Team #18

Stellantis Lab Scale Die-Casting Machine

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Academic Mentors: Prof. Berry **Client Mentors:** Corey Vian, Neil Hurlock, and Kyler Blowers

Customer Background

Our project is being funded and supported by Stellantis. Stellantis was previously known as FCA (Fiat Chrysler Automobiles) and merged with PSA Groupe (Peugeot S.A.) to make Stellantis in December of 2019. Their brand includes names such as Dodge, Chrysler, Jeep, Ram, Peugeot, Vauxhall, and Citroen. We specifically are working with the Kokomo Die Casting plant to develop new die casting technologies. The die casting plant is the largest in the world currently and opened in 1965. They were also the first casting plant ever to receive the World Class Manufacturing Bronze Award.

Problem Statement / Scope of Work

Problem: This die casting machine in the State Farm building is old and comes with no digital monitoring or extra safety equipment. In order to improve the machine and make it more representative of a modern die casting setup, some sensors and monitoring capability need to be implemented.

The goal of the project is to acquire and implement the work that has already been completed by the previous team. This includes the testing and installation of Allen-Bradley logic controllers as well as debugging of the associated programs.

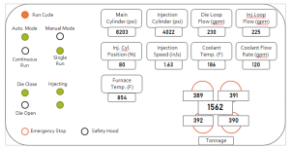
The machine's control board will be stripped down and replaced with an updated board which uses fewer physical lights. The lights will be replaced by PLC displays and readouts of machine parameters will be included in this interface.

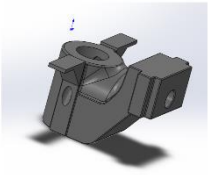
Requirements

Rep. #	Requirement	Description	Test to Verify
1	Cost	Within university & Stellantis' Budget	Total cost analysis
2	Control panel relay upgrade	The old control panel will be removed and PLC logic will replace the physical relays & lights.	Software displays values from sensors and lights.
3	Parameter recording	Sensors will be able to record strain on tie bars, hydraulic loop pressure/flow and water loop pressure/flow.	Sensors give back data that is to be expected from the process
4	Safety Stops	The machine will shut down the current process quickly and safely if stop is executed	Emergency stop command tested in PLC logic
5	Manual control	The machine should still be controllable manually for maintenance purposes.	Test PLC logic loop on simulator with manual button

Experimentation and Concepts

Example of Micro800 Series PLC



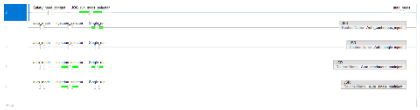


PLC Concept and Research
Originally considered Micro800 series PLCs
- Software compatibility with team computers
- Relatively inexpensive

HMI/User Interface
Initial designs also included a user interface for real-time monitoring
- Strain gauge readouts
- Hydraulic pressure readouts
- PLC software connectivity

Previous Team's Concepts
- Gooseneck redesign of the machine
- Initial sensor concepts and choices

Final Design



PLC Logic & Device
Main program switches between subroutines using panel inputs; ControlLogix 5570 used

Position/Velocity Sensor
Bracket made of 1/8" steel flat stock

Control Box Frame
Built from 1/8" steel box tube

Hydraulic Pressure Sensors
3 T-fittings and adapters for sensors

FMEA

PLC Logic Breakdown
- Missing/incorrectly entered values cause logic loop to fail or operate unexpectedly
- Machine is left unsafe – practically in an unaltered state from original

Strain Gauge Failure
- Bad communication wire or gauge variability could cause logic breakdown
- Again, lack of safety is created through unmonitored pressures
- Machine will be essentially unchanged from default without gauge monitoring

Hydraulic Flow Meter Failures
- pressure transducers installed on the hydraulic lines could fail either via communication or present a leaking issue
- if communications fail, machine is left unsafe again
- Sensors may become failure point for pressure seals/hydraulic lines

Testing

General Automation & Manual Testing			
Step	**Test**	**Details**	**Outcome**
1	Frame Stability	The fabricated frame must be able to withstand the installation of the new control box.	The frame was secured and put under load without any issues
2	Position/ Velocity Sensor mounting bracket	The bracket must be able to handle the force applied by the injection piston.	String on sensor was pulled: no flexing or failure occurred
3	Injection piston mount and connector	The bracket must be able to handle the force applied by the string without bending.	The bracket didn't flex when load was applied
4	Initial Machine functionality	The machine needed to open and close under its own power before we could work on adding sensors and brackets	The die opened and closed