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# 4D Printing Evolution on Key Industries Disruption

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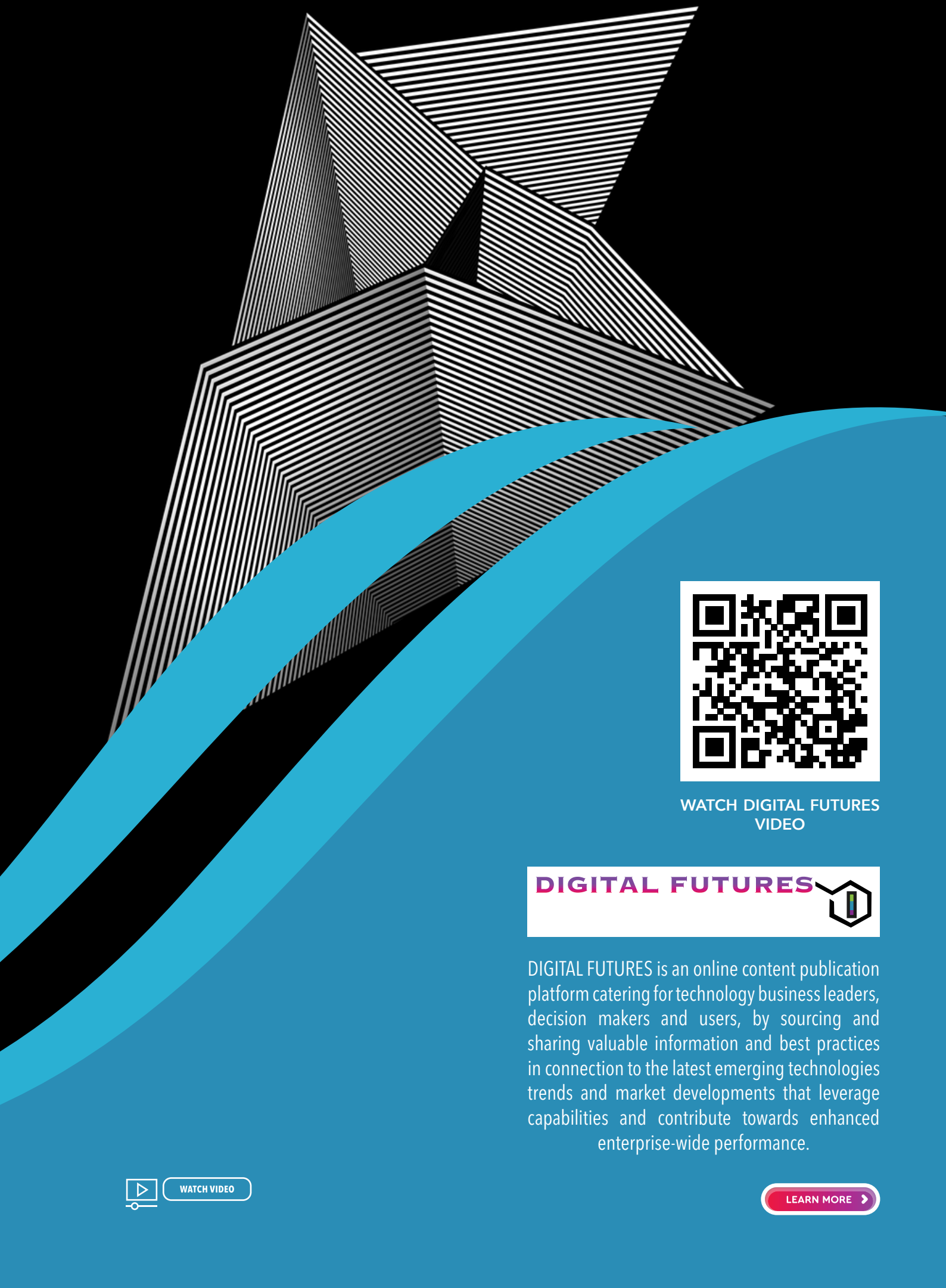

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# Introduction

3D printing presents a significantly adjustable process of production and rapid prototyping. Since its first early beginnings in 1983 with the rise of stereolithography (STL File format) and commercial rapid prototyping systems invented by Chuck Hull, the executive president and chief technology officer of 3D Systems, 3D printing has been making waves in various industries throughout the globe. The most important benefits of 3D printing and additive manufacturing are generally described as free complexity, mass-customization and the ability to minimize weight/volume while maximizing strength in components.

An even more advanced type of printing has been recently introduced, which has come to be known as 4D printing. This evolution of 3D printing offers the option of further changing the object's form and/or functioning after printing. This method augments current operations to introduce the fourth dimension – time - whereby different parts are able to adjust their shape or property. 4D printing provides a variety of remarkable benefits over 3D printing which might provide essential capabilities in facilitating broader adoption. In particular, it provides the material with actuation, sensing and programmability, without depending on external devices and electromechanical technologies. This presents some exceptional benefits:

a. minimizing the number of components in a product or system.

b. minimizing assembly time as compared to conventional processes; where motors, sensors and electronics are assembled post-fabrication.

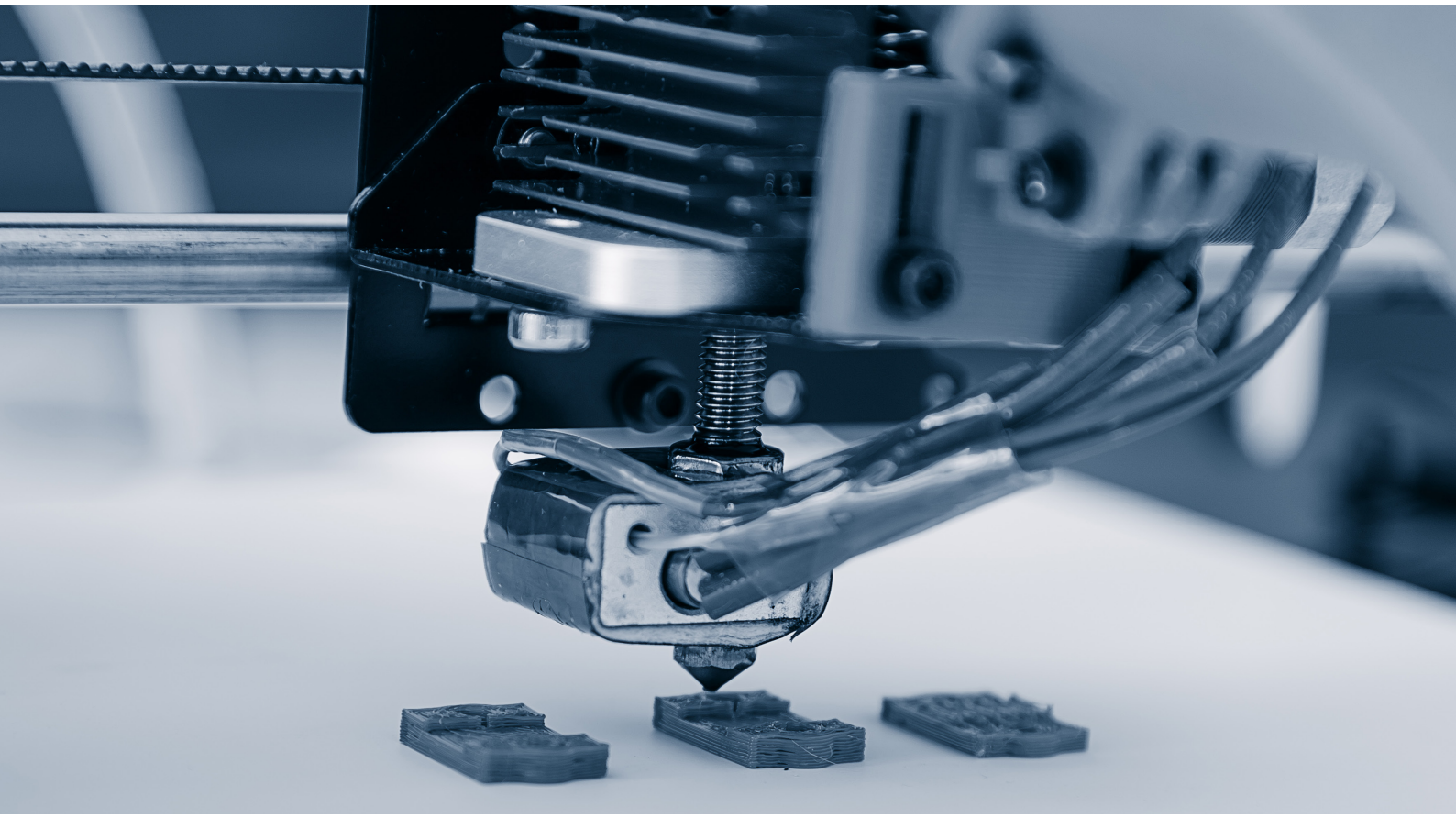
c. minimizing cost as compared to expensive components.

d. minimizing failure-prone devices that have become common in electronics and robotics.

**To generate "smart" objects, materials and architectural systems once previously necessitated extra components which were high-priced, failure-prone and challenging to assemble.**

Nevertheless, 4D printing now enables the programming of intelligent materials with linear actuators, folding mechanisms, curling/bending surfaces and material sensors. Printing is now able to become a Materials Science chamber where the designer is capable of customizing the deposition of materials, anisotropic behaviors and active sensing depending on the environmental conditions [1].

[1] Tibbits, S., McKnelly, C., Olguin, C., Dikovsky, D., & Hirsch, S. (2014). 4D Printing and Universal Transformation.



SECTION 1 |

# 7 Key Points to Picture the 4D Printing Global Market

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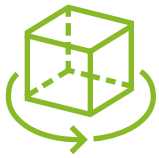
1.

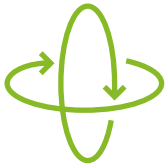


## Additive manufacturing or 3D (three-dimensional) printing

Additive manufacturing or 3D printing is a process of creating three dimensional solid objects - from a digital file - by laying down successive layers of material.

## 4D (four dimensional) printing

The advancements of printing techniques make use of smart materials in order to print formations which can alter their shape with time. This distinctive shape adjustment introduces the fourth dimension of time to the printing result which eventually promoted the further evolution of 4D (four-dimensional) printing techniques.



2.

3.

## 4D Printing market outlook and forecast

4D printing market will reach USD 537.8 million by 2025, demonstrating a CAGR of 42.95 percent. The advancement is at the point of marketing and will take the place of 3D printing during the forecast period.

## 4D Printing market share

The US remains one of the most powerful leaders regarding the adoption of 4D printing. It is anticipated to retain its position as the market leader during the period between 2019 and 2024.

4.

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