Oakville, Ont.-based supplier of the technology.

“The invention or the implementation of the assembly line changed the way manufacturing works and 3D printing is going to change the way manufacturing works in the future. When the web took off, it gave us the tool for everybody ... to become a publisher that was something that only a few of the biggest companies in the world were able to do it before that. Well, with 3D printing, we’re all able to be manufacturers.”

The list of materials that can be ingested and outputted by 3D printers is growing, some might say into sci-fi territory. The capabilities of 3-D printing hardware are evolving rapidly, too. They can build larger components and achieve greater precision and finer resolution at higher speeds and lower costs. Together, these advances have brought the technology to a tipping point—it appears ready to emerge from its niche status and become a viable alternative to conventional manufacturing processes in an increasing number of applications.

Should this happen, the technology would transform manufacturing flexibility—for example, by allowing companies to slash development time, eliminate tooling costs, and simplify production runs—while making it possible to create complex shapes and structures that weren’t feasible before. Moreover, additive manufacturing would help companies improve the productivity of materials by eliminating the waste that accrues in traditional (subtractive) manufacturing and would thus spur the formation of a beneficial circular economy (for more, see [“Remaking the industrial economy”](#)). The economic implications of 3-D printing are significant: McKinsey Global Institute research suggests that it could have an impact of up to \$550 billion a year by 2025.

The promise of a 3-D printing-based supply chain is simple: “Additive manufacturing will democratize the manufacturing process.” So says Ed Morris, director of NAMII, the federally-funded initiative set to define and promote the future of the industry.

“In terms of impact on inventory and logistics,” he says, “you can print on demand. **Meaning you don’t have to have the finished product stacked on shelves or stacked in warehouses anymore.** “Whenever you need a product,” he explains, “You just make it. **And that collapses the supply chain down to its simplest parts, adding new efficiencies to the system.**”

Those efficiencies run the entire supply chain, from the cost of distribution to assembly and carry, all the way to the component itself, all the while reducing scrap, maximizing customization and improving assembly cycle times.

Basically, Morris says, it tears the global supply chain apart and re-assembles it as a new, local system.

The traditional supply chain model is, of course, founded on traditional constraints of the industry, the efficiencies of mass production, the need for low-cost, high-volume assembly workers, real estate to house each stage of the process and so on.

But additive manufacturing bypasses those constraints.

3-D printing finds its **value in the printing of low volume, customer-specific items, items that are capable of much greater complexity than is possible through traditional means. This includes hollow structures like GE’s fuel nozzles that would normally be manufactured in pieces for later assembly.**

This at once **eliminates the need for both high volume production facilities and low level assembly workers, thereby cutting out at least half of the supply chain in a single blow.**

From there, the efficiencies of that traditional model stop making sense, it is no longer financially efficient to send products zipping across the globe to get to the customer when manufacturing can take place almost anywhere at the same cost.

The raw materials today are digital files and the machines that make them are wired and connected, faster and more efficient than ever. And that demands a new model—a need to go local, globally.

### III. 3D Printing: Video Interview

At eft's last European flagship logistics and supply chain event, the 3PL Summit and Chief Supply Chain Officer Forum, attendees explored the industry game changers, opportunities and technologies facing senior executives from 3PL providers and their customers. The top level speaker faculty shared their exclusive inside knowledge and top takeaways on a number of the key issues affecting the industry.

The 3D printing session at the 3PL Summit attracted a lot of interested parties as Martin Wegner, VP Solutions and Innovation at DHL Innovation kicked off the conversation debating how 3D printing might impact both manufacturing and consumer behaviour. Sebastiaan Scholte, CEO at Jan De Rijk joined Martin later to express his views on how implementation of 3D printing may affect the air cargo business.

The eft team caught up with Sebastiaan Scholte after his presentation to further explore his perspective on 3D printing in this short [video interview](#).

According to Sebastiaan, who has more than 16 years in the air cargo and logistics industry, 3D printing is "going to change and revolutionise traditional manufacturing but I think it's going to enhance it instead of replacing it..."

He believes that there is still a long way to go in terms of the speed of 3D printing but "it will help develop prototypes faster....and you will improve production".

Sebaastian predicts: "It's an interesting development but it's not going to change a lot in the industry".





## IV. 3D Printing

By Mark Patterson, Vice President - Innovation and Product Incubation - EMEA,DHL Supply Chain

There is little doubt that 3D printing is a potentially transformational technology. It would normally be bold to compare an innovation to the invention of electricity or the internet, but I believe that this turns the traditional approach to design and manufacturing on its head.

In some ways 3D printing is the opposite of traditional manufacturing – it creates objects by adding, rather than subtracting, material and allows us to seemingly create objects such as shoes and toys out of thin air. However, what's really fascinating is its transformative potential. Supply chains have typically been all about warehousing and shifting products outwards from the point of manufacture. Now 3D printing allows us to shave weeks off of manufacturing times and reduce the carbon footprint associated with production and distribution. What's more, it produces little waste, so helps with both environmental concerns and the costs associated with disposal.

3D printing shouldn't be thought of purely for manufacturing, since it could have much broader supply chain implications. Indeed it can currently only be used for printing small numbers of simple objects made of one or two materials. Its most exciting uses seem to me to be twofold. The first is in the customization of objects. A classic example is iPhone cases. People love customizing their phones, and a custom-made case can be printed in about an hour. This is much better for consumers than choosing between a limited range of objects, which then need to be shipped from China over the course of six weeks. It's a huge step forward.

The other major impact the technology has affects Service Parts Logistics. With 3D printers at their disposal, service parts engineers could download designs for spare parts and print them from the back of a vehicle within a very short timeframe. Similarly, the supply of the raw materials that are used to print items would become a major new aspect of the logistics industry.

This potential doesn't mean that the 3D printing revolution is without its obstacles. There are implications for the digital supply chain to go along with the physical one, since the intellectual property resides in the file from which the object is printed rather than the product itself. This means that in future, we'll need to really examine this data chain to ensure that the information it contains is securely transported and managed. This is a great growth opportunity for our industry. As supply chain professionals we need to develop our data exchange offering, so that we can continue to offer our customers a one stop shop for supply chain solutions, be they physical or digital.

The other major obstacle comes in the form of understanding. Despite first appearing in the 1980s, 3D printing is still a fledgling technology and universities and engineers are still working hard to develop it. In order to secure the technology's future, we'll need to help to develop their understanding and help to create an environment where the technology can really flourish and fulfill its immense potential. Research should focus not only on its manufacturing implications, but also on how 3D printing will impact upon broader supply chain processes.

If 3D printing gets the support that it needs, we have every reason to believe that it can be a really significant development in the history of supply chains. It could really improve what we do at a fundamental level. I don't know about you, but I find that really exciting.


## V. 3D Printing—Presentations

At the recent 3PL Summit and CSCO Forum in Chicago, Michael Donovan, Chief Technologist Consumer, Retail and Transportation Industries at HP, shared his views on disrupting IT developments creating business opportunity. [See the full presentation here](#)


### And then there are the unknowns...

#### 3D Printing


- First big wave, like 2D printing in the 70s and 80s, is likely to be 3D print centers
- A state of the art distribution center for on-line retail sales today could easily be converted into a general purpose "factory" to print furniture, clothing, parts...or anything else with a simple set of assembly processes
- Logistics operations at all scales take on some responsibility for assembly on behalf of others with local delivery
- To reach the dream, additive manufacturing needs breakthroughs and significant evolution in workflow and information management, as well as seeing progress in materials and machines
- Key number to track is not annual \$ spent by consumers on 3D printers; Key number is annual \$ spent by consumers on items enabled by additive processes



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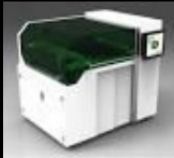




At the summit, attendees were also privy to a presentation from Dr Steve Brady, CEO of Supply Chain Innovations Today who spoke about 3D printing as a black swan event. [See the full presentation here](#)



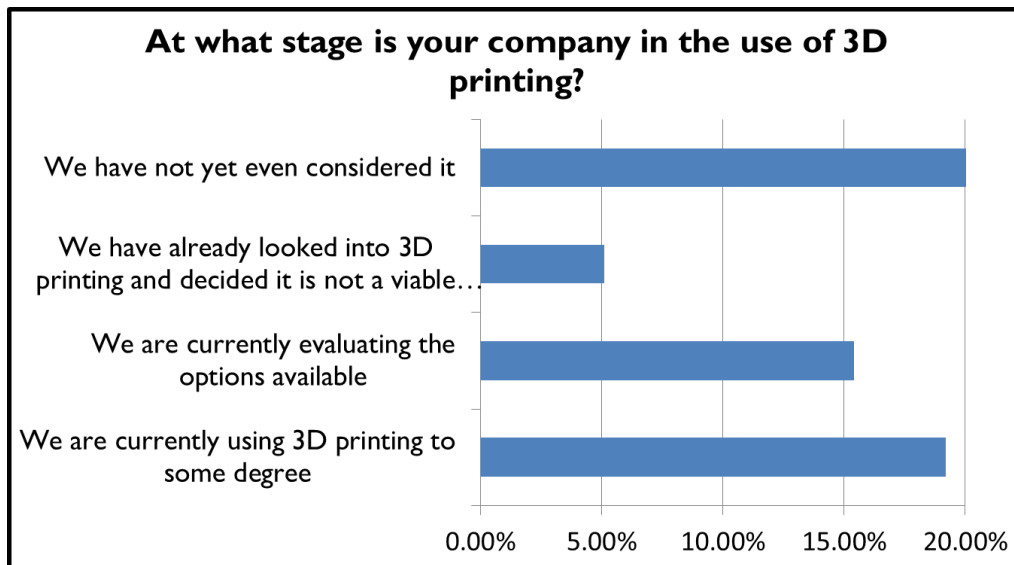
### 3D PRINTING

- Creative Design. Eliminate transitional mold/casting production limitations
- Lower total cost of ownership:
  - No tooling investment
  - Print "on demand"
- Highly Responsive to demand fluctuations
- Automated reverse engineering through laser inspection tools
- High quality post-production inspection through laser tools



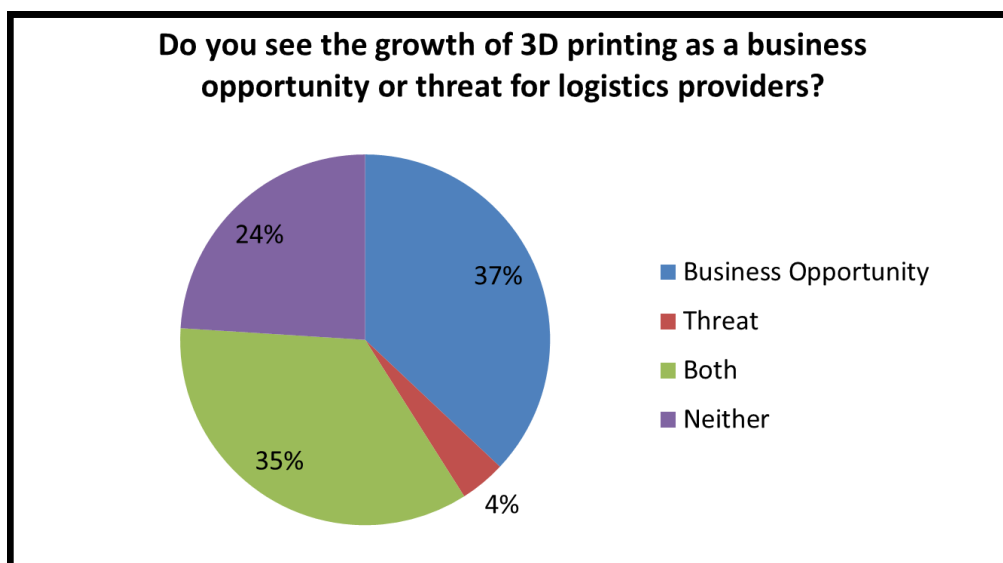
## VI. 3D Printing—eft research

Recent eft research surveyed supply chain and logistics, exploring the use of 3D printing at various companies and their thoughts on this phenomenon as a business opportunity or threat.

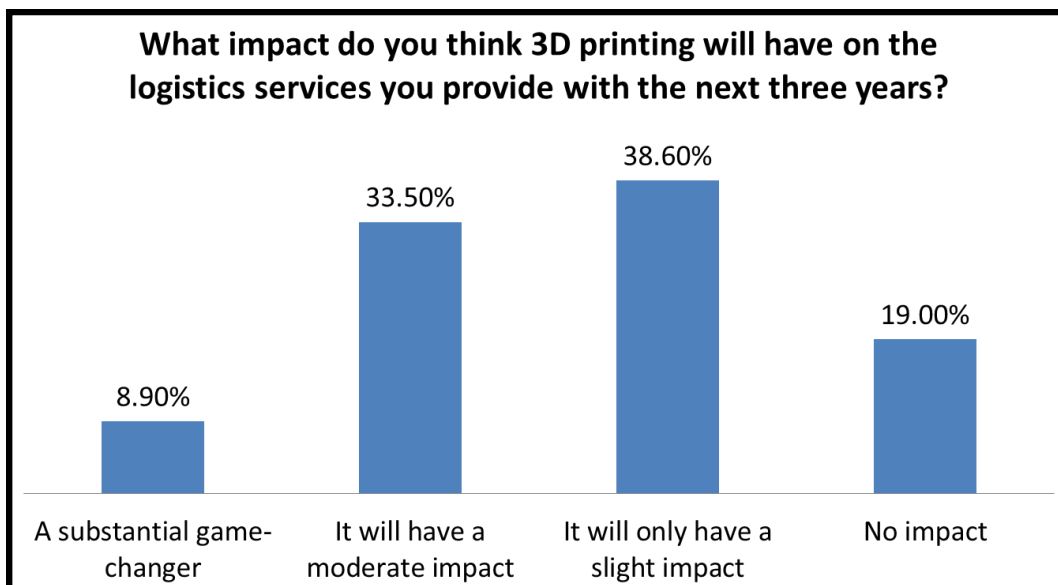
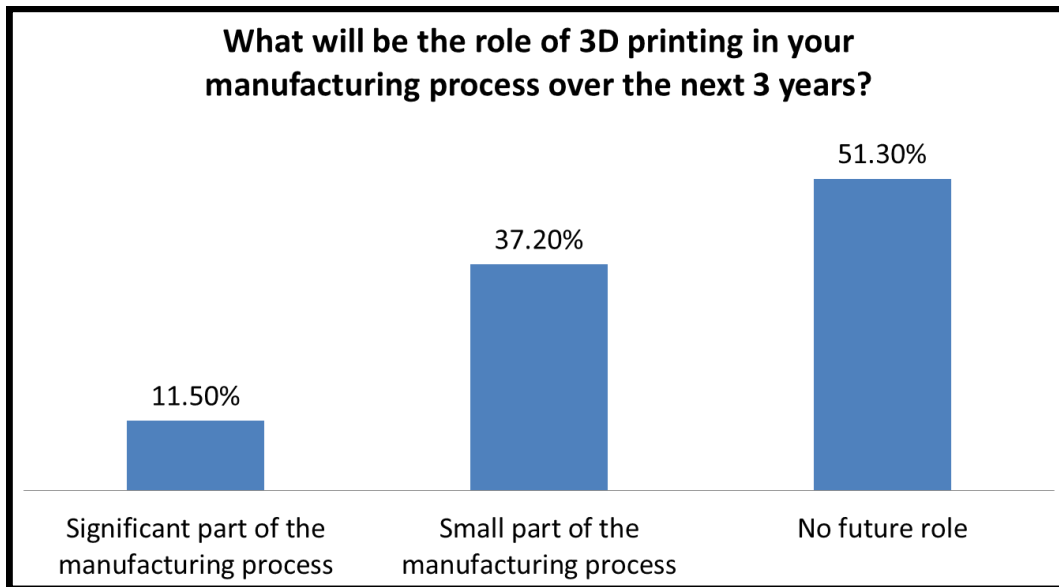


3D printing has been the focus of many recent supply chain discussions. eft surveyed participants to understand at what stage companies are in the use of 3D printing. According to the results above, which surveyed manufacturers only, nearly 20% are currently using 3D printing, quite a significant proportion. Recent developments in the world of 3D printing suggest that it has the capacity to change the face of manufacturing, with regards to the locality of production and the manufacturing of spare parts. It will be interesting to see how this phenomenon impacts supply chain in the next 5-10 years.

The next question was posed just to logistics providers and provided some interesting answers with 35% of logistics providers believing that 3D printing is both a business opportunity and a threat.



These next questions looked into the future of 3D printing to understand its role in the manufacturing processes over the next three years (only manufacturers were asked) and the impact it will have on the logistics services provided (only logistics providers were asked). Sizeable proportions of both groups of respondents saw an impact in the next 3 years for 3D printing. Nearly half of all manufacturers believe it will play a role in this processes and 42% of logistics providers see it as having a moderate or substantial impact on their services



### III. Conclusion

3D printing is clearly a transformational manufacturing innovation. As noted in this packet, there are numerous opportunities, and challenges, that face us as we find ways to adapt this technology to existing processes, and identify and adopt new processes. What does the future hold, and are we ready for it?

I have been considering the “black swan” future of 3D Printing.

Nassim Taleb first introduced the idea of the Black Swan event in his book, “Fooled by Randomness” when talking about the highly unlikely event that, if it occurred, has impacts that are far reaching and unpredictable. In the book *The Black Swan* (excerpted in the *New York Times*) Taleb wrote :

“What we call here a Black Swan (and capitalize it) is an event with the following three attributes.

“First, it is an outlier, as it lies outside the realm of regular expectations, because nothing in the past can convincingly point to its possibility. Second, it carries an extreme impact. Third, in spite of its outlier status, human nature makes us concoct explanations for its occurrence after the fact, making it explainable and predictable.” (<http://www.nytimes.com/2007/04/22/books/chapters/0422-1st-tale.html>)

3D printing, as it is today, can support existing design and production operations. It can assist in rapid prototyping, and in some cases can produce in limited quantities parts that have been out of production for long periods of time. With the introduction of the “home printing” movement we are able to produce items in the home, but we are limited to plastics, and generally producing items with any degree of complexity requires the printing of multiple parts, and “some assembly required.”

Sebastian Scholte is most likely correct when he said in the video interview that 3D printing will “... change and revolutionise traditional manufacturing but I think it’s going to enhance it instead of replacing it...”

But *what if...*

*What if* the prices of 3D printers continues to fall? *What if* the types of affordable 3D printers expands to include metals, and ceramics, and other materials? *What if* towns started to see collections of printers, such that we no longer needed to ship finished products long distances, but could truly manufacture everything locally?

Imagine the “Black Swan” as “the return of the village commons.” Instead of the “Blacksmith” or “Ladle Liner” we have the metal printer. Instead of the “Saddler” or the “Leather Carrier” we have the plastics printer. What changes does this “new world” bring?

For starters, intellectual property will become the dominant trading space. As Mark Patterson noted here, the “digital supply chain” and its security will become critical. In 1996 I had proposed discussing the “internet” as the 6<sup>th</sup> mode of transportation. In this new world, the movement of the technical description of product becomes the dominant transportation activity. Along with this, will customization be allowed? Can I purchase a license to build something that is “almost” what I want, but then tailor to my exact needs? Will this “new village” allow for nearly infinite variation?

Of course, there is the effect on the manufacturing base. Will large-scale, industrial manufacturing still occur? Undoubtedly. Large complex items, such as automobiles and appliances will continue to be manufactured and then shipped. The complexity of the parts will most likely still exceed the capabilities of local printing. But what happens to the smaller manufacturing sites? Will lamps, and speakers, and perhaps even televisions/digital displays become locally built and customized?

The impacts of this shift go far beyond the obvious challenges to the manufacturing base. 3PL operations, centered on the storage and distribution of sub-assemblies and finished goods, will find demand for their core functionality disappearing.

Transportation requirements will change as well. Rather than shipping finished goods in carefully packed and climate controlled containers, where often more air is shipped than product, the raw materials are what matter. Trucks will be delivering pallets of metal and ceramic powders, barrels of inks and dyes, and reels of plastic. The packaging industry, so focused now on protecting fragile finished products will have to respond to this change, devising more efficient ways of packaging the raw materials, perhaps to speed the transition from truck to production.

It doesn't take much imagination then to see the impacts on the environment. Less trucks on the road. A reliance on electricity (increasingly generated through renewable sources) rather than fossil fuels. The near elimination of waste through additive rather than subtractive processes. Each of these serves to limit the impacts on the environment. Collectively, we can realize a significant impact.

Finally—innovation will accelerate. When the idea of a product shifts from choosing from a limited selection of (modestly) customizable products, to a range of digital designs the whole discussion of “product” shifts. When every production run is a size of 1 (or 5) the ability to rapidly prototype and adapt for every customer can become the distinctive between a successful business and an also-ran.

Of course, the rules of economics are always at play. If the costs of printing and assembling locally are greater than the costs of mass-production, then this vision of the future may never play out. But if the costs of local production continue to decline, and the costs of delivering a product (the storage, packaging, shipping, customs, security, and so forth) are added in, this scenario becomes more likely. Add to that the opportunity for creativity and customization and the positive externalities for the environment, and this just may be the future.

A Black Swan? Yes—but they do exist.



This piece has explored 3D printing challenges and opportunities from the perspective of the industry experts.. Now it's your turn to get involved. Do you agree with the research and analysis here? Do you have anything to add? How are you taking advantage of this game changing technology?

Whatever your opinion on the potential of 3D printing, we're sure that you'll want to share your views. The Chief Supply Chain Officer Forum, taking place in Amsterdam on November 18-20, will give you the chance to do that.

The forum brings together around 300 senior supply chain and logistics executives from the logistics and supply chain industry. The event will explore the impact disruptive technologies, but that's not all. Supply chain big data and the Internet of Things, demand planning and S&OP, supply chain transformation and doing business in SE Asia and the Middle East are just some of the other topics on the table for discussion. Just take a look at some of the executives who are sharing their knowledge on these subjects:

- Ewald Raben, CEO, Raben Group
- Andreas Welbrook, MD & Member of the Board, BLG Logistics
- Christian Leyson, Executive Chairman, Ahlers
- John Allan, Chairman, Dixons Retail
- Ivanka Janssen, MD Global Supply Chain, Diageo

**Join the discussion!** Contact Sophie Farrow (sfarrow@eft.com) or head online to [www.3plsummit.com/eu](http://www.3plsummit.com/eu) for more details on ticket prices.

