Automation of Charge Chute Fans

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Vacation Work Project

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Introduction & Background

Introduction

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Beng Mechatronic Engineering

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Vacation work period:
04 December 2023 – 13 January 2023

[redacted]

Content

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- Section 1: The process flow of the Rustenburg Smelter plant
- Section 2: Automation of charge chute fans

Aim & Objective

The **aim** of this project is:

- Learn the theoretical and **practical** aspect of the process flow of the Rustenburg Smelter plant.
- Investigate the functioning and impact of charge chute fans.
- Automate the functioning of the charge chute fans.

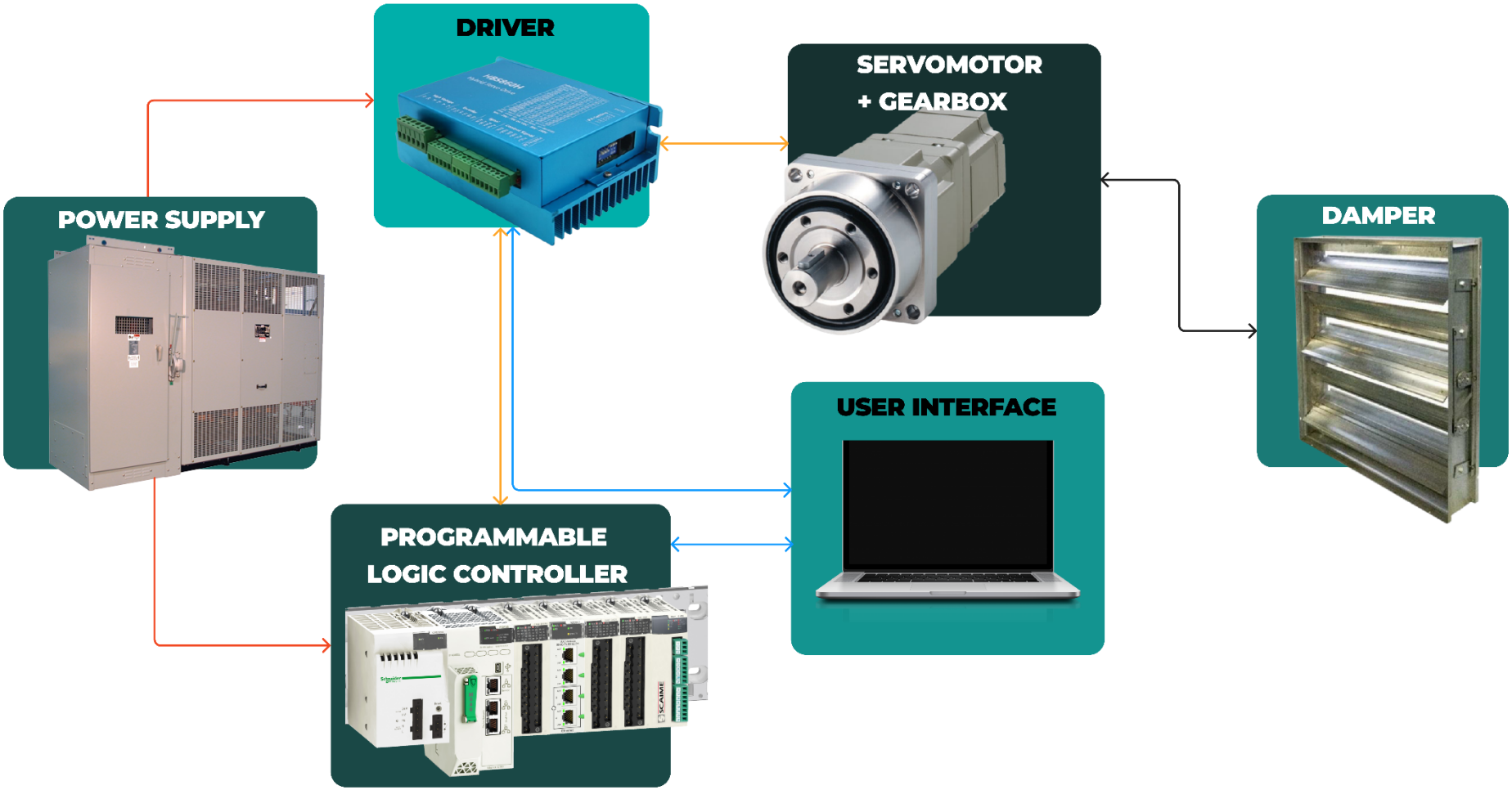
The **objective** of this project is:

- Use information gathered to develop a better solution to proposed problem.
- Design and manufacture a system that will automatically switch between the charge chute fans.
- Identify best method for actuating the damper lever.
- Design and implement a control system and user interface using PLC technology.

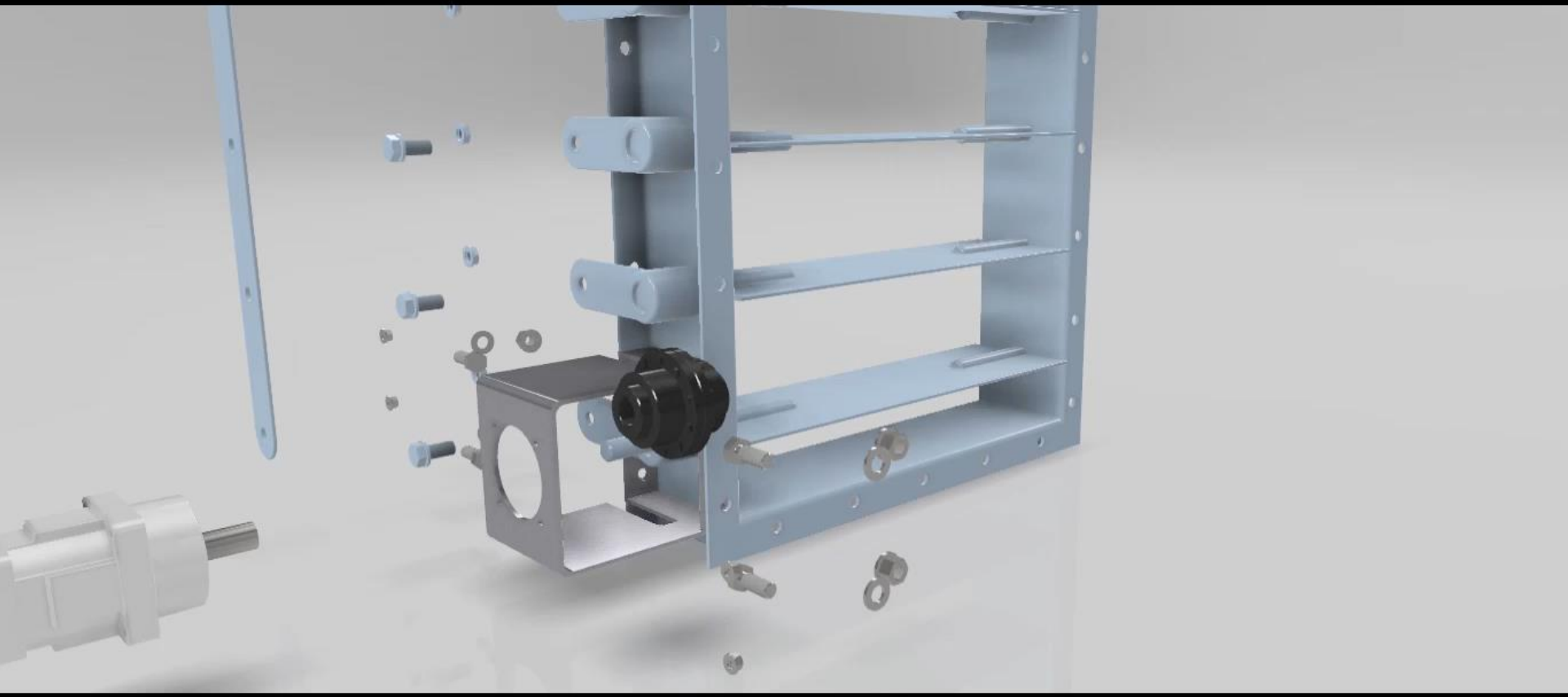
Section 1: The process flow of the [redacted] Smelter plant

Section 2: Automation of charge chute fans

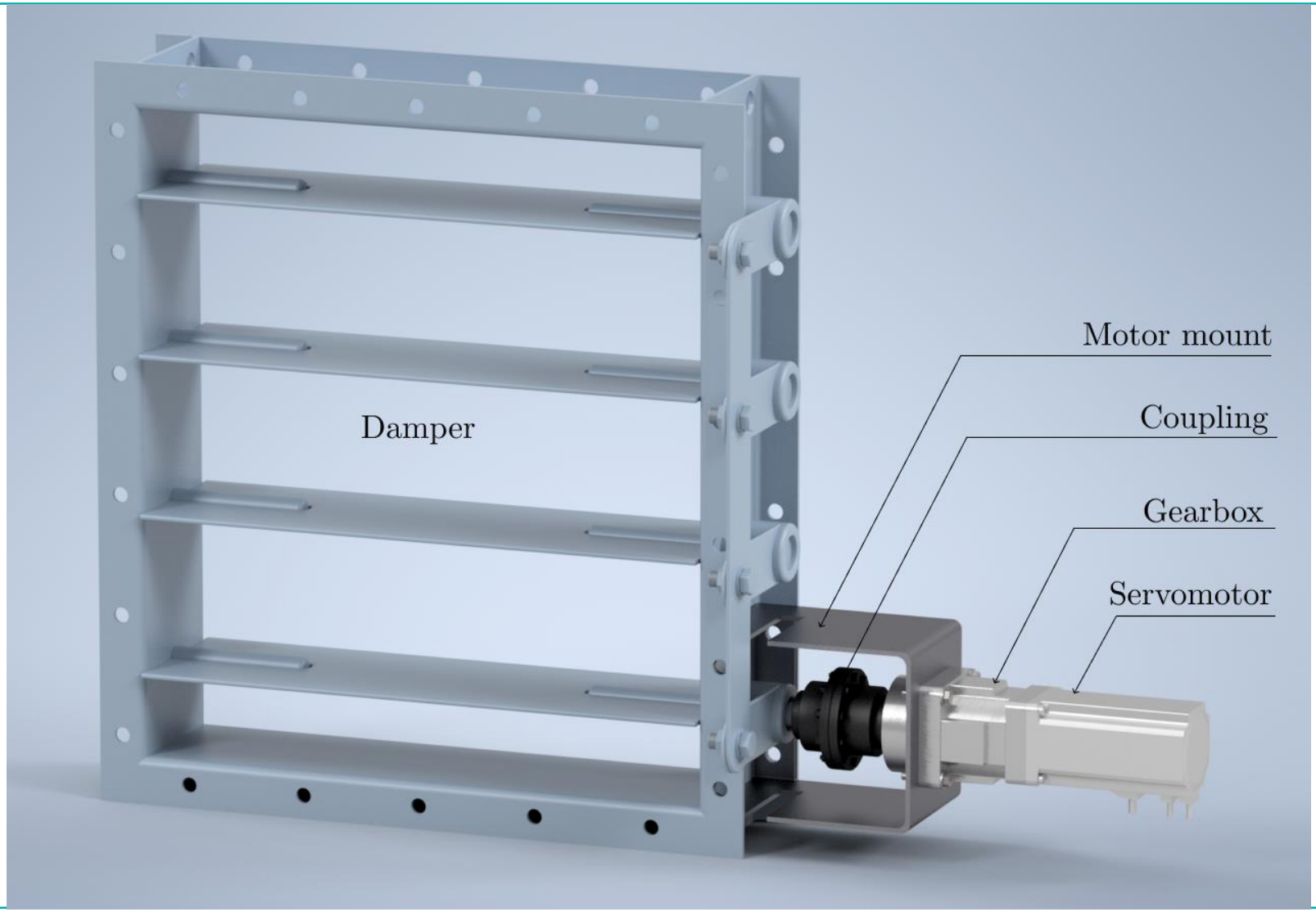
System Level Block Diagram



Final Concept: Assembly

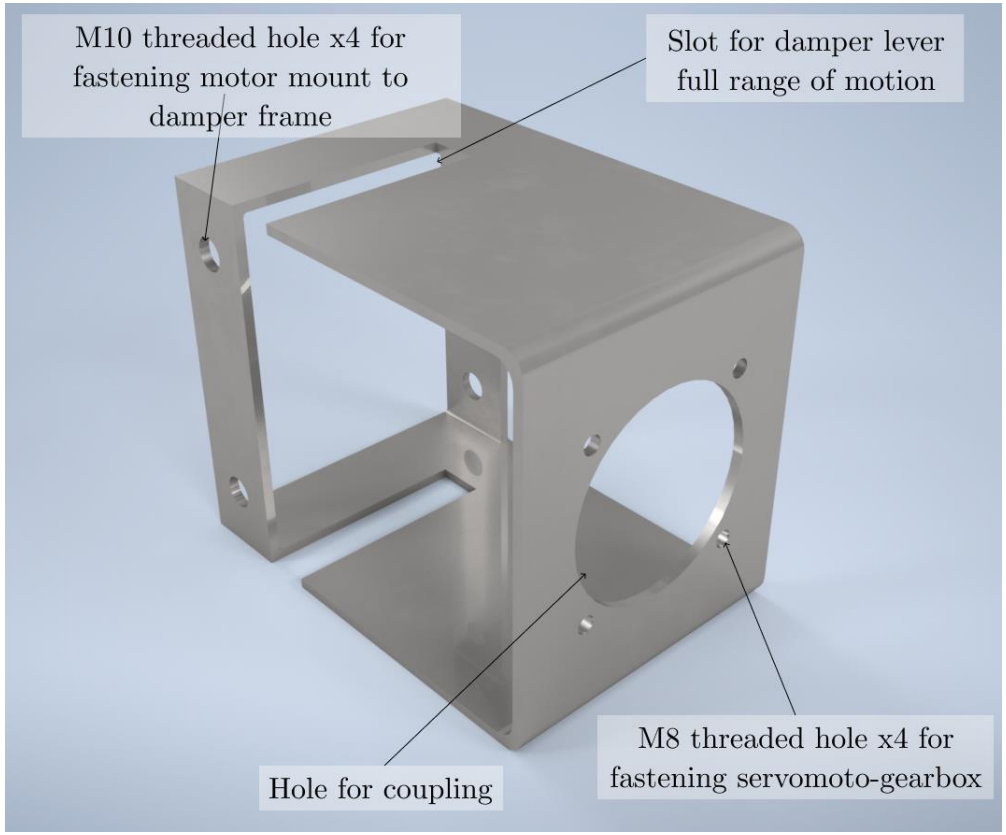


Final Concept: System Overview



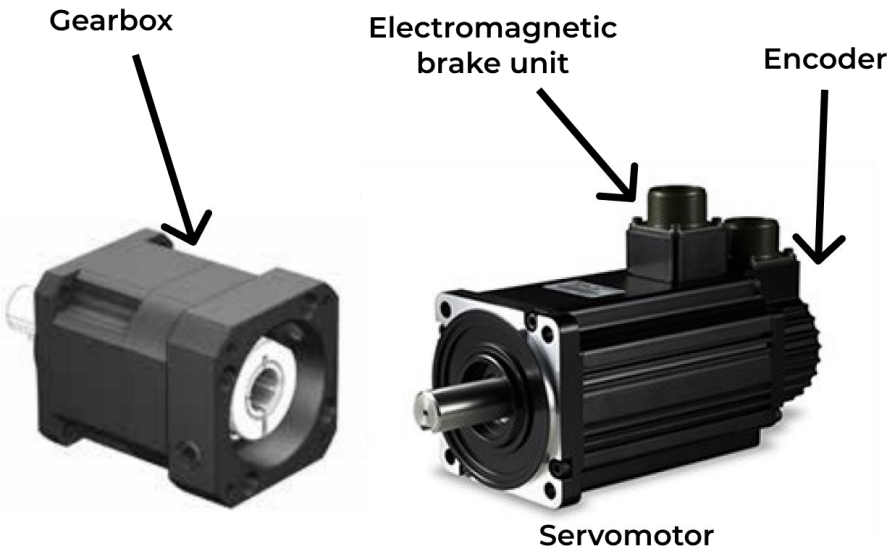
Final Concept: Motor Mount

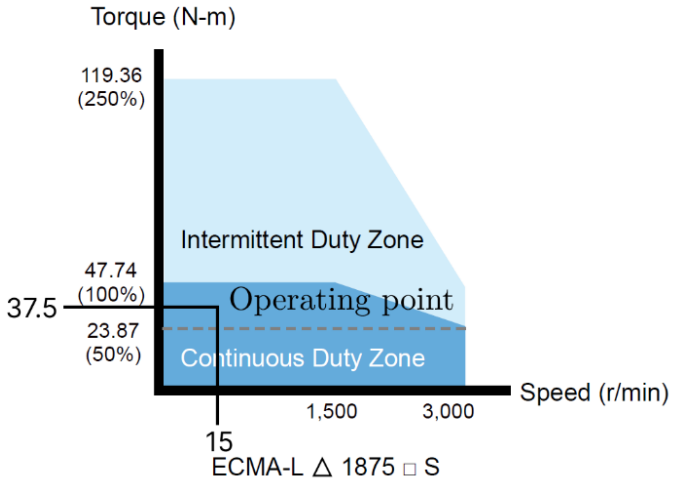
- Four M10 holes –allow mounting motor to damper frame
- 25 mm wide and 110 mm deep slot – allow damper lever motion
- Four M8 holes – allow mounting of the servomotor and gearbox
- 100 mm diameter hole – allows motor-gearbox peripheral to fit while motor is mounted
- Material used is mild carbon steel
- Significant deflection of 0.392 mm can be improved



Final Concept: Servomotor + Gearbox

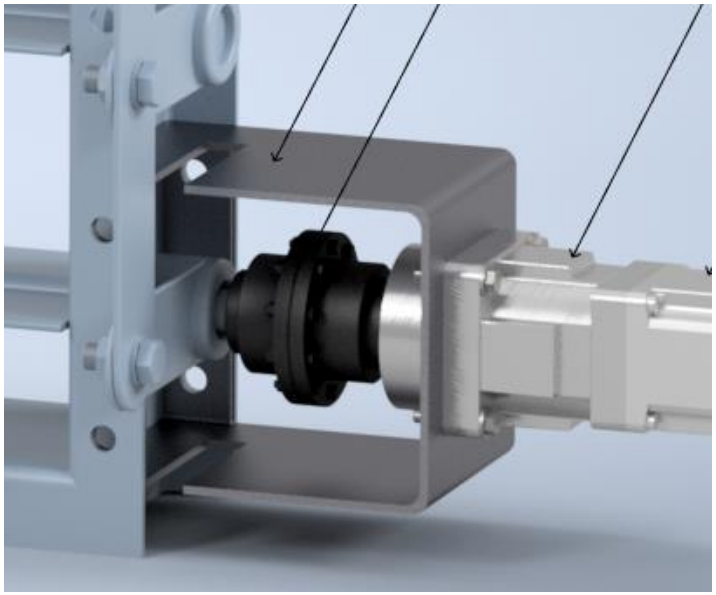
- Desired speed : min. 15 rpm
- Desired torque: min. 370 Nm
- Gear ratio: 10
- Reduced desired torque : 37 Nm
- **ECMA-LA1875S3** motor model + gearbox manufactured by Delta Electronics.
- Rated at 7.5kW, 400V
- Motor Nominal torque: 47.74 Nm
- Motor Nominal speed: 1500 Nm
- Speed range: 0 to 3000 rpm





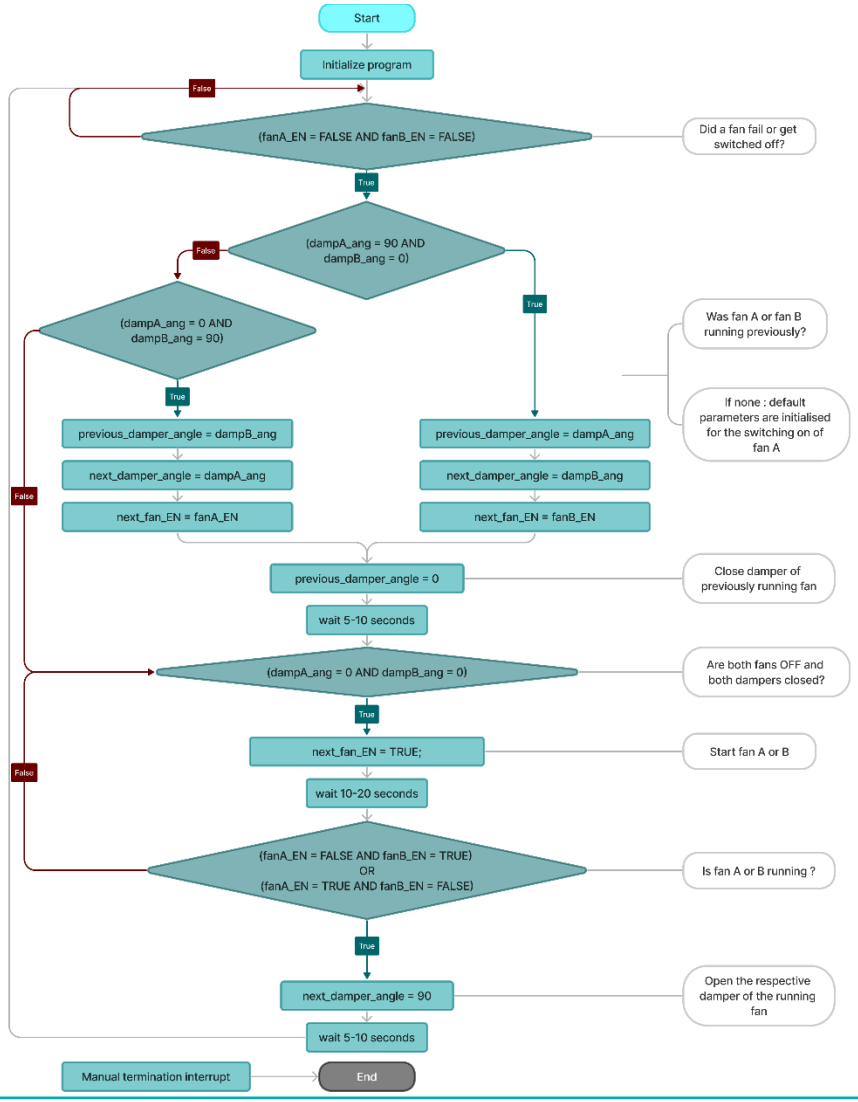
Final Concept: Coupling

- Coupling required to transmit approximately 54 W of power
- Spiderflex coupling: torsionally flexible, damped system vibrations, accommodates misalignment.
- **RSC150 (644915)** Spiderflex coupling manufactured by Renold Couplings
- Rated power transmission – 6.78 kW
- Nominal torque - 600 Nm
- Maximum speed rating – 3600 rpm



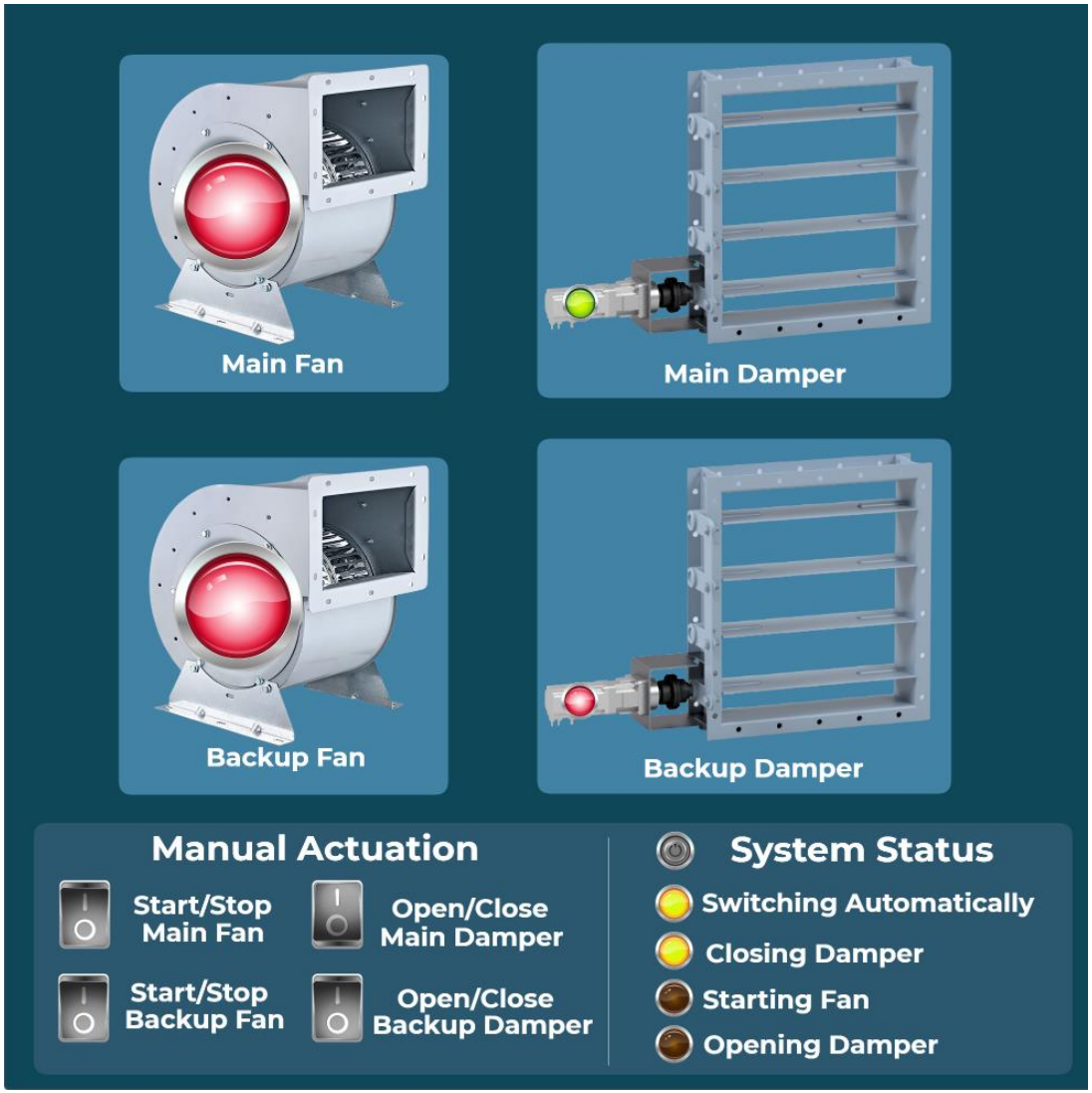
Control System

- Checking the status of each damper and fan
- If fan fails or is manually switched off during normal furnace operation
- Logic identifies the failed or switched off fan
- Closes damper of failed or switched off fan
- Sequentially starts other fan – while all dampers closed and waits to prevent high start up currents.
- Lastly opens damper of running fan.

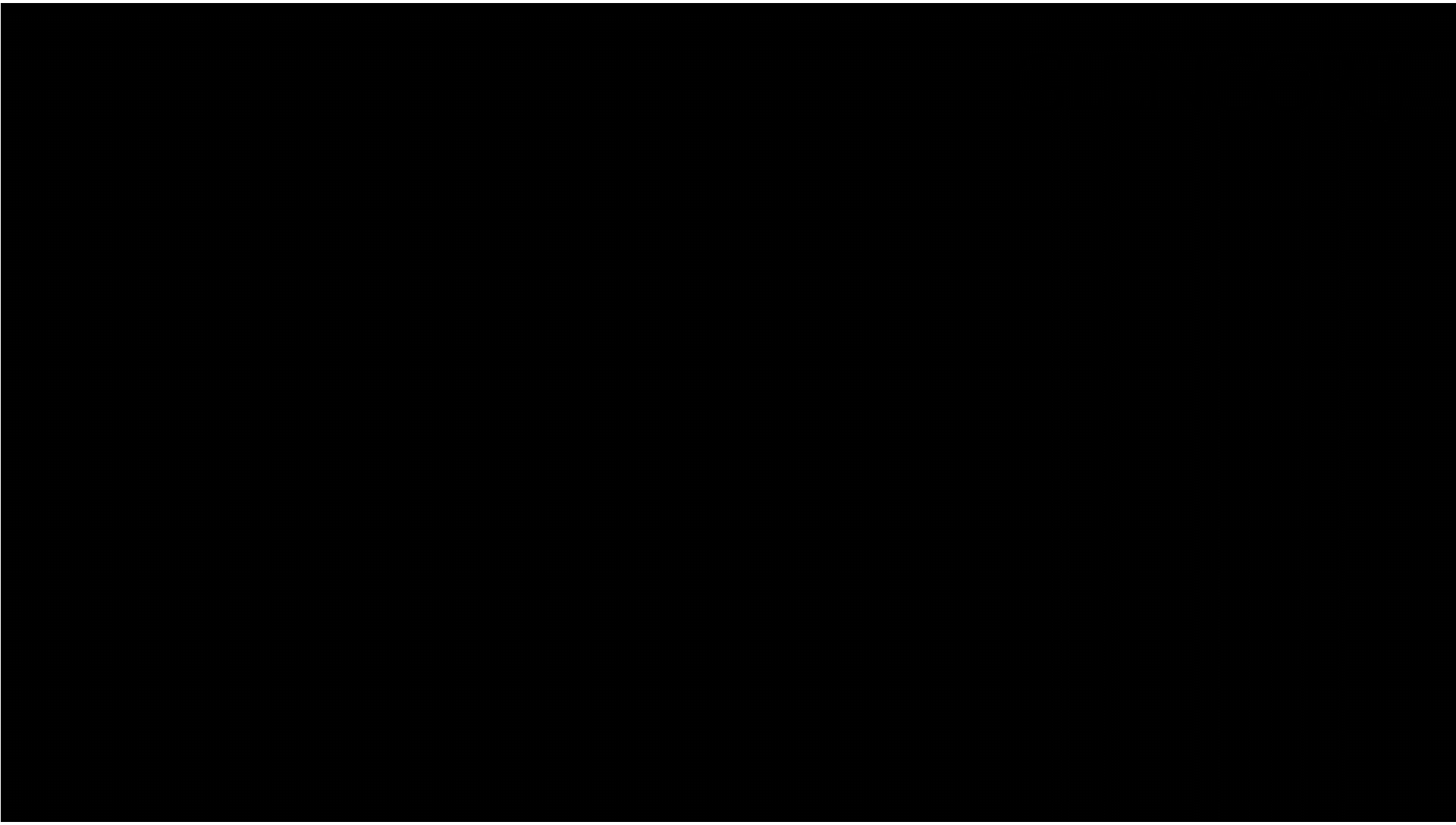


User Interface (UI)

- CODESYS – programming platform
- Implemented using ladder logic
- Visualization/UI implemented on CODESYS
- Dashboard showing state of charge chute system
- Manual control
- Automatic control



Testing: Control System + UI



Conclusion

- All the objectives - until the design stage - were met.
- The next stage would be to get quotation, order parts, build the device and test it before deploying it for full operation in the plant.
- Project contributions:
- Reduce delays – optimizing the change over process.
- Eliminate mistakes – sequential control system
- The project is critical for production.

Recommendations

- Improve structural rigidity of motor mount design by adding some structural reinforcement such as triangulation or cross-bracing to prevent deflection
- Use actual experimental data, and damper specifications or measurements to find a more accurate torque value.
- Improve motor selection by using different motor-gearbox combination, a smaller motor and larger gear ratio.
- Further testing of the control system is recommended checking for all possible scenario's and observing the behavior of the system, then adapting the code to eliminate any logic discrepancies if any are present.

Thank you

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