Rapid Tooling Techniques for the Die-Casting Industry

Presented by
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Overview

- Rapid tooling process's
  - Laminate tooling
  - laser sintering
  - Wiba process
- Advantages over current tooling techniques
  - Conformal cooling
  - Shorter cycle times
  - Reduction / elimination of design constraints
- Research and future technology…….

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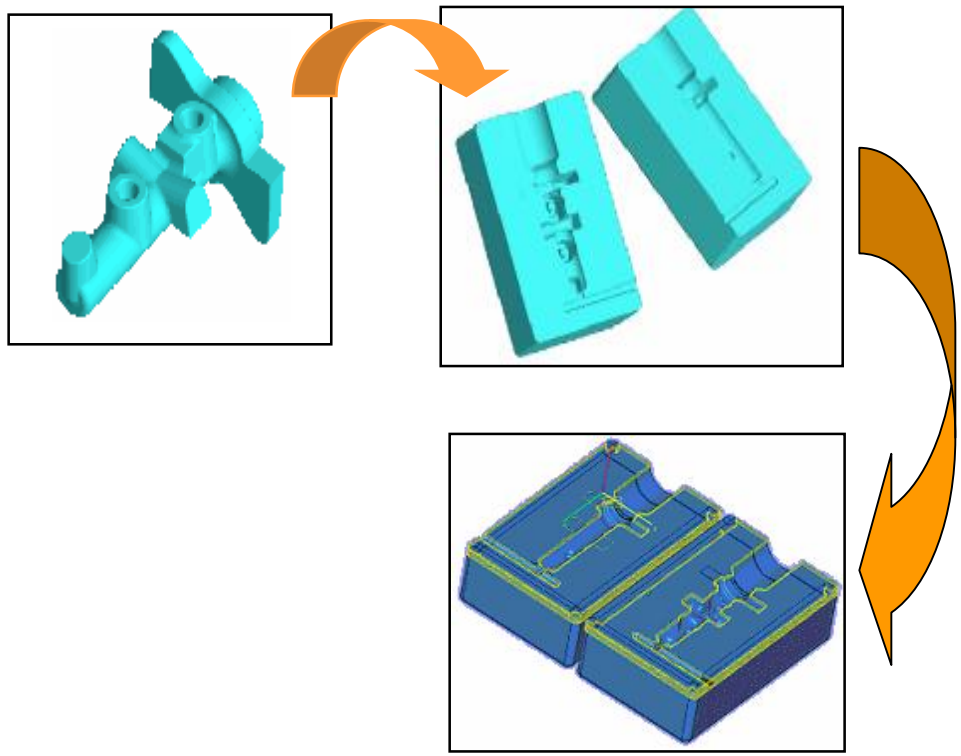
Rapid Tooling Process's

- Additive method of tool manufacture.
- 3D stl CAD file of the component required.
- 3D stl CAD file of the die halves created from the component file.
- Files sliced producing the layer by layer building data.



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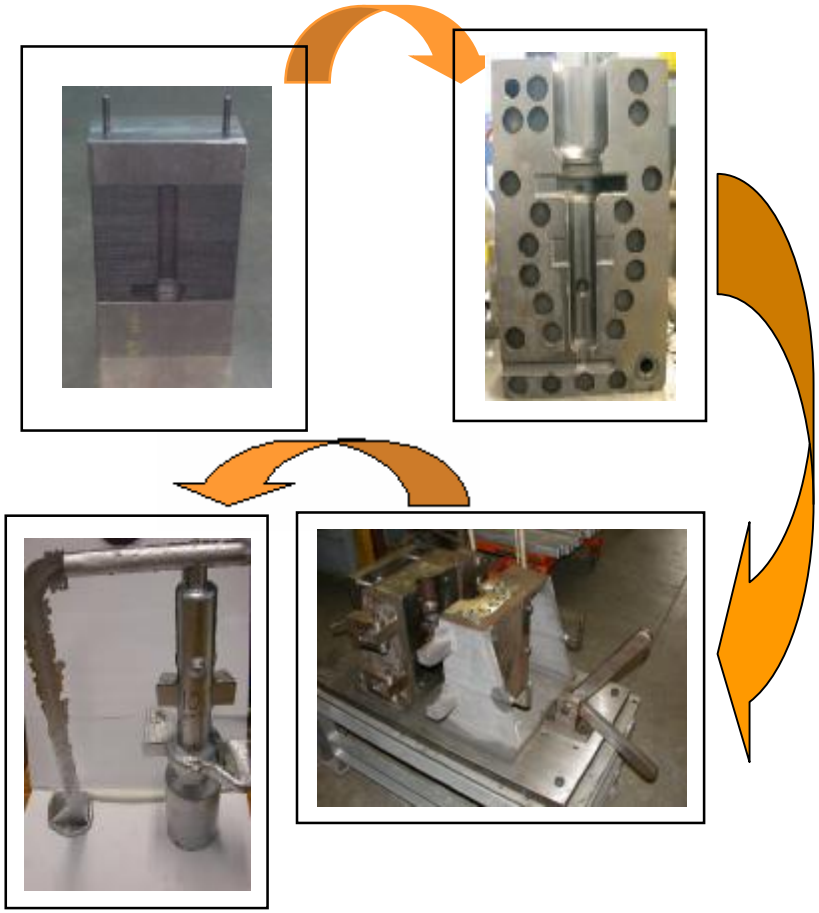
Laminate Tooling

- Laminated tools are produced by laser cutting H13 sheet steel.
- Bolted or braze bonded together.
- Dies are finished by either high speed machining or electrical discharge machining.



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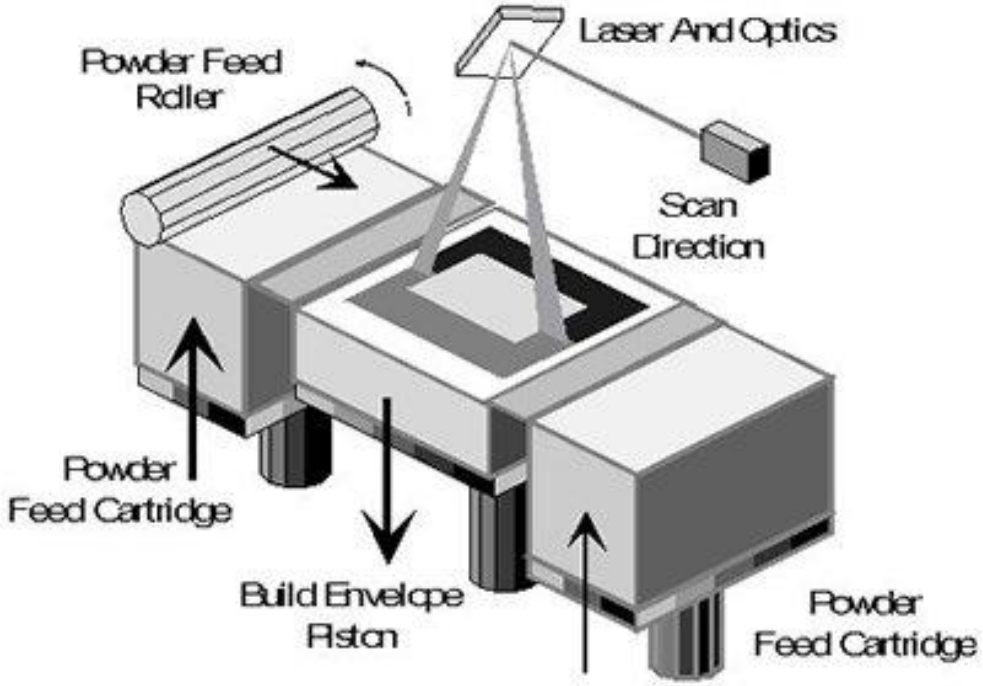
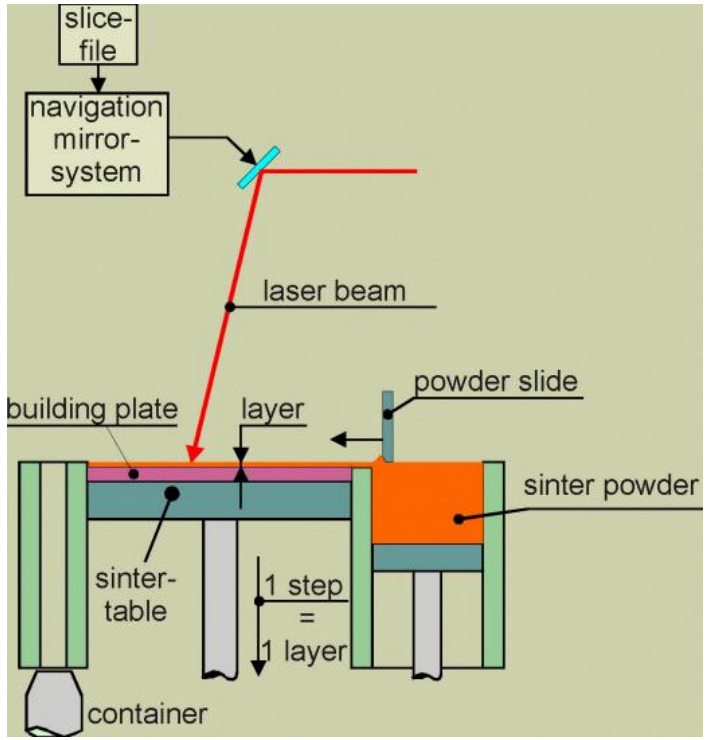
Laser Sintering (LS)

- Methods used to manufacture inserts



Selective Laser Sintering



Direct Metal Laser Sintering

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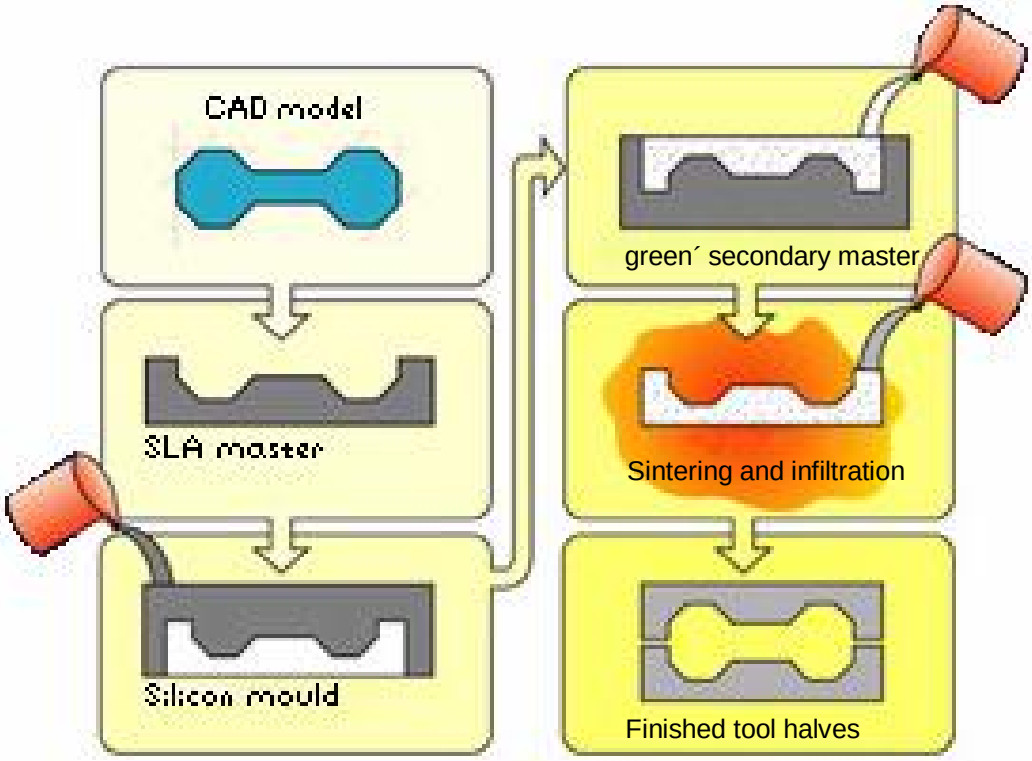
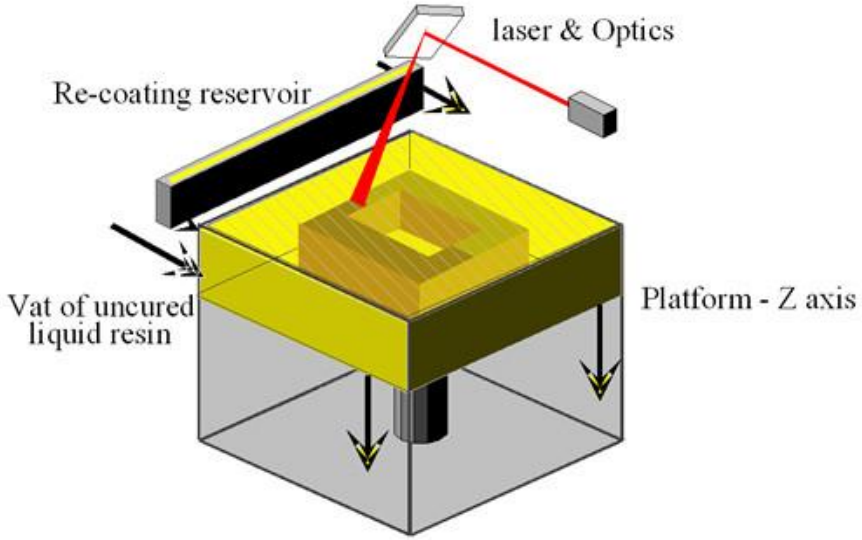
Wiba tool (Metal Copy)



Wiba Process



SLA Process

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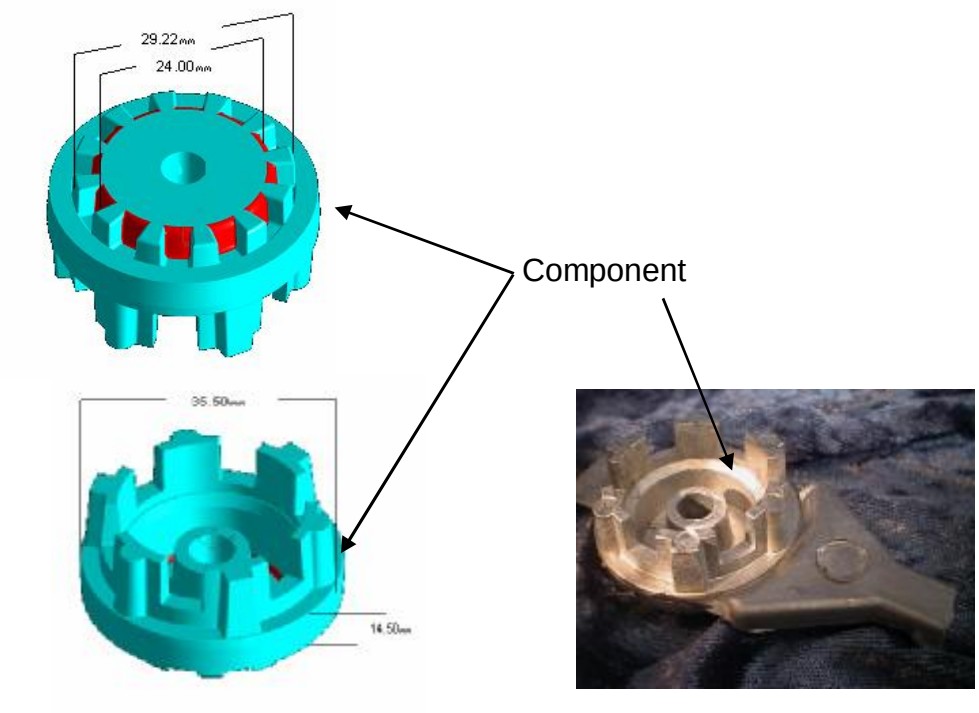
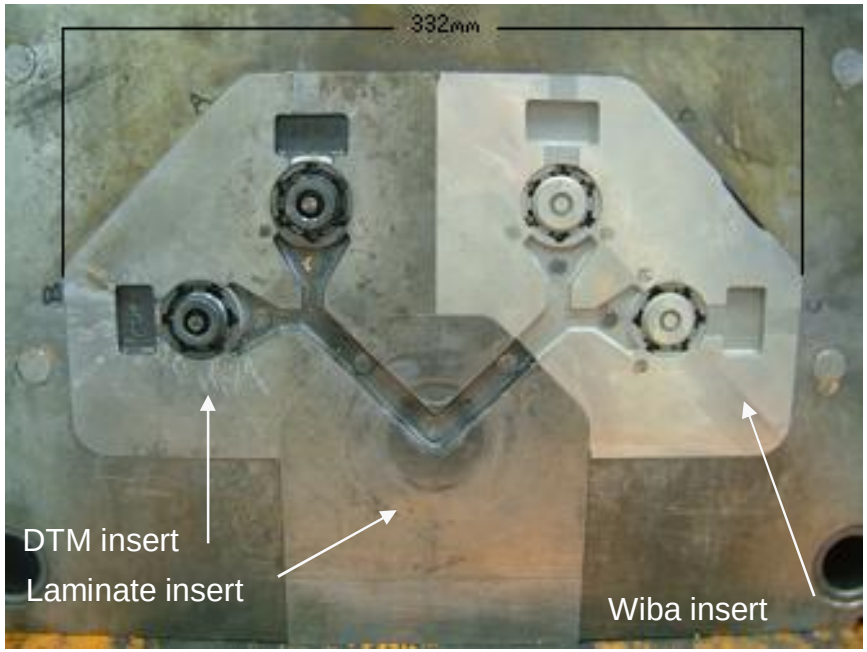
Advantages Over Current Tooling Techniques

- Greater control and uniform die temperatures achievable
- Faster solidification rates
- Improved productivity
- Less constraints on tool and component geometry
- Die design validation
- Component can be tested for functionality

Research

- Aluminium (LM24) clutch housing die provided by Dyson & Kemlows Diecasting Products Ltd
- Tool ran on a Frech 125 DAK SDV cold chamber die-casting machine





Casting Technique

- Insert water channels tested for leaks
- Aluminium LM24 melt temperature 710^0C
- Die pre heated to 150^0C – 200^0C
- Cycle time 20s - 24s (production speeds)
- Die lubrication delta cast 333 R3 every two shots
- Water cooling of biscuit area and plunger tip

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Casting Technique Continued

Operator Starting cycle 1-2 sec	Die Close 1sec	Ladling 5-8 sec	Injection 1 sec	Solidification 3 sec		Die Open 3 sec	Ejection 3 sec	Release Agent 3 sec
Operator Starting cycle 1-2 sec	Die Close 1sec	Ladling 5-8 sec	Injection 1 sec	Solidification ? sec	Die Open 3 sec	Ejection 3 sec	Release Agent 3 sec	

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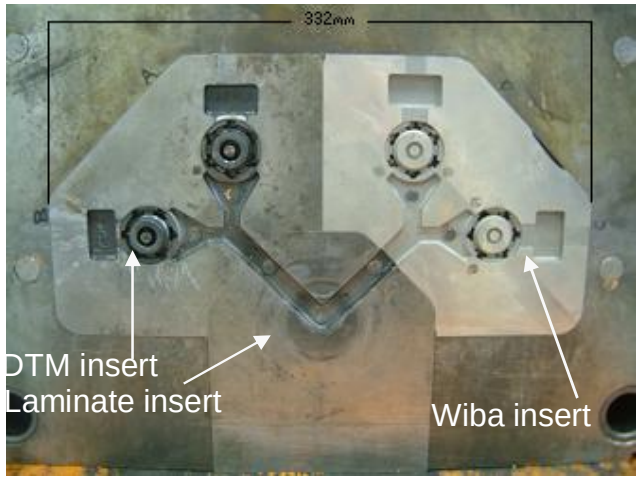
Laminate Insert Performance

- 500 components cast prior to the braze failing in the biscuit area.
- Conformal cooling insert reduced solidification time reduced from 3 seconds to 1 second
- No signs of wear or hot cracking of the H13 sheet steel laminates



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Wiba and LS Insert Performance

- 100 castings produced prior to hot cracking on both DTM and Wiba inserts.
- Cracks continued to propagate during casting run.
- Casting run was stopped after 500 castings due to laminate insert failing.

Insert Costs

- Laminate insert
  - CAD modelling time
  - H13 sheet steel price
  - Laser cutting cost and time
  - Nickel brazing cost and time
  - Machining cost and time

  - Total time = 7 days
  - Total cost = £1500

Insert Costs Continued

- Laser sintered insert
  - CAD modelling
  - LS build time and material
  - Machining

  - Total time = 7 days
  - Total cost = £1700

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Insert Costs Continued

- Wiba insert
  - CAD modelling
  - SLA Master build time and material
  - Silicon negative mould build time and material
  - Cast green part time and material
  - Infiltration and sintering time and material
  - Machining

  - Total Time to manufacture= 10 days
  - Total Cost = £1900

Research Conclusions

- Conformal cooling has been proven to reduce solidification time.
  - Reductions of 11% in the clutch housing die
- Prototyping quantities are achievable
  - 100 defect free castings produced
  - 500 castings manufactured in total
- The rapid tooling techniques allow validation of a die design prior to the manufacture of a production tool
- Components can be mechanically tested and compared to design specifications.

Future Technology …….

- Material Advancement
  - Improving laminate tooling
    - Alternative or improved bonding technique
  - Material improvement for LS and Wiba
    - Fully dense inserts
    - Alternative infiltrating with a low melting point alloy
    - Improved sintering powders
    - Heat treatable materials to 40 – 50 Rc

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Future Technology Continued

- Process change or improvement
  - Hot isostatic pressing (HIP)
    - Diffusion bonding of laminate dies
    - Diffusion bonding of laminate billet containing conformal cooling channels, from which the core and cavity machined.
    - Tool strength, ductility and fatigue life may improve since hipping removes porosity from materials
    - Functional graded tooling
  - Ultrasonic welding
    - Integrated conformal cooling channels
    - Functional graded tooling

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Future Technology Continued

- Tool design
  - Hybrid tooling (combination of manufacturing techniques to produce inserts in a die)

Review

- Rapid tooling for the die-casting industry is in the early stages of development due to the temperatures and pressures involved in the process.
- Research needs to develop to produce a robust cost effective rapid tooling technique.
- If achievable the benefits would be overwhelming
- Potential to Improved die life
- Die validation, component validation etc.
- Conformal cooling channels reduce cycle times

Questions?

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