

# What are the implications of 3D printing

Manar Rsheed Almunyif  
4419603554

Department of Computer Science ,  
College of Engineering and Computer Science  
Prince Sattam bin Abdulaziz University Riyadh ,  
[441960354@std.psau.edu.sa](mailto:441960354@std.psau.edu.sa)

Shatha moshapap alshehry  
441050076

Department of information systems,  
College of Engineering and Computer Science  
Prince Sattam bin Abdulaziz University Riyadh ,  
[441050076@std.psau.edu.sa](mailto:441050076@std.psau.edu.sa)

Worod Seraj Alyami  
441051722

Department of information systems,  
College of Engineering and Computer Science  
Prince Sattam bin Abdulaziz University Riyadh ,  
[441051722@std.psau.edu.sa](mailto:441051722@std.psau.edu.sa)

**Abstract:** The article presents the winning additive manufacturing technologies importance in the recent past and increasingly intrusive. In this article we briefly describe the historical development of additive manufacturing technology, highlights current consumer 3D printing applications and business markets and assess current entrepreneurial skills potential users and consumers. We identify five factors that can do this In this way, the influences users' understanding of 3D printing technology., which affects the likelihood of user adoption. results from Then exploratory studies were presented. Technologies to start new businesses answering the question: How does 3D printing (3DP). Development of new business models? To this end I approach what is called Elements of the business model and characteristics of Industry 4.0 i 3DP, whereby the previous literature on the subject is compared and analyzed Impact of 3DP on Business Models.

**Keywords** Industry 4.0, 3D printing, business models, technology, effects, technology complementarity, service

## I. INTRODUCTION

background In 1986 it was patented by Charles "Chuck" Hull The stereolithography machine, one of the first 3D printers. Stereolithography soon followed, along with many others key patents have become core competencies of 3D Systems, Founded by Hull in [13]. A few years later, in 1988, Scott Crump invented Fused Deposition Modeling (FDM), another 3D model. FDM printing technology has become the basis of company he founded with his wife Lisa Crump for a year after - Stratasys [8]. These two companies were later two of the most famous companies in the field of 3D Printing and rapid prototyping [9]. since twenty years, 's 3D printing technology has quietly evolved and grown The was primarily used by designers and engineers in commercial spaces. However, this began to change in 2005 with the advent of the so-called Project RepRap. dr Gordon started the RepRap project, open-source community dedicated to 3D creation printing technologies accessible to all. To succeed in competitive global markets, companies must innovates its products and business models [1] and grows Opportunities [2] that result from investing in technology [3] as 3DP. According to many observers, this technology could enable "one of the next great technological revolutions". [4] and have "an immense and widespread influence in the world" [5]. For example, the 3DP industry is currently valued higher over \$3 billion, with an expected increase to \$13 billion by 2018 and 21 billion

dollars by 2020 [6]. This exploratory study aims to help fill this gap literature and demonstrate the impact of 3DP on corporate level. This article is built around the question: How 3D Printing is Driving New Business Developments models? In this study, the business model is a "representation". how the company creates and delivers value, both for customers and companies.

## II. LITERATURE REVIEW

History Simply put, the term means "additive manufacturing". the process of building products by adding a lot very thin layers of material, layer by layer. Historical Speaking of the, additive manufacturing has its roots in of the 19th century, especially in the field of topography a photographic sculpture. In "A brief history of the add-on Manufacturing and the Roadmap 2009..." by Beaman et al., citing that Giraud published the first technology that made this possible in 1972 The truly represented the current definition of additive manufacturing [3]. Giraud's method is described as trapping fusible materials and then using an energy beam to melt the material build a product by fusing layer by layer. Unfortunately, drawings and sketches are still available on Giraud's invention there is no evidence of this the technology was actually manufactured and executed. After a few years, Chuck Hull came up with the so-called Stereolithography (SLA) in 1986. This machine is considered the first 3D printer [10] [15]. THE stereolithography machine slowly poured liquid plastic into it build plastic handles. No wonder this technology is here very expensive and therefore only used by large studios universities, large companies and government research laboratories.

### *general applications*

**1. Rapid Prototyping** "Rapid Prototyping" is probably the most mature additive manufacturing/3D printing applications technologies in the enterprise space. Indeed, in some studies Rapid Prototyping refers to a

different add-on 551 Sessions PICMET '15 2015: Managing the Technology Age Key patented 3D manufacturing/printing processes players in this field: Stratasys, 3D Systems, Object, Z Corp, and Solids cape [17] [8]. However, during this study Rapid prototyping refers to the 3D design process Model with CAD (Computer Aided Design) software e.g., by making a prototype, usually out of plastic, in 3D Printing technology. This prototype then becomes the basis to design the final product [14]

**2. On-Demand Manufacturing** As labor costs rise in markets like China, in 1, the cost advantage of outsourcing jobs abroad begins to wane disperse. Therefore, a current McKinsey paper coined the so-called, the term "Next Support". Next Shore is an idea that manufacturing jobs will return to the US because There is now a competitive advantage when crafting items in the markets served [7]. Probably partly assigned to 3D printing. "Think local, act global" [11]. When product specifications or drawings are submitted directly to the local production site, logistics costs relating to the transportation of the asset from the factory an end user plus inventory costs Management. In theory, the creation of small local outlets for each relevant market can make the product cheaper and faster. Another article published by the CSC suggests - "3D Printing and the Future of Manufacturing" [2]. With 3D a simpler supply chain is possible thanks shorter delivery times and lower inventory levels. If The item is ordered online, the customer designs the item first and then proceeds to checkout. Local after ordering Manufacturing facility builds the item and then ships it their local customers. Because the products would be shipped shorter distances, shipping costs are lower.

**3. Low Volume** " Also think ten thousand units, not ten million (bulk). one (mass customization). Products no longer have to is sold in large numbers to reach and find global markets of their listeners" [1]. "Small Batch Production" is a manufacturing process, according to which the trader or economic operator determines the minimum quantity of a given product makes economic sense. In the past, small batch production wasn't like that profitable as assembly line production. production is generally cheaper when there are economies of scale were reached, which is the price of each unit produced thereafter decreases as more units are produced [16]

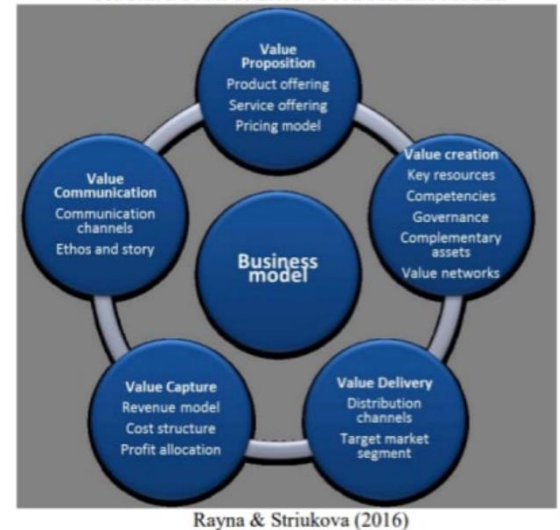
### III. RESEARCH PLAN

#### A. Business Model

There are several definitions of business models [10, 11], but in general, a business model involves five components (FIGURE I): Value proposition, the offering of products and services that are of value to customers [12]; value creation, the transformation of tangible and intangible resources to create products that customers want to pay for [13]; value communication, "ensures the delivery of value proposition as a message to the target groups, such as customers, investors, etc." [13]; value

delivery, "defines the means by which enterprises establish interactions with the customer in order to provide the value" [13]; and value capture, "describes how the value proposition is transformed into a revenue stream and then captured as profit" [13].

FIGURE I. COMPONENTS OF A BUSINESS MODEL



As mentioned above, this exploratory research study is organized based on two user groups – consumers and businesses. These user groups were evaluated based on five factors to evaluate knowledge profiles: 1) hardware familiarity, 2) software familiarity, 3) hardware specifications, 4) cost, and 5) interest in customization. These factors were determined based on observations from the

#### A. Hardware Familiarity

Hardware familiarity refers to the user's understanding of a 3D printer's capabilities and product outputs. Additionally, hardware familiarity also addresses the user's understanding of 3D printing materials – plastics, metals, ceramics, food, and human cells.

#### B. Software Familiarity

Software familiarity refers to the user's understanding of computer aided design software (CAD), as well as 3D scanners or digitizers. CAD software is a critical skill in the 3D design process. Do users recognize that proficiency in products like SketchUp, Autodesk, and Inventor are prerequisites for the 3D printing process?

#### C. Hardware Specifications

Key 3D printer hardware specifications include filament material (plastic, metal, ceramics, etc.), durability, size of build, peripheral technologies, and ease of use. Do users

understand the design considerations required to address any or all of these hardware specs?

#### D. Cost Consumer

3D printers price points currently range from \$400 to \$3000. In the business space, most 3D printers range from \$500 –\$80,000, and the 3D printers are often procured to facilitate the research and development process. How much are users willing to pay for these technologies? **E.** Interest in Customization Outputs from 3D printers are highly customized. In the consumer space, users' interest in personalized gifts or products may affect their likelihood to adopt the technology. Particularly, if users frequent complementing services like Zazzle, Etsy, and Bonanza. In the business space, the need for Unique parts or components, tailored to a specific business need, may affect and increase in adoption levels

### IV. RESEARCH METHODOLOGY

#### A. Mixed methods approach

To test our research hypotheses described above, In we used a mixed-methods research approach. The included 1) a consumer survey and 2) interviews with professional users with experience in 3D printing. The dates were using two methods (consumer survey and company interviews), and the data were analyzed by two dominant user groups (consumers and entrepreneurs). THE consumer surveys enabled more consumers to participate than the interviews would provide and therefore more substantial pattern series. The interviews, in turn, were intended examples aimed at understanding business users , which has been using this technology for years. Then the A Study was not possible due to difficult access representative samples from experienced professional users

#### B. Consumer Segment

The Consumer User Base Survey, administered through SurveyMonkey, included nineteen questions split across five web pages to increase likelihood of response. One question included yes/no logic; only those that answered yes to Question 5 were prompted to respond to Question 6. Therefore, some people answered eighteen questions, not nineteen. Based on an average response rate of 10%-15% for most online surveys, the targeted sample population was 300, with 45-50 responses. The survey was communicated in a phased approach via Facebook, LinkedIn, and email. Ultimately, due to a very high response rate of 61% after one week, the sample population was reduced to 115

#### C. Business Segment

Five interviews were conducted to evaluate the business users. The sample set was a purposive sample of individuals identified through our business networks. Each of the five interviewees' positions and companies are listed below

TABLE 1: BUSINESS INTERVIEWEES

Interviewee	Position	Company
No. 1	Design Specialist	NRI
No. 2	Frame Design Engineer	Cycling Sports Group
No. 3	Quality Team Lead	Shapeways
No. 4	Engineering Manager	Richards Manufacturing Co
No. 5	Designer	Con Edison

*Note: See Appendix for Company Descriptions*

The interviews took place over two months from May 2014 to end of June 2014. In addition to evaluating each interviewee based on the five factors identified in Section 3 – Research Plan, key interview questions were also determined.

They are bulleted here:

- D.** How is the technology used?
- E.** What model?
- F.** What kind of software?
- G.** Are any of the outputs the final product?
- H.** What are the current challenges of the technology?
- I.** In 5-10 y

### V. RECOMMENDATIONS AND FUTURE DIRECTIONS

This section discusses recommended future directions for the 3D printing industry. Based on a consumer survey and business intelligence research results, these studies recommendations focus on three 3D segments Printing industry: 1) Consumer 3D printing 2) 3Dsoftware manufacturers and 3) 3D printing services. **A.** Consumer 3D printing company

**A.** consumer survey found that 46.77% of respondents said it would only spend \$0 to \$299 for 3Dprinters.Considering the discussed possibilities of 3D printing, this suggests that consumers were not convinced of the value of the technology. Because the consumer Is currently buying a 3D printer? Most respondents still see 3D printing primarily as a business application, not the solution for DIY or in-house production. as price3D printers are shrinking over time, more and more consumers and Entrepreneurs don't necessarily think about buying 3D Printer. Consumers need to be won over by the technology has value, largely because 90% of consumers don't. Used a 3D printer. Manufacturers of consumer 3D printers like MakerBot should do this plan to expand its marketing and education efforts. According

to a survey of consumers, designers et Al engineers are now major users of consumer 3D printers. These people used technology to do this at school or work. That's why they can move ideas or uses for working from home. For each other consumers, again based on the survey responses they need for 3D Design Training: Get the Idea Design a 3D model in a CAD program and convert it to a project file Select the appropriate file type, and then print the template. The Recommendation, increasing marketing and education accconsumer 3D printing companies are essential for the consumer 3D Printing Company to Accelerate Consumer Adoption Tech rate. Spivey, a professional NRI practitioner who was interviewed, did the same Recommendation for Consumer 3D Printing Companies - a 3D printer repair shop. In his view, one of the challenges of the 3D design process are also material maintenance. If you have problems with the 3D consumer, many users don't know where to fix it. MakerBot has few store visits and Retail/repair shops like Best Buy and Tek Serve are gone skills to date to diagnose and repair hardware.

**B.** 3D software company Contrary to Anderson's belief [1] we are not all creators; Average consumers still have relatively high prices barriers to entry. 3D software is still difficult to use, and it is Key Skills Required to 3D Print, designed by consumers. As Spivey explained, consumers who buy 3D printers are not trained in the 3D design process. In In the case, someone bought a MakerBot and thought Adobe Illustrator can be used to create the design. Theis not 3D modeling software and Illustrator will not produce the type of 3D model to send to MakerBot printed.

This example shows a lack of knowledge. This however the also offers opportunities for 3D software providers— Design user-friendly packaging, then educate yourself consumers. There are several that have come onto the market

**C.** 3D printing service Based on an interview with Boyle, Shape ways may bone of the hottest companies in 3D printing Industry. Especially since 46.77% of consumers do not is willing to shell out over \$299 for intercurrently, most mainstream 3D printers cost around \$2,000. Perhaps this is why Shape ways undertakes educational activities consumers with programs like #madewithcode, partnerships with companies like Hasbro and informational events coworking spaces like Witco consumer 3D printers is priced, the more users are willing to pay, a software is easier to use, they can use 3D printing Service. This is a much more convenient option and users doesn't have to worry about post-processing or calibration 3D printer.

## VI. CONCLUSION

This was an exploratory research study with consumer studies and company interviews Segment for the collection of quantitative and qualitative research. THE Study had three main limitations. First, as mentioned inspection 4 – Research Methodology, a consumer study was conducted Comfort sample. Survey participants are identified based on our personal and professional networks. Secondly, Study was time limited because our goal was to conduct the survey state

of the art within a reasonable time. Third technology is very new to the consumer space. Consequently, most academic research on the user base is pretty hypothetical and very actual - in the last five years. Overall, 3D printing is very useful for projects presented. Jewelry is a good example. Simply Rings easy to make using traditional methods. However, an extremely complex alliance with finesse details and cutouts can be better when you are done with it 3D printer. Other complex projects involve 3D models architecture and engineering projects discussed by Spivey. By examining 25 case studies, the results suggests that 3DP can not only affect the value of companies Creation and Value Proposition; it can also affect the value communication, distribution and collection on a larger scale compared to previous studies. According to informants, 3DP leads to the development of new companies and business models and also affects existing businesses. 3DP With you can create services and products that didn't exist before possible - or developed completely differently Fashion While 3DP benefits startups, it also undermines them existing profitability. Company of craftsmen and artists who hand-prototype, jewelers who produce jewelry molds and architects offering pattern making services, to name just a few examples, are vulnerable to compromise short term. During the interviews I heard several cases of so-called companies print spare parts that they previously bought from their suppliers. This can generate intellectual property issues and patent infringement. One of 3DP's main contributions seems to be this product development processes are cheaper, faster and greener because there is almost no waste during printing parts, but which can allow for faster and cheaper prototyping companies are getting their products to market faster, which could also be the reason current products become obsolete faster. Generate 3DP more negative than positive impact on the environment? There are many issues that need to be investigated, e.g., B. Driver technology acquisition in Industry 4.0. In the 3DP area, e.g. In, for example, acquiring technology is not just a matter of strategy or a business opportunity. Various small businesses of those surveyed bought their first 3D printer for this reason Novelty Factor: The technology was new and interesting. Over time, realized they could make money from printers respondents/companies have never thought of starting a large company a company with few employees and many services. More research is needed to overcome these limitations by increasing the sample size and enlarging the cross section analyzes in different countries.

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