A

Seminar report

On

Rapid Prototyping

Submitted in partial fulfillment of the requirement for the award of degree
Of Mechanical

SUBMITTED TO: **SUBMITTED BY:**

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Preface

I have made this report file on the topic **Rapid Prototyping**; I have tried my best to elucidate all the relevant detail to the topic to be included in the report. While in the beginning I have tried to give a general view about this topic.

My efforts and wholehearted co-corporation of each and everyone has ended on a successful note. I express my sincere gratitude to …………..who assisting me throughout the preparation of this topic. I thank him for providing me the reinforcement, confidence and most importantly the track for the topic whenever I needed it.

Acknowledgement

I would like to thank respected Mr…….. and Mr. ……..for giving me such a wonderful opportunity to expand my knowledge for my own branch and giving me guidelines to present a seminar report. It helped me a lot to realize of what we study for.

Secondly, I would like to thank my parents who patiently helped me as i went through my work and helped to modify and eliminate some of the irrelevant or un-necessary stuffs.

Thirdly, I would like to thank my friends who helped me to make my work more organized and well-stacked till the end.

Next, I would thank Microsoft for developing such a wonderful tool like MS Word. It helped my work a lot to remain error-free.

Last but clearly not the least, I would thank The Almighty for giving me strength to complete my report on time.

Content

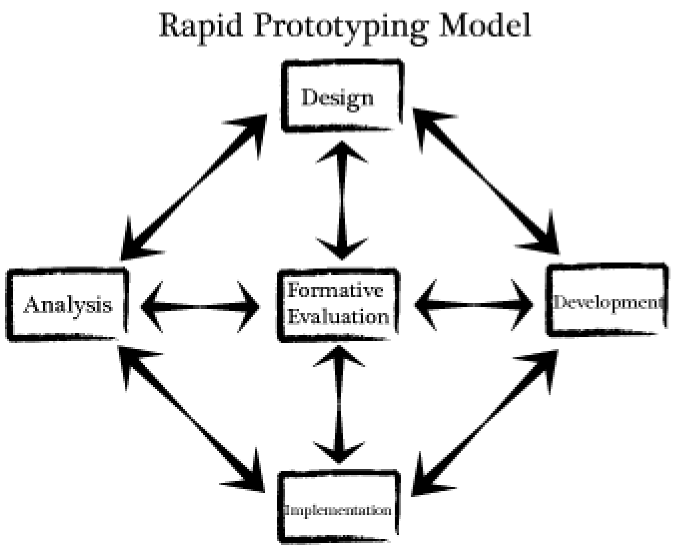
Introduction

Rapid Prototyping (RP) can be defined as a group of techniques used to quickly fabricate a scale model of a part or assembly using three-dimensional computer aided design (CAD) data. What is commonly considered to be the first RP technique, Stereolithography, was developed by 3D Systems of Valencia, CA, USA. The company was founded in 1986, and since then, a number of different RP techniques have become available.

Rapid Prototyping has also been referred to as solid free-form manufacturing, computer automated manufacturing, and layered manufacturing. RP has obvious use as a vehicle for visualization. In addition, RP models can be used for testing, such as when an airfoil shape is put into a wind tunnel. RP models can be used to create male models for tooling, such as silicone rubber molds and investment casts. In some cases, the RP part can be the final part, but typically the RP material is not strong or accurate enough. When the RP material is suitable, highly convoluted shapes (including parts nested within parts) can be produced because of the nature of RP.

What is Rapid Prototyping?

Rapid Prototyping is the "process of quickly building and evaluating a series of prototypes" early and often throughout the design process. Prototypes are usually incomplete examples of what a final product may look like. Each time a prototype is used, a formative evaluation gathers information for the next, revised prototype. This cycle continues to refine the product until the final needs and objectives are met. The following diagram demonstrates the non-linear nature of Rapid Prototyping.



Why Rapid Prototyping?

The reasons of Rapid Prototyping are

- To increase effective communication.
- To decrease development time.
- To decrease costly mistakes.
- To minimize sustaining engineering changes.
- To extend product lifetime by adding necessary features and eliminating redundant features early in the design.

Rapid Prototyping decreases development time by allowing corrections to a product to be made early in the process. By giving engineering, manufacturing, marketing, and purchasing a look at the product early in the design process, mistakes can be corrected and changes can be made while they are still inexpensive. The trends in manufacturing industries continue to emphasize the following:

- Increasing number of variants of products.
- Increasing product complexity.
- Decreasing product lifetime before obsolescence.
- Decreasing delivery time.

Rapid Prototyping improves product development by enabling better communication in a concurrent engineering environment.

How does Rapid Prototyping Work?

Rapid Prototyping, also known as 3D printing, is an additive manufacturing technology. The process begins with taking a virtual design from modeling or computer aided design (CAD) software. The 3D printing machine reads the data from the CAD drawing and lays down successive layers of liquid, powder, or sheet material — building up the physical model from a series of cross sections. These layers, which correspond to the virtual cross section from the CAD model, are automatically joined together to create the final shape.

Rapid Prototyping uses a standard data interface, implemented as the STL file format, to translate from the CAD software to the 3D prototyping machine. The STL file approximates the shape of a part or assembly using triangular facets.

Typically, Rapid Prototyping systems can produce 3D models within a few hours. Yet, this can vary widely, depending on the type of machine being used and the size and number of models being produced.

Applications of Rapid Prototyping

RAPID TOOLING

- Patterns for Sand Casting
- Patterns for Investment Casting
- Pattern for Injection moldings

RAPID MANUFACTURING

- Short productions runs
- Custom made parts
- On-Demand Manufacturing
- Manufacturing of very complex shapes

AEROSPACE & MARINE

- Wind tunnel models
- Functional prototypes
- Boeing's On-Demand-Manufacturing

AUTOMOTIVE RP SERVICES

- Needed from concept to production level
- Reduced time to market
- Functional testing
- Dies & Molds

BIOMEDICAL APPLICATIONS - I

- Prosthetic parts
- Presurgical planning models
- Use of data from MRI and CT scan to build 3D parts

- 3D visualization for education and training

BIOMEDICAL APPLICATIONS - II

- Customized surgical implants
- Mechanical bone replicas
- Anthropology
- Forensics

ARCHITECTURE

- 3D visualization of design space
- Iterations of shape
- Sectioned models

FASHION & JEWELRY

- Shoe Design
- Jewelry
- Pattern for lost wax
- Other castings

Basic Process

Although several rapid prototyping techniques exist, all employ the same basic five-step process. The steps are:

1. Create a CAD model of the design

2. Convert the CAD model to STL format

3. Slice the STL file into thin cross-sectional layers

4. Construct the model one layer atop another

5. Clean and finish the model

CAD Model Creation

First, the object to be built is modelled using a Computer-Aided Design (CAD) software package. Solid modelers, such as Pro/ENGINEER, tend to represent 3-D objects more accurately than wire-frame modellers such as AutoCAD, and will therefore yield better results. The designer can use a pre-existing CAD file or may wish to create one expressly for prototyping purposes. This process is identical for all of the RP build techniques.

Conversion to STL Format

The various CAD packages use a number of different algorithms to represent solid objects. To establish consistency, the STL (stereolithography, the first RP technique) format has been adopted as the standard of the rapid prototyping industry. The second step, therefore, is to convert the CAD file into STL format. This format represents a three-dimensional surface as an assembly of planar triangles, "like the facets of a cut jewel." 6 The file contains the coordinates of the vertices and the direction of the outward normal of each triangle. Because STL files use planar elements, they cannot represent curved surfaces exactly. Increasing the number of triangles improves the approximation, but at the cost of bigger file size. Large, complicated files require more time to pre-process and build, so the designer must balance accuracy with manageability to produce a useful STL file. Since the .stl format is universal, this process is identical for all of the RP build techniques.

Slice the STL File

In the third step, a pre-processing program prepares the STL file to be built. Several programs are available, and most allow the user to adjust the size, location and orientation of the model. Build orientation is important for several reasons. First, properties of rapid prototypes vary from one coordinate direction to another. For example, prototypes are usually weaker and less accurate in the z (vertical) direction than in the x-y plane. In addition, part orientation partially determines the amount of time required to build the model. Placing the shortest dimension in the z direction reduces the number of layers, thereby shortening build time. The pre-processing software slices the STL model into a number of layers from 0.01 mm to 0.7 mm thick, depending on the build technique. The program may also generate an auxiliary structure to support the model during the build. Supports are useful for delicate features such as overhangs, internal cavities, and thin-walled sections. Each PR machine manufacturer supplies their own proprietary pre-processing software.

Layer by Layer Construction

The fourth step is the actual construction of the part. Using one of several techniques (described in the next section) RP machines build one layer at a time from polymers, paper, or powdered metal. Most machines are fairly autonomous, needing little human intervention.

Clean and Finish

The final step is post-processing. This involves removing the prototype from the machine and detaching any supports. Some photosensitive materials need to be fully cured before use. Prototypes may also require minor cleaning and surface treatment. Sanding, sealing, and/or painting the model will improve its appearance and durability.

The Rapid Prototyping Technique

In the Rapid Prototyping process the 3D CAD data is sliced into thin cross sectional planes by a computer.

The cross sections are sent from the computer to the rapid prototyping machine which build the part layer by layer.

The first layer geometry is defined by the shape of the first cross sectional plane generated by the computer.

It is bonded to a starting base and additional layers are bonded on the top of the first shaped according to their respective cross sectional planes.

This process is repeated until the prototype is complete.

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Advantages of Rapid Prototyping

· Today's automated, toolless, patternless RP systems can directly produce functional parts in small production quantities.
· Parts produced in this way usually have an accuracy and surface finish inferior to those made by machining.
· However, some advanced systems are able to produce near tooling quality parts that are close to or are the final shape.
· The parts produced, with appropriate post processing, will have material qualities and properties close to the final product.
· More fundamentally, the time to produce any part --- once the design data are available --- will be fast, and can be in a matter of hours.

Disadvantage of Rapid Prototyping

One more disadvantage of rapid prototyping is that it may not be suitable for large sized applications.

The producer may produce an inadequate system that is unable to meet the overall demands of the organization. Too much involvement of the user might hamper the optimization of the program.
The producer may be too attached to the program of rapid prototyping, thus it may lead to legal involvement.

Conclusion

Finally, the rise of rapid prototyping has spurred progress in traditional subtractive methods as well. Advances in computerized path planning, numeric control, and machine dynamics are increasing the speed and accuracy of machining.

Modern CNC machining centers can have spindle speeds of up to 100,000 RPM, with correspondingly fast feed rates. 34 Such high material removal rates translate into short build times. For certain applications, particularly metals, machining will continue to be a useful manufacturing process. Rapid prototyping will not make machining obsolete, but rather complement it.

References

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