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Designing a Face Shield Frame in PTC Creo and Printing it in a 3D printer

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ABSTRACT

Coronavirus infection (COVID-19) is a transmissible disease that was recently discovered. The infection is mainly transmitted through droplets produced by an infected person coughing, sneezing, or breathing. These droplets are too heavy to hold the air and fall rapidly on floors or surfaces. When you come into contact with people who have a coronavirus or touch a contaminated surface, you can become infected by the virus after touching your eyes, nose, or mouth. The face shield is generallyintended to provide protect from droplets produced by the infected person. A large number of healthcare workers were infected atthe start of the pandemic was due to a shortage of personal protective equipment (PPE). How all of a sudden hospitals can be obtained protective equipment's, ventilators and some other spare parts needed. Shortage of medical and personal protective equipment has affected the ability of many countries to respond to the pandemic. Three-dimensional printing (3DP) is well suited to address this shortage, and these components can be printed effectively using 3D Printers.

Personal protective equipment (PPE) is in short supply during the coronavirus pandemic. Health care workers should use a face shield to protect their faces from droplets. The current work aims to design a face shield mask frame in PTC Creo as per requirement and print it in a 3D printer machine. The process followed to print the model is FDM technology and PLA (polylactic acid) material has been used to print the frame. The filament material (PLA) is deposited layer by layer on a build platform by heating it to its melting point. The combination of many layers would give a final 3D model.

Keywords: Face Shield Frame, PTC Creo Parametric, Cura and 3D Printer

INTRODUCTION

3D Printers are playing an important role in the fight against COVID-19. 3D Printing, also known as Additive Manufacturing (AM) is a process in which the material is deposited in layers using digital 3D modelling data. The Combination of these layers results in the formation of a solid object. In contrast to most of the machining processes, which are subtractive and remove material from the work-piece to achieve the desired dimension and shape three-dimensional printing takes the raw material in the form of wire and deposits it in the form of layers to achieve the required shape. Three-dimensional printing (or Rapid Prototyping) can be used to generate objects with complex geometrical features that would be difficult and impossible to generate using subtractive techniques.

The following 3D printing techniques are commonly used for commercial purposes:

a) Stereo-lithography (SLA) b) Fused deposition modelling (FDM)
c) Laminated object manufacturing (LOM) d) Selective laser sintering (SLS)
e) Three-dimensional printing (3DP).

The basic working principle in all of the above techniques is the same depositing the layer of raw material, one upon the other, in the pattern given by the computer program to obtain the desired geometry and shape. However, each of these techniques has distinguishing characteristics that make one technique superior or more Suitable than others for creating a specific object. Nowadays, additive manufacturing has a wide range ofapplications in various human activities:

-Medical industry -Military -Engineering - Education
-Research -Agriculture -Architecture -Fashion,
-Computer industry and many others.

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We can now easily convert any design into a 3D model with 3D printing technology. Face shield mask, safety goggles, nasal swabs, Ventilators, Oxygen venturi valves, hands-free door openers, tweezers, a convenient tool for buttons, Respirator mask, 3D Printing pill dispenser, medical equipment and surgical tools, and so on are among the useful 3D prints for Covid-19.

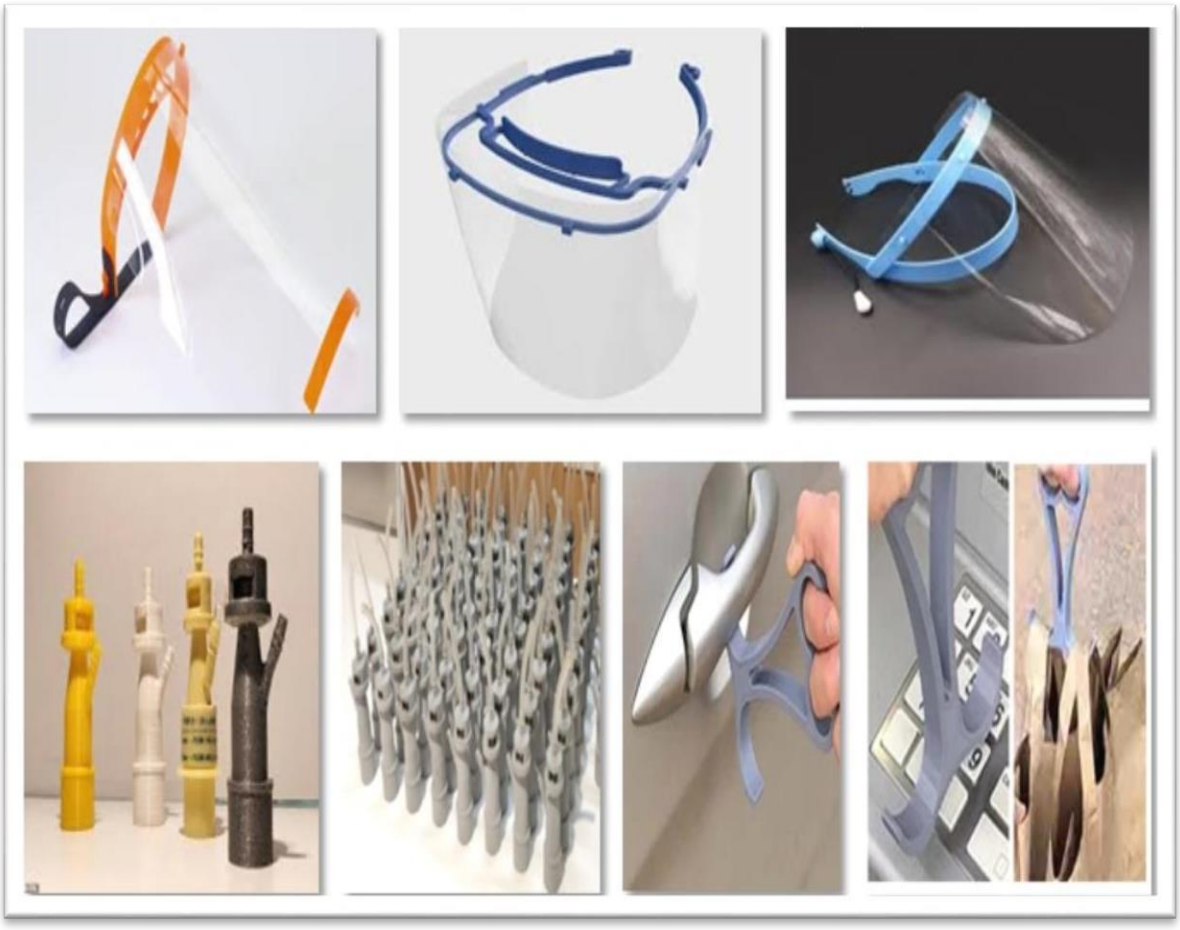


Figure1. Useful 3D prints

Fused Deposition Modeling (FDM) Process

FDM is the most preferable technique available for making durable parts from thermoplastic materials. Polylactic Acid (PLA) is a thermoplastic polyester that is one of the most popular bio-plastic materials derived from renewable resources. PLA possesses important characteristics of being eco-friendly and having biocompatibility (with the human body).

In the FDM process, the desired three-dimensional object is directly generated from the three-dimensional CAD model given as input. The software converts the 3D CAD model into layers. Important process characteristics suchas Print Speed, layer height, Filament Diameter, print area, etc. are used to build the control file for the 3D printing machine. The machine then begins the printing process. In general, the material is melted by heating its melting temperature, and then it is extruded in a specific pattern over a layer of the previous extrusion. The FDM technique is suitable for different materials such as thermoplastics, chocolate, pastes, and even "exotic" materials suchas metal- or wood-infused thermoplastic. FDM is widely accepted because it is easiest way to obtain 3D models and this method is inexpensive and effective.

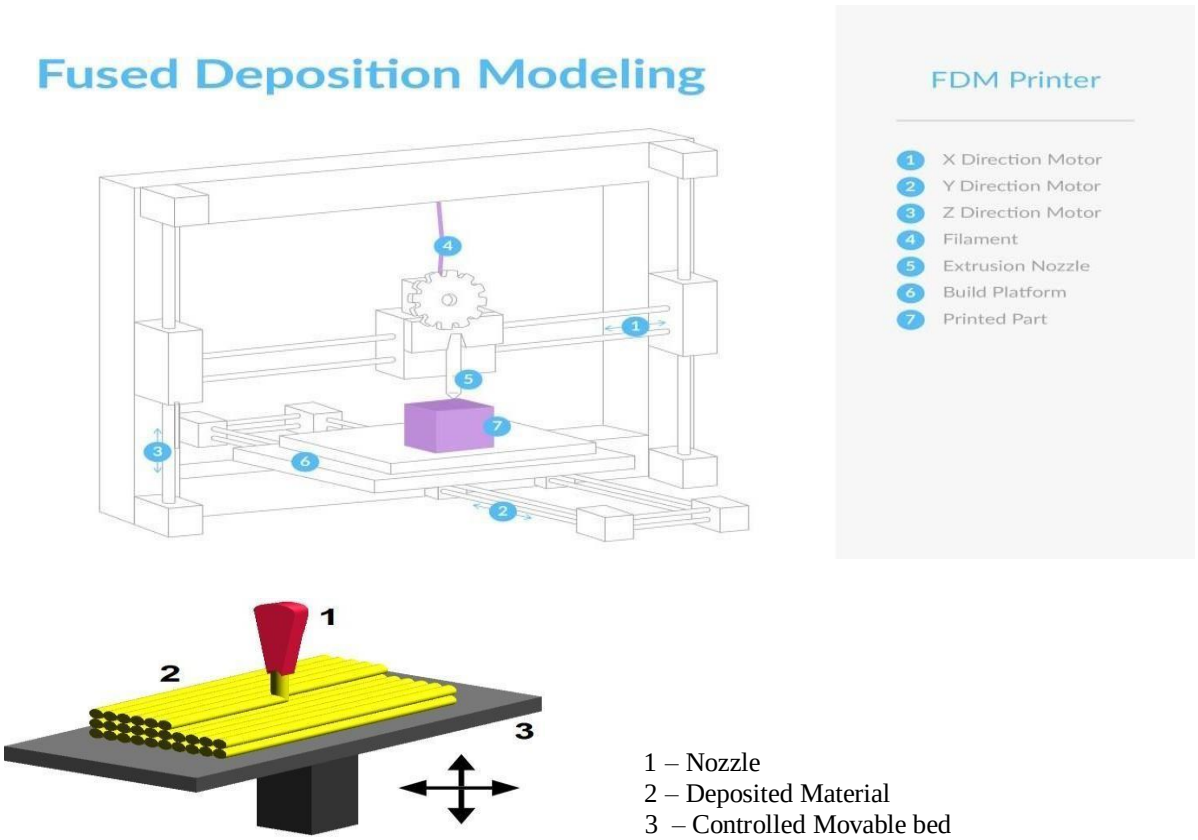


Figure2. FDM Process

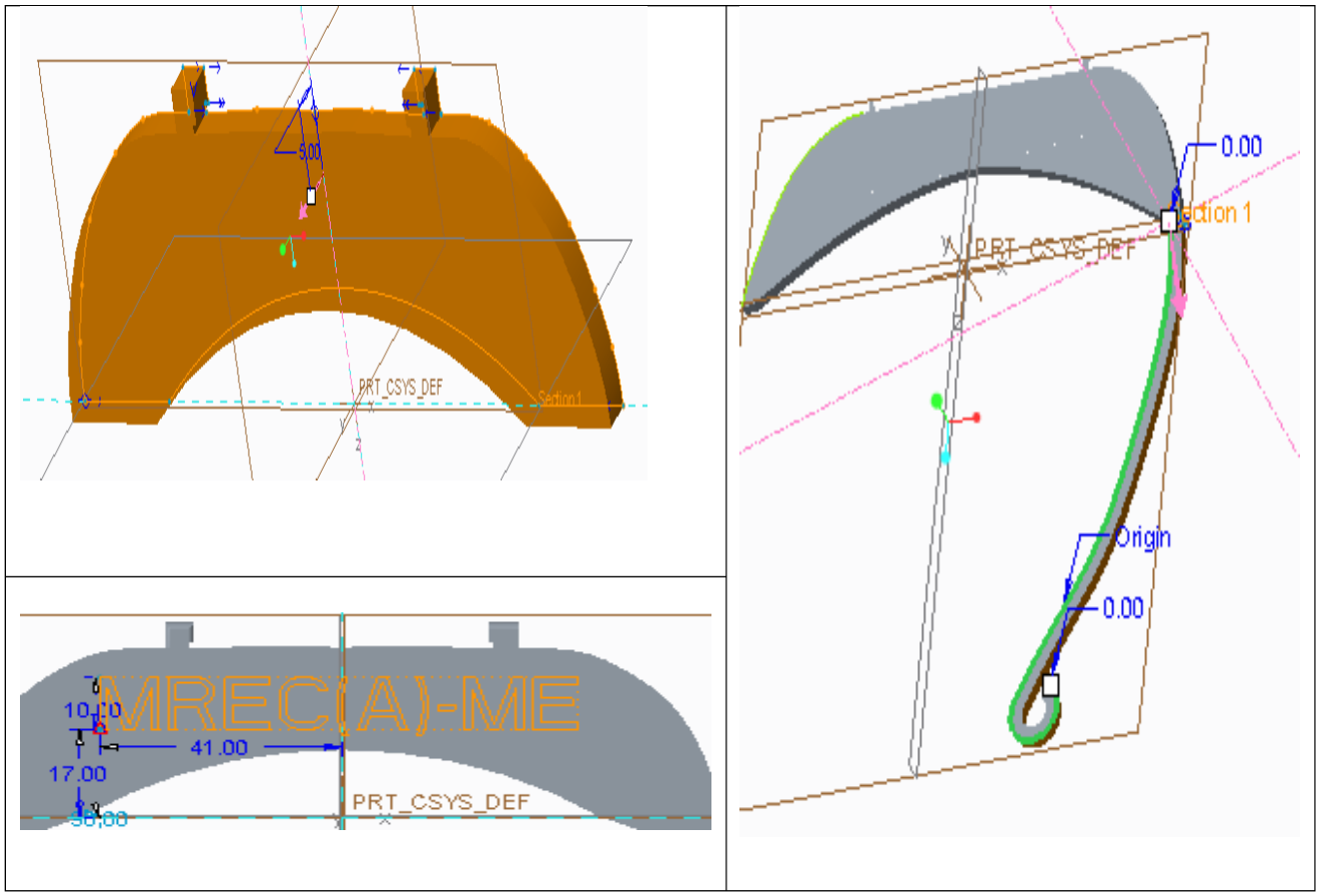
Table 1: FDM Functions& Equipment

Function	**Equipment**
Driving the filament from spool to the heater	Drive wheels
Melting the filament	Heater and Liquefier
Extrusion of filament	tip (nozzle)
Base for deposition of filament	Platform
Movement of the platform in z-axis	Piston

FRAME DESIGN

During the coronavirus pandemic, the face shield became an essential part of personal protective equipment (PPE) for front-line health care workers and individuals. The face shield presented in this article was designedat our 3D printing center (Malla Reddy Engineering College- Autonomous). 3D Printable models can be generated using CAD software or a 3D scanner. Any modelling software package such as PTC Creo Parametric, Auto CAD Fusion 360, Solid Works, and CATIA etc. can be used to design the face shield frame. Users can use Creo Parametric to create 3D models with a variety of features such as sweeps, revolves, and extrusions. It is one of the leading cad software used in many engineering and technical careers.

CREO (Formerly known as Pro/ENGINEER) is a product design software developed by PTC for 3D modelling. Creo is a powerful, integrated family of product design software. It is used by thousands of leading manufacturers across the world. In the following figure, you can see the design of the Face Shield Mask Frame.



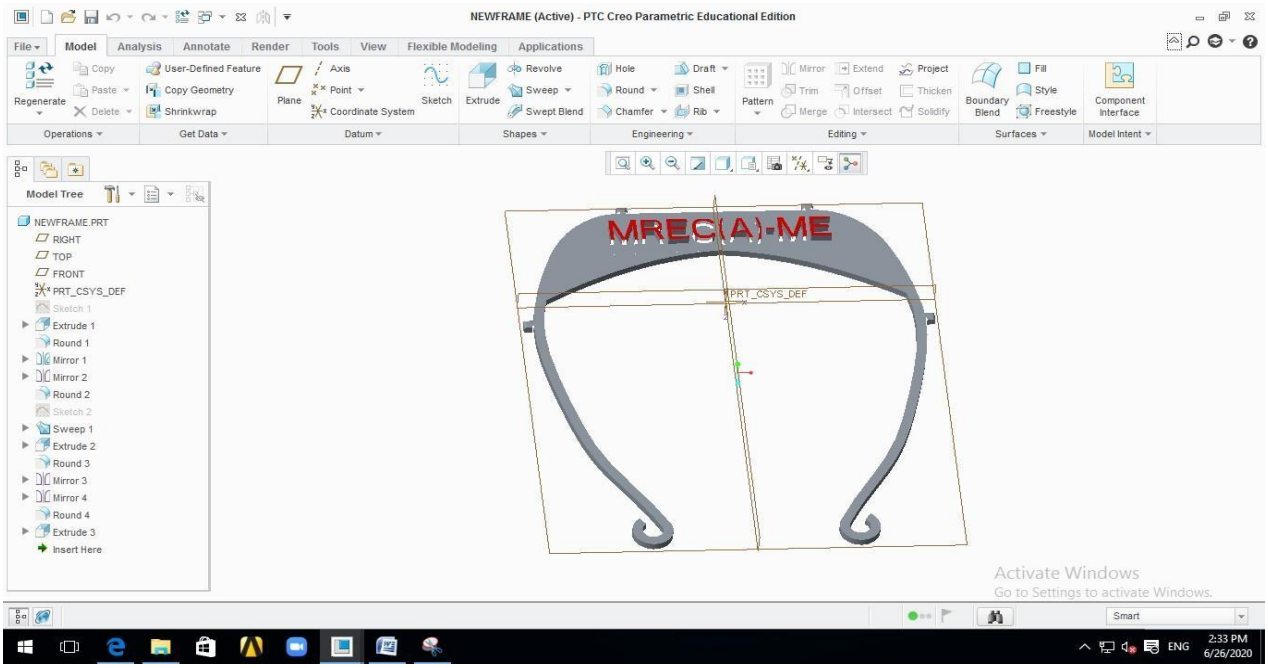


Figure3. Face Shield Frame design in PTC CREO

SLICING AND GENERATION OF G-CODE

There are numerous slicing software options available on the market, including CURA, Slic3r, Idea Maker, KISSlicer, Z-Suite, Maker Bot Print, and others. The process in CURA software begins with importing the STL or OBJ files. The software slices the model into layers and generates a G-code file (understandable for the 3D printer). This coding instructs the 3D printer with the commands that the printer should execute. The 3D printer deposits successive layers of material to gradually build a model, following the G-code instructions. Based on the method of 3D printing used, the complexity involved in the model, and the size of the model, the time needed may range from several hours to days.

The parameters such as Print Speed, layer height, maximum temperature, Filament Diameter, print area, bed temperature, and nozzle size these details about the 3D printer must be entered in a Cura software. Once the required information of the model is conveyed to the Cura software. Cura calculates the necessary path to print the required model and generates a list of printer directions. These instructions are saved in the form of a G-code file The G-code can be saved to an SD card and then inserted into the 3D printer or sent directly from Cura software to the printer via cable, depending on the printer.

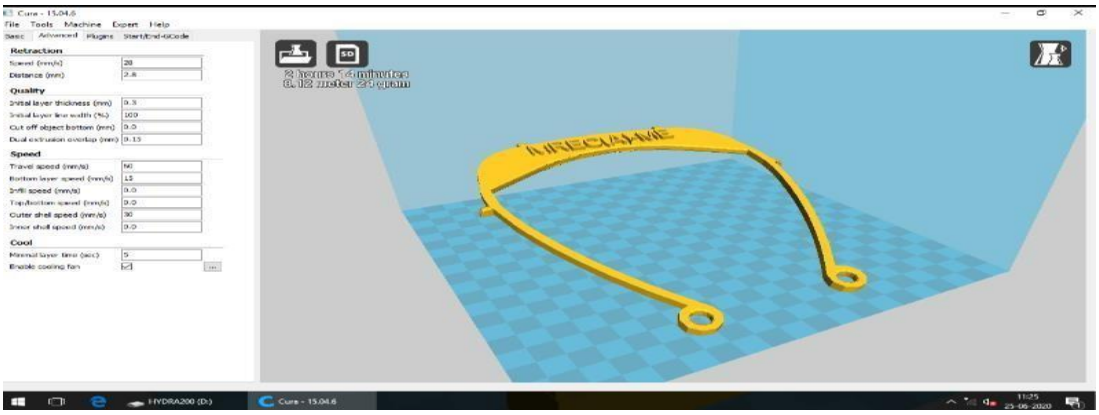


Figure4. Face shield frame in CURA

FRAME MANUFACTURING PROCESS

3D printers are manufactured and distributed by 3D printing companies (Brahma 3, Think 3D, Zegroup Robotics, 3D Dying, and so on). Many also provide 3D printing services, and some even offer 3D printing training programs. 3D printing has the power to change the whole industrial landscape because you do not have to make or buy special moulds or tools. 3Ding is one of the largest manufacturers of FABX & Hydra 3D printers. We used the Hydra-200 3D Printer to print the face shield frame. The parameters must be entered manually by selecting the Machine tab Add a new machine in the Cura software.

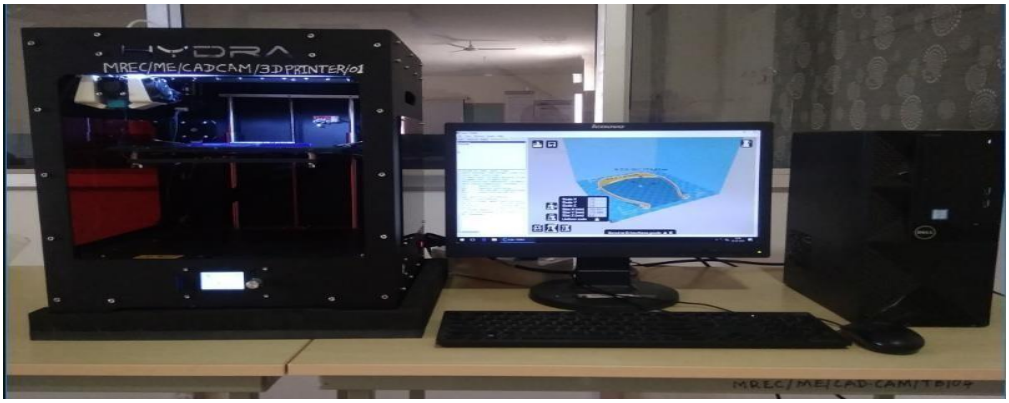


Figure5. 3D Printer Setup

3D PRINTED FACE SHIELD MASK FRAME

The designed face shield frame was printed at our 3D printing center (Malla Reddy Engineering College-Autonomous). A clear plastic sheet can be used as a visor. We took an A4 Clear overhead projector sheet, punched the holes in it according to the design of a frame and perfectly fixed it. 120 face shields were distributed to Malla Reddy Narayana Multi Speciality Hospital's front-line health care workers. 25 members were provided feedback and advised us to create a design without any gap between the forehead and the overhead projector sheet to the face shield. Design changes were made to meet their requirements. The printed face shield mask frame is shown in Figure 6.

Figure6. 3D Printed face shield frame

CONCLUSION

During the coronavirus pandemic, the face shield became an important part of the PPE used by health care workers and individuals. We wanted to develop a locally manufactured face shield that would fulfill the requirements of health care workers, individuals and it is a reusable protective face shield that covers the entire face. It does not affect the user's vision and is comfortable to wear throughout the day. The frame is curved at the forehead portion and the other end to fit into the head. The frame was designed without a gap between the forehead and the overhead projector sheet, such that it does not allow any particles to enter from the top. On the other hand, the frame's side and end thicknesses were set at 3mm to accommodate the head comfortably. 3D printing innovation has the potential to reform and change the world. Developments in 3D printing technology will radically alter and improve the process of producing personal protective equipment (PPE) in response to the world's rapidly expanding globalization. 3D printing brings limitless design possibilities in product development.

PTC Creo is used to design a Face Shield Frame, which is then printed in a 3D printer. It is hoped that the methodology and approach presented in this paper will be of great assistance to the public at this critical time. Finally, it concluded that the face shields could be made quickly and included as part of strategies to safely and significantly reduce the spread of covid. The importance and social impact of 3-D printing technology is increasing day by day, affecting human life, the economy and modern society.

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