Fresh Look on the Casting Industry

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Introduction

Buderus Guss GmbH

Industry Trends

- Price-/Cost Pressure
- Global Footprint
- Connectivity
- Environment
- Electro Mobility

Summary
Outside Casting Industry: Several Prejudices
Fascinating casting industry:

• Casting is the most important manufacturing technology today and in the future for production of metal-based near net shape components!

• From physics/chemistry point of view: Basis processes are not well understood!

• OEM-casting product market: Core competence only with few companies!
Key historic milestones

Historical development of foundry competencies…

1731
- Founding of Buderus in Laubach

1913
- Breidenbach Foundry plant

1935
- Start of automotive casting

1946
- Strategical decision for concentrating on brake discs

1973
- Acquisition of the Buderus AG from the Robert Bosch GmbH

1985
- Integration of Breidenbach in Buderus AG

1991
- Implementation of the first cupola oven

2002
- Foundry activities are bundled in the Buderus Guss

2003
- Start of production Foundry II

2007
- Acquisition plant Ludwigshütte

2011
- Upgrading Foundry II

2012
- Part of CC

… over the last century
Long history/experience ➔ Promising Future!
Buderus Guss facts 1(2)

- Foundry is focused on brake discs
- Market Leader for OEM passenger car brake discs in Europe
- Process technology leader
- Success Factor: Automation
  - Full automatic, vertical moulding lines
  - Cores are placed automatically in moulds
  - Full automatic machining lines
  - Inline control: Parts are measured automatically
  - Automatic (Optical) Inspection
Buderus Guss facts 2(2)

- All relevant surface treatments possible

- Coating: Application of zinc dust, Geomet coating (silver), Senotherm (black) and new materials

- Longterm engineering experience with grey cast iron materials and brake disc design

- Independent brand Buderus; lean standalone company organization

- Innovative products:
  - Light weight rotors
  - New coatings
Introduction

- Buderus Guss GmbH

Industry Trends

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Summary
Industry Trends: Watch them carefully!

- Price-/cost pressure
  - Process technologies
  - Automation
  - Production chain
  - Lightweight

- Environment
  - CO₂-Reduction
  - Energy management
  - Efficiency
  - Particle emission

- Electro Mobility
  - Innovation (new vehicle concepts)
  - Lightweight
  - Product Life Time

- Global Footprint
  - Request to quote/deliver globally
  - Investments
  - Partnerships
  - Joint Ventures
  - Innovation

- Connectivity
  - Industry 4.0
  - Traceability
## Casting products as Commodity?

<table>
<thead>
<tr>
<th>Commodities</th>
<th>OE-Brake disc</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Standardized product</td>
<td>- OE-tailored product (material/coating/cooling technology); engineering today covered/led by OEM due to complexity &amp; safety relevance of the product!</td>
</tr>
<tr>
<td>- Prod. processes standard competence</td>
<td>- Core competence of few companies.</td>
</tr>
<tr>
<td>- Interchangeable with other competitor goods of the same type on short notice</td>
<td>- Release time constants by OEM 2-3 years (for the few companies)!</td>
</tr>
<tr>
<td>- Applicable for different fields of use</td>
<td>- Developed for specific applications</td>
</tr>
<tr>
<td>- No differentiation by features or quality</td>
<td>- Strong differentiation by performance, features and quality</td>
</tr>
<tr>
<td>- Information about producer irrelevant for market success</td>
<td>- Producer and brand important for acceptance on the market</td>
</tr>
</tbody>
</table>

OE-brake discs are complex customer tailored products based on the core competence of few companies  =>  no commodities!
Price-/Cost-Pressure 1(2)

**Automation**
- Focus on productivity
- Automated coldbox core production/ coldbox handling
- Automatic Inspection
- Automated liquid metal transportation
- Innovative gripper technologies
- Connectivity (Industry 4.0)

**Processes**
- Improve basic understanding of production processes
- Deep-dive of cost analysis of all process-steps!
- Stabilization of manufacturing processes/ robustness!?  
- Introduction of Toyota Production System (BPS)
- Technologies:
  - Molding process technologies  
    e.g. vertical vs. horizontal → new alternatives / search fields
  - Hydraulic vs. electronic motion control
  - Inspection technologies
Cost analysis of production process e.g. molding:

Product specific analysis depending on several parameters → surprising results!
Testing procedures: Automatic Optical Inspection (AOI)

BGG-Automatic Optical Inspection
Price-/Cost-Pressure 2(2)

Location: LowCostLocation ⇔ HighCostLocation

• Global footprint
• Manufacturing-/engineering in low cost locations
• Establishing partnerships/joint ventures
• Political environment!?

Lightweight technologies

• Metallurgy:
  New material standards e.g. higher tensile strength
  => new design with regard to lower weight possible
• Substituting
  casted parts by materials with lower specific weight
e.g. Aluminum/Steel etc.
  => Combination of diff. manufacturing technologies
• Coating
  => reducing thickness of casted metals
Weight saving by new material standard HCLSi

- By the development of the material HCLSi a higher strength can be achieved.
- This allows for wider cooling channels and significant weight reduction.
- Natural frequency can be kept within specified limits.

![Graph showing weight saving and material properties](image)

Example: Rotor 314 x 28 for 16” brake.

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<thead>
<tr>
<th>Material strength</th>
<th>Natural frequency</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Series brake disk</td>
<td>Series design with material HCLSi</td>
<td>New design with material HCLSi</td>
</tr>
</tbody>
</table>

- Less weight due to increased width of cooling channel.
Gain of market share by HCLSi

New material meets customer requirements and market trends:
- Increasing share of ventilated brake discs
- Trend towards high carbon materials
- Increasing share of larger brakes/brake discs (16“ ->18“/19“)

• Two material market standards established by BGG.
Environment

Energy management

• Iron Casting – The Green Technology!
  Iron Casting foundries are role model for the recycling industry!
• New ISO 50001 for Energy Management Systems!
• Energy costs
• Furnaces: MFO’s / cupola furnace

Impact of industrial product pollution

• Emission → e.g. new filter technologies
• CO₂ reduction:
  → Product: Lightweight, product lifecycle
  → Plant: Value stream orientation
    e.g. heat recovery system
• Reduction of product related pollution e.g. brake dust
• Improvement of facility/product lifetime
Iron Casting
- The green technology:

Iron Casting foundries are role model for the recycling industry!

Buderus was the first casting company in Europe passing the ISO 50001, Energy Management Systems!
Operation of a Core Drying Furnace by Waste Heat Recovery of the Cupola

Partly usage of anthracite coke in hot blast cupola

The foundry coke should be placed partly by anthracite coke. Compared to foundry coke, anthracite has a lower carbon content as well as a slower dissolving in the cupola furnace. The advantage of that is the reduced emission of carbon dioxide.

Target is to use 10% anthracite coke to cut down carbon dioxide by 280 tons.

Average rate of domestic gas use of conventional furnaces:
360,000 m³ = 13,000€/a

Proposed rate of domestic gas use waste heat recovery furnaces:
200,000 m³ = 6,900€/a

Savings: 160,000 m³ = 6,000€/a = 100 to CO2/a
## Innovative surface treatment/coatings

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<th><strong>Lifetime</strong></th>
<th><strong>Durability</strong></th>
<th><strong>Electrification</strong></th>
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</thead>
<tbody>
<tr>
<td>➔ Disc lifetime</td>
<td>➔ Stable coefficient of friction</td>
<td>➔ No corrosion even if brake is not used</td>
</tr>
<tr>
<td>➔ Pad lifetime</td>
<td>➔ No cracks after endurance tests</td>
<td>➔ Weight reduction</td>
</tr>
<tr>
<td>➔ No corrosion on friction surface</td>
<td></td>
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<td>➔ No surface scratches</td>
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- No corrosion on friction surface
- No brake dust
- No surface scratches

- Stable coefficient of friction
- No cracks after endurance tests
- No corrosion even if brake is not used
- Weight reduction
Global Footprint

Supplying products in different regions

- Investments: Complete or part of the value chain (melting/molding/machining/coating)
- Cooperation with regional/local companies
  - Partnerships e.g. project/customer related
  - Joint ventures
- Purchasing local for local

Challenges

- Flexible manufacturing processes
- Regional marked adjusted product design
- Task sharing/responsibilities (RASIC)
- Local casting industry competences
- Availability of energy-resources
Buderus Guss is an international automotive supplier with global offices for development and manufacturing of brake discs for passenger cars.
Connectivity

Industry 4.0

- Interconnecting customer and supplier, products and manufacturing processes, …
- Data collection $\rightarrow$ data mining $\rightarrow$ data allocation
- Preventive maintenance / pre-warning systems

Challenges for casting industry

- Combine different cultures/competences:
  - Casting
  - Electronic
  - Software/Internet
- Introducing known sensor technologies (e.g. RFID)
- New sensor technologies
  - …
Innovation path to intelligent casting products
Industry 4.0 – Are we ready?
Foundry 4.0 - Dealing with big data on the shopfloor

Producer

Costumer

Independent machine management and reports

Costumer knows the product status and history → new orders

data collection → data mining → data allocation → decisions
Summary

| • **Most important manufacturing technology today and in the future for production of metal-based near net shape components!**  
  → Fascinating! |
|---------------------------------------------------------------|
| • **Basic processes are not well understood:**  
  → Huge potential for improvements and innovations! |
| • **Industry trends:** Watch them carefully! |
| • **Industry 4.0** Are we ready? |
Thank you!