

RAPID PROTOTYPING TECHNOLOGY

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Introduction

- Rapid Prototyping (RP) is one of the newest manufacturing technologies
- Charles Hull is the inventor of stereolithography (SLA), in 1986.
- The first commercial process was presented at the AUTOFACT show in Detroit in November 1987, later in 1988, 3D system, Inc. sold its first RP machine.

The 3D Systems, Inc

Corporate Headquarters

is located in Valencia, California



Visit 3D Systems, Inc

Students from CSULA visited the company on
2/26/03



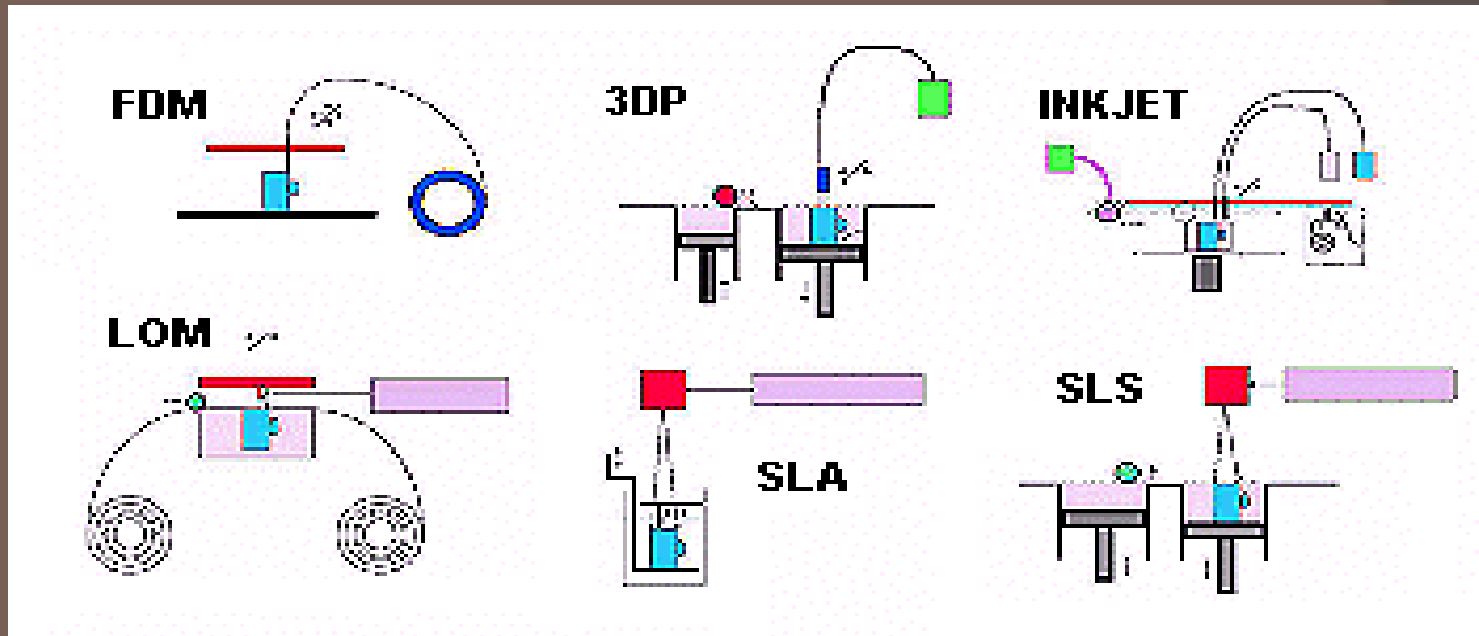
Definition and Characteristic of RP

- ⦿ A special class of machine technology that quickly produces models and prototype parts from 3-D data using an additive approach to form the physical models.

Main characteristic:

- ⦿ 3-D design software, STL format.
- ⦿ It add and bond materials in layers to form objects, is different from the classical subtractive fabrication methods such as milling or turning

Types of RP



- The most obviously difference among them is using different heating apparatus and materials of the models being produced
- Fused Deposition Modeling (FDM); Three Dimensional Printing (3DP); Inkjet-based systems (INKJET)
- Laminated Object Manufacturing (LOM); Stererolithography (SLA) Selective Laser Sintering (SLS)

Fused Deposition Modeling (FDM)

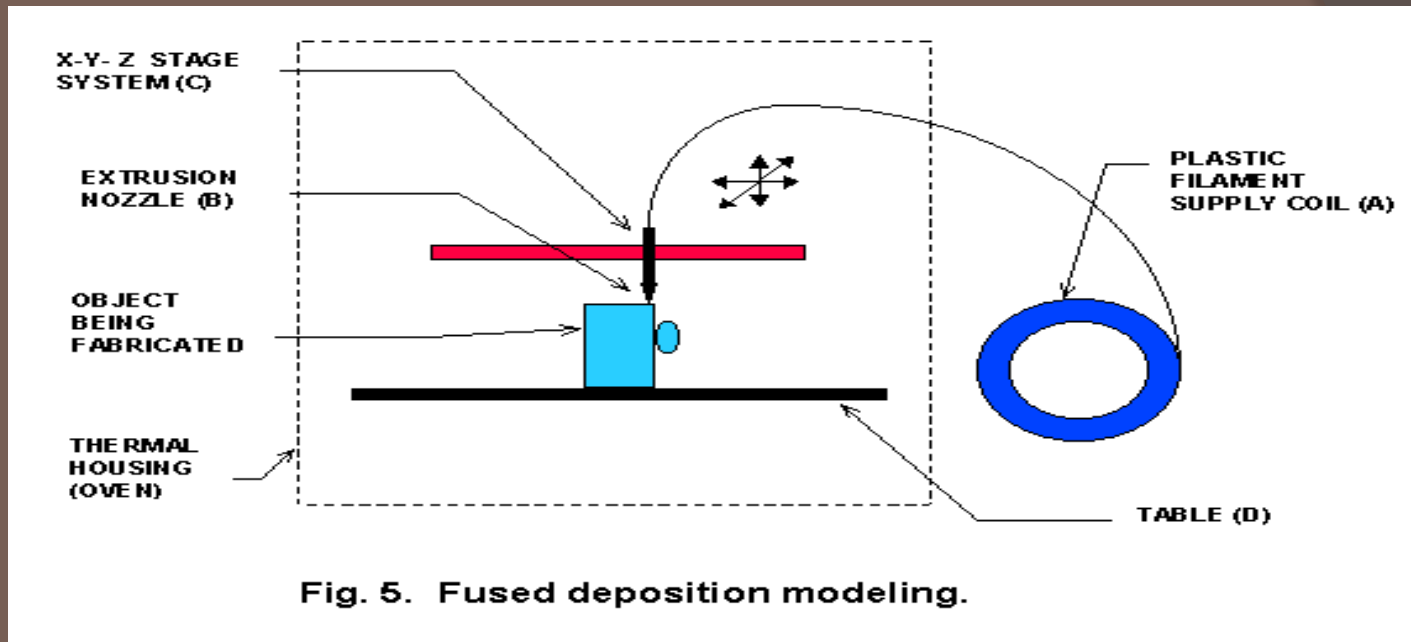
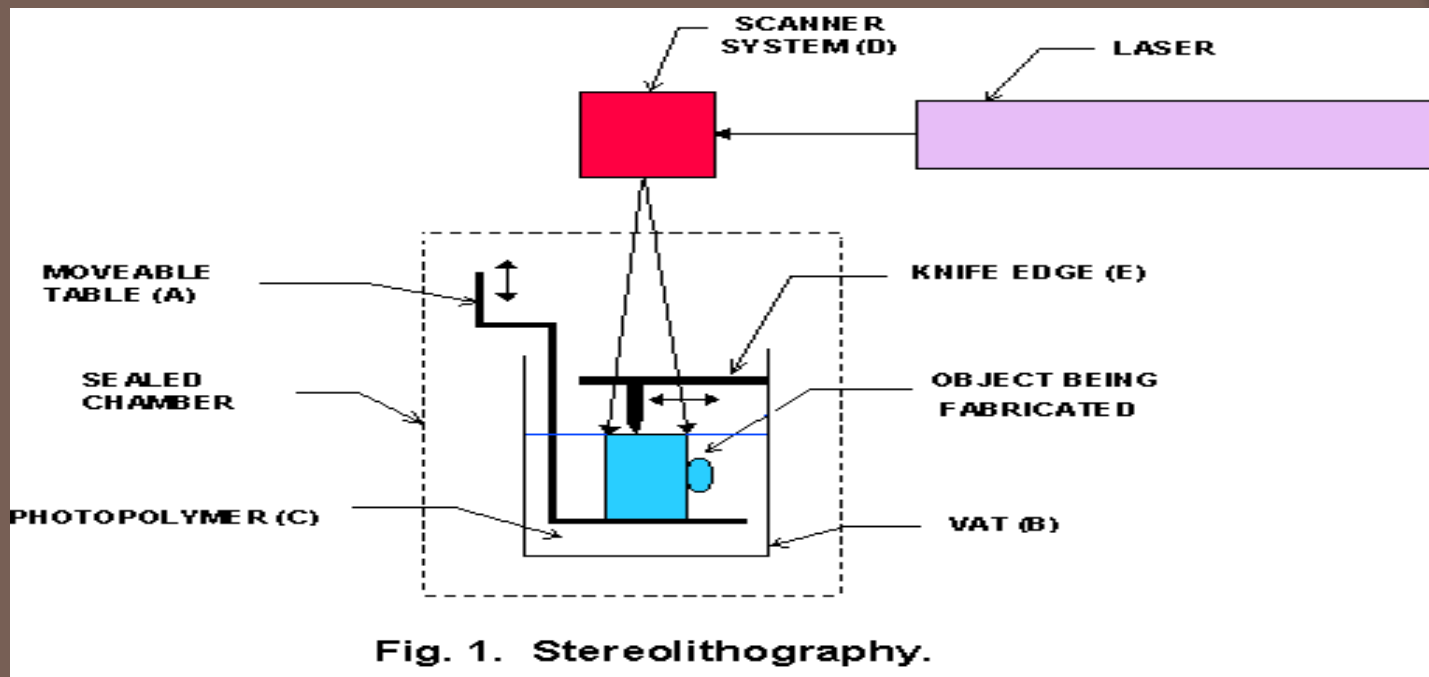


Fig. 5. Fused deposition modeling.

FDM is the second most widely used rapid prototyping technology. A plastic filament, approximately 1/16 inch in diameter, is unwound from a coil (A) and supplies material to an extrusion nozzle (B). The nozzle is heated to melt the plastic and has a mechanism which allows the flow of the melted plastic to be controlled. The nozzle is mounted to a mechanical stage (C) which can be moved in horizontal and vertical directions

Stereolithography (SLA)

- SLA is the most widely used rapid prototyping technology.



A moveable table, or elevator (A), initially is placed at a position just below the surface of a vat (B) filled with liquid photopolymer resin (C). This material has the property that when light of the correct color strikes it, it turns from a liquid to a solid. The most common photopolymer materials used require an ultraviolet light, but resins that work with visible light are also utilized. The system is sealed to prevent the escape of fumes from the resin.

RP Market

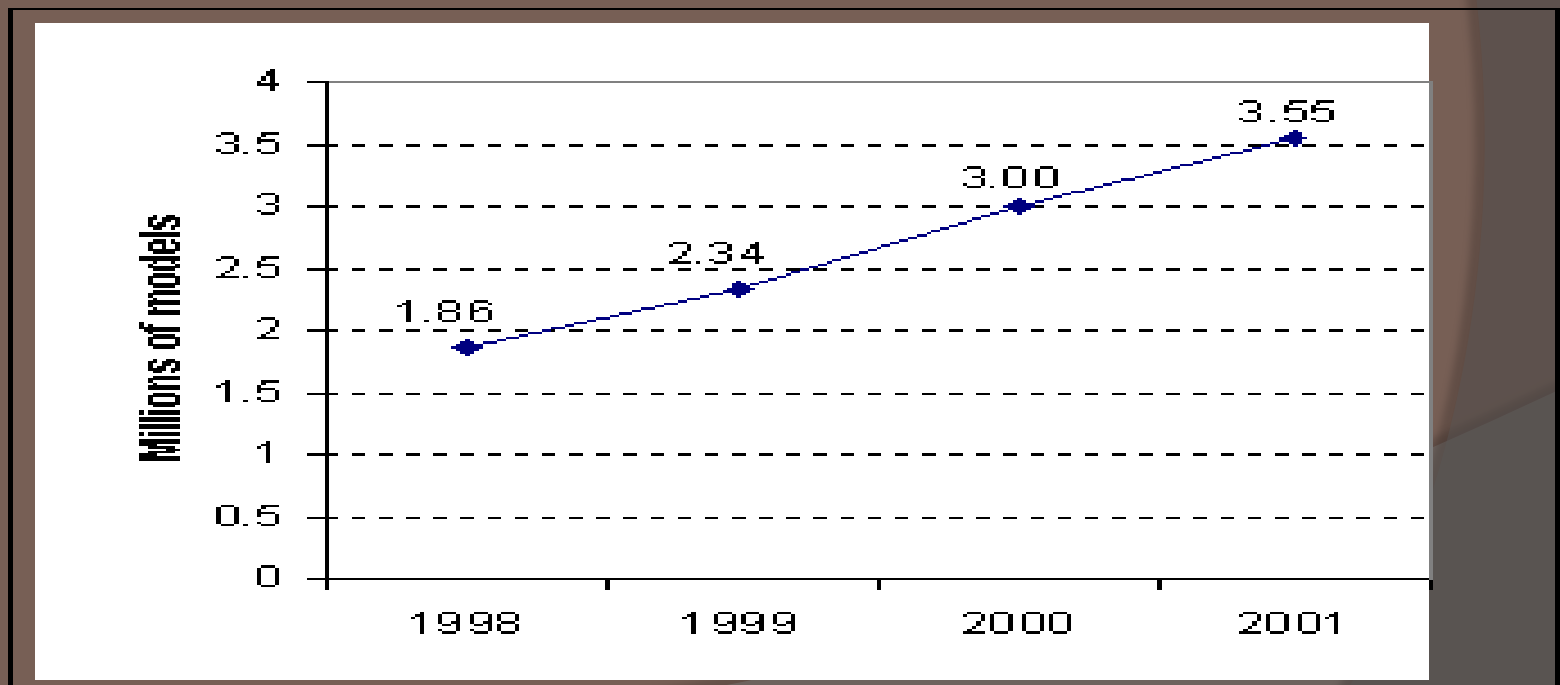
- During the past sixteen years, Rapid Prototyping Industry has developed steadily and approaches a \$1 billion per year industry including all primary and secondary market segments.
- The worldwide installed base of systems stood at about 8,000 at the end of 2001, producing an amazing 3.55 million models and parts during the year.

Rapid Growth of RP Market

Item	1988	2001
Vendor	1	31
Machines	1	30+ Types/Styles
Materials	1	100+
Systems Sold	32	1298
Service Bureaus	0	200+

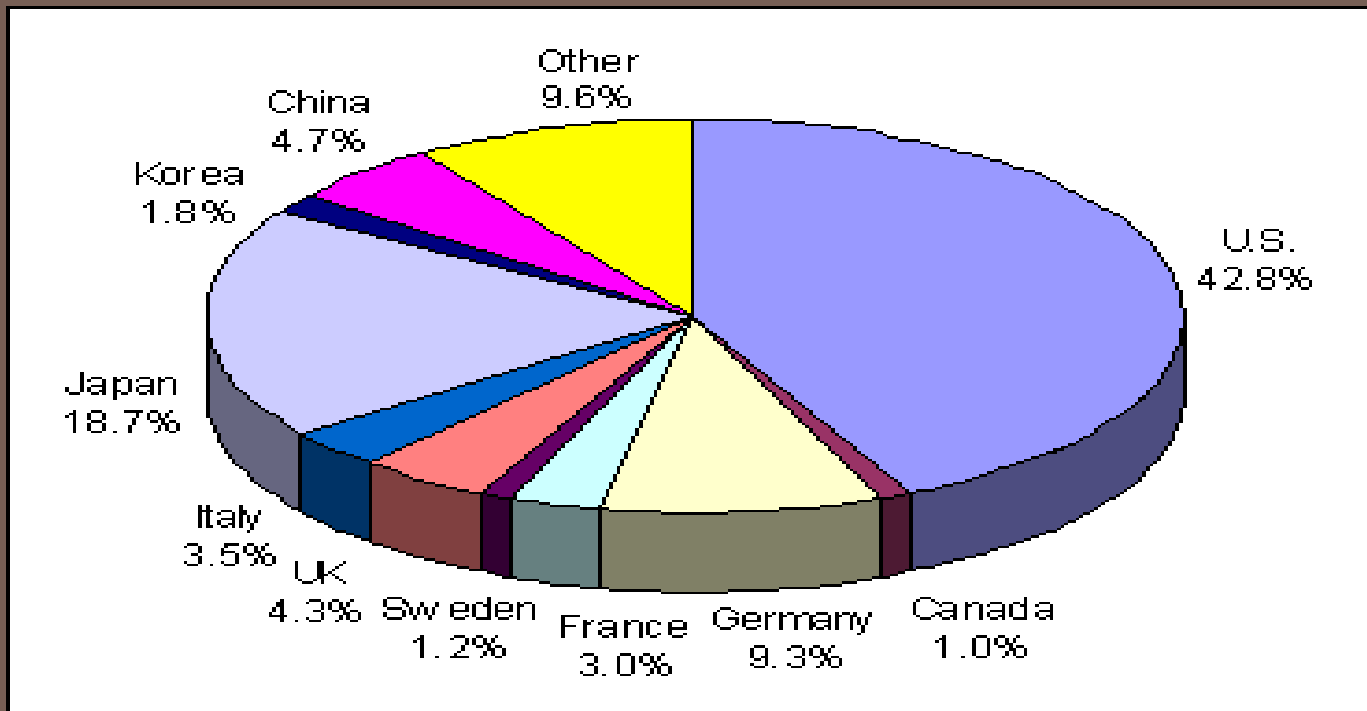
The number of the models by RP

- RP users worldwide produced an estimated 3.55 million models and prototype parts in, as shown in the following chart. This is up 18.3% from the 3 million models produced in 2000. An estimated 2.34 million and 1.86 million parts were produced in 1999 and 1998, Respectively (Wohlers, 2002).



Market Structure

The chart below shows the RP system purchases and installations in 2001 by country. The U.S. has the highest percentage, and then it is followed by Japan, Germany, China, and UK.



Market Pricing

- Early RP machines sold for hundreds of thousands of dollars. At that time, most buyers were very large companies who could handle such a high price.
- In 1996, the system prices decreased below the \$60,000 level.
- At the beginning of 2002, two major US competitors, Stratasys and Z Corporation, introduced machines with selling prices in the \$30,000 range which should serve to further this trend (Grenda, 2001).

Market Trends

- The RP market trends depend on the several key business and technology trends that are converging on the foundations of RP.
- The business trends include users' need to reduce time to market, the reorganization of business practices along cross-functional lines, and the globalization of the enterprise.
- The technology trends include the ongoing reduction in the cost of computing platforms, the introduction of lower cost 3D MCAD applications, and the growth of network communications.

Market Trends-cont

Since 2002, the recession in the U.S. caused stagnation in the RP industry.

- ⦿ Tightened spending trickled down to product development.
- ⦿ Projects were cut or put on hold, which decreased the need for prototyping and prototyping equipment

Conclusion

- ⦿ Although economic is still in depression, over the past three years, there have been many positive developments in rapid prototyping. The most important of which is the evolution of the technology from RP to RM (rapid manufacturing).
- ⦿ The barriers must be overcome before it becomes common practice: surface finishes, inadequate dimensional accuracy and repeatability, part sizes limitation, and the price of RP system and materials.

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