Impact of 3D Printing on Global Supply Chains by 2020

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Summary: This thesis aims to quantitatively estimate the potential impact of 3D printing on global supply chains. Over the past few years, application of 3D Printing has moved from prototyping to manufacturing. Led by Automotive and Life Sciences, 3D Printing is projected to grow from a $1B industry in 2014 to $4.4B by 2020. Experts project that adoption of 3D Printing could dramatically alter the supply chains, but most only provide *qualitative* descriptions of what that impact may be. Our research makes an attempt at providing *quantitative* estimate of impact of 3D printing. Using the data collected from expert interviews, site visits and online sources we developed a model for comparing the current total supply chain processes and cost with the future total supply chain processes and cost after the adoption of 3D Printing. Our analyses suggest that 3D Printing will reduce the total supply chains cost by 50-90% as production will move from make-to-stock in offshore/low-cost locations to make-on-demand closer to the final customer with major reductions coming from transportation and inventory costs.

Varun Bhasin holds over 8 years of experience spanning Supply Chain strategy, planning, business processes, ERP systems & analytics in Fashion, Technology, FMCG, Agriculture, Pharmaceuticals and Fertilizer industry. Prior to the SCM program, Varun also has a B. Tech in Electronics Engineering.

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KEY INSIGHTS

1. Adoption of 3D Printing is providing a new way for companies to do manufacturing and is impacting the logistics industry.
2. Adoption of 3D Printing can reduce Supply Chain Costs by 50-90%; this is especially true for slow Moving and Custom products.
3. 3D Printing provides a low cost-high availability solution for manufacturing custom implants for life sciences industry.
4. Automotive industry can reduce spare parts inventory by 90% and ensure 100% availability.

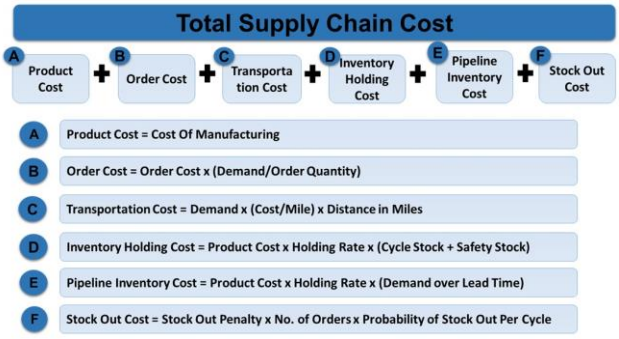
INTORDUCTION

Adoption of 3D Printing is providing a new way for companies to manufacture products on demand in small batch sizes in physical proximity of the end customer with a capability to customize products. This has altered the supply chain equation in a complex way. While the qualitative impact can be easily assessed it is very difficult to quantify the magnitude of this impact. Companies want to understand the quantitative impact to understand what it means for their business and make decisions to improve their operational efficiency and provide better service offerings.

In our thesis, we developed models to quantify the impact of 3D Printing using the data and information from site visits and secondary research.

METHODOLOGY

We developed our model by comparing the AS-IS i.e. current supply chain processes and cost with TO-BE i.e. future supply chain processes and cost with the adoption of 3D Printing. The model is described below.



We used the industry standard total supply chain cost model and fine-tuned the equations for our model to effectively compare the two supply chains.

We focused on Automotive and Life Sciences industries. Data collected by interviewing industry experts and conducting site visits was used to calculate the value for each supply chain cost component.

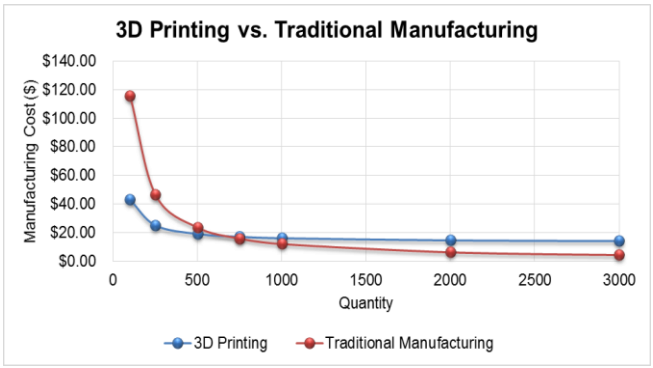
The numerical results obtained from our model are based on the assumptions.. One of the key features of our thesis is that we explicitly state all our assumptions, and present a model that is amenable to what-if analysis. For example, in one of our use cases, we performed sensitivity analysis by varying the rate of adoption of 3D Printing to understand its impact on total supply chain cost.

Product Cost - 3D Printing vs. Traditional Manufacturing

In order to compare the product cost of 3D Printing and traditional manufacturing, we looked for a product that was simple enough for a preliminary analysis and currently being produced by traditional manufacturing methods such as injection molding as well as 3D printing for custom designs. An iPhone case qualified our requirements for a sample product.

We compared the total manufacturing costs for the two technologies by comparing machine cost, setup cost, product design cost, cost of mold and raw material cost. The cost of mold and machine setup are major costs in injection molding technique while cost of printer and raw material which are currently proprietary of the 3D Printer manufacturer are major costs in 3D Printing.

We took quotes from a number of 3D Printing and injection molding companies to compute the unit manufacturing cost for a given quantity as shown in the graph below.

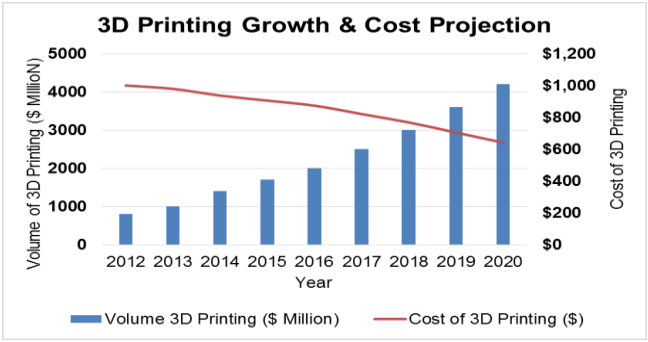


The results reinforce our hypothesis that **3D Printing is more economical for small quantities; however as we get into larger quantities, the economies of scale in injection molding far exceed** the initial advantage of 3D printing.

Future Cost of 3D Printing

According to the Gartner Hype Cycle for Emerging Technologies 2013, it will take 2-5 years for enterprise 3D printing to reach 'plateau of productivity', after which the mainstream adoption of a technology is expected to take off.

With the increase in adoption, the cost of 3D printer and 3D printing material are projected to go down, and that has implications for our model. But, how do we estimate the reduction in cost of this new technology? So, we decided to make use of analogy to similar technologies for which this information was available. We performed a regression analysis to quantify the growth in adoption and its effect on price for RFID and LED and applied the results to projected the growth curve for 3D Printing to estimate future costs.



The results in the above graph represent a 36% drop in the cost of 3D Printing, making 3D printing affordable for many more products and applications.

RESULTS

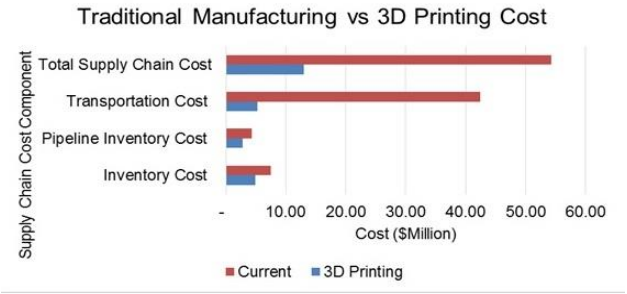
We looked at the quantitative impact of 3D Printing from two different perspectives. First we looked at impact of 3D Printing on a single echelon (adoption in a warehouse for different product categories). Second, we looked at complete supply chains in two different industries Automotive and Life Sciences.

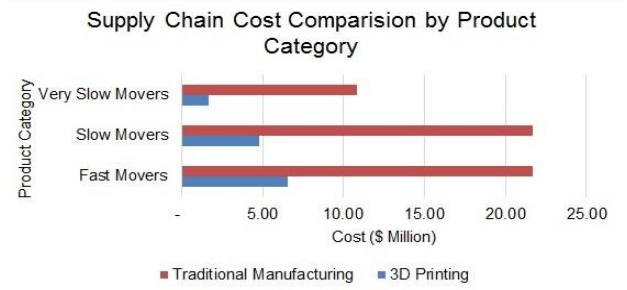
Case I – Adoption of 3D Printing in a Warehouse

In our visit to warehouses of Automotive and Life Sciences companies, we noticed that action was concentrated on a small part of the warehouse. 20% of the warehouse stocked the fast movers while 80% of the warehouse was stocked with slow movers and very slow movers and visited just once or twice a day. Truly, inventory holding for a just in case scenario was a big problem, but no one knew what to do.

The purpose of this basic model was to get an overview of the current supply chain costs and study how the adoption of 3D printing will change the total supply chain costs. To calculate this impact, we assumed that 3D printing will be largely adopted for very slow movers and slow movers while fast movers will have a very small adoption due the economies of scale advantage of traditional manufacturing.

Using our model we compared the components of supply chain costs in the graph below.





The major savings of 85% comes from Transportation cost due to reduced cost of shipping the finished goods from Asia. We also observe a saving of 17% respectively in the Inventory Cost and Pipeline Inventory Cost. This is largely due to warehouse holding less stock of the finished good. Overall we project savings of 70% in the Total Supply Chain costs.

The greatest percent saving is observed in very slow moving product category which strengthens our original hypothesis that 3D Printing is more suitable for low volume manufacturing.

Case II – Adoption of 3D Printing for Auto Spare Part

When Jay Leno`s 1907 White Steamer broke down last summer he had nowhere to go for the spare parts. 3D Printing created the magic, Jay`s team created a 3D scan of the old part and then print the parts to fix the car, Jay was astonished and wrote a blog on 3D Printing.

Automotive companies maintain spare parts inventory for all car models for 7-10 years, this leads to very high inventory holding cost or a low item fill rate if the part is out of stock.

In this case, we are modelling the impact on total supply chain costs from transitioning a low volume, very slow mover automotive part from traditional manufacturing to 3D Printing. In our proposed case, 3D printing facilities will be installed in warehouses and product will be printed on demand.

Our model projects a total supply chain cost savings of 90%. This is achieved by virtually eliminating all Inventory Holding Cost and a big reduction in transportation cost. Another advantage will be improvement in product availability to virtually 100% potentially leading to higher customer satisfaction.

Case III – Adoption of 3D Printing for Life Sciences Medical Implant

Jose Delgado was born without most of his left hand. He faced a difficult choice when the doctors prescribed him a $42,000 prosthetic. When Jeremy Simon a member of e-NABLE used the design of the "Cyborg Beast" to 3D print a prosthetic for $50, Jose and his family had tears in their eyes.

In this case, we compared the total supply chain costs of a Life Sciences part - a knee implant - manufactured by traditional manufacturing against that of 3D Printing.

Currently, knee implants are manufactured in Asia and then they are shipped to this warehouse and distributed to hospitals while in future it is proposed that they will be 3D Printed on demand.

Our model shows that Inventory Holding Cost and Pipeline Inventory Cost have reduced to almost nothing, since there is no stock. Transportation cost has dropped by 90% as the product is now manufactured closer to the customer. Product cost is also expected to come down. Overall we foresee a savings of 62% in the total supply chain costs while still maintaining 100% service level.

Besides cost savings, there are other associated benefits of 3D Printing like faster speed to market and supply chain agility.

What does this imply?

Overall, our model suggests that adoption of 3D printing can reduce the total supply chain cost by up to 90% in Automotive and provide a solution for spare parts for older models and vintage cars. In Life Sciences. The total supply chain cost can be reduced by up to 62% while providing customized implants.

Difficulty of quantifying the impact of 3D printing on Supply Chain

The industry adoption of 3D printing is still very limited. In our research and industry interactions we found that though companies are excited about the prospect of 3D printing in future not a lot of companies have moved from traditional manufacturing to 3D printing. It was thus really challenging to make assumptions around the industry adoption numbers in our model. We also found it very difficult to predict how 3D printing cost structure will change over the next 5-10 years. This is especially related to the cost of 3D Printer and the raw material used.

With the rapid advancement going on in 3D Printing technology it is difficult to predict what type of product can or cannot be 3D Printed in future. Design for 3D Printing is in nascent stages at this stage it was fairly difficult to quantify this and include in our model.

Keeping the above concerns in mind, it is quite challenging to predict how 3D Printing will displace traditional manufacturing and what will be the quantitative impact of this change. In our model we have made explicit assumptions which help us create a framework to quantify the results under the given conditions.

Impact on Logistics Industry

For a logistics company, the major impact of adoption of 3D Printing will be on the Freight Revenues. Based on the results the total transportation spent by a warehouse may be reduced by up to 85% leading to a significant loss of revenue.

This challenge provides an opportunity to expand the value added service offerings by offering 3D Printing services in the warehouse. We observe that margins in the value added services business are much higher than freight, 3PL companies should be able to hold on to their profits even if there is a loss of revenue.

Providing 3D Printing facilities to help customers improve supply chain efficiency and develop custom products can be a big competitive advantage for 3PL companies in the future.

CONCLUSION

The model developed in this research is not restricted to Life Sciences and Automotive industry. Rather, the insights can be applied across virtually every industry that wants to adopt 3D Printing.

The models developed in this thesis provide a good starting point to understand how adoption of 3D printing will affect the supply chain costs. 3D Printing also provides a very good rationale to bring manufacturing back from Asia to onshore in US.

For OEM manufacturers this means that supply chain managers can reduce their inventories to virtually zero while still maintain 100% item fill rate. No out of stock will keep customers happy and improve customer loyalty. It is not all bad news for 3PL companies either. While they are projected to lose revenue on the freight business this can be an opportunity to transform their service offerings and forge partnerships with OEM to provide integrated manufacturing and supply chain services.