AUTOMATION OF FURNACE TENDING: MEET ARFT (PATENT PENDING)

Presented by:

Yves Larouche, Dynamic Concept

Malcolm Caron-Boivin, Eng., EPIQ Machinery

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Presenter’s Bio

- **Yves Larouche**
  - Bachelor Degree in (1995)
  - Company/Organization: Dynamic Concept
  - Present position: Technical Sales
  - Work experience

- **Malcolm Caron-Boivin, Eng.**
  - Bachelor’s Degree, Mechanical Engineering, Laval University (2017)
  - Company/Organization: EPIQ Machinery
  - Present position: Product Manager
  - Work Experience

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- Introduction
- Solution: Technical Description of ARFT
  - Mobility/Transportation options
  - Power
  - Vision system
  - Operating Mode and Results
- Benefits of the solution
- Conclusion

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Introduction

- Furnace Tending is an intensive operation in Casthouses using mobile vehicles with adapted tools or Specialized Machines
- Alcoa was looking for a fully automated programmable multi-task solution for their Casthouses around the world
- Dynamic Concept proposes a fully automated robotic solution with automated mobility and flexibility to adapt to each plant
- Dynamic Concept's solution was chosen for the level of automation, flexibility of operation and efficiency/accuracy of all tasks

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Introduction

Dynamic Concept and EPIQ Machinery combine their strengths to develop an automated fully programmable robotic solution.

Dynamic Concept

Custom robotic and vision system with molten aluminium processes

EPIQ MECFOR

Mobility and Furnace Tending expertise

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Solution: Technical Description of Automated Robotic Furnace Tending (ARFT)

PATENT PENDING

- **The ideal solution is a fully programmable robot performing all tasks: Skimming, Cleaning of the walls and floor, Stirring, Charging**
- **Challenges**
  - **Very large volume and extended area to cover**
  - **Load of the tools: high working force at maximum reach**
  - **Mobility: move from one furnace to another**
  - **Heat: Molten Metal Furnace**
  - **Power**
  - **IT / Vision system**

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Solution: Technical Description of Automated Robotic Furnace Tending (ARFT)

PATENT PENDING

Commercial standard robots offered on the market are designed for high-speed and small payload: not suitable for the application

Solution:

Custom robot with required capacities for:

- Wide working envelope
- Full robotic software and adaptable programming
- Flexible force/position control, speed control and position feedback
- Full mobility

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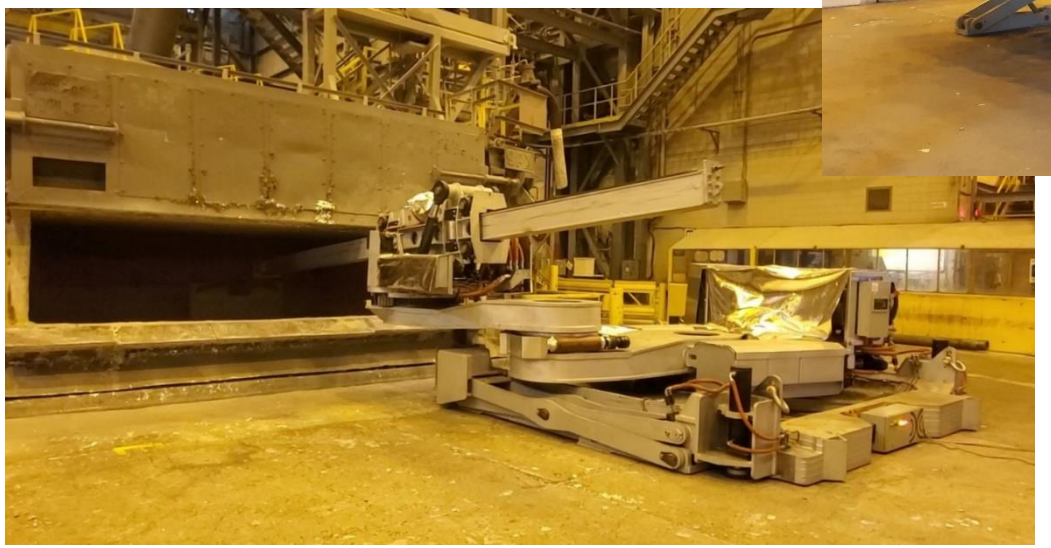
Solution: Automated Robotic Furnace Tending (ARFT)

PATENT PENDING

Custom designed SCARA-type robot offering:

- Very Large Stroke
- Heavy Payload
- Up to 6 mobile axes



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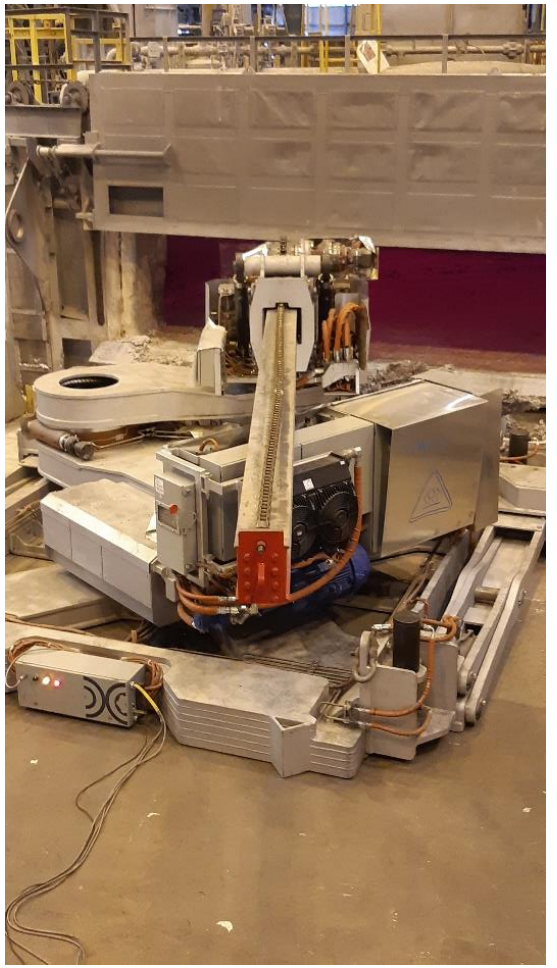
Solution: Automated Robotic Furnace Tending (ARFT)

PATENT PENDING

Custom designed SCARA-type robot offering:

- Performing all operations from one position in front of the furnace
- Full control on tool position, speed and applied force



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Solution: Automated Robotic Furnace Tending (ARFT) | Mobility

PATENT PENDING

Transportation option

Automated Guided Vehicle (AGV) that automates moving and positioning of the equipment in front of furnaces, as required.

- **EPIQ AGV Molten Metal Hauler design is compatible with ARFT platform.**
- **AGV can handle other tasks while ARFT works on furnace**

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Solution: Automated Robotic Furnace Tending (ARFT) Mobility

PATENT PENDING

EPIQ AGV

The same AGV that moves the robot can be utilized to:

- Carry / handle alloy or scrap charger platform next to the robot
- Move crucible into Casthouse
- Move the dross pan in and out in front of furnace

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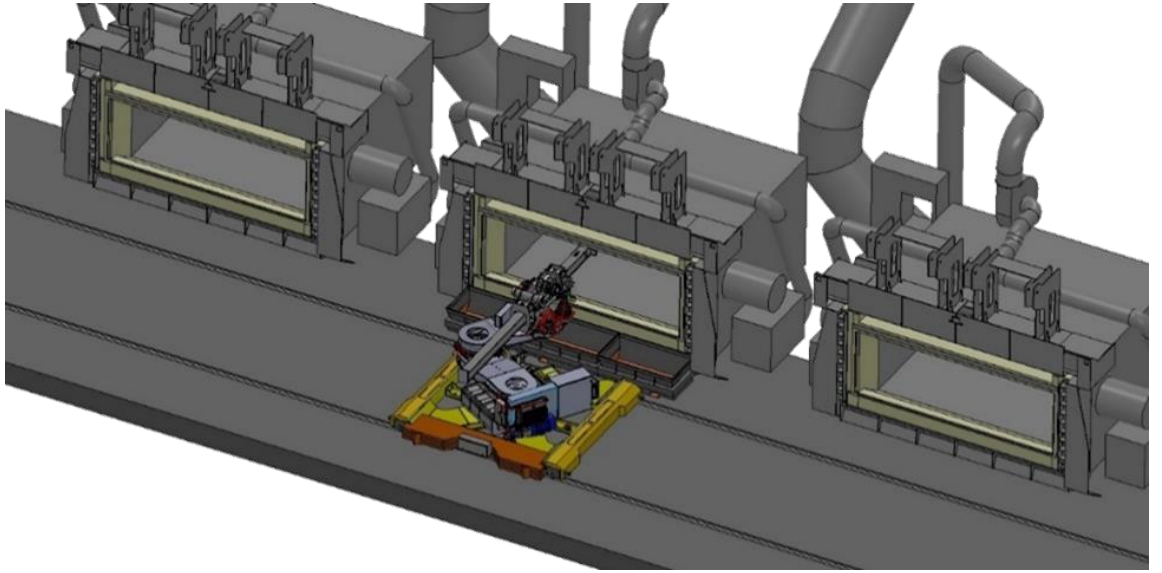
Solution: Automated Robotic Furnace Tending (ARFT)

PATENT PENDING



Other Transportation Options

- **Rails**
- **Remote Control Trolley**
- **Dedicated Vehicle**

Except for rail installation, ARFT's mobility options allow for quick start-up with minimal changes to the plant layout.

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Solution: the Automated Robotic Furnace Tending (ARFT)

PATENT PENDING

Power:

Battery powered is the chosen solution to avoid constraints due to mobility.

It features :

- Electrical Power
- Battery pack similar to the ones from EPIQ AGV
- Auto recharging

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Solution: Automated Robotic Furnace Tending (ARFT)

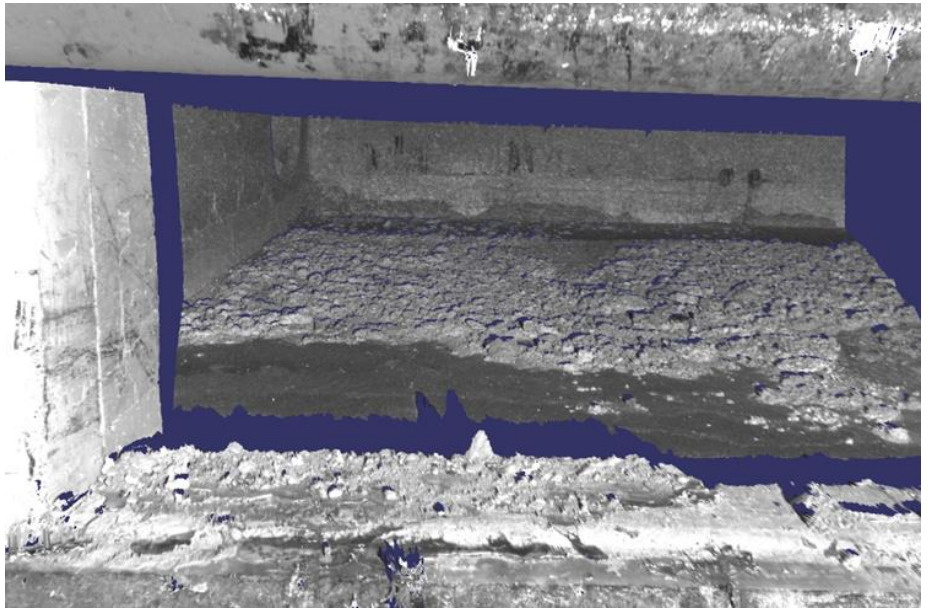
PATENT PENDING

Vision System

To increase efficiency of operation, a vision system has been developed and integrated.

This vision system can:

- Monitor dross location;
- Evaluate dross efficiency;
- Provide other operating assistance;
- Determine location of walls, door opening, metal level for robot operation;
- Map where dross is to remove;
- Inspect Quality of Skimming;
- Provide feedback for Fine Tuning of Skimming;



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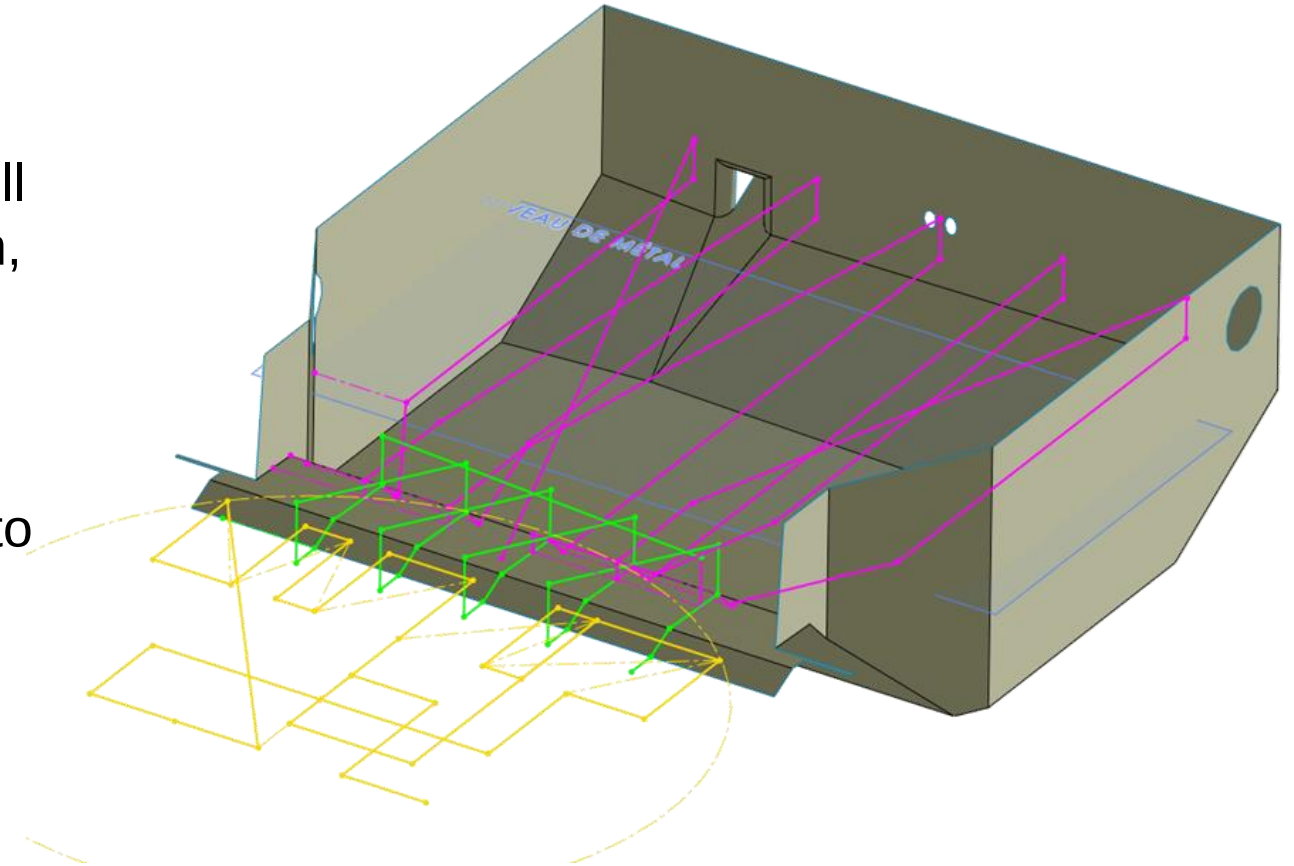
ARFT | Operating Mode and Results

General

Real robotic solution allows full control on movement, position, speed and applied force.

Depending on the task, all parameters are programmed to give the best efficiency in any circumstances.



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ARFT | Operating Mode and Results

Skimming

- The system is programmed to cover complete surface with accurate positioning of the tool.
- The tool can be immersed inside the dross layer with precise adjustment to minimize metal pick-up.
- Since the metal level is measured, the penetration of the dross inside the metal is adjusted to minimize metal pick-up.
- The vision system allows a quality control check in order to locate and remove any remaining dross.

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ARFT | Operating Mode and Results

Mixing

- Optimized path programs
- Circle or figure eight movements at various depths in the metal
- Reach the floor of the furnace along the course of its path, ensuring proper mixing of heavier alloying elements that tend to sink to the bottom
- Very homogeneous alloy mix

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ARFT | Operating Mode and Results

Cleaning

- A big advantage of this robotic system is its capacity to control applied force to the walls to remove the dirt without breaking the refractory.
- Combined to the ability to reach all walls and bottom, the cleaning task is very efficient.
- Furthermore, since the operation is automated, cleaning tasks can be performed on a higher frequency to avoid built up on the walls and bottom.

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Benefits of the ARFT

- **Reduced Opex:**
  - **Significant reduction of refractory breakage**
  - **Reduction of operating personnel**
- **Increased security; no more operator exposure to hot metal**
- **Accuracy of skimming allowing reduction of metal losses in dross**
- **Regular cleaning of furnace to ensure cleaner metal and prevent metal accumulation and inclusion in hot metal**
- **Reduction of production losses due to dirty metal in furnace**

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Benefits of the ARFT

- **Same AGV performing the following tasks**
  - **Carry / handle alloy or scrap charger platform next to the robot**
  - **Move crucibles into Casthouse**
  - **Move dross pans in and out of skimming position in front of furnace**

----> All complementary operations are covered: no operator interaction on the production floor for maximal safety

- **Solution to expected lack of manpower in many countries**
- **Improve stirring to prevent uneven alloying mix and production lost**

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Conclusion

- **Break Through Technology**
  - Fully Programmable For Any Task
  - High Efficiency and Repeatability
  - Optimum Mobility with Rechargeable Battery pack
  - Artificial Intelligence Capability

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