

Innovative Manufacturing Processes

Rapid Prototyping Overview

Rapid Manufacturing Main Characteristics

- Manufacturing of real models using directly solid 3D CAD files.
- The manufacturing of the model is taking place layer by layer from the bottom upwards, based on the solid CAD file.
- RM methods can result in time reduction compared with the conventional manufacturing methods.
- Production of highly customised products with no need of tooling

Rapid Prototyping Capabilities

- **Models**
 - Initial models (Concept models)
 - Design verification models
 - Communication models
- **Form-Fit-Function Prototypes used for:**
 - Assembly checking
 - Mechanical characteristics & behaviour
 - Thermal behaviour
 - Aerodynamic behaviour
- **Patterns for the production of moulds**
 - Manufacturing of the appropriate negatives for the production of tools/moulds.

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Rapid Prototyping Methodology

IDEA



PROTO
TYPE

Solid Modeling System

Solid Modeling



STL File
Generation

Rapid Manufacturing System

STL File error check

Build-up Orientation

Supports generation

Slicing



RP Machine

Set – up
& Build

Finishing Stage

Post Processing

- Removing Excess Liquid Resin
- UV light to complete curing
- Sanding, Sand Blasting
- Painting or Dyeing

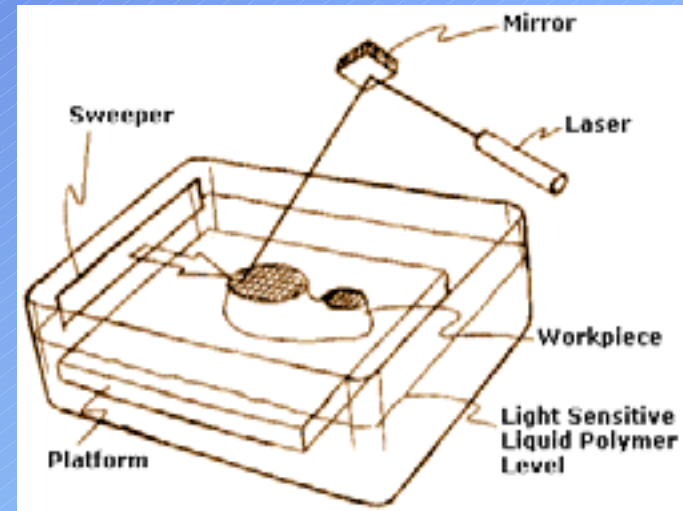
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Rapid Prototyping Stereolithography (SL)

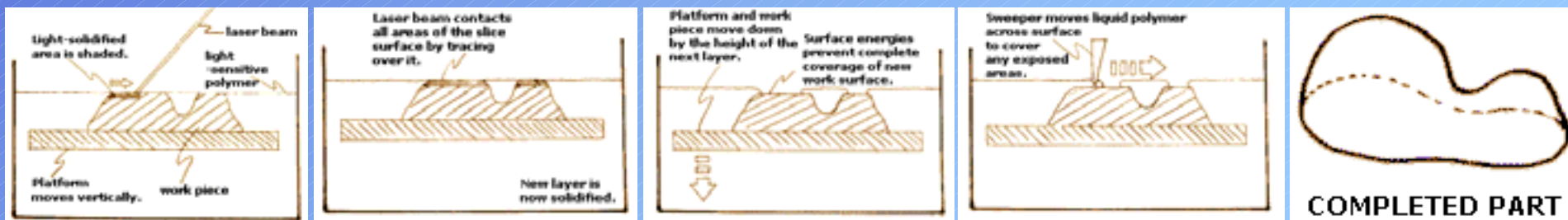


SLA-250/30
by 3D Systems

- 45mW HeCad laser
- Material: UV sensitive epoxy resin
- Accuracy: 0.12 mm
- Working Envelope: 250x250x250 mm



Process Overview



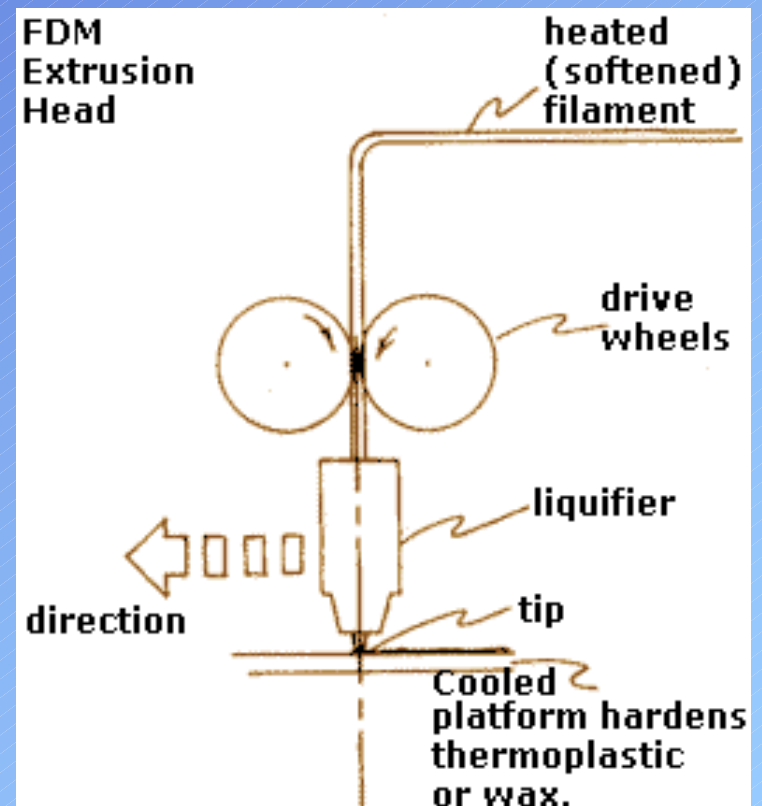
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Rapid Prototyping Fused Deposition Modeling



- Accuracy: 0.127mm
- Material: ABS P400 plastic, Investment Casting Wax
- Working Envelope: 254x254x254 mm

FDM-1650
by Stratasy



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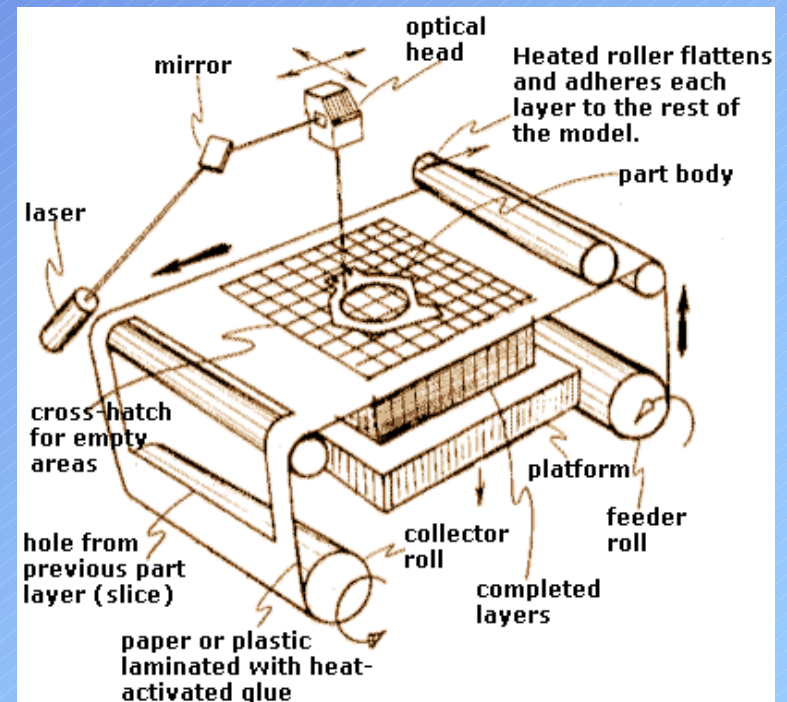
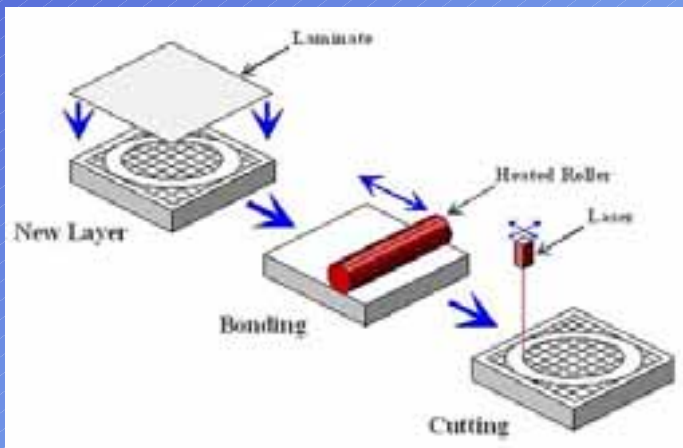
Rapid Prototyping Laminated Object Manufacturing (LOM)



LOM-1015
by Helisys

- 25W CO2 laser
- Material: Paper 0.042 & 0.080 in thickness
- Accuracy: 0.254mm
- Working Envelope: 381x254x356 mm

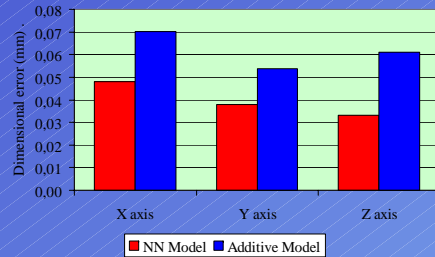
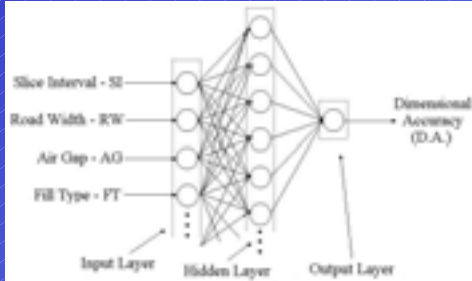
Process Overview



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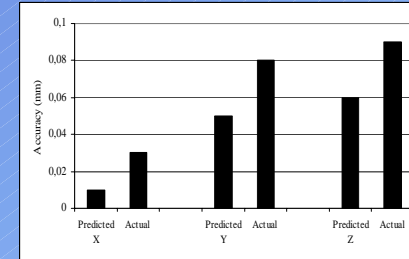
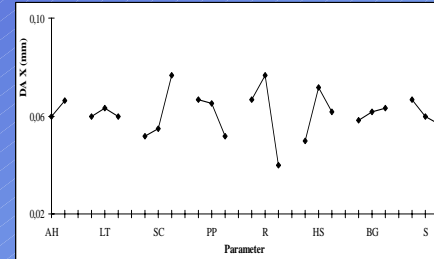
Rapid Prototyping Research

FDM process



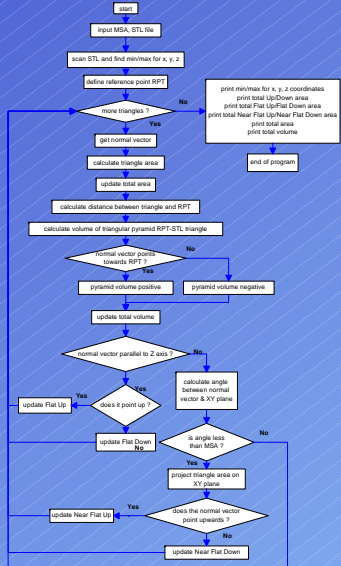
REF: G. Chryssolouris, S. Zannis, C. Derdas, K.Tsirbas, "Dimensional accuracy of FDM parts" Proceedings of the 34th International CIRP Seminar on Manufacturing Systems.

SLA process

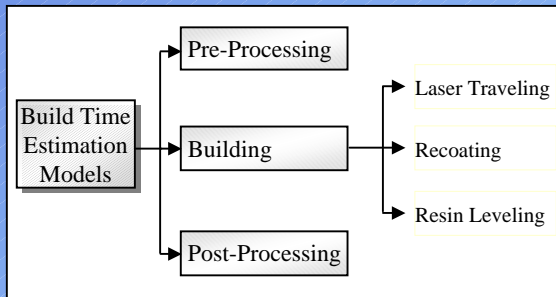


REF: G., Chryssolouris, J. Kotselis, P. Koutzampoikidis, S. Zannis, D. Mourtzis, "Dimensional accuracy modeling of Stereolithography parts" Proceedings of the 32nd CIRP International Seminar on Manufacturing Systems.

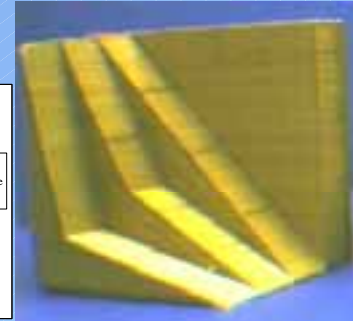
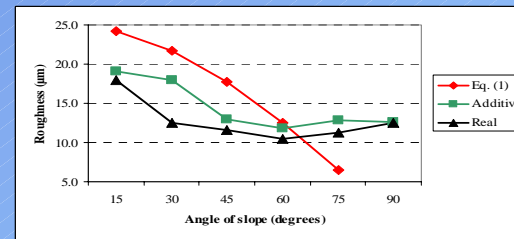
RP build time estimation



REF: G. Chryssolouris, J. Kechagias P. Moustakas, E. Koutras, "Estimation of build times in Rapid Prototyping processes" Proceedings of the 8th European Conference on Rapid Prototyping and Manufacturing, Nottingham.



LOM process



REF: KJ. Kechagias, S. Zannis, G. Chryssolouris, "Surface Roughness Modelling of the Helisys Laminated Object Manufacturing (LOM) Process" Proceedings of the 8th European Conference on Rapid Prototyping and Manufacturing, Nottingham.

REF: K. Salonitis, G. Tsoukantas, P. Stavropoulos, A. Stournaras, "A critical Review in stereolithography process modeling", Proceedings of the 1st International Conference on advanced research in Virtual & Rapid Prototyping, (VRAP 2003).

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Rapid Tooling

Rapid Tooling

Soft Tooling

Lot Size: 5 to 50 parts
Low mould strength
Low mould cost

- Room Temperature Vulcanizing
- Urethane Casting
- Epoxy tooling
- Investment Casting
- Direct Investment Casting
- Quickcast
- Indirect Investment Casting
- Sand casting
- Direct Shell Production Casting
- Topographic Shell Fabrication
- Rubber Plaster Mold
- Liptool

Bridge Tooling

Lot Size: 50 to 1.000 parts
Medium mould strength
Low mould cost

- Direct AIM - ACES Injection Molding
- Direct Croning Process – EOSINT S
- Direct Metal Laser Sintering - DMLS
- Rapid Plastic Injection Mold Tooling
- Prometal rapid tooling system
- Spray Metal Tooling
- Laser Reproduction metal spray tooling
- Rapid Metal Casting - Rapitypes
- Copper Prototype Tooling Process
- Express Tool
- Spin Casting
- ProtoTOOL - ProtoCAM
- Prototype Hard And Soft Tooling

Hard Tooling

Lot Size: 1.000 to 1.000.000 parts
High mould strength
High mould cost

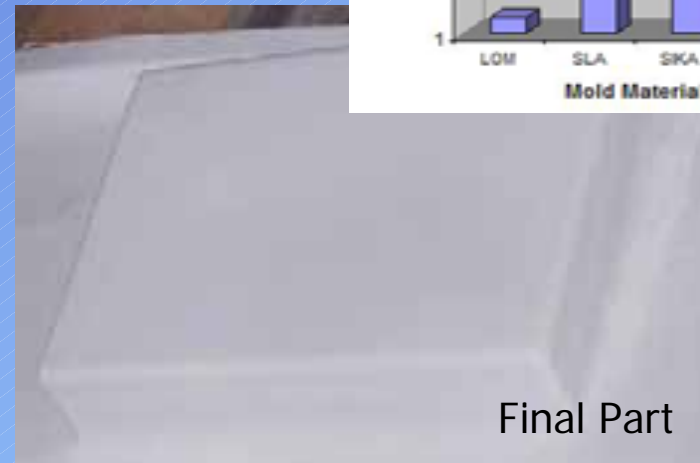
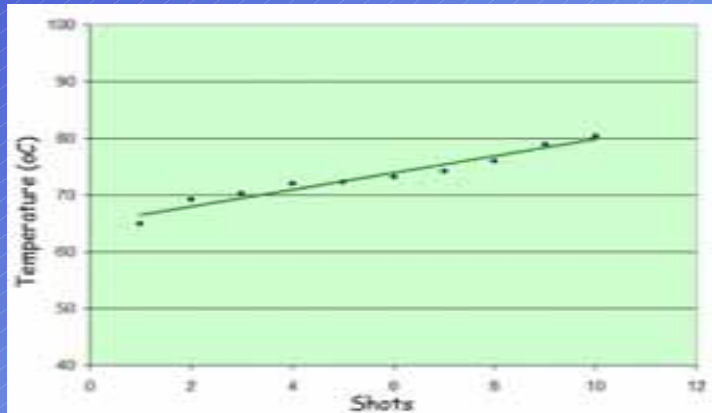
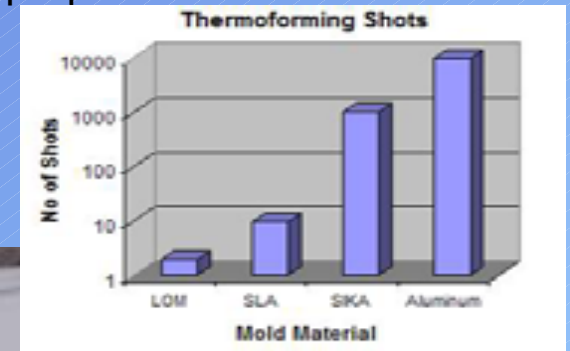
- 3D Keltool (3D Systems)
- Laser Engineered Net Shaping (LENS)
- RapidSteel (DTM corp.)
- Direct Metal Deposition – DMD
- Rapid Solidification Process
- Ford's Sprayform
- PolySteel
- EcoTool
- Cast Kirksite Tooling
- Space Puzzle Molding
- Electron Beam Melting - Arcam
- Solidica
- Laminate Tooling

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Rapid Tooling Research



Direct Rapid Tooling for Thermoforming
LOM mould: building & preparation time 60 h
SLA mould: building & preparation time 110 h

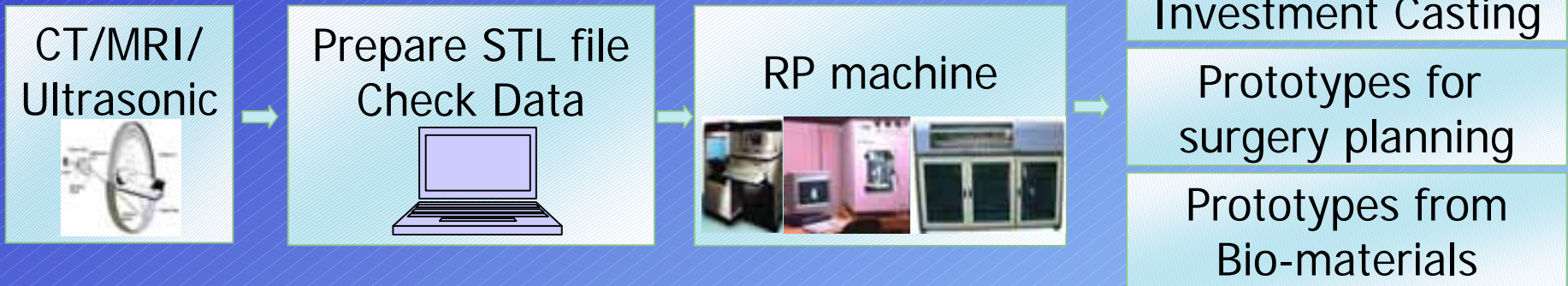


REF: K. Salonitis, G. Tsoukantas, P. Stavropoulos, S. Drakopoulos, "A preliminary experimental investigation of the use of Stereolithography for Rapid Tooling in Thermoforming", Proceedings of the Euro-uRapid 2002 Conference.

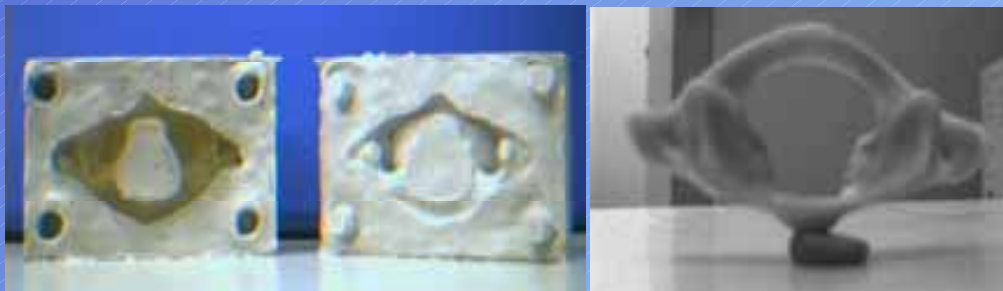
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Rapid Manufacturing for medical Applications Methodology and Research

Methodology



Research



Rapid Tooling of C1 Cervical Vertebra

Used for manufacturing implants from bio-compatible materials

REF: S. Zannis, A. Vavouliotis, K. Salonitis, "Utilization of Rapid Tooling methods in medicine: a case study on C1 cervical vertebra", Proceedings of the Euro-uRapid 2002 Conference.