Layered Manufacturing*

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* This is a high-level and somewhat dated outline of Layered Manufacturing. All technical details have been omitted. -- May 9, 2011.

Printing Technology

~1960's: IBM 1403 (~$25K)

"2D"

2007: Epson Stylus C88 ($80)

1997: Stratasys FDM1650 (~$110K)

"3D"

2005: Stratasys Dimension (~$39K)

Rapid Physical Prototyping

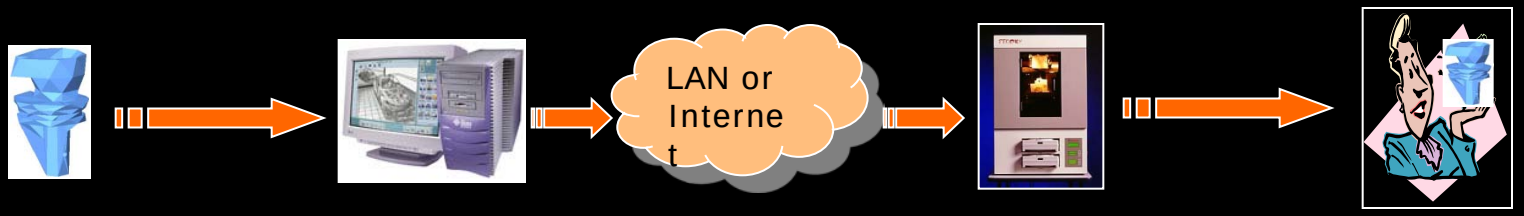
- "3D printing" technology that creates physical prototypes of 3D solids from digital models
- Used extensively in the automotive, aerospace, medical, etc. industries.

Model Acquisition
- CAD Software
- CT Scans
- Laser Scanning
- 3D Photography

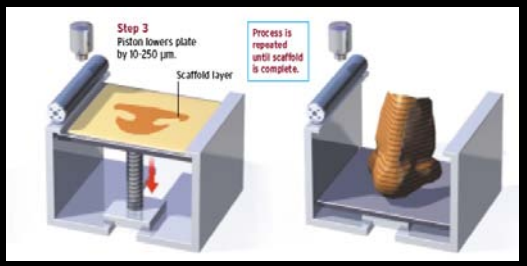
Computer-Aided Process Planning
- File repair
- Model orientation
- Slicing
- Support creation

Model Building via **Layered Manufacturing**

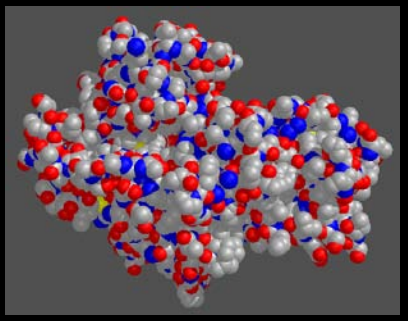
Postprocessing
- Remove supports
- Improve finish
- Inspect model



RPP Applications



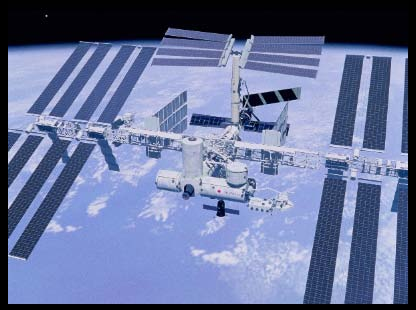
Biomedical Engg.



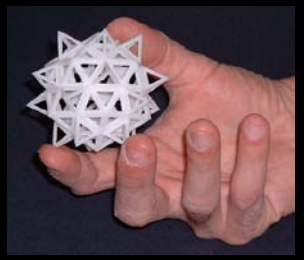
Bioinformatics

Defense

RPP



Space



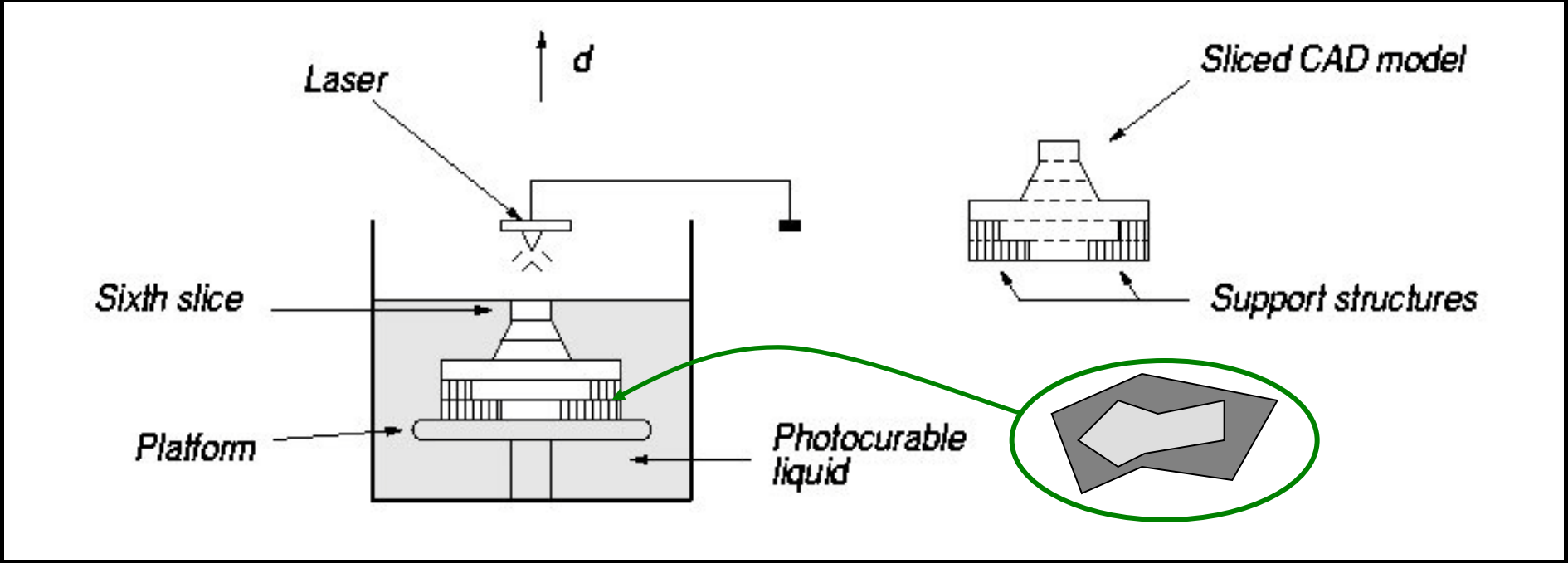
Art

Design and Manufacturing

Layered Manufacturing

- Builds 3D models as a stack of 2D layers

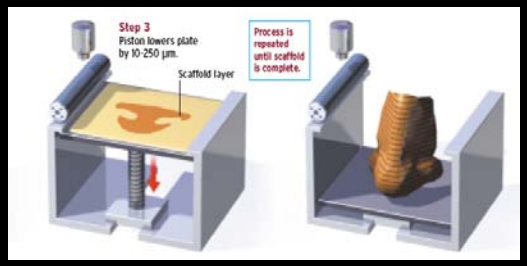
Stereolithography



- Many other LM processes: FDM, LOM, SLS, etc...

Applications in Computer-Aided Tissue Engineering (CATE)

- Emerging technology for creating artificial organs/tissues *in vitro for* subsequent implantation ("physiologic replacement parts")
- Goal is to restore/maintain/improve human health.
- *Tissues*: skin, muscle, blood vessels, (soft tissue), cartilage (semi-soft), and bone (hard).
- *Organs*: liver, kidneys, pancreas, lungs, etc.



CATE Pipeline

Overlay vascular network. Model soft/hard tissue

Acquire data via noninvasive imaging, e.g., CAT scan (slices)

Segment images and extract tissue information (type, density, etc.)

Build 3D model of organ by stitching slices.

Infer appropriate **scaffold structure** from organ model.

Build suitable data model

Fabricate scaffold and seed with cells simultaneously. **(Bioprinting)**

Determine topology and surface characteristics + interconnection channels to facilitate optimal cell growth, adhesion, and migration.

Incorporate biological, mechanical, geometric, and fabrication info.

Avoid/minimize supports, achieve desired surface finish; coordinate multiple “tools” and materials.