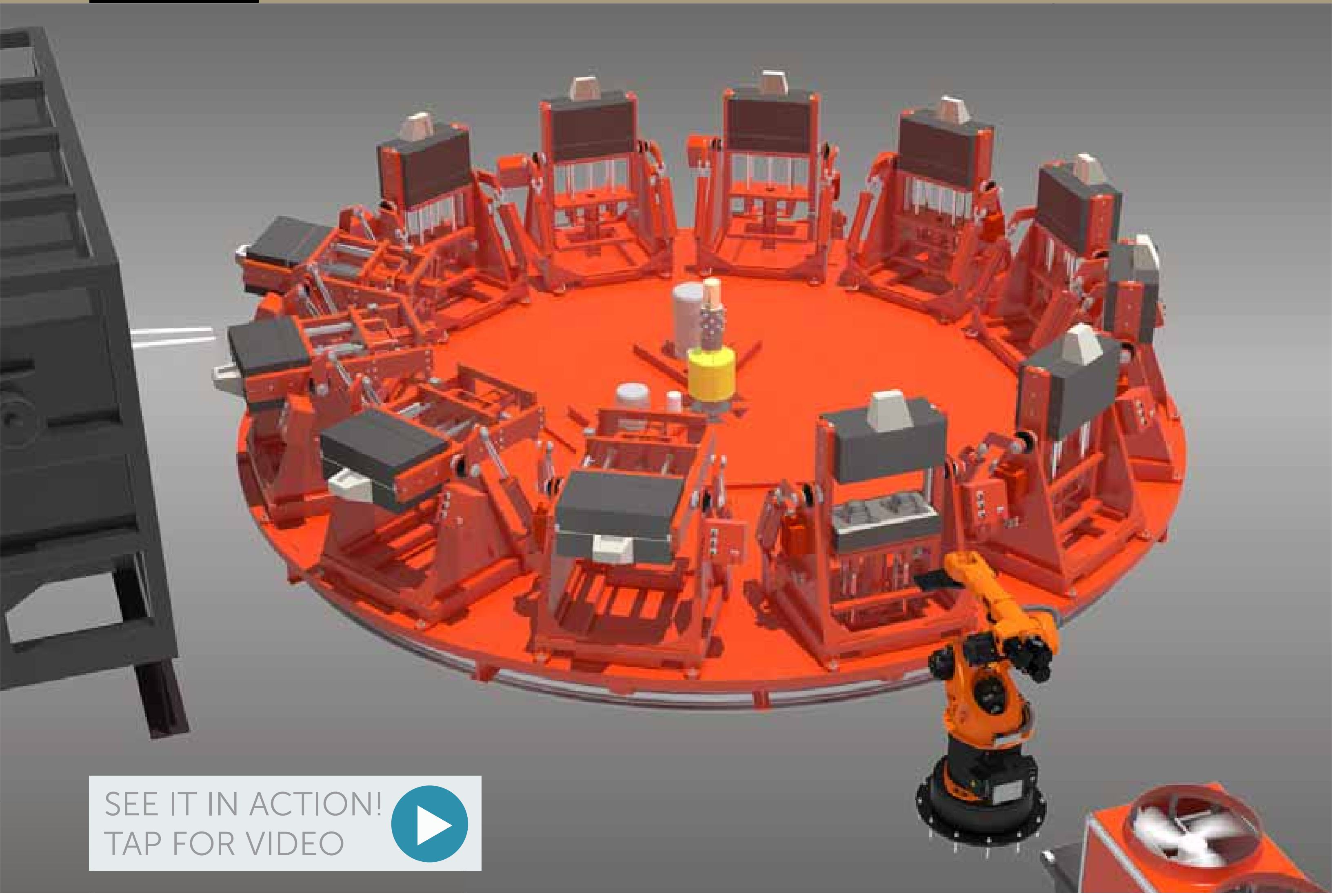


ROBOTIC AUTOMATION IN PERMANENT MOLD FOUNDRIES

John Hall
President
www.cmhmfg.com

Article Takeaways:

1. Robots will be part of the foundry's future because they provide the flexibility needed to most effectively meet changing global pressures
2. How to justify adding robotic automation

We in the foundry industry have learned the hard way that the world is flat. The last forty years has seen our global industry grow while our domestic industry has shrunk. Like many other industries, foundries must constantly be on the lookout for new ways to boost their productivity, cut costs and increase quality. Robotic automation is one of the tools for accomplishing this goal. Robots can provide foundry floor production capabilities that allow the foundry to respond effectively to global pressures and future market changes. Although difficult to measure, this capacity has a clear economic value. A robot can be reprogrammed and retooled so that it can be a valuable tool as our customers' needs change. An automated foundry work cell will reduce direct labor and related cost and reduce the requirements for employee services and facilities.

Justifying Robotic Automation

Justifying robotic systems is a multi-step process. Deciding when to automate and to what degree can be a difficult task,

STEP 1. TECHNICAL FEASIBILITY STUDY[1]

Is the casting designed for robotic handling?

- Is it possible to do the job with the planned procedure?
- Is it possible to do the job in the given cycle time?
- How reliable will the total system be?
- Does the foundry have operators and engineers that can work with robots?
- Is it possible to maintain safety?
- Can the required quality standards be maintained?
- Can inventory be reduced?
- Can material handling be reduced?
- Is the current material handling system adequate?

STEP 2. SELECT WHICH JOB TO AUTOMATE.

- Castings belonging to the same family
- Castings presently being manufactured near each other
- Castings that can share tooling
- Castings that are of similar size, dimensions, and weight
- Castings with a simple design

STEP 3. INTANGIBLE CONSIDERATIONS

- Will the robotic system meet the direction of foundry's vision statement?
- Will the robotic system meet the foundry's standardization of equipment policy?
- Will the robotic system meet future model changes or production plan?
- Will the plan improve morale of the workers?
- Will the plan improve the foundry's reputation?
- Will the plan improve technical process of the foundry?

STEP 4. DETERMINATION OF COST AND BENEFITS

- Capital investment cost as compared to changes in profit

STEP 5. PROJECT COST FOR AN EXAMPLE CELL THAT WILL POUR, EXTRACT, AND COOL

- 210kg robot $85,000
- End effector $10,000
- Tool changer $3,500
- Programming $20,000
- Peripheral equipment .. $15,000
- Guarding......................... $4,000
- Installation cost............. $5,000
- Total............................ $142,500
- Salvage........................... $5,000
- Standard accounting methods are then applied to determine the project's feasibility.

STEP 6. ADDITIONAL ECONOMIC CONSIDERATION

- The values for the components in the cash flow equation are incremental values. They are increases or decreases resulting directly from the project (investment) under consideration.
- The higher the NPV and rate of return, the better and lower the payback period.
- The use of the payback period as a primary criterion is questionable. It does not consider the cash flows after the payback period.
- In the case of evaluation of mutually exclusive alternatives, select the alternative with the highest NPV. Selection of the alternative with the highest rate of return is incorrect. This point is made clear in many references (see Stevens (1995), Blank (1989), and Thuesen and Fabrycky (1989)).
- In selecting a subset of projects from a larger group of independent projects due to some constraint (restriction), the objective is to maximize the NPV

of the subset of projects subject to the constraint(s).

- Automation in Permanent Mold Foundries

The aluminum foundry industry could be poised for growth worldwide. With the massive shift in the automobile industry from iron to aluminum and other light alloys, for both ecological and economic reasons, foundries should be investing heavily in new machinery and automation. Traditional casting methods do not have the flexibility needed to cast wheels, engine/transmission components, structural components, and more complex parts with thinner walls. Robotics can play an important role in improving quality, consistency, and improving profits.

Foundries are a complex and demanding environment to work in. The automation of specialized tasks requires detailed process know-how and the right hardware to handle castings and cores with power and precision. Such tasks include:

- Core shooting/machine tending
- Core assembling/gluing
- Core cleaning
- Core handling and placement
- Die casting machine tending
- Investment casting, dipping, and handling
- Ingot handling/furnace tending
- Ladling
- Deburring/deflashing/degating
- Premachining
- Machine center tending
- Inspection/x-ray/leak testing

Labor saving is not the only advantage in robotic ladling. Automated ladling can reduce a metal caster's material cost in two ways.

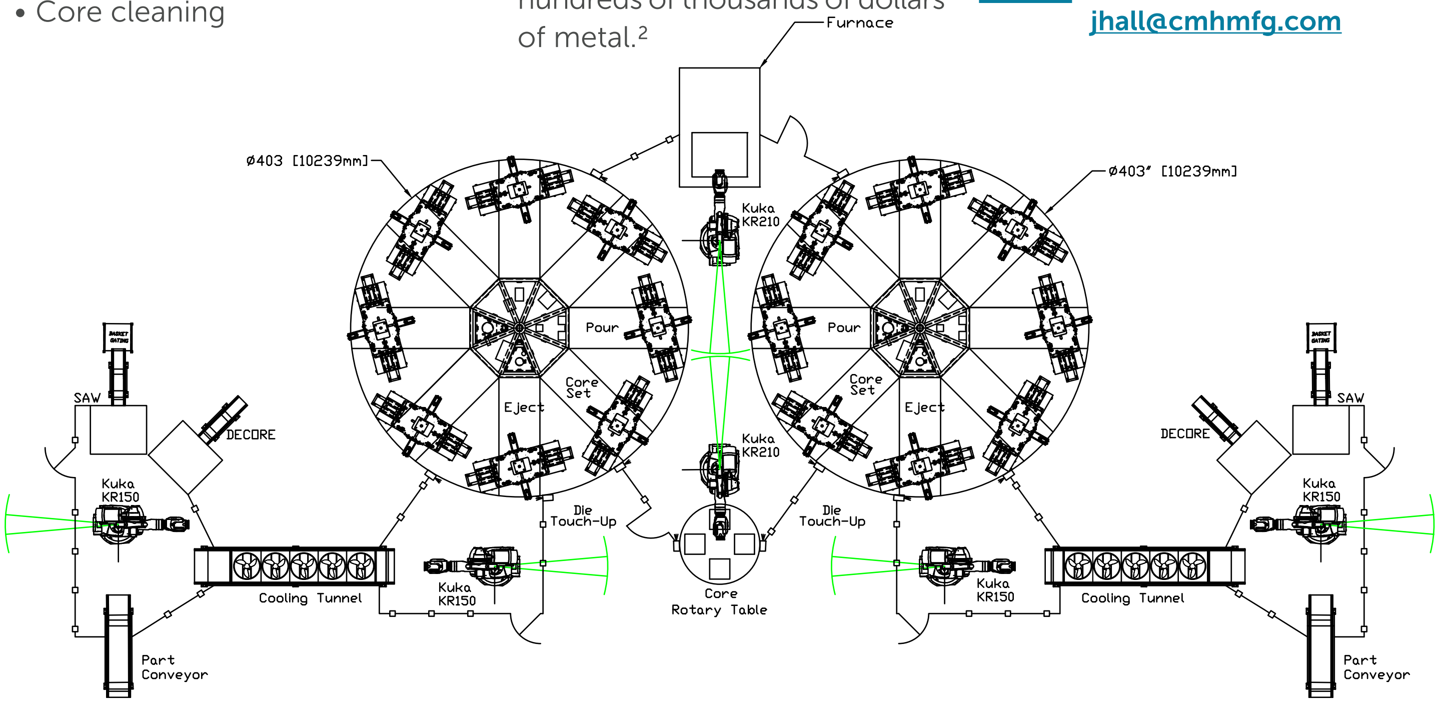
- By creating products with greater metal integrity, less metal will be needed to be reworked, reducing wasted throughput time.
- Robotics minimize the amount of spilled metal, by being able to pour more consistently than individuals who may tire as a grueling day wears on. For example, if a manufacturer pours 100 lbs. of metal an hour spilling 10% over the course of an eight hour shift, and operations run 24 hours/day, 365 days/year, a manufacturer can lose over 40 tons of metal per year – wasting hundreds of thousands of dollars of metal.[2]

The following illustration is an example of an unmanned cylinder heat casting cell. Unmanned cells are more difficult to operate than manned cells because the most flexible and intelligent element has been removed, the human worker. Unmanned must be able to operate without the human thinking and sensory system with zero defects. The cell must have the intelligence to make decisions and deal with variations that are common in the foundry.

The cell consists of:

- Two eight station rotary tables with cylinder head casting machines
- One holding furnace
- One pouring robot common to both tables
- One core setting robot common to both tables
- Two extraction robots
- Two cooling tunnels
- Two knockout machines
- Two riser saws
- Two casting exit conveyors

Contact:
John Hall
jhall@cmhmfg.com



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Hall Foundry Systems

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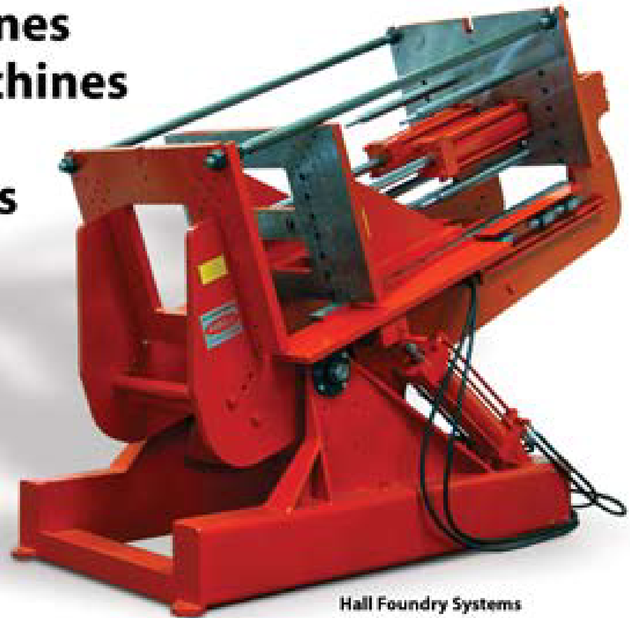
Permanent Mold Machines
Gravity Die Casting Machines
Tilt Pour Process
Autocast Style Machines
Rotary Tables



Hall Foundry Systems
By CMH Manufacturing

Automation Work Cells
Riser Saws
Casting Coolers
Casting Catchers
Foundry Accessories

3R & 6R — No tie-bars to interfere with robotic core placement or casting extraction.

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Tel: 806-744-8003
sales@cmhmfg.com
www.cmhmfg.com

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