RAPID PROTOTYPING OF COMPLEX-CURVED MOLDS

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ABSTRACT

CCM is pursuing several projects in Resin Transfer Molding (RTM) and Vacuum Assisted RTM. Mainly these technologies are associated with fabrication of flat composite parts. However, today many applications require complex – shaped geometries.

This research develops a rapid prototyping station based on Laminated Object Manufacturing (LOM).
The system will have several features such as :

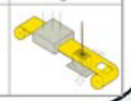
- ✓Low cost;
- ✓Flexible;
- ✓Rapid;
- ✓Repeatable.

GOAL

- ✓To develop all necessary system components for rapid, flexible and high quality fabrication of complex – shaped composite parts;
- ✓To show the efficiency of the developed system based on fabrication of samples such as a 1composite helmet.

COMPARISON OF EXISTING TECHNOLOGIES FOR MOLD FABRICATION

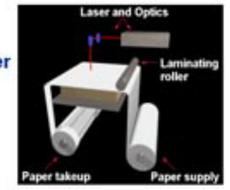
TABLE OF TECHNOLOGES

TECHNOLOGY	MATERIALS	MATERIAL PRICE	SYSTEM PRICE	ADVANTAGES	WEAKNESSES	PICTURE
Manual milling	Alumi-nium, Plastics, Wood	$0.65/lb	$25-60 K	Large part size	Variable tolerances, Manual work, Material waist, Low throughput	
CNC Milling	Alumi-nium Plastics Wood	$0.65/lb	$60-300 K	Large part size High - productivity Office OK Constant tolerances	Material waist, High costs	
Stereolitho-graphy	Plastics	$75-110 /lb	$100-500 K	Large part size Accuracy	Post processing	
Fused Deposition Modeling	Plastics	$60-180 /lb	$55-300 K	Office OK Price	Limited materials Speed	
Laminated Object Manufactu-ring	Paper	$5-8 /lb	$120-240 K	Good for castings Low material cost	Part stability Smoke/Fire	

RAPID PROTOTYPING OF MOLD/MASTER MOLD WITH LOM

Rapid prototyping (RP) is the process of building up a physical model directly from a 3D triangulated representation of a CAD model.

LOM technology in brief:



- ✓CO2 laser used to cut the shape of each layer and cut waste material into cubes.
- ✓The paper is bonded to the previous layer using a heated roller which melts a plastic coating on the bottom side of the paper.
- ✓After manufacture the waste material is broken away to reveal the required 3D structure.

Advantages

- ✓LOM results in a prototype that looks, feels, and acts like wood.
- ✓LOM requires no post-curing.
- ✓LOM models can be sprayed with coatings.
- ✓LOM is the RP technology that requires the least amount of site preparation.

SELECTION OF TECHNOLOGY

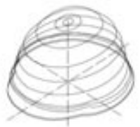
- ✓ CCM has major components of the LOM system – the laser cutting facility. No investment required to acquire other components.
- ✓ LOM system will provide independent curvilinear mold fabrication.
- ✓ Low fabrication costs – will not exceed 0.1k for single helmet master mold when CNC costs is around 4k.
- ✓ Very flexible system, independent on shape complexity.
- ✓ Other RP technologies are more expensive than LOM.

THE NECESSARY MODULES OF LOM SYSTEM:

1. 3D AutoCAD model design module;
2. The sectioning Auto-Lisp program ;
3. Laser cutting module;
4. Laminating assembling device;
5. Surface treatment module.

THE STAGES IN LOM OF CURVILINER MASTER MOLDS (1)

1. 3D AutoCAD model design;

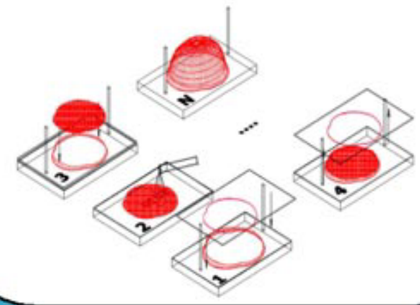


2. Slicing of 3D AutoCAD model and file preparation for laser cutting machine;

3. Cutting the shapes of each layer with CCM laser;

THE STAGES IN LOM OF CURVILINER MASTER MOLDS (2)

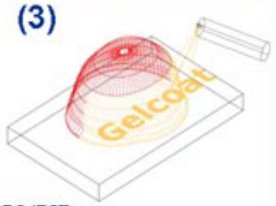
4. **Bonding of profiles**:
   - ✓ Lay up the frame of profile – 1;
   - ✓ Application of adhesive on profile surface – 2;
   - ✓ Bonding of profile inside its frame – 3;
   - ✓ Taking out the frame of profile – 4;
   - ✓ Repetition of the steps above until all prototype is formed – N.



THE STAGES IN LOM OF CURVILINER MASTER MOLDS (3)

SUMMARY

5. Surface of solid model can be polished or treated by applying gel coats.



CURRENT STAGE OF THE PROJECT

- ✓ 3D CAD model is designed;
- ✓ The sectioning software is developed;
- ✓ Laminating assembling device is under development.

FUTURE WORKS

- ✓ Fabricate different shape and size master molds;
- ✓ Evaluate strength and weaknesses;
- ✓ Complete/improve all LOM modules.