# The Use of Acoustic Control Technology to Improve the Manufaturing Process to Foster Better Engineering Environment.
## (Phase 1: Automatic Pouring Machine)

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**Abstract**

Through this project; the semi-automated system will be improved to a fully automatic system by using acoustic technology. This Machine acts as a combined Melting Furnace, Spin Casting Loading and Automatic Pouring Machine. The sound of the pouring process will be captured and the signal of the sound will be analyzed. After feature extraction, the data will then be inserted to the neural network and trained to recognize the sound of the liquid which has reached the sufficient level of the pouring process. For the early stage (Phase 1), this paper concentrates on the Automatic Pouring Machine and how the process can protect the workers. For this Machine, "Electro pneumatic" are used to control the machine process. This Machine is designed to discharge molten metal in directly into Centrifugal Rubber Mold Casting (CRMC).

Keywords: Automatic Pouring Machine, Electro Pneumatic, Centrifugal Rubber Mold Casting, Acoustic Technology, Workers, Improving Engineering Environment.

## 1. Introduction

Casting is a manufacturing process by which a liquid material such as a suspension of minerals as used in ceramics or molten metal or plastic is introduced into a mould, allowed to solidify within the mould, and then ejected or broken out to make a fabricated part. Casting is used for making parts of complex shape that would be difficult or uneconomical to make by other methods, such as cutting from solid material. The Casting Industry sometimes uses a pouring process in which molten metal is poured from a ladle into a mold by tilting the ladle. Since the process involves high-temperature molten metal, the process creates a dangerous environment for workers [5].

Spin casting or Centrifugal Rubber Mold Casting (CRMC) is a method of utilizing centrifugal force to produce castings from a rubber mold. Typically, a disc-shaped mold is spun along its central axis at a set speed. The casting material usually molten

metal or liquid thermo set plastic is then poured in through an opening at the top-center of the mold. The filled mold then continues to spin as the metal solidifies or the thermo set plastic sets. The two defining characteristics of spin casting; semi-permanent (non-expendable) rubber molds and utilization of centrifugal force make the process relatively unique compared to machined die-based and expendable mold casting methods. Most spin casting is done with pewter and zinc alloys or thermo set plastics [1].

Commercial spin casting machines are available in two different types, front-loading and top-loading. Due to the weight and bulkiness of spin casting molds, front loading machines tend to offer several advantages regarding ease of use and time savings. Rubber molds can become quite heavy, especially at larger diameters and when casting metal. Because loading and unloading the caster is performed by hand, it is easiest and less fatiguing to manipulate the mold at waist level in one fluid motion as allowed by a front-loading spin caster.

*Existing Pouring Process* - The current Molten Loading system is semi-auto and need the experienced and trained operator to handling the liquid steel manually. Operator will stop the pouring process based on the sound of the liquid when the liquid has reached the sufficient level. This is a need to spend a lot of time for this system to operate, if not it will affect the quality of the product. This system, the productivity is depended to the operator skill and also will become high risk to cause are accidents.

*New Pouring Process* -An Automatic Molten Loading System for spin casting process will auto Ladler Robotically retrieves metal from Furnace Machine and pours it into the mold in a continuous cycle. Trough the Autoloader, it will save the time and work if comparing with the manually loading system. The fully automatic system is controlled by basic stamp programming to interface mechanical part and electrical part. An acoustic technology is used in the system. The pouring will automatically stop when some of the liquid pouring into vessel is captured and reached the sufficient level. When all the process is done, the ladler will automatically to home position.

Table 1 - Comparing key aspects of Spin casting, Die-casting and Injection Molding [1].

| | **Spin Casting** | **Die Casting** | **Injection Molding** |
|---|---|---|---|
| **Mold Material** | Vulcanized rubber | Machined tool steel | Machined aluminum, brass or tool steel |
| **Casting material** | Zinc, tin, lead, pewter, thermoset plastics, pattern wax | Zinc, aluminum, magnesium | Most thermoplastics |
| **Average Cost of Mold Tooling (USD)** | $35 to $250 | $10,000 to $250,000 | $5,000 to $150,000 |
| **Ability to Make Design Changes** | Easiest | Very difficult | Very difficult |
| **Typical Initial Casting Lead Time** | 4 hours to 2 days | 12 to 24 weeks | 12 to 24 weeks |
| **Casting Tolerances** | Very close | Closest | Closest |
| **Per Part Cost (ignoring startup costs)** | Very Low | Lowest | Lowest |
| **Range of Part Sizes (length or width)** | < 1/2"-12" (< 1.25 cm-30 cm) | < 1/2"-24" (< 1.25 cm-60 cm) | < 1/2"-24" (< 1.25 cm-60 cm) |

## 2. Methodology

In the early stage of this project, the literature review, survey and background study is done by means of journals, courses and conferences on the processes, properties of pouring molten metal and support in spin casting technology. The objective of this project is to capture the sound of molten metal during pouring process. Artificial neural network is used to model the system based on sound. The system will be integrated to the all machines. The testing process will be conducted to make sure all the process sequence of the machine successful run. For the Phase 1, we concentrated to Machine Design and System Operating.

## 3. Machine Design

The Autoloader is designed to enable the pouring process automatically starting from loading the molten steel from the furnace Machine and move it to the next position to pouring the molten steel into the spin casting machine. Through the Autoloader, it will save the time and work compare to the existing loading system. The knowledge in engineering design is an important element to design this machine.

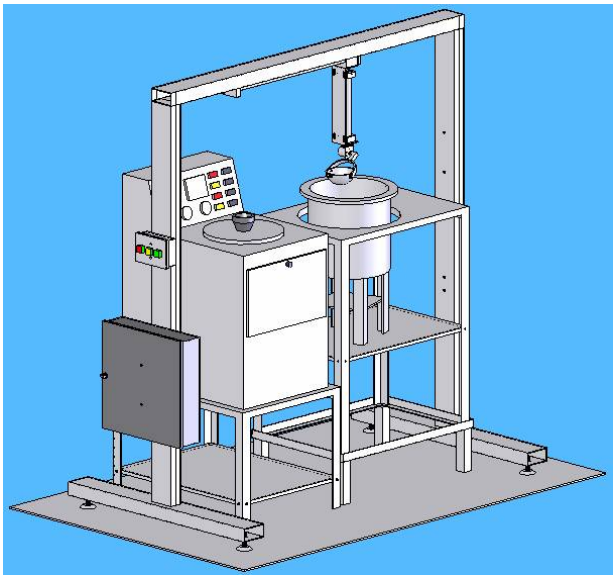

Figure 2 – Automatic Spin Casting Machine, (1) Spin Casting Machine, (2) Melting Furnace, (3) Automatic Pouring Machine.

For the System Operating, we concentrated on Electro Pneumatic System. This system is easy and helps to design a machine using standard cylinders & other components.

Control is as easy as its simple ON - OFF type control. Pneumatic systems tend to have long operating lives and require very little maintenance. Because air is compress able, the equipment is less likely to be damaged by shock. The air in pneumatics absorbs excessive force, whereas the fluid of hydraulics directly transfers force. For this machine, we used three actuator, Rod less Cylinder, Air Cylinder and Rotary actuator.

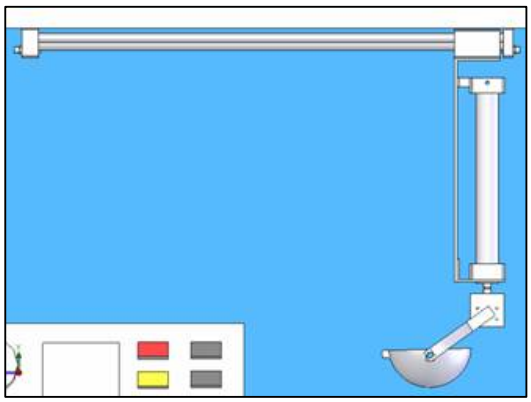

Figure 3 – Automatic Pouring Design, (1) Rod less Cylinder, (2) Air Cylinder (3) Rotary Actuator.

*Programmable Controller*- Is a digital computer used for automation for industrial processes, such as control of machinery on factory assembly lines. PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, resistance to vibration and impact[14].

*Ladder Diagram*- Is a method of drawing electrical logic schematics. It is now a graphical language which is very popular for programming Programmable Logic Controllers (PLC). It was originally invented to describe logic made from relays. The name is based on the observation that programs in this language resemble ladders, with two vertical "rails" and a series of horizontal "rungs" between them[18].

## 4. Conclusion

For the first stage, we just completed 40% from the schedule target due to component achievement delay. Component will be arrived on end of April and we target to complete this stage on May. Hence now, we already completed the machine design and fabricate the automatic pouring frame of the machine.

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