

## Rapid Manufacturing Research Group

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Rapid Product Development and manufacture is a major focus for companies wanting to compete in the more open Global Marketplace. This has created considerable interest in techniques and technologies that help companies introduce new products more quickly, at lower cost and with greater flexibility. Computer Aided Design (CAD) and the introduction, in the late 1980s, of a group of technologies known as 'Rapid Prototyping' have greatly helped this. It is now possible to design and manufacture objects within a few hours. The next stage is to use these layer-manufacturing technologies to manufacture saleable end-use items. However, few companies have invested in the technology, but many are very interested in investigating their use. The research portfolio of the RMRG is directed at providing the future technologies industry will require, and, through the Consortium, is providing a route that allows partners, and others, to gain the required knowledge and expertise concerning the technologies and their use.

### Scope of the Rapid Manufacturing Research Group

The Rapid Manufacturing Research Group concentrates on the following areas:

- High performance tooling
- Rapid Manufacturing

Rapid tooling had previously been the main focus of work for the previous 8 years but had become less of a research issue for two reasons:

- a) High speed machining and improved programming has made Rapid Tooling techniques less competitive
- b) The future shift towards using layer-manufacturing techniques for production will eliminate the need for most prototype tooling and some production tooling.

However, though there is less of an emphasis on the research for Rapid Tooling (RT), there will also be a need for technology transfer activities for RT. Although the research group is moving ahead of Rapid Tooling there are still many companies that could make use of these processes during the next 5 – 10 years.

However, although Rapid Tooling will not be heavily pursued, "High Performance" tooling has great potential. Work has shown it is possible to manufacture tools with greater functionality with features such as cooling and heating channels that conform to the cavity geometry or with functionally graded materials. This could provide benefits such as reduced cycle times, improved tool life, better part quality due to improved thermal control, and variable part properties due to differential cooling. High performance tooling could be commercially exploited immediately.

Rapid Manufacturing is the group's key research area and basically involves the use of additive manufacturing techniques to produce parts in batch sizes of 1 up to millions. This will be an important manufacturing technique within the next 10 years.

There are three areas to be considered in Rapid Manufacturing:

*Processes* - The technology side of Rapid Manufacturing will form the basis of future work. We are investigating how conventional printing technology can be combined with layer manufacturing to give a high output system. Paste-printing has been identified as an important process that could be used for inks with a high viscosity and these can be loaded with a wide variety of materials. Research uncovered a process under development in Germany called Direct Printing where screen-printing manufactures extruded 2D sections for catalysts. If a system can be produced with an adaptive screen rather than the current fixed screen then the process could move from extruded 2D sections to complex 3D geometry. Promising processes for manufacturing include Solid-state bonding, powder sintering, 3D Printing and Jetting. Materials are limited at the moment but there is a major opportunity for new materials (especially composites), controlled porosity (shape and amount - filters) and graded materials. Construction has recently been recognised as a potential area for Rapid Manufacturing research and so work on this started as a new activity from 2003 onwards.

*Design* - With the EPSRC Design for Rapid Manufacture and subsequent Materials Analysis and Design Optimisation projects, the first steps have now been taken to consider the design aspects of Rapid Manufacturing. With the introduction of Rapid Manufacturing there will be major changes in the way designers work because they will have few geometry restrictions. It will be possible to have re-entrant shapes without complicating manufacturing, eliminating split lines and draft angles, enabling variable wall thickness, and fewer parts leading to easier assembly and lower stock. A wide range of work is being highlighted from this research and so new work will occur such as the modelling of textures and textiles.

*Management* - This new way of producing parts could revolutionise how manufacturing industry is organised. There could be true flexible manufacturing as random changes of product geometry would be possible without affecting efficiency. This could result in elimination of tooling - shorter lead times and lower capital investment, more Just In Time - less work in progress, less storage requirements and easier production planning (less tooling and so random product scheduling and easy changes to production schedules). There will be management issues around the introduction and adoption of Rapid Manufacturing. This area is now being considered in a DTI Foresight Vehicle Funded project entitled "Management, Organisation and Implementation of Rapid Manufacturing".

Research themes include:

1. Rapid Tooling
2. High Performance Tooling
3. Rapid Manufacturing Processes and Materials
4. Design for Rapid Manufacturing
5. Management of Rapid Manufacturing

## **The Research Portfolio**

The recent / current EPSRC, DTI and European Commission fund research portfolio:

### *EPSRC-IMRC – RADICAL*

This project investigated the use of laminate tooling for the production of cost effective die-cast tooling for large automotive components.

### *EPSRC-IMRC – Rapid Manufacturing Processes*

This project is investigating the feasibility of using high speed printing techniques as an additive manufacturing process for the high volume production of parts.

### *EPSRC-IMRC – Direct Fabrication of Functionally Graded Materials*

In partnership with the University of Liverpool, UMIST and Queen Mary College, London an investigation was concerned with placing multiple powders to produce fully dense structures by laser melting. The industrial partners were BAe Systems and Osprey.

### *EPSRC-IMRC – Design for Rapid Manufacture*

This project is investigating the design issues involved with the use of layer manufacturing techniques for production. The partners are 3D Systems Ltd., Delphi, Bafbox, RIM-CAST, Vantico, Jaguar, Landrover, MG Rover.

### *EPSRC-IMRC – Conformal cooling and heating channels for high performance tooling*

This project is investigating the design of heating and cooling channels for tooling in the foam production industry when using laminated tools. The partners are Collins & Aikman, Fehrer, Rojac and Webster Components.

*DTI Foresight Vehicle programme – Management, Organisation & Implementation of RM:* This project is investigating the issues surrounding the implementation of Rapid Manufacturing. The partners are Engineering Forum, Aston Martin, Jaguar Cars, Land Rover, JCB, Martin-Baker Aircraft, MG Rover Group, Mitre Group, Perkins Engines.

### *EU IMS – Tooling for Die-Casting and Injection Moulding.*

The RMRG are members of the EU IMS - Rapid Product Development consortium which itself is part of a wider consortium based in the US, Australia, Canada and Korea. RMRG is investigating new materials for die-casting and injection mould cavities. The partners are Fhg IPA, Danish Technological Institute, Swedish Institute for Production Technology, DaimlerChrysler, Bombardier Rotax, Materialise, Arkk, Ensinger.

### *EU Framework 6 – Custom Fit*

This large EU funded integrated project will investigate an integrated system for the data capture, design, production and distribution of body fitting customised parts for both internal and external use.