MANTECH Publications

Journal of Product Design, Quality Engineering & Technology
Volume 6, Issue 2, May-August 2021

Implications of Fast Model Making in a Variety of Engineering and Technology Fields

R. S. Kumaravelan, C. Sathish Gandhi, P. Ramesh, L. Venkatesan

Student[1, 2], Assistant Professor[3]

Department of Mechanical Engineering

Dewan College of Educational Studies

Corresponding Author's E-mail:- *rkumaravelan@yahoo.com*

Abstract

Model making, often known as prototyping, is an essential stage in the product design and development process that aids in the conception of a design. Rapid prototyping (RP) is a method of layer-by-layer material deposition that became popular in the early 1980s as computer-aided design and manufacturing (CAD/CAM) technology grew rapidly. The edges and surfaces of a complicated solid model, as well as their information, are utilised to define a product that is then CNC machined into a completed product. For different applications of RP models, this article offers a better platform for researchers, new learners, and product makers. As a result, it raises public knowledge of the rapidly evolving RP manufacturing technique in product design, development, and applications.

Keywords: *Prototyping, layer-by-layer, CAD/CAM, product design*

INTRODUCTION

RAPID PROTOTYPING (RP) is a set of methods for rapidly creating a scale model of a component or a group of components using 3-dimensional computer-aided design (CAD) data. Because of the global rivalry for products, the manufacturing sectors have placed a greater emphasis on the product development phase. As a result, RP and manufacturing methods are critical in product development. Reducing the product development time and cost offers a lot of potential. It's a crucial tool for fast product development in digital manufacturing. To deposit the material for constructing a proto model using the RP

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

process, a number of techniques may be utilised. Stereolithography (SLA), Selective Layer Sintering (SLS), 3D Printing (3DP), and Fused Deposition Modelling are some of the main techniques utilised in industries for producing product models (FDM).

LITERATURE REVIEW

Many articles have been written on fast prototyping and tooling methods in the creation of a specific product. The literature was compiled with techniques, products, and product development in mind for a variety of applications. Rapid prototyping (RP) is a novel forming method that fabricates real components layer by layer under computer control straight from 3D CAD models in a relatively short period, as described. In contrast to conventional machining techniques, most fast prototyping systems create components using an additive manufacturing process rather than removing or subtracting material.

As a result, the restrictions imposed by traditional machining methods have no bearing on this kind of manufacturing. Since the introduction of the first RP system in 1988, RP technology has been effectively used in the automobile, aerospace, electronics, toy, and other sectors. Stereo Lithography (SL), Selective Laser Sintering (SLS), Fused Deposition Manufacturing (FDM), Laminated Object Manufacturing (LOM), Ballistic Particle Manufacturing (BMP), and Three-Dimensional Printing are some of the commercially available RP techniques (3D printing).

The manufacturing sector is moving toward digitization, network, and globalisation. With the rapid advancement and widespread use of Internet technologies, they have been widely used in the development of manufacturing systems to connect various product development activities, such as marketing, design, process planning, production, customer service, and so on, that are spread across multiple locations into a single environment.

To facilitate the deployment of Web-based RP production, created a tele-service system for RP service bureaus.

Described the creation of a distributed fast prototyping system via the Internet in order to provide a framework for Internet prototyping and production to aid in the development of effective products. The suggested technique is aimed at a broad audience who use a variety of computer

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

systems to connect to remote rapid prototyping facilities for prototype manufacturing over the Internet.

The approach may be used in both educational research and remote scientific visualisation to educate developing rapid prototyping technologies. This method is based on the combination of object-oriented modular software architecture and client-server connections enabling Internet-based remote control of fast prototyping hardware (also known as fused deposition modelling).

Other Web tools are utilised to provide the remote user more control over the server programmes that have a direct connection to the front-end terminals that operate the rapid prototyping gear. A remotely accessible laboratory for fast prototyping was recently established.

The goal of this project is to create and distribute a Tennessee Technological University Remotely Accessible Rapid Prototyping (RRP) Laboratory (TTU). Presented a real-time design guidance system that may suggest the best path for making a physical prototype.

Using poly(ethylene) glycol (PEG) as a cell-repulsive substance and a collagen/poly-D-lysine (PDL) combination as a cell-adhesive material reported on the utilisation of inkjet printing to construct neuron- sticky patterns such as islands and other forms. They utilised a positive relief technique: PEG was used as the background and anti-fouling substance, while the collagen/PDL combination was used as the printed foreground and cell-adhesive material.

They also propose that the inkjet printing method might be used to layer-by-layer construction of 3D structures. Functionally graded material processing techniques have become a study topic in the material science, composites, ceramic engineering, and metallurgy sectors. Investigated the SLS technique for manufacturing polymer composites. Such heterogeneous objects may be created with SLS. The amount of material deposited may be changed over time to produce a functionally graded material item with a changing material distribution. Micro-pores were discovered in the scaffold structure created by SLS from physically blended Hydroxyapatite

(HA)/polyetheretherketone and HA/polyvinyl alcohol composites in. According, porosity allows for the introduction of new elements into the item during post-processing, which may change

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

the material composition and assist regulate component stability. Calcium phosphate powders coated with polymethyl methacrylate have been successfully treated using SLS, and further post-processing allows for the creation of robust porous structures.

Highlighted how RP techniques are the best approach for fabricating tissue scaffolds as compared to traditional methods, as well as the present limits and future developments in scaffold manufacturing. The testing of materials for fast prototyping in FDM technology was addressed. Before being utilised for their intended purposes, the majority of the RP components are finished or touched up.

Discusses the orthodontic uses of RP models. Patients generally do not tolerate lengthy orthodontic therapy because patient cooperation is lost. Patients' compliance may be enhanced by utilising sophisticated engineering concepts to create a localised dental vibrator that allows for quicker tooth motions.

OBJECTIVE OF THIS STUDY:

The primary goal of this article is to raise awareness among industry workers, researchers, and students about product development and model manufacture using computer modelling, as well as the use of RP model creation in different areas. This article discusses the difficulties of Rapid Prototyping as well as the variables to consider while creating Rapid Prototyping methods in the Indian context.

APPLICATIONS OF RAPID PROTOTYPING MODEL

This article discusses the use of RP models in a variety of fields, including medicine, textiles, electrical appliances, footwear, architectural interior design, and furniture design, among others.

Textile Application

In the textile industry, RP methods models are extensively utilised. Complicated contour profile dresses are designed in a 3D model using a computer and are directly linked to the production process. Figure 1 depicts the RP model's complex outlines.



Fig. 1 RP model of dresses with special contours

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

Electrical Appliances:

PR methods are extensively used in the production of household electrical products. These RP methods are ideal for creating the unique shapes seen in electrical products. RP models of electrical equipment are shown in Figure 2.

Foot-Ware Design:

The RP method is used to manufacture foot-ware for human comfort. This kind of footwear should be less in weight and more durable than traditional footwear. In addition, the RP method models are used to create complex foot-ware designs that do not need any fasteners. When compared to traditional models, the RP model has a relatively high level of dependability. The created foot-ware model using the RP method is shown in Figure 3.



Fig.2 RP model of an electrical appliances



Fig. 3 RP model of foot-ware

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

Furniture Design:

RP methods are used to design and manufacture the furniture. This model is lightweight and does not have any temporary or permanent joints. It is made out of a single component with various profiles and no joints. The furniture model created using the RP method is shown in Figure 4.

E. Design of Special Objects

Some unique shaped objects, such as spherical, hemispherical, and tree stems, are created using RP methods. The interior side of this type has a hollow area, whereas the outside shell is thick. This kind of item has been created using the traditional technique, which is very complex and time-consuming. However, as compared to the traditional approach, the RP methodology allows it to be produced in the lowest amount of time. The RP model of the unique items produced in the RP methods is shown in Figures 5 (a) and (b).



Fig. 4 RP models of an architectural interior design



Fig. 5 (a) RP model of special objects (Spherical)

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

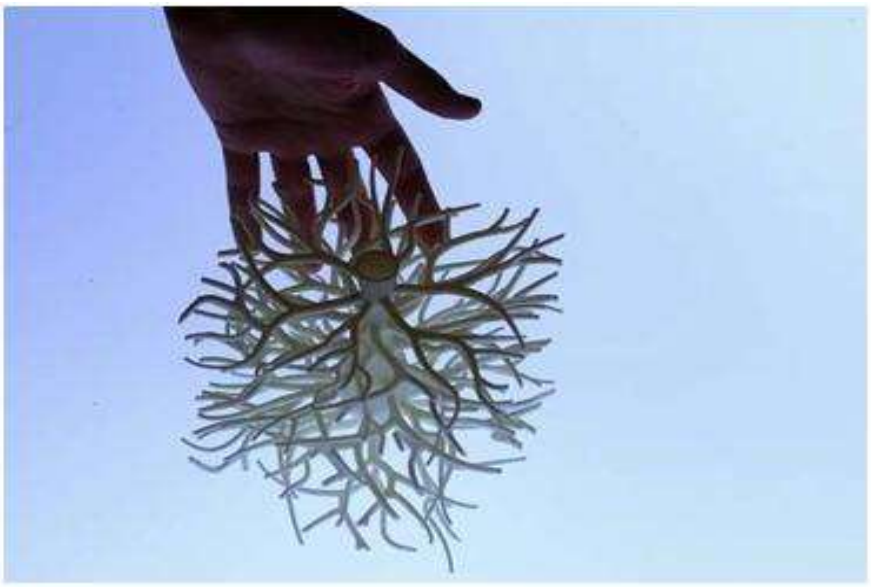

Fig. 5 (b) RP model of special objects (Tree stems)

CHALLENGES ASSOCIATE INSIGHT IN RAPID PROTOTYPING

The difficulties associated with insight in fast prototyping are listed below. The RP models are manufactured using an automated machine straight from a computer-aided design model. As a result, the following should be taken into account while designing the RP system.

a) Create an automated recognition system for suitable geometric characteristics in STL files, such as minimum wall thickness.

b) Create guidelines for prototyping metal components.

c) Improve the categorization or definition of prototype usage by users.

d) Determine which distribution method best meets the requirements of small businesses and who would be accountable for its maintenance.

e) Create a complete system in a native programming environment that can be delivered in the specified way.

FACTORS TO BE CONSIDERED WHILE DEVELOPING RP TECHNIQUES IN INDIAN SCENARIO

The following are the factors to be considered for developing the RP techniques in Indian scenario.

a) Initial investment Cost
b) Availability of trained people
c) Knowledge in the automatic system
d) Availability of material

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

e) Programming language
f) Awareness of RP techniques
g) Reality of the model
h) Knowledge in the 3D modeling
i) Selection of Modeling software

CONCLUSION

RP is one of the fastest-growing new technologies for producing a variety of goods by layering materials and working directly from a 3D CAD model linked to an automated machine. The different RP models relevant to the area of applications are discussed in this article. This article offers a platform for researchers, new learners, and product makers to get an understanding of fast prototyping and manufacturing technologies for producing complex and unique contour goods in a variety of fields. In this article, the different aspects are addressed in order for academics to get a better understanding of the difficulties associated with fast prototyping. However, certain considerations are made for creating RP methods in the Indian context.

REFERENCES

1. N. K. Vail, L. D. Swain, W. C. Fox, T. B. Aufdlemorte, G. Lee, J. W. Barlow, Materials for biomedical applications. Mater. Des., Vol. 20, 1999, pp. 123–132.
2. A. Fidan, N. Ghani, Acquisition steps of a Remotely Accessible Rapid Prototyping Laboratory. International Journal of Computer Applications in Technology, Vol. 30, No. 4, 2007, pp. 266–272.
3. D. T. Pham, S. S. Dimov, Rapid Manufacturing: the Technologies and Applications of Rapid Prototyping and Rapid Tooling, Springer, London, 2001.
4. H. B. Lan, K. S. Chin, J. Hong, Development of a teleservice system for RP service bureaus. Rapid Prototyping Journal, Vol. 11, No. 2, 2005, pp. 98–105.
5. D. King, T. Tansey, Alternative materials for rapid tooling. Journal of Materials Processing Technology, Vol. 121, 2002, pp. 313–317.
6. P. F. Jacobs, Stereolithography and other RP&M Technologies: From Rapid Prototyping to Rapid Tooling, ASME Press, New York, 1996.
7. D. T. Pham, R. S. Gault, A comparison of rapid prototyping

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved

technologies. International Journal of Machine Tools & Manufacture, Vol. 38, 1998, pp. 1257– 1287.

8. H. Yang, D. Xue, Recent research on development Web-based manufacturing systems: a review. International Journal of Production Research, Vol. 41, No. 15, 2003, pp. 3601–3629.

9. L. Novakova - Marcincinova, J. Novak - Marcincin, Testing of Materials for Rapid Prototyping Fused Deposition Modelling Technology. World Academy of Science, Engineering and Technology, International Science Index 70, Vol. 6, No. 10, 2012, pp. 396 - 399.

10. F. E. H. Tay, Y. P. Khanal, K. K. Kwong, Distributed rapid prototyping a framework for internet prototyping and manufacturing. Integrated Manufacturing Systems, Vol. 12, No. 6, 2001, pp. 409–415.

Page 62-70 © MANTECH PUBLICATIONS 2021. All Rights Reserved