The Die Casting Process: A Designer’s Overview

An OEM Mini-Seminar on Capitalizing on the Advanced Die Casting Process for Cost-Efficient Component Production

This is a 24-slide silent Webinar presentation, approximately 12 minutes in length.

Click Attached “Notes” for viewing, in panel at left, before advancing with “Forward Arrow.”

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CWM operates under third-generation family management from a modern 136,000 sq. ft. facility in Bensenville, IL near Chicago’s O’Hare Airport. Founded in 1937, CWM’s top management team represents more than 160 years of design, engineering and production of exceptional Al, Mg and Zn die cast housings and components for OEMs worldwide.
The Die Casting Process

Overview Presentation Summary

- Cost-efficient, net-shape parts for wide range of applications
- Unique cost & performance benefits for product designers
- Alloy options: Al, Mg, Zn— Performance & Cost comparisons
- Production options: Miniature 4-slide to Large-part capacity
- Tooling options: Comparisons by alloy, complexity & cost
- Prototyping options: Performance & Cost Comparisons
- Part cost-reduction options: Hi-tech tooling vs Post-casting CNC
- Surface finishing options: Library of finishes with cast samples
- Recommendations to designers for optimizing process results
- Reference guide to additional resources
Die casting offers net- and near-net shape components—intricate shapes produced at lowest unit costs.
Tight-toleranced features, bosses and holes cast-to-size — with superior as-cast surface finishes
Light-weight parts offering high strength and rigidity, —with built-in EMI shielding and excellent heat dissipation
Die Casting Product

Cost Benefits

- Net-shape to final specs without machining
- Intricate, complex shapes, as cast
- Minimum or zero draft angles, as cast
- High-quality surface finishes, as cast
- Alloys offering inherent bearing properties
- Allows designs to reduce multiple-part assembly
Die Casting Product

Performance Benefits

- High strength, stiffness and rigidity
- The look and feel of real metal
- Sound dampening properties
- Can meet 100% pressure tightness requirements
- Excellent part surface for cosmetic final finishes
- Uses recyclable Al, Mg and Zn alloys
Special Benefits
for Electrical/Electronic Products

- Built-in EMI/RFI shielding
- High thermal conductivity
- Excellent heat dissipation for integral heat sinks
- Strong, thin walls for minimum package sizes
- Cast part weights comparable to plastic
## Alloy Options: Performance Comparison

<table>
<thead>
<tr>
<th>Property</th>
<th>Aluminum</th>
<th>Magnesium</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strength/Stiffness</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Strength-to-Wt. Ratio</td>
<td>High</td>
<td>Very High</td>
<td>Average</td>
</tr>
<tr>
<td>Dimensional Stability</td>
<td>Very Good</td>
<td>Very Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>Thermal Conductivity</td>
<td>Good</td>
<td>Good</td>
<td>Very Good</td>
</tr>
<tr>
<td>As-cast Surface Quality</td>
<td>High</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td>Corrosion Resistance*</td>
<td>Good</td>
<td>Good</td>
<td>Good</td>
</tr>
</tbody>
</table>

* For galvanic corrosion protection, appropriate design considerations may be necessary

See more in Notes
### Alloy Options: Cost Comparison

<table>
<thead>
<tr>
<th></th>
<th>Aluminum</th>
<th>Magnesium</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Processing Costs</strong></td>
<td>Average</td>
<td>Above Average</td>
<td>Below Average</td>
</tr>
<tr>
<td><strong>Die Maintenance Costs</strong></td>
<td>Above Average</td>
<td>Average</td>
<td>Below Average</td>
</tr>
<tr>
<td><strong>Machining Costs</strong></td>
<td>Average</td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td><strong>Surface Finishing Costs</strong></td>
<td>Average</td>
<td>Above Average*</td>
<td>Below Average</td>
</tr>
<tr>
<td><strong>Material Cost</strong></td>
<td>(Varies by relative material volume of casting)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

* Electroplating of magnesium requires additional surface preparation.

See more in Notes
Automated Die Casting
Performance Options

Miniature (4-slide) Machines

- Net-shape parts to very close tolerances, flash-free
- Very fast cycle times, dies guaranteed for project life
- Limited to Zn (including ZA-8 alloys), small part sizes

Small to Large (50- to 4000-ton) Machines

- Wide part size & weight range, complex features
- Net- and near-net-shape parts in Al, Mg & Zn alloys

See more in Notes
Automated Die Casting
Part Size & Weight Range

Miniature (4-slide) Machines

- Size Range
  - Minuscule to 4 in. x 4 in. x 1 in.

- Weight Range
  - Fractions of an oz. to 3/4 lbs.

Small to Large (50- to 4000-ton) Machines

- Size Range*
  - .5 sq. in. to 2,000 sq. in.

- Weight Range**
  - .25 oz to 50+ lbs.

* Part sizes will vary directly with the projected area of the cast part
** Dependent on the projected area of the cast part.
Die Cast Production
Tooling Investment Options

- **Miniature Machine Die**
  - 4-slide dies for specialized miniature machines

- **Unit Die for Small-to-Medium Machines**
  - Modular units in standard frames for lower die costs

- **Single-Cavity Die for Small-to-Large Machines**
  - Small- to large-part production at lower unit costs

- **Multiple-Cavities for Small-to-Large Machines**
  - Small- to large-part production at lowest unit costs

See more in Notes
## Die Cast Tooling
### Investment Option Comparisons

<table>
<thead>
<tr>
<th>Alloy Choices</th>
<th>Part Complexity</th>
<th>Die Costs</th>
<th>Part Costs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zn (Incl. ZA-8)</td>
<td>High</td>
<td>Low</td>
<td>Very Low</td>
</tr>
<tr>
<td>Al, Mg, Zn</td>
<td>Average</td>
<td>Low</td>
<td>Very Low</td>
</tr>
<tr>
<td>Al, Mg, Zn</td>
<td>High</td>
<td>Med/High</td>
<td>Very Low</td>
</tr>
<tr>
<td>Al, Mg, Zn</td>
<td>High</td>
<td>High</td>
<td>Very Low</td>
</tr>
</tbody>
</table>

See more in Notes
Prototyping Options prior to Die Construction

1. **Single-Cavity Prototype Die**
   or “Unit” Prototype Die Casting Die

2. **Gravity Casting plus Machining**
   to proposed Die Casting Production Specs

3. **CNC Machining**
   from Wrought, Rod or Sheet Stock

4. **Rapid Prototyping (RP)**
   in Plastic Resin

5. **RP Master to Plaster Mold and Metal Pour**
   Plastic Rapid Prototype to Plaster to Gravity Pour

See more in Notes
## Prototyping Option Comparisons:
**Costs and Dimensions/Properties Match**

<table>
<thead>
<tr>
<th>Method</th>
<th>Costs</th>
<th>Die Cast Dimensions</th>
<th>Die Cast Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single-Cavity Unit or Prototype Die</td>
<td>High to Very High</td>
<td>Exact</td>
<td>Exact</td>
</tr>
<tr>
<td>Gravity Casting + Machining</td>
<td>High</td>
<td>Very Close</td>
<td>Varies*</td>
</tr>
<tr>
<td>CNC Machined Stock</td>
<td>Medium</td>
<td>Very Close</td>
<td>Varies*</td>
</tr>
<tr>
<td>Rapid Prototyping (RP)</td>
<td>Low to Medium</td>
<td>Close</td>
<td>Plastic**</td>
</tr>
<tr>
<td>RP +Plaster Mold + Metal Pour</td>
<td>Medium</td>
<td>Close</td>
<td>Varies*</td>
</tr>
</tbody>
</table>

* Any non-die casting alloy property requires analysis for each desired die cast property.
** Properties of plastic resin are not transferable to die cast part properties.

See more in Notes
Die Cast Part  
Cost-Reduction Alternatives

- Higher-Tech Tooling for Cast-to-Spec Features (a)

  Not always feasible for every part design

  OR

- Post-Casting Machining to Final Specs (b)

  CNC finishing can offset cost of added or alternate tooling

(a) Two long slots at top of frame were more cost-efficient cast to net shape
(b) A part with an opening requiring alternate configurations may be more cost-efficiently produced with post-casting machining

See more in Notes
Die Cast Component
Surface Finishing Options

- **Decorative**
  To Meet Cosmetic Appearance Specs

- **Wear Resistance**
  Protect Against Premature Wear

- **Corrosion Barrier**
  Environmental or Galvanic Protection

- **Pressure Tightness**
  To Meet 100% Specs

- **Shielding**
  Further Enhance Built-in EMI/RFI *

* Where 100% fail-safe EMI shielding is a mandatory specification

See more in Notes
# Surface Finishing Options

## By Alloy

<table>
<thead>
<tr>
<th>Surface Finishing Options</th>
<th>Aluminum</th>
<th>Magnesium</th>
<th>Zinc</th>
</tr>
</thead>
<tbody>
<tr>
<td>Decorative Finish</td>
<td>Powder coat</td>
<td>Powder coat</td>
<td>Powder coat</td>
</tr>
<tr>
<td></td>
<td>Liquid paint</td>
<td>Liquid paint</td>
<td>Liquid paint</td>
</tr>
<tr>
<td></td>
<td>Plating</td>
<td>Plating</td>
<td>Plating</td>
</tr>
<tr>
<td>Added Wear Resistance</td>
<td>Hard anodize</td>
<td>Hard anodize</td>
<td>Plating</td>
</tr>
<tr>
<td>Corrosion Barrier</td>
<td>Powder coat</td>
<td>Powder coat</td>
<td>Powder coat</td>
</tr>
<tr>
<td></td>
<td>Liquid paint</td>
<td>Liquid paint</td>
<td>Liquid paint</td>
</tr>
<tr>
<td></td>
<td>Tri. chromate</td>
<td>Tri. chromate</td>
<td>Tri. chromate</td>
</tr>
<tr>
<td>Pressure Tightness</td>
<td>Impregnate</td>
<td>Impregnate</td>
<td>Impregnate</td>
</tr>
<tr>
<td>Added EMI Shielding</td>
<td>Nickel Plate</td>
<td>Nickel Plate</td>
<td>Nickel Plate</td>
</tr>
</tbody>
</table>

See more in Notes
Die Cast Surface Finishing

Sample Plate and Reference Library

CWM maintains a unique library of finished die cast sample plates in Al, Mg and Zn.

Each plate is keyed to a comprehensive Surface Finishing Reference Manual describing the uses, advantages and limitations of each finish.

Sample plates and the Reference Manual are available to OEM designers when discussing a die casting project.

See more in Notes
Guidelines for Optimizing Production Results

1. Think part function first then the optimum process

2. Choose a producer who offers all options for the process

3. Involve the producer early for all the benefits of DFM cost reduction

4. All post production requirements should be outlined well prior to die design

5. Inform yourself on how design features impact process success

See more in Notes
Reference Materials for this Webinar

Access these resources at the CWM Web OEM Resource Center

A “Design & Production Planning Guide,” PDF Item # 5114 under Engrg. Bulletins, provides a detailed summary of all items listed.

**Die Casting Design & Spec Guide**, CWM, 16p (# 0325)

**Product Design for Die Casting**, NADCA, 178p (# 3101)

**Engineering Bulletins & Tech Briefs:**
- Engineering Bulletins # 020, 021, 022, 071, 074, 075.
- Application/Tech Briefs # 024, 031, 034.

**Die Casting Product Standards**, NADCA, 223p (# 3103)

**Quick Guide to Surface Finishing**, CWM, 8p (# 3318)

**Checklists: Tooling, Production, Finishing,**
- NADCA D.C. Tooling (#065), D.C. Production & Finishing (#090)

**CWM Custom Production Capabilities Credentials:**
- Complete D.C. Capabilities (#3100), Mini D.C. Capabilities (#3400)
- CNC Machining (#3300), Contract Manufacturing (#3200)

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