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Original Article

The Solidworks Design Software in a Teaching and Workshop Mode for Creating Daily Products

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Abstract *- Entrepreneurship begins with a lush (vivid) imagination. 3D printers are being procured for different business premises, start-up initiatives, branches, and professional wholesale and retail stores. 3D-printed walls as hangars and partition walls even stand in luxurious restaurants. Kinetic facades contain 3D-printed parts with twisted geometries. The automotive industry has been the fastest-growing industry in the 3D printing market. There were also a few ministerial projects for creating custom-made toys for persons with disabilities. 3D printing penetrates a lot of industries, facilitating the manufacture, costs, delivery, etc. In this manuscript, the Solidworks design software has been accessed through a teaching and workshop mode for creating daily products.*

Keywords *- Entrepreneurship, 3D printers, Twisted geometries, Solidworks design software, Teaching and workshop mode.*

1. Introduction

In today's world, 3D printing designs and rapid prototyping technologies have skyrocketed in the industry and simplify the manufacture, assemblies, and emulations of materials processing. In 2009th, 16% of 3D additive manufacturing processes were intended for integral part production, 21% for functional models, and 23% for tooling and metal casting patterns [1]. The idea is that the design would move around the globe as a digital file to be printed anywhere by any printer that could meet the design standards. The utilization of 3D printing in academic and educational institutions has grown staggeringly since the 2017th year.

In civil engineering, 3D printing ought to assist construction practitioners in fabricating materials and textiles for new building assets [2,3]. Synthetic resins, scaffolds, formworks, concrete brands, and small-sized bridges are made by large 3D printers. A large powder-bed 3D printer enables the printing of huge volumes up to 6 x 6 x 6 m [4]. Recently, it was created and tested a 3D-printed facade system called "Spong 3D".
Food on the market revolutionized into 3D printing foods made of creamy powders, making the gastronomical industry effortless. The 3D meat printer based on the extrusion of fibrous meat proteins was developed [5].

3D printed models, in ecology, mimic living organisms, attract predators, stimulate pairing, and point out different body functions due to different body morphologies [6].

In this manuscript, the whole utility of Solidworks design software was demonstrated through teaching and workshop mode alive. After Solidworks design software sessions, the models of jewelry and other daily products were cast from 3D PLA (plastic) filaments.

2. Solidworks as a 3D Modelling Software

The Solidworks design software is a CAD (computer-aided) 3D modeling software which transforms digital models from STL files into tangible models. This design software enables 3D printing of counterparts (integral parts) as well as of the whole.

To create mockups and make blueprints and renderings of products, there are several other popular 3D modeling softwares such as Solidworks: Rhino, Sketchup, Revit, 3Ds Max, AutoCAD, and Maya [7]. The manual and powered wheelchair and its frame were tested under the human body's weight in Solidworks 3D modeling software. The aluminum alloy 1350 showed more deformation than steel, but aluminum was used due to its lightweight [8]. The jack screw with a rotating nut was modeled in the Solidworks software. Its sustainability impacts (acidification of air, carbon footprint, total energy consumption, water eutrophication) were analyzed if it is used in Europe or America [9].

In Solidworks 3D modeling software, there are several constraints while contouring the model, such as mass constraint, dimensions constraint, angle constraint, the velocity of the nozzle in creating a model, substrate material, support, or no support structure.

2.1. A Palette of 3D Modelling (Industrial, Building) Printing Designs in the Solidworks Software

A set of industrial design artefacts was printed through a workshop mode of Solidworks 3D modeling design software. By routing to the function buttons (Swept Boss/Base, Lofted Boss/Base, and Revolved Boss/Base), curved shapes of the design artifacts can be configured. Multiple cuts and orbicular edges define the final form of the products [10].

3D printing leads to the third industrial revolution. It comprises hundreds of raw materials: nylon, acrylic, sand, plastics (polymers), pebbles, and nutrients. With the common 3D printers, mechanically sculpted figures have a limited thickness, and the figures are much more like adornments. The semi-products usually have a fixed form and a configuration [11].

3D printed artifacts originating from fused deposition modeling have mostly a spongy structure and a high rate of intrinsic pores; therefore, such 3D printed artifacts are of poor quality. On the quality of FDM-originated artifacts influence: filament feed rate, geometry, and permeability of its walls, etc. It was proved that by increasing the k value, sc. extrusion multiplier, the volumetric flow rate through 3D printed items was reduced, which led to the enlarged impermeability of 3D printed products [12].

A patient's bladder was fabricated by using a 3D scaffold from a 3D printer and subsequently coated with the patient's own bladder cells. There are also some other testimonials of 3D printing's usage in reconstructing the cartilage, liver, bones, and blood vessels [13]. The 3D-printed medical gear, like a bracelet, was invented during the COVID-19 pandemic in Montenegro and was probed in hospital conditions. The gear was palpable for the human body temperatures and changed colors in its presence[14].

Once created, 3D model designs are handed to the slicer software, which prepares the model for 3D printing operation. In slicer software, the 3D model can be with or without a grid, the edges can be thinned, and the model rotated. Most common slicer software gives the 3D digital files an extension (.stl). The other settings can be processed on 3D printers themselves, such as filament temperature in the nozzle, the velocity of nozzles, the proximity of the platform, and the time of creating a 3D model.

Below, Fig.1,2,3, and 4 are presented 3D models fabricated in Solidworks design software workshop sessions. 3D models have twisting geometries, loops, rounded parts, and crossing elements.

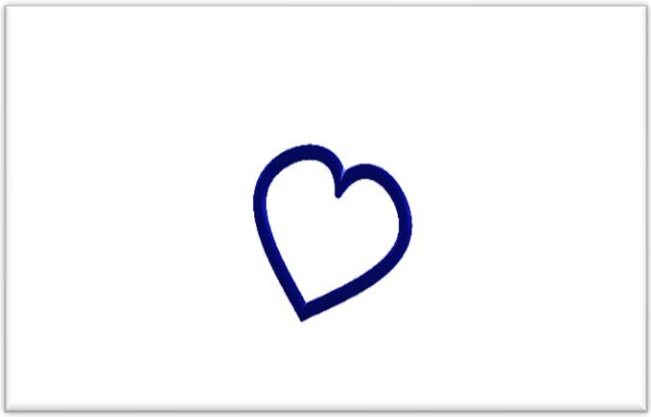

Fig. 1 Solidworks workshop model 1 (by author)

Fig. 2 Solidworks workshop model 2 (by author)

Fig. 3 Solidworks workshop model 3 (by author)

Fig. 4 Solidworks workshop model 4 (by author)

3. American 3D Printing Market Size and Prognosis

The advanced technologies, such as smart materials known for latent heat storage in the buildings' fund, Industry 4.0, machine learning, and artificial intelligence, triggered 3D manufacturing.

As per data stemming from Global Industry Report by Strategic Market Research, the global 3D printing market size is oriented towards revenue of 77.83 billion dollars in 2030th. In 2021. the data pointed out that the industrial printer took part in the market with over 70%. In the same year, as the most used 3D material, metal had a portion of the market with over 50%. Prototyping as 3D technology also had the largest market share in the 2021st year. [18]. So far, 3D printing is still a small niche in the world market, fabricating one-off products and parts of a whole. Additive manufacturing must advance in three interrelated areas, throughput, factory integration, and quality control, to be more globally acceptable [16].

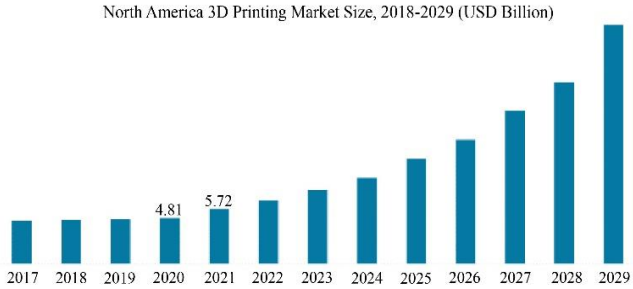

Fig. 5 The prognosis of the USA monetary revenues from the 3D printing market (2018.-2029.) [17]

North American countries Canada and USA were pioneers in ushering 3D printing on the American continent. According to the graphic in Fig.5. [17], the monetary revenue from the 3D printing market in North America was 5.72 billion dollars for 2021. year. Visually, the pillar for 2021. a year can be contained around 5 times in the projected pillar of monetary revenues for 2029. year. The facilitating fact for the expansion of 3D printing in North America is the existence of a multitude of 3D printing companies. Global projections of monetary revenues from 3D printing markets are 50 billion dollars up to the 2030th year.

4. Conclusion

Handovers of final product designs and their final decisions are time-consuming. One product requires dozens of iterations up to its final physical appearance; thus, such 3D modeling softwares as Solidworks are useful. In other words, Solidworks 3D modeling design software improves production efficiency and accelerates production batches. In this manuscript, Solidworks was discussed through teaching and workshop paradigms for creating the products for daily use.

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