

# Casting Technique

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



# Casting Technique Continued

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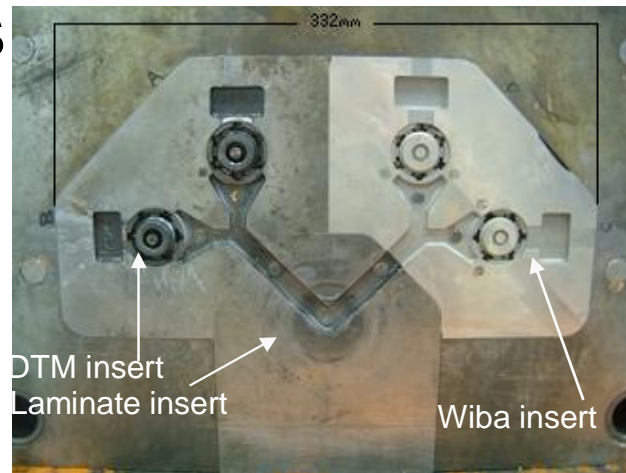
<b>Operator Starting cycle</b> 1-2 sec	<b>Die Close</b> 1sec	<b>Ladling</b> 5-8 sec	<b>Injection</b> 1 sec	<b>Solidification</b> 3 sec	<b>Die Open</b> 3 sec	<b>Ejection</b> 3 sec	<b>Release Agent</b> 3 sec
<b>Operator Starting cycle</b> 1-2 sec	<b>Die Close</b> 1sec	<b>Ladling</b> 5-8 sec	<b>Injection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



# Laminate Insert Performance

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- 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



# Wiba and LS Insert Performance

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- 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

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- 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

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- Laser sintered insert
  - CAD modelling
  - LS build time and material
  - Machining
  
  - Total time = 7 days
  - Total cost = £1700



# Insert Costs Continued

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- 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

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- 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 .....

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- 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



# Future Technology Continued

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- 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



# Future Technology Continued

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



# Review

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- 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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