# Decentralized Manufacturing: Global Decentralized Network Directly Connecting Manufacturers, Designers, and Consumers

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## Abstract

In this article, a new supply chain for manufacturing from design to delivery is presented. An open-source protocol and collection of smart contracts called 3D-Chain is introduced by authors to become an ecosystem for manufacturers, designers and customers. Within this framework, the 3D Printing and fabrication technologies become a global common infrastructure for all and anyone can access 3D Printing network or become a stakeholder in its development.

Supporting software infrastructure for sustainable merge of 3D Printing into a new decentralized manufacturing market, bringing the value of new technologies to accelerate the innovation, addressing cross-functional components in manufacturing and design (designer, manufacturer, customer, researcher, supplier, and ...) to develop a programmatic approach for supply chain, decentralizing and adapting production and service against the needs of customers, and unlocking mass customization are 3D-Chain's objectives.

## Introduction

### The future of manufacturing

Manufacturing is a critical contributor to productivity, innovation, and trade. Time of big growth always has been supported by manufacturing revolutions (Steam engine, mass production, and automation). In advanced economies, a shrinking manufacturing sector is seen as evidence of decline in growth and in developing countries; manufacturing is the engine of development. Productivity is the core of manufacturing and it must be sustainable to serve the growth in long term.

Today, the global manufacturing is facing a fierce competition over every scrap of market share and we can see rates of economic growth in major economic blocks are declining (Figure 1). Neither building factories offshore to take advantage of the cheap labor nor expanding factories are the answer to this.

Manufacturers plan to make significant and often fundamental changes to their business to drive future growth. However, Limited baseline growth is expected in most manufacturing markets. Forward-thinking players will need to sense and anticipate the future and create an adaptive response (e.g. digitization of manufacturing sector [2]).



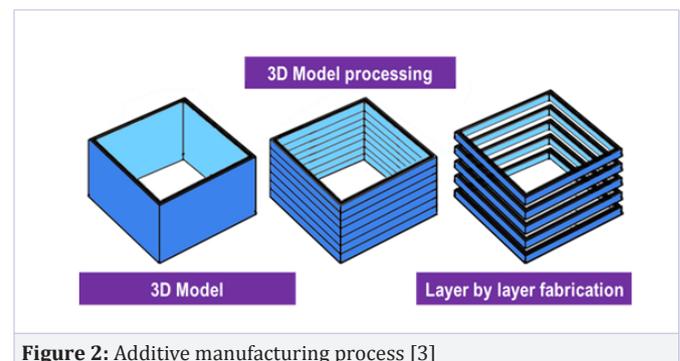**Figure 1:** Global GDP growth 1965-2016 (annual %) [1]



**Figure 2:** Additive manufacturing process [3]

3D Printing also known as Additive Manufacturing (AM) creates physical objects from a digital file using layer upon layer printing approach. Figure 2 shows the process which starts with modeling the object that can be of almost any geometry. At

second level, the 3D model was processed and sliced in layers. Finally, the object was fabricated through laying down material layer by layer.

For manufacturers, 3D Printing is not the future, it is a production method like any other. A survey shows manufacturers consider additive manufacturing a vital part of their business operation and recognize an urgent need to increase their investment into innovation and R&D [3].

## 3D Printing Market and Forecast

Global 3D printing market is driven by new innovations, optimization in printing performance, expanding application, and declining price. The global 3D Printing market is projected to reach USD 32.78 Billion by 2023, at a compound annual growth rate of 25.76% between 2017 and 2023 [4]. [Figure 3]



**Figure 3:** Growth in global 3D printing market
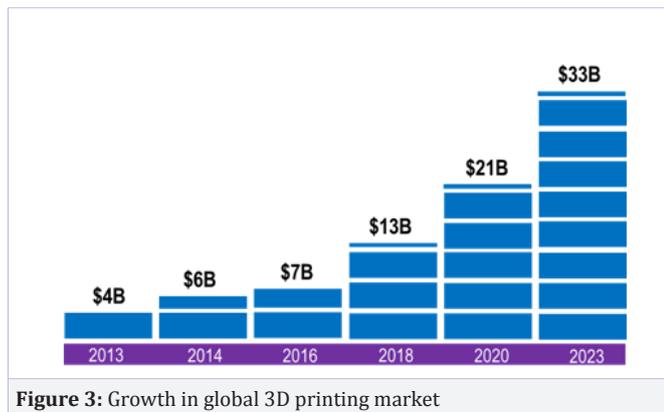
Prototyping and proof of concept are the leading use of 3D Printing. However, accelerating product development, product customization, and increase flexibility in production are the future priorities. 3D Printing industry's segmentations are:

- Prototyping

- Service

- Industrial goods

    ■ Aerospace

        ■ Specialized components

        ■ Engine parts

    ■ Engineering

        ■ High Tech and electronics

    ■ Automotive

        ■ Engine production

        ■ Innovation and concept car

        ■ Customized body parts

- Medical

    ■ Dental industries

    ■ Orthopedic implants

    ■ Personalized prosthetics

- Consumer goods

    ■ Fashion accessory production

    ■ Custom jewelry

    ■ Apparel production

    ■ High performance goods

- Construction

    ■ Large scale fabrication

    ■ Concrete 3D Printing

The consumer electronics and automotive industries are early-adopter of the additive manufacturing and contribute for more than 20% of the 3D Printing market. 3D Printing has generated positive results for the consumer electronics industry through developing prototype, increasing flexibility in new product, and designing concepts. The next big 3D printing opportunity for the consumer electronics industry is in smartphones, which comprise an estimated 35% of total consumer electronics sales. Medical device industry is the next biggest contributor in 3D Printing market (16%). Industrial Goods is also a very dynamic sector while service is a quite different market from other industries when it comes to 3D Printing.

## Problems: Present Concerns within Mainstream Application of 3D Printing

Mainstream application of 3D Printing requires investment in tools and materials for any specific product. You need to have skills to design your idea, have right tools to develop a prototype, and be familiar with all the optimization tools that is needed to turn a 3D file into a physical object. Having luxury of enough time, enough money and right skills to go through the whole process is very rare. The main restrictions are:

### Size Restriction

Future growth in large scale 3D printing requires investing a lot of money or using external 3D printing services.

### Material Restriction

Plastic is the most common 3D printing material followed by resin. To 3D Print a product, specific material which satisfies the requirements is necessary. On the other hand, having access to a 3D Printer with special application is challenging.

### 3D Printing technology

There are several 3D printing technologies, each has different way to process input material and create a final product. Therefore, finding a manufacturing company to make the design compatible with required specifications demands lots of time and efforts.

### Innovation and Intellectual Property Issues

The shift in global demand for 3D printed good requires very

different service with different features and price points. Offering variety of designs while protecting copyright is challenging for designers and manufacturers. These questions arise in global 3D printing and design environment which is different from past with more complexity, uncertainty, and risk.

## Challenges in Current Supply Chain of Manufacturing

With manufacturing focused on adopting new technology, ensuring the supply chain is ready for growth is a priority. Currently, the commercial adoption of 3D Printing technology has been delayed by insufficient infrastructure.

## 3D-Chain: A Decentralized Network for Future Manufacturing

Despite significant growth, there is a wealth of untapped potential in 3D Printing. What if we combine existing manufacturing process and innovation in technology sector to create next manufacturing invention, a productive environment that does complex non-repetitive tasks?

Blockchain technology gives manufacturing an opportunity to transform the supply chain into a decentralized environment to achieve a new level of productivity and efficiency. The only thing missing is a platform which enables secure and sustainable transactions.

We introduce 3D-Chain as a secure platform which uses greater intelligence in product design and manufacturing to boost resource efficiency and track activity by implementing blockchain technology. 3D-Chain introduces the first supply chain using cryptography for expansion of 3D Printing and automated fabrication technologies to consumer market (B2C) and industrial applications (B2B). 3D-Chain is a fully integrated system across the entire manufacturing industry, from the moment a design is developed by designer to the final delivery on the customer's doorstep. It helps forward-thinking players to take advantage of blockchain technology for next generation of manufacturing.

3D-Chain is developed by authors and is highly focused on providing new growth opportunity for manufacturing market. Our goals are, increasing adaptation range of new technologies, saving cost, reducing the risk of faulty design, protecting copyright, and expanding customized design and fabrication using advantages of blockchain technology. In larger scale, global manufacturing which is linked in 3D-Chain platform based on cryptography, will be expanded to a more productive and decentralized scale, will create more jobs, and will result in economic growth (Figure 4).
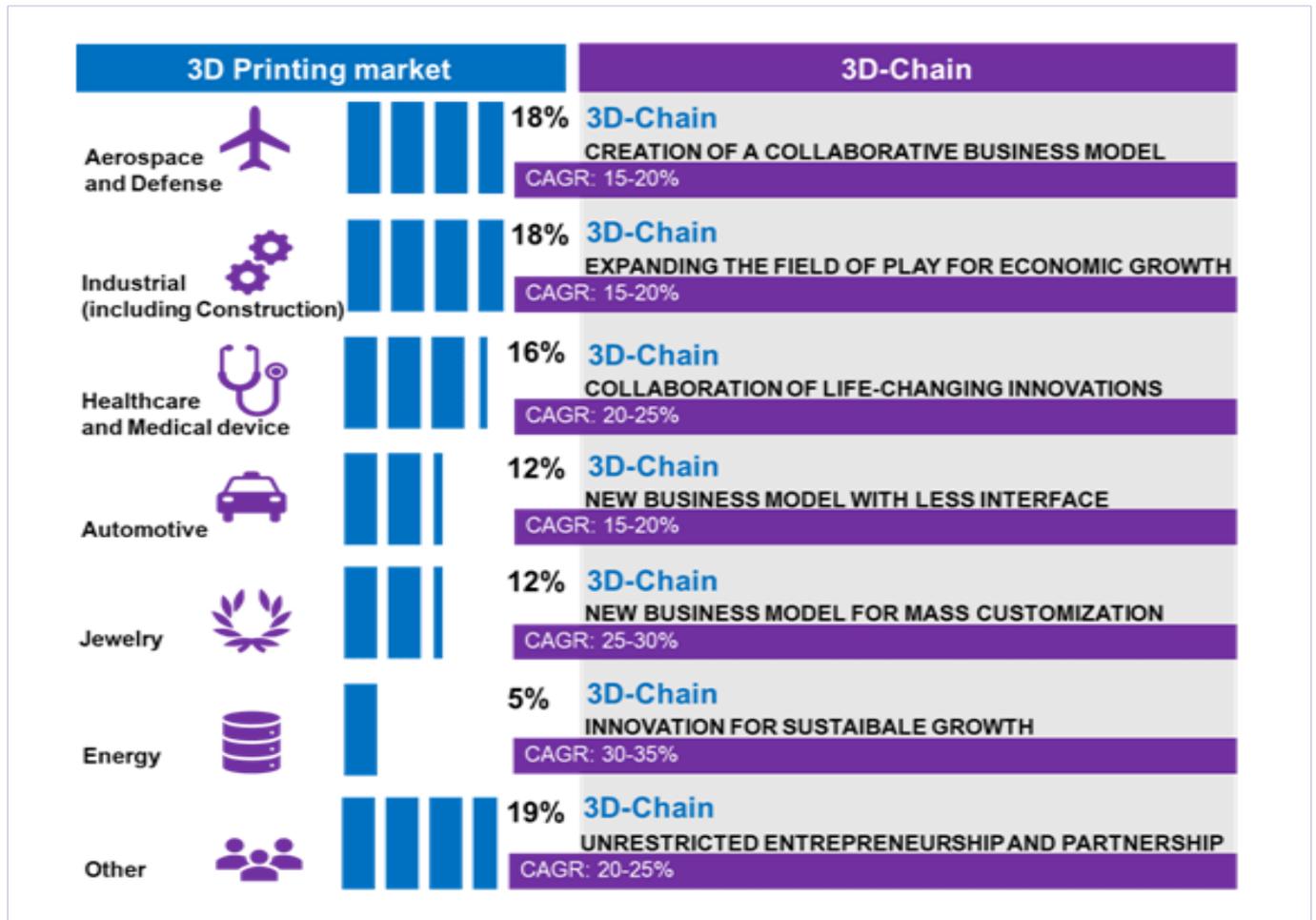


**Figure 4:** 3D Printing market, future growth; source data: [5]; and 3D-Chain's contribution to drive growth

Many designer and engineers are outsourcing their 3D printing demands as speed and precision of external 3D printing providers has increased dramatically in last years. 3D-Chain will be market place to guarantee communication between production and delivery. 3D-Chain is a network of 3D Printers in different sizes for scale variation in manufacturing and a decentralize network which provides a platform of material for 3D Printing. Moreover, consumer, designers, and manufacturer can connect to the 3D-Chain network and select a specific technology for their application. It also sets a decentralize third party governance program to lower the risk of uncertainty and ensure the compliance with contractual obligations. With 3D-Chain, the meaning of each cryptographic transition is only accessible for interpretation by the parties involved. The contract is completed and stored on the main blockchain which gives designers more visibility and allows contributors to communicate with ease.

### 3D-Chain's Ecosystem

The 3D-Chain ecosystem is a global decentralized platform where consumers can buy designs directly from designer, personalize a design, select among different materials and specifications, optimized the design for a specific fabrication technology, and send the design to appropriate manufacture and receive it in manageable time.

Raw material supplier, component supplier, 3D Printing machine manufacturer, fabrication technology provider, researcher, service provider, distributer, and end user define the ecosystem of the 3D-Chain. The 3D-Chain's audiences are as follow:
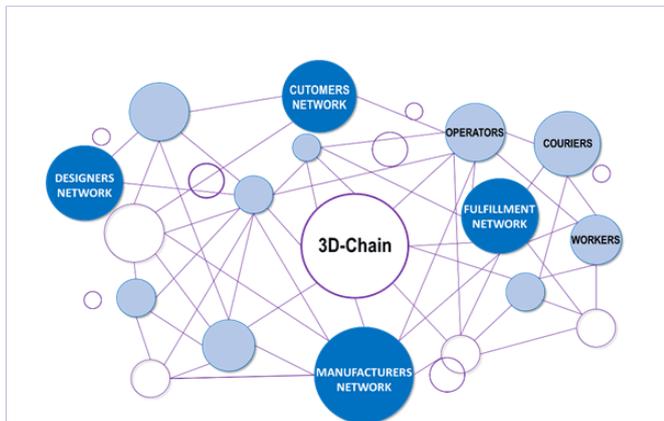


**Figure 5:** 3D-Chain's network

• Providers of 3D Printing solutions (Desktop, Industrial)

• Providers of 3D Printing services

• Providers of 3D Printing materials (Plastic, Metal, Concrete, and Other Materials)

• Providers of 3D Printing accessories

• Providers of 3D Printing consultation

• Providers of 3D Printing software (Printing, Design, and Inspection)

• Designers and Computer-aided design (CAD) developers

• Distributers and wholesalers

• End users and customers

• Educators and researchers in 3D Printing and automated fabrication technology [Figure 5]

### Mission and Strategy

The era of mass customization, customers get to pick their own combination of features from a basic underlying object, such as shoes or cloths to the place that they live. 3D-Chain provides a competitive market to overcome the restrictions in mainstream application of 3D Printing. Manufacturing industry can benefit from 3D-chain in area of:

• Customizing products in large scale: 3D-Chain facilitates the mass customization and opens door to unlimited possibilities. Moreover, 3D-Chain technology offers production of customized product in a secure environment and it will be a real partner in future manufacturing which provides customers with most personalized experience.

• Simplifying the supply chain: fewer inventories will be required since production is decentralized, and it will be closer to customer.

• Declining Cost: Cost decline and innovation are top trends that could have major impact on 3D printing in next few years. Global cost decline makes the use of this technology easier for companies and individuals.

• Saving time: Product will be available in market faster since less time required for design and production.

• Solving Complexity in production: Accessibility to different material and different 3D Printing provide the opportunity to create complex products without initial capital investment in tools.

• Educating for future manufacturing: 3D-Chain also increase awareness and education which help the market grow faster every year.

• Managing the waste: Less material will be wasted by taking advantage of proper fabrication technology for specific application.

## Conclusion

This article summarized a concrete way to decentralize manufacturing for global growth. Authors believe that in the future 3D Printing industry and automated fabrication technologies will be more and more application-driven to meet specific demands for business and customers. By connecting network of 3D Printers with different capabilities on a decentralized platform, manufacturers and customers have the freedom to focus on the application which will cause the real transformation in the industry.

3D-Chain, based on blockchain technology, proposes a leaner supply chain and fewer risks by creating a digital supply chain for manufacturing. Moreover, 3D-Chain increase collaboration

between existing and future players in its decentralized platform. A co-creation framework which integrates manufacturing (hardware, software, service, ...) to drive innovation and serve customers.

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