

Collaborative Engineering

Prototyping, Testing and Trials



- Prototyping Requirement
- Rapid Prototyping Methods
- Rapid Manufacturing

OrthoCAD Lab, I.I.T. Bombay

Prototyping Requirement : Form

2D Sketch:
Communicate the design concept.



3D CAD model:
Good for visualization.
Absence of feel & touch.
No physical sense of scale.



Prototype:
Exact shape as the original to check the 'look and feel'.



Courtesy: Denby Pottery, England.
Physical prototype made by Z Corporation ZPrinter

Prototyping Requirement : Fit

Fit-check:
Dimensions, clearances, and mating between parts.



After polishing SLA model >>>



F1 helmet design concept, known as the "Stealth" showcased in Grand Prix exhibition, Australia. Prototype made from SLA by 3D systems.

Prototyping Requirement : Function

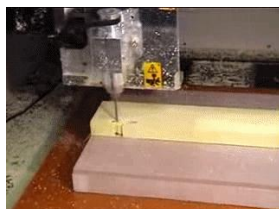
Function check: Materials same as a regular manufactured product.



Courtesy: Steeda Autosports, functional prototype of cold-air intake kit mounted in Ford engines to measure actual air flow and pressure drop.

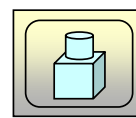
Rapid Prototyping: Material Removal

- Using a dedicated CNC machine available in design department
- Starting material is often wood or aluminum
- Desktop machining

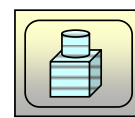


Rapid Prototyping: Material Addition

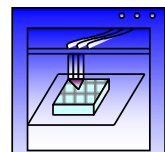
Also called Layered Manufacturing, Additive Manufacturing or Free Form Fabrication



3D modeling

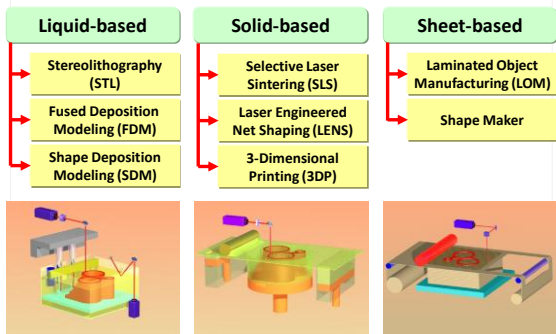


Virtual slicing



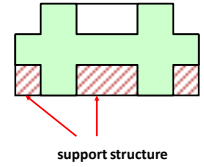
Layer by layer fabrication

Rapid Prototyping: Methods



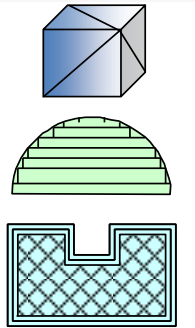
Rapid Prototyping: Complexity

- **Overhanging features (undercuts)**
 - can be produced in RP without any special tooling
 - but require a support structure during fabrication.
- **Material**
 - same: liquid, solid, powder
 - different: solid
- **Support Removal**
 - machining
 - breaking off
 - dissolving / melting
 - loose powder - shake off



Rapid Prototyping: Accuracy

- **Errors in the model**
 - Tessellation (chord error)
 - Missing elements (edges, facets)
- **Model slicing (number)**
 - Slice thickness (staircase effect)
 - Adaptive slicing
- **Rastering scheme**
 - Cross hatch / contour parallel
 - Coarse / fine
 - Hybrid schemes



Toward Rapid Manufacturing...

- Part accuracy and surface finish
- Limited variety of materials



LayerWise, Belgium

Loughborough University, UK

SUMMARY

- Rapid prototypes for form, fit, function evaluation
- By additive (layer) manufacture / free form fabrication
- Directly from CAD to part without part-specific tooling
- Different methods, materials, quality outcomes
- Suitable for both plastic and metal parts.