### Segment Overview

**Cold Jet Specialist: Mike Rivir / Mike Henderson**

<table>
<thead>
<tr>
<th>Major Players</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Auto Parts Suppliers</strong></td>
</tr>
<tr>
<td>• TRW Automotive</td>
</tr>
<tr>
<td>• Valeo</td>
</tr>
<tr>
<td>• Visteon</td>
</tr>
<tr>
<td>• Lear Corp.</td>
</tr>
<tr>
<td>• Aisin</td>
</tr>
<tr>
<td>• Faurecia</td>
</tr>
<tr>
<td>• Alcoa</td>
</tr>
<tr>
<td>• Etc.</td>
</tr>
<tr>
<td>Generally, Automobile manufacturing plants are assembly facilities. While auto manufacturers are also Cold Jet customers, they purchase CJ equipment for PROCESS cleaning, such as weld lines and paint shops (<em>see contract cleaning automotive</em>).</td>
</tr>
<tr>
<td>Auto manufacturers source their molded and/or fabricated parts from outside manufacturers and generally do not manufacture them themselves.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Applications</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Primary:</strong></td>
</tr>
<tr>
<td>• Permanent Molds</td>
</tr>
<tr>
<td>• Core Boxes</td>
</tr>
<tr>
<td><strong>Ancillary:</strong></td>
</tr>
<tr>
<td>• facilities cleaning and general production equipment cleaning</td>
</tr>
</tbody>
</table>
Segment Overview (cont’d)

According to the North American Die Casting Assn. (NADCA), steel makes up 56% of an average vehicle, followed by cast iron at 11%, plastic at 10% and aluminum at 6%. Magnesium is starting to take away from plastics, as the magnesium casting market is projected to increase significantly. Significant growth in the use of ductile iron also is expected.

<table>
<thead>
<tr>
<th>Metal parts</th>
<th>Metals used</th>
<th>Manufacturing Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Wheels</td>
<td>• Ferrous and Non-ferrous alloys</td>
<td>• Permanent mold casting</td>
</tr>
<tr>
<td>• Engines</td>
<td>• Iron</td>
<td>– Die casting</td>
</tr>
<tr>
<td>– front covers</td>
<td>– austempered ductile iron (ADI) / ductile</td>
<td>– Permanent molding</td>
</tr>
<tr>
<td>– blocks</td>
<td>– grey</td>
<td>– Low-pressure permanent molding (LPPM)</td>
</tr>
<tr>
<td>– cradles</td>
<td>– compacted graphite iron</td>
<td>– Semi-solid metal molding (SSM) or squeeze casting</td>
</tr>
<tr>
<td>• Chassis components</td>
<td>• Magnesium</td>
<td>– Graphite mold casting</td>
</tr>
<tr>
<td>– knuckles</td>
<td>• Intermetallics</td>
<td></td>
</tr>
<tr>
<td>– spaceframes</td>
<td>– titanium aluminate</td>
<td></td>
</tr>
<tr>
<td>– wheel carriers</td>
<td>• Steel (stainless)</td>
<td>• Coatings used</td>
</tr>
<tr>
<td>– control arms</td>
<td>• Aluminum</td>
<td>– Graphite based</td>
</tr>
<tr>
<td>– brackets</td>
<td>• Carbon alloy</td>
<td>– Talc based</td>
</tr>
<tr>
<td>• Etc.</td>
<td>• Etc.</td>
<td>– Calcium silicate based</td>
</tr>
</tbody>
</table>

According to the North American Die Casting Assn. (NADCA), steel makes up 56% of an average vehicle, followed by cast iron at 11%, plastic at 10% and aluminum at 6%. Magnesium is starting to take away from plastics, as the magnesium casting market is projected to increase significantly. Significant growth in the use of ductile iron also is expected.

<table>
<thead>
<tr>
<th>Metal parts</th>
<th>Metals used</th>
<th>Manufacturing Processes</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Wheels</td>
<td>• Ferrous and Non-ferrous alloys</td>
<td>• Permanent mold casting</td>
</tr>
<tr>
<td>• Engines</td>
<td>• Iron</td>
<td>– Die casting</td>
</tr>
<tr>
<td>– front covers</td>
<td>– austempered ductile iron (ADI) / ductile</td>
<td>– Permanent molding</td>
</tr>
<tr>
<td>– blocks</td>
<td>– grey</td>
<td>– Low-pressure permanent molding (LPPM)</td>
</tr>
<tr>
<td>– cradles</td>
<td>– compacted graphite iron</td>
<td>– Semi-solid metal molding (SSM) or squeeze casting</td>
</tr>
<tr>
<td>• Chassis components</td>
<td>• Magnesium</td>
<td>– Graphite mold casting</td>
</tr>
<tr>
<td>– knuckles</td>
<td>• Intermetallics</td>
<td></td>
</tr>
<tr>
<td>– spaceframes</td>
<td>– titanium aluminate</td>
<td>• Coatings used</td>
</tr>
<tr>
<td>– wheel carriers</td>
<td>• Steel (stainless)</td>
<td>– Graphite based</td>
</tr>
<tr>
<td>– control arms</td>
<td>• Aluminum</td>
<td>– Talc based</td>
</tr>
<tr>
<td>– brackets</td>
<td>• Carbon alloy</td>
<td>– Calcium silicate based</td>
</tr>
<tr>
<td>• Etc.</td>
<td>• Etc.</td>
<td></td>
</tr>
</tbody>
</table>
Automotive Foundry
Process flow chart for engine block manufacturing

Process/Quality Requirement
1. The moulded section SHOULD be masked (aged) 1-3 hrs in the aging area.
Casting Processes

### Die Casting

Die casting is used to produce small- to medium-sized castings at high-production rates. The metal molds are coated with a mold surface coating and preheated before being filled with molten metal. A pre-measured amount of liquid metal is forced under extreme pressure from a hot chamber into the permanent mold or die. Castings of varying weights and sizes can be produced. Nearly all die castings are produced in nonferrous alloys with limited amounts of cast iron and steel castings produced in special applications.

<table>
<thead>
<tr>
<th>Terms &amp; Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Core box:</strong> the core is the part of a mold used in the casting process that forms the internal shapes of a casting. The core box is the mold that makes the core. These core boxes have screen or slot vents.</td>
</tr>
<tr>
<td><strong>Hot chamber:</strong> This process involves the use of a plunger which traps a certain volume of molten metal and forces it into the die cavity through a gooseneck and nozzle. After the metal has solidified in the die cavity, the plunger is withdrawn, the die opens and the casting is ejected. Metals having low melting points such as Zinc, copper, magnesium and lead are cast using Hot chamber die casting.</td>
</tr>
<tr>
<td><strong>Cold chamber:</strong> In this process molten metal is poured into the injection cylinder manually by a hand ladle or by an automatic ladle. The metal is forced into the die cavity at high pressures. High melting point alloys of aluminum and copper are normally cast using cold chamber die casting.</td>
</tr>
</tbody>
</table>
Casting Processes (cont’d)

### Permanent Molding

Another form of permanent molding is where the molten metal is poured into the mold, either directly or by tilting the mold into a vertical position. In this process, the mold is made in two halves, male and female, from cast iron or steel. If cores are to be used, they can be metal inserts, which operate mechanically in the mold, or sand cores, which are placed in the molds before closing. If sand cores are used, the process is called "semi-permanent molding."

### Low Pressure Permanent Molding (LPPM)

“Low pressure" means that the liquid metal is forced into the mold rather than poured.

### Semi-Solid Metal Processing (SSM) / Squeeze Casting

**SSM** is similar to high-pressure die casting in that metal is injected into a reusable steel die under pressure. However, rather than using liquid metal, SSM uses metal that is about 40% liquid and 60% solid. Currently, aluminum is the major alloy used with this process, and the major users are automakers.

*Squeeze casting* is a technique in which molten metal is metered into a metal permanent mold die cavity and, as the metal solidifies, pressure is applied. Generally, the squeeze casting process is used for high-production runs in aluminum alloys.
Casting Processes (cont’d)

Die Casting

SSM Billet

Squeeze Casting

LPPM

Hydraulic Press

Core box

Pouring

Part release

Metal shaping under pressure + Application of pressure during solidification (cooling)

This corebox is made of cast iron and is used to produce cores for cast iron cylinder sleeves.
Examples of Parts

- SSM cast rear axle end
- Squeeze cast automotive knuckle
- LPPM cast crossmember
- Hollow (cored) ductile iron steering knuckle
- Die cast magnesium structural bracket
The Cold Jet Solution
Die Casting Permanent Molds

Value Summary

• Online Cleaning
  – Cleans molds hot and in place for reduced downtime (from 2-3 hours to 10-20 minutes)
  – Cleans fast for a rapid return to production – coatings can be immediately reapplied

• Increased cleaning effectiveness
  – Effective residue removal
  – Non abrasive – does not damage carousel lines or tilt machines, molds, core boxes or surrounding equipment

• Worker health and safety
  – No secondary waste or atmospheric contamination with dust (causing lung damage)
  – Cool blast stream provides welcome relief
The Cold Jet Solution

**The Problem**

**Permanent Molds**
- During the casting process there is a breakdown of the release agent on the mold halves (cope and drag) and the core.
  - The molds may be touched up for a while first
  - Eventually the coating needs to be removed completely and reapplied.
- It is very difficult to get a smooth feather when touching up the molds using the conventional methods of wire brushes and/or steel wool.

**Core Boxes**
- Core boxes have delicate screen and slot vents that allow for the catalytic gas or heat to penetrate the box and bind the resin to the sand.
- The resins that bind the sand to form a rigid casting core build up on the core box and in the core box vents.

---

**The Consequences**

- Coating irregularities and/or resin residue build-up causes dimensional errors and quality defects on the final casting leading to scrap.
- Screen and slot vents get clogged preventing the catalyst (gas or heat) from passing through and consistently solidifying the core material (sand).
# The Cold Jet Solution

## Traditional Methods –

**Manual cleaning**
- slow and labor-intensive
- often inconsistent and ineffective
- *With solvents, scrapers & brushes:*
  - Requires cooling, disassembly, transport to tool shop, reassembly, reheating
    - Time consuming
    - Potential damage to tooling during all phases
  - Solvents are hazardous to workers’ health
  - Damaging to electrical components and motors
  - Solvents incur disposal costs
  - Wet process: tooling has to dry
  - Scrapers & brushes are damaging to tooling

*Sand/other abrasive Blasting*
- Rapidly wears tooling
- Damages molds and core boxes
- Creates secondary waste and atmospheric and/or downstream contamination

**Results:**
- Ineffective or non-existent cleaning
- Elevated scrap rates and damage to tooling
- Extensive production downtime
- High labor and cleaning material costs
- Damage to and/or contamination of surrounding installations

## Cold Jet Value -

**Dry ice blasting**
- Cleans online – no disassembly or reassembly required
- Quick and easy
- Highly effective and consistent
- The process:
  - Dry ice sublimates leaving no secondary waste to clean up
  - Dry ice blasting is a dry process – tooling remains dry and there is no damage to electrical components and/or motors
  - Dry ice blasting is non-abrasive

**Results:**
- Cleaning can be integrated into production process
- Increased production time
- Reduced scrap rates
- Reduction or elimination of tooling damage and wear
- Reduced labor costs
- No damage to surrounding or downstream installations
- Elimination of hazardous waste disposal costs and drill bit replacement costs
Value of the Cold Jet Solution

Permanent Mold Cleaning

**Challenge:** To Clean an engine mount mold hot in a Stahl tilt machine.

**Results:** Cleaned both mold segments in less than ten minutes (runners not included). Tool was 85° F (29° C) at start of cleaning. Temperature dropped to 65° F (18° C) at end of cleaning. Spray coating was immediately reapplied and parts were made within 15 minutes of cleaning completion. *Total down time: 25 minutes.*

**Cost Justification:** One satisfied Cold Jet customer reports an annual net profit of over $105,000 from labor savings and productivity gain alone from using this dry ice blasting process on their 5 molding machines. *Tool wear savings not included.*

**Customer Testimonial - Die Casting Company in Ohio**

We used to use sandblasting and solvents to clean our molds. Since we have starting using Cold Jet dry ice blasting equipment, our shop floor is safer now because sandblasting caused potential eye injuries and solvents created environmental hazards. Also, sand blasting led to sand particles getting into bearings and other moving equipment. Some of the equipment that we needed to clean had some rather hard-to-get-at surfaces and Cold Jet was able to match a nozzle to the application and solved the problem.
Value of the Cold Jet Solution

Core Box Cleaning

The original cleaning method for core boxes combined grit blasting, scraping and chemical processes. This required the disassembly of the core box from the machine and even then, it was not effective in completely cleaning the gas vents, which had to be cleaned one at a time by hand with knives.

Benefits of dry ice blasting:

- Online cleaning
  - No disassembly or reassembly required
  - Therefore no damage to tooling through misalignment or transport
  - Therefore no cool down and minimal reheat time required
  - Therefore faster production turnaround
- Elimination or reduction of chemical solvents
  - Elimination or reduction of chemical disposal costs
  - Elimination or reduction of worker exposure to Chlorofluorocarbon and Chlorocarbon
  - no painstaking and un-ergonomic knifing
- Non abrasive process
  - No damage to tooling
    - no replacement costs
    - extended tool life
    - tolerances and quality maintained
  - no secondary waste (no additional cleanup required)
## Cost Justification

### Core Box Cleaning

<table>
<thead>
<tr>
<th>Pin, dome and gate core boxes</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Old Method:</strong></td>
<td><strong>Dry Ice Blasting:</strong></td>
<td></td>
</tr>
<tr>
<td>• 4 hours total cleaning time</td>
<td>• 45 minutes total cleaning time</td>
<td></td>
</tr>
<tr>
<td>• disassembly &amp; reassembly required</td>
<td>• no disassembly &amp; reassembly required</td>
<td></td>
</tr>
<tr>
<td>• cool down and reheat time required</td>
<td>• no cool down and minimal reheat time</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Body core boxes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Old Method:</strong></td>
<td><strong>Dry Ice Blasting:</strong></td>
</tr>
<tr>
<td>• 1 hour</td>
<td>• 30 minutes</td>
</tr>
<tr>
<td>• Weekly cleaning of coldset tools with dismantling for vent cleaning: 12 hours</td>
<td>• Weekly cleaning of coldset tools: 90 minutes</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Hotboxes</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Old Method:</strong></td>
<td><strong>Dry Ice Blasting:</strong></td>
</tr>
<tr>
<td>• 8 machines required 16 hours a week of knifing</td>
<td>• 8 machines - 4 hours</td>
</tr>
</tbody>
</table>
Recommended Product Configuration

**Primary**

- **SDI-5**
- **AeRO 80 HP or SDI-5**
  - For more broad brush cleaning of tooling and surrounding areas

**Complementary**

- **i³MicroClean**
  - For small, hard-to-reach and/or intricate cavities, crevasses and molds
  - Nozzle choice will depend on the user – all currently work well
  - angled nozzles are under development
## Select Installed Systems

<table>
<thead>
<tr>
<th>Customer</th>
<th>Location</th>
<th>Application</th>
<th>System + Accessories</th>
</tr>
</thead>
<tbody>
<tr>
<td>ThyssenKrupp</td>
<td>Waupaca, WI</td>
<td>Coreboxes</td>
<td>AeRO 75</td>
</tr>
<tr>
<td>Waupaca, Inc.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ThyssenKrupp</td>
<td>Kingsville, MO</td>
<td>Permanent aluminum molds + coreboxes</td>
<td>AeRO 75-DX + 523 SLF (cold molds) + MS-136 (with extension – hot molds)</td>
</tr>
<tr>
<td>Stahl</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPX Contech</td>
<td>Portage, MI</td>
<td>Metal forging</td>
<td>VSH</td>
</tr>
<tr>
<td>Grede Foundries</td>
<td>Greenwood, SC</td>
<td>Permanent aluminum molds + coreboxes</td>
<td>AeRO 30</td>
</tr>
<tr>
<td>GKN Sinter Metals</td>
<td>PA (two locations)</td>
<td>Powder metal forging die molds</td>
<td>VSH + AeRO 75-DX</td>
</tr>
<tr>
<td>Mahle</td>
<td>Morristown, TN</td>
<td>Permanent aluminum molds</td>
<td>SDI-5</td>
</tr>
<tr>
<td>Honda</td>
<td>Anna, OH</td>
<td>Coreboxes</td>
<td>AeRO 30 + 523 SLF, 223, 412, 413, MS-045</td>
</tr>
<tr>
<td>GM Powertrain</td>
<td>Saginaw, MI</td>
<td>Coreboxes</td>
<td>AeRO 75-DX &amp; AeRO 30 (trial)</td>
</tr>
<tr>
<td>Amcast Automotive</td>
<td>3 locations</td>
<td>Aluminum wheel molds</td>
<td>2 x RDS 500 and 1 x VSH + 412 SL + 508 SL</td>
</tr>
<tr>
<td>Kawasaki</td>
<td>3 locations</td>
<td></td>
<td>RDS 500</td>
</tr>
</tbody>
</table>
Case Study
Permanent Mold Cleaning – Grey Iron*

Existing Situation:
• Molds cleaned daily to remove soot build-up
• 19,074 molds put through mold repair in 1996
  • Process:
    • molds blasted in wheelabrator
    • molds re-vented
    • repairs conducted if needed
    • cycle time for 2 molds (4 halves) is 50 seconds (does not include loading & unloading time)
  • Labor:
    • one man cleans the molds and knocks out the vents
    • one man crimps and re-installs the vents
    • one man repairs and transports the molds
  • Cost:
    • with an average of 31.1 vents per mold and 75.9 molds cleaned per day, there are 2,360 vents replaced per day
    • 21,588 Molds left on machine in 1996 were sandblasted by third shift set up

*Based on Grede Foundries – February 1997 – applies to aluminum equally
Case Study (cont’d)
Permanent Mold Cleaning – Grey Iron*

Problems of Existing Situation:
• **Wheelabrator** is self-destructive
  • $80,000 to replace
  • $1250/year for repair parts
  • excessive maintenance labor cost
• **Sandblasting** the machines on the permanent molding floor caused
  • deterioration of the machine in general (bearings, rollers, cylinders, etc.)
  • deterioration of the molds (decreased life expectancy)
  • housekeeping and safety issues (sand and/or shot media on the floor)

Note: **Soda** media Alternative was dropped due to
• $7300 ongoing maintenance and shot cost
• need for enclosed area
• not as abrasive as current method (sand)
• secondary waste disposal requirements

Example of “Sandblasting Zone”

*Based on Grede Foundries – February 1997 – applies to aluminum equally*
Case Study (cont’d)
Permanent Mold Cleaning – Grey Iron*

**Costs:**
- Estimated clean time: 1 minute per mold
- Estimated ice usage:
  - 1.5 lbs per mold
  - $0.25 per lb
  - annual ongoing cost of $15,248.25

**Savings:**
- Reallocation of productive **labor**: approx. 75% of vents weren’t knocked out & replaced
  - Time Savings: 250 days * 8 hours = 2000 hours * 75% = 1500 hours reduction
  - Cost Savings: 1500 hrs at average rate of $13.40 (incl. fringe) = $20,100 per year for labor alone
- Cost of the **vents**:
  - 2360 vents/day * 200 working days = 590,122 vents
  - 590,122 vents * $0.03 each = $17,703.68
  - 75% of $17,703.68 = $13,277 saved
- Estimated **shot** usage reduction (wheelabrator usage reduced by 90%)
  - $7283.00 * 90% = $6554.70 saved

**Total Ongoing Savings:** $39,932.46 per year

*Based on Grede Foundries – February 1997 – applies to aluminum equally
Case Study (cont’d)
Permanent Mold Cleaning – Grey Iron*

Intangible/Uncalculated Benefits:
• **Safety**: elimination of secondary waste shot from the floor eliminates risk of injury from falling
• **Extended mold life**: due to non-abrasive nature of dry ice media and reduced usage of wheelabrator
• **Extended machine life**: elimination of sandblasting on the floor eliminates damage to bushings, bearings, rollers, etc.
• **Reduced salvage for vents**:
  • **Proper vent alignment**: with the vents being cleaned rather than replaced, misalignment and movement due to misalignment is reduced
  • **Vent area preservation**: cleaning the vents versus replacing them also reduces deterioration of vent area
  • Cleaning room is freed up

*Based on Grede Foundries – February 1997 – applies to aluminum equally