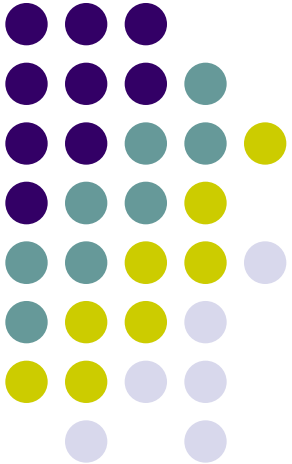
ME 482 – Rapid Product Development and Manufacturing

Chapter 6

Rapid Manufacturing (Part I)



Mechanical Engineering
University of Gaziantep

Dr. Sadık Olguner

Introduction to Rapid Manufacturing (RM)

- **Rapid manufacturing (RM)** is the use of a computer aided design (CAD)-based automated additive manufacturing process to construct parts that are used directly as **finished products or components**".
- The additive manufactured parts may be post-processed in some way by techniques *such as infiltration, bead blasting, painting, plating, etc*.
- The term "**additive**" manufacturing is used in preference to "**layer**" manufacturing as it is likely that some RM systems operate in a multi-axis fashion as opposed to the layer-wise manufacturing.
- Although **Rapid Prototyping (RP)** systems are being successfully used in special applications for the production of end-use parts, these RP systems have not been designed for manufacturing and many problems remain to be solved. These include *surface finish, accuracy and repeatability,* among others.

Introduction to Rapid Manufacturing (RM)

- The design freedoms afforded by **RM** are immense and the processes are capable of creating mind boggling geometries.
- The field of RM has grown in recent years and it eliminates tooling, has profound implications on design and manufacture of new products.
- The elimination of tooling, for products where machining is difficult or impossible, opens up a host of possibilities for low and medium volume RM.
- Rapid Manufacturing offers profound possibilities across a broad spectrum but has initially been met with a wide-ranging degree of acceptance, often leading to lively debate.
- Key areas of the Rapid Manufacturing technology
  - Design
  - Processes
  - Materials
  - Applications

Design in Rapid Manufacturing

There are two important approaches related to design, on which Rapid Manufacturing directly affects. These are Design for Manufacturing (DFM) and Design for Assembly (DFA)

- **Design for Manufacturing (DFM)** is a philosophy or mind-set in which manufacturing input is used at the earliest stages of design in order to design parts and products that can be produced more easily and more economically.

  The most important principle is to design for ease of manufacture and fabrication, which could be different depending on the manufacturing processes adopted.

- **Design for Assembly (DFA)** provides guidelines at the design stage, significant reductions in manufacturing cost and improvements in the ease of assembly can be achieved. *(Reducing parts count, reducing handling time, ease of insertion)*

Design in Rapid Manufacturing

- **By using RM technologies**, it will be possible to reduce the number of parts within an assembly. Therefore, the most important DFA guideline, which concerns the reduction in part count, is easily achievable.
- In theory, it is possible to reduce the number of parts to just one, though in practice this may not feasible as parts are generally not being used in isolation and their interaction with other components would impose limitations on a part's count. Thus, with the advent of the Rapid Manufacturing techniques, there is the potential for many of the current obstacles to be removed.
- Areas of particular interest that are enabled by the freedoms afforded by RM include:
  - Design complexity/optimisation
  - Parts consolidation
  - Body-fitting customisation
  - Multiple assemblies manufactured as one

➢ Design complexity / optimisation

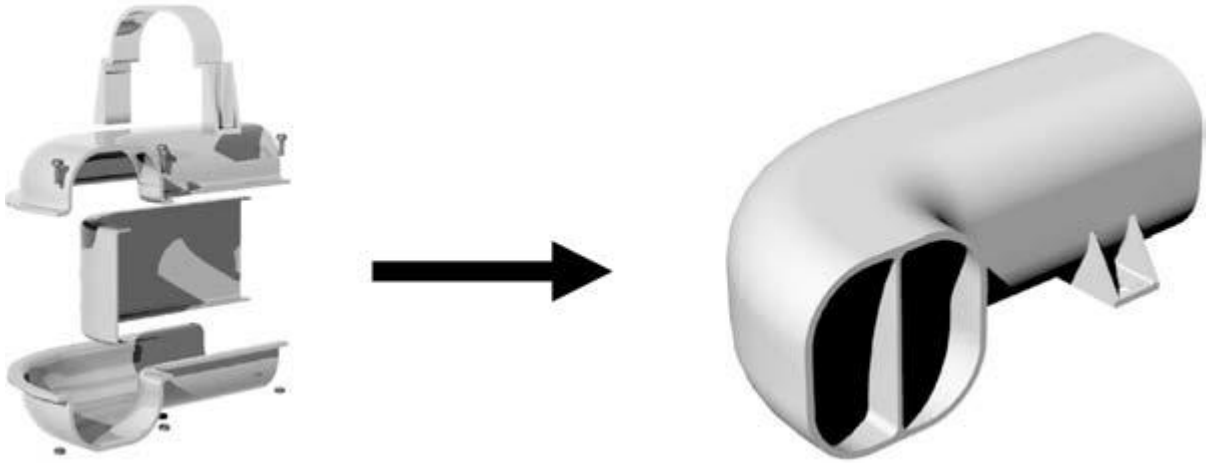
Conventional front plate

Optimised flow channels and optimised front plate

Internal flow channels that have to be conventionally gun-drilled. A consideration has been made as to what the design would be like if it were possible to manufacture this by RM. Figure shows firstly the flow channels that would be anufacturable by RM followed by a design that is optimised for minimal weight that has been constructed around the flow lines.

➤ Part Consolidation

Parts consolidation in aircraft ducting



Consolidation of the control pod

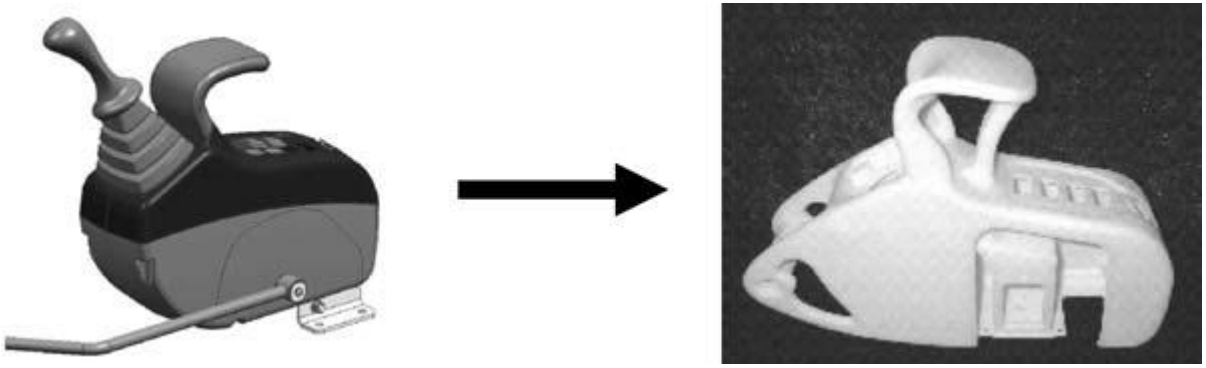
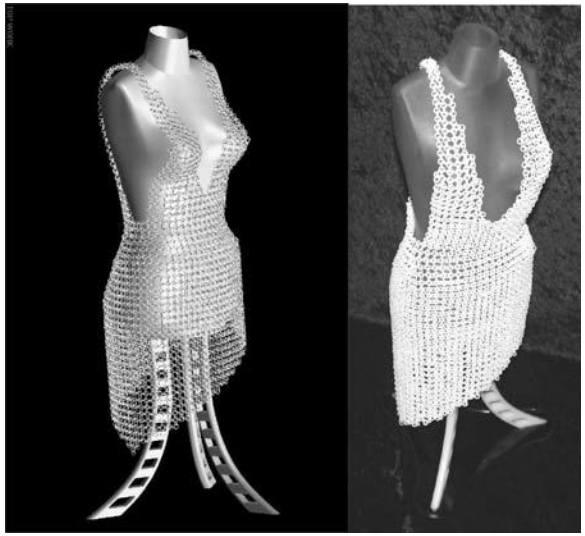


Figure shows how an assembly of over 25 parts has been consolidated into just one piece (with an extra cover) and then manufactured by stereolithography (SL).

➢ Body Fitting Customisation

Body fitting seating platform

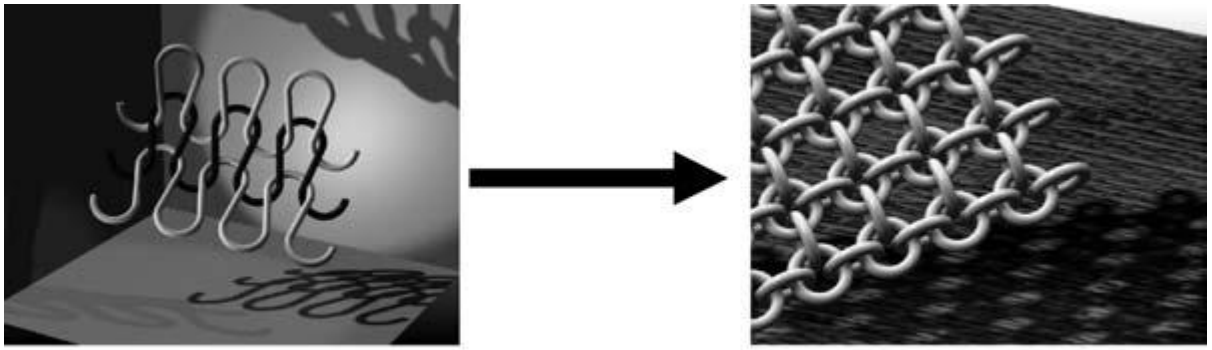
Laser sintered fabrics



This feature is particularly focused on the aerospace and automotive sectors. Figure shows a body fitting seat that has been produced for one of the suppliers. The parts are then manufactured automatically using RM technologies that require no expensive tooling.

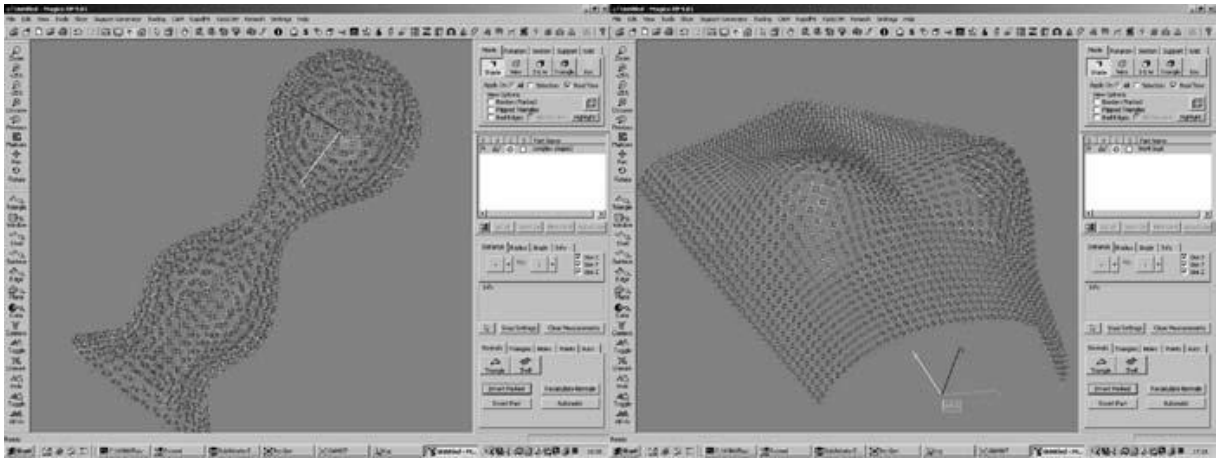
➢ Multiple Assemblies

Smart Textile Applications



Conventional knitted weave

RM weave



RM developed a preliminary methodology to wrap textile links over complex surfaces and then manufacture them by SLS.

Design in Rapid Manufacturing

- Designers will be able to manufacture almost any shape that they come up with and will no longer be constrained by the necessity to produce parts in moulds.
- In addition, using processes such as the laser sintering of dissimilar powders, RM will provide designers with new and exotic materials not available to other manufacturing processes.
- At the design phase, RM allows almost whatever shape is desired as the mould process will no longer limit design. This means objects can be designed with re-entrant features, no draft angles, unlimited wall thickness and increased complexity, with none of the limitations imposed by either the moulding process or the tool making process, as neither will be required.
- One of the most profound implications of RM on design will be that, each component can be different, potentially allowing for true mass customisation of each and every product.