



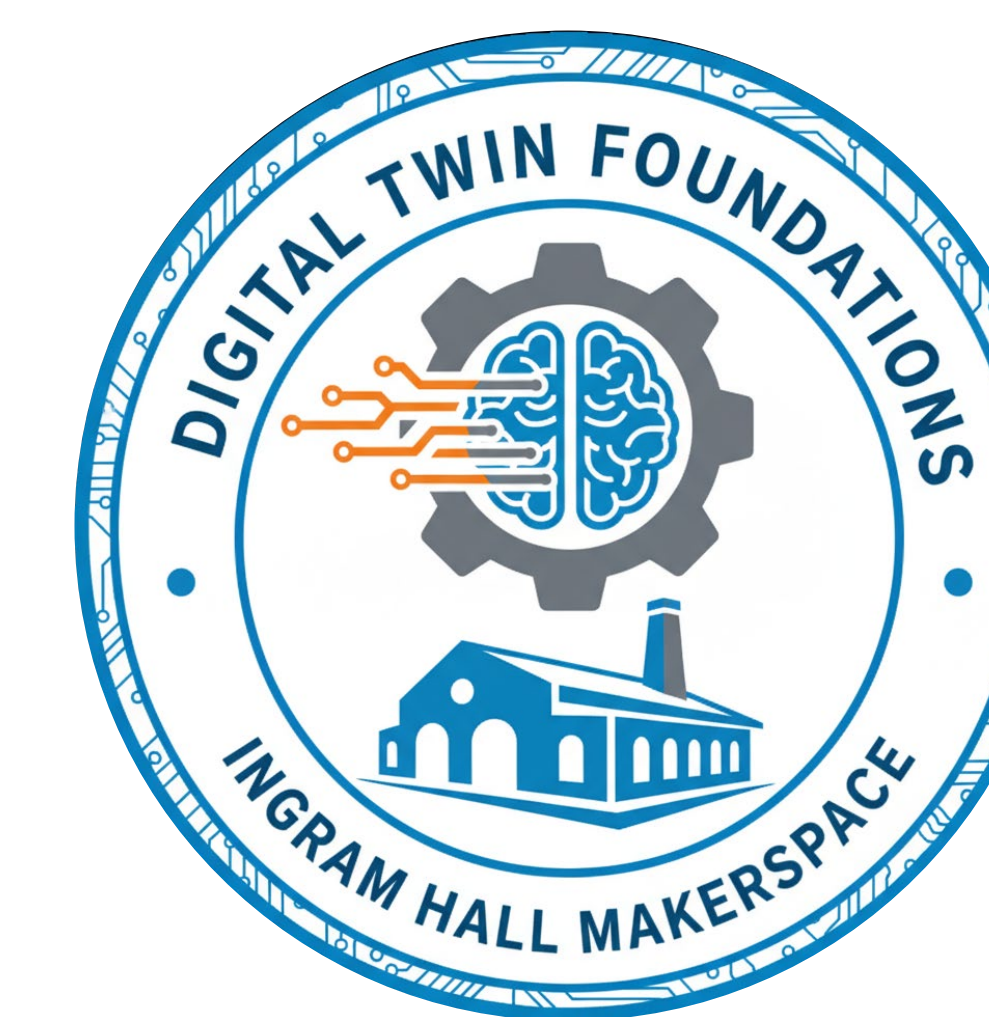
TEXAS STATE UNIVERSITY

Ingram School of Engineering

Group M.05 - Digital Twin Foundations

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Digital Twin Foundations for Ingram Hall's Makerspace



Project description

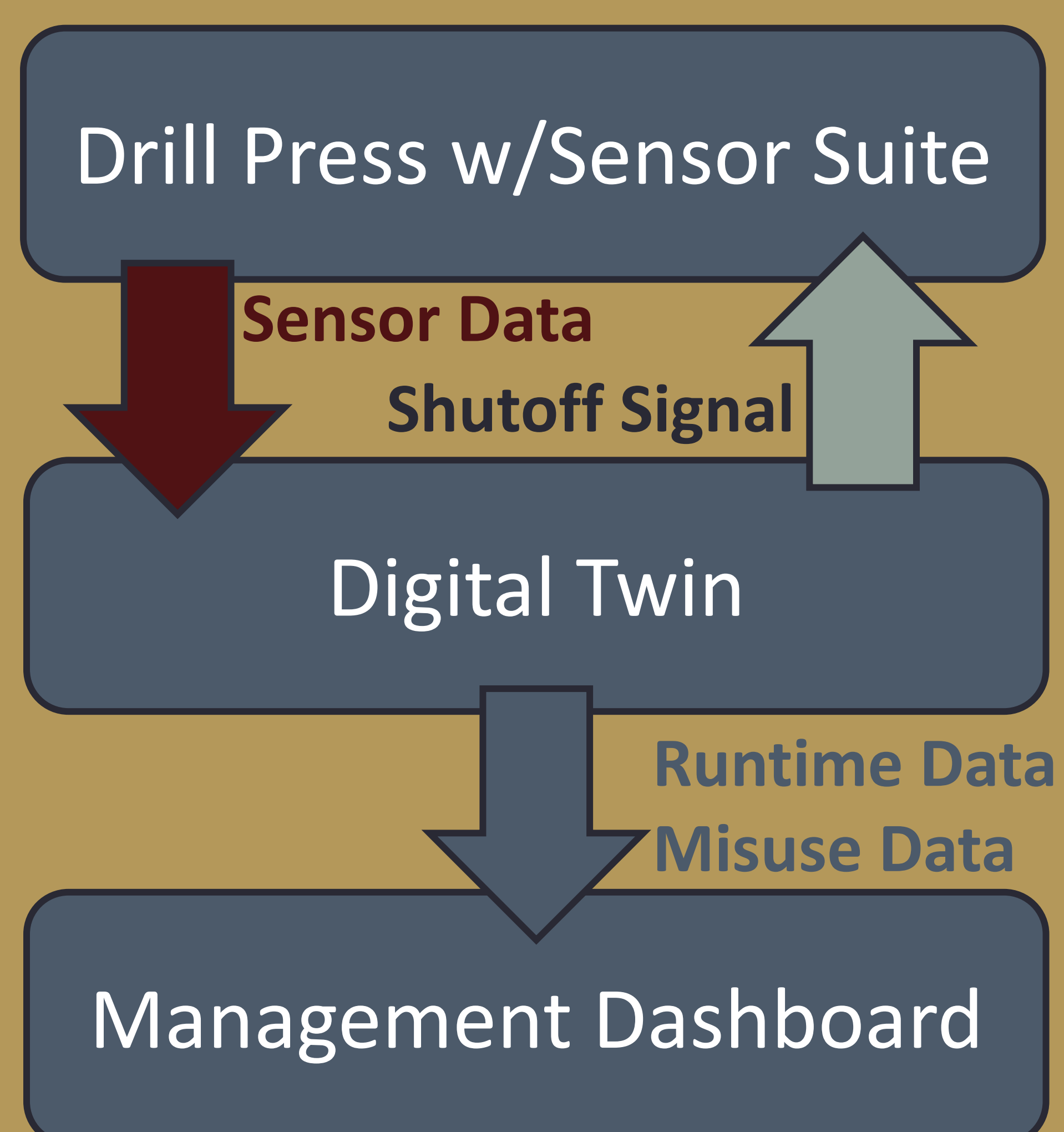
The Ingram Makerspace currently lacks real-time visibility into how its manual machines are used. This project creates a low-cost digital-twin foundation for these machines, starting with the drill press.

The system aims to achieve two core functions:

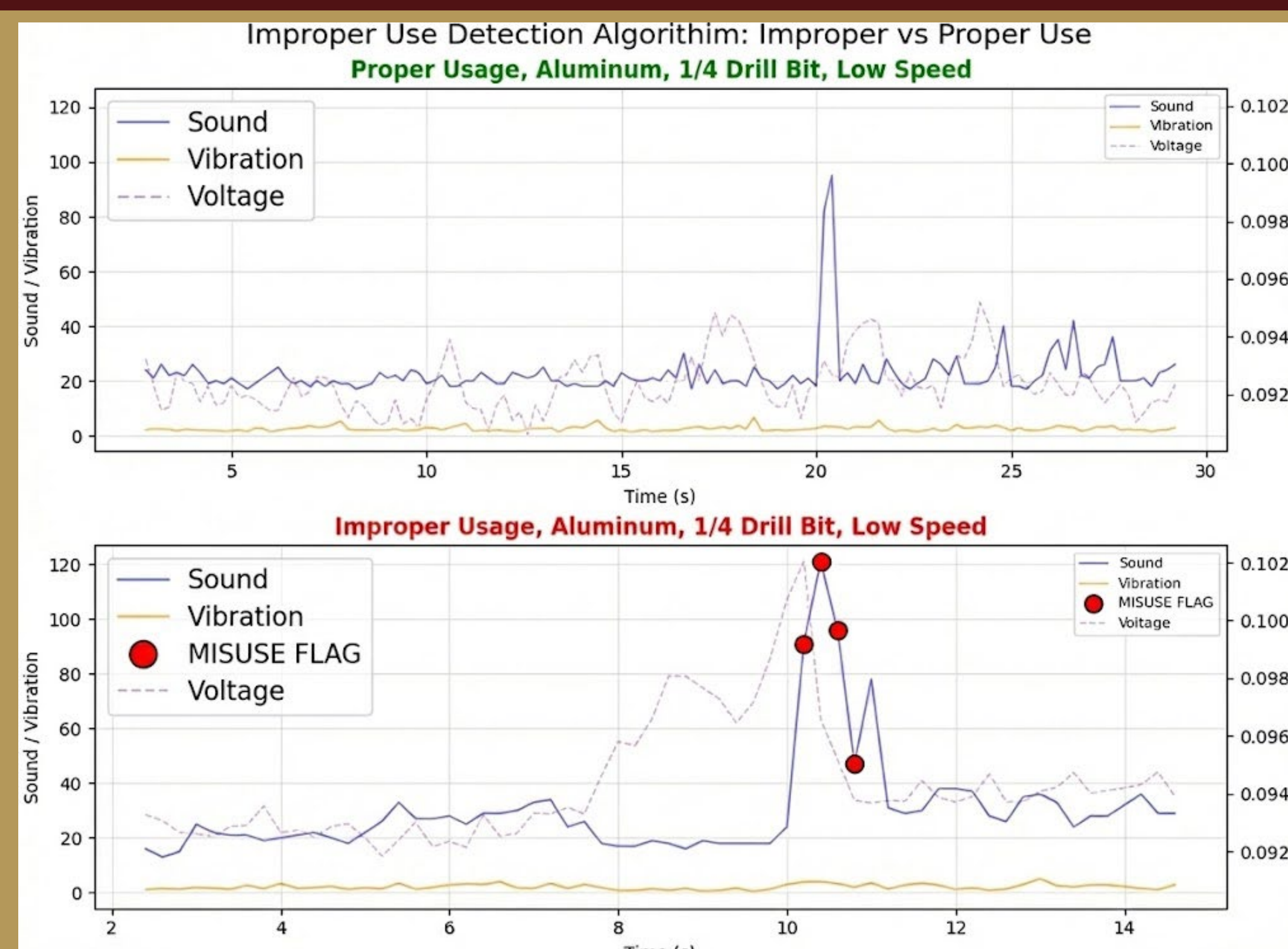
- A live dashboard that tracks machine usage from sensor data
- Automated misuse detection that triggers an electrical shutoff when abnormal signals occur

This pilot project also enables future expansion to other makerspace equipment.

System Architecture



Tests and Results



Detection Algorithm Initial Success:

Graph shows proper and improper data streams from drill press using the same scale

Our algorithm is in its early stages, but it builds a baseline for sensors readings and detects when they are at unsafe levels

Defining 'Misuse' vs 'Proper Use'

Mainly, our tests are defined as:

Misuse = Not Pecking
Proper Use = Pecking

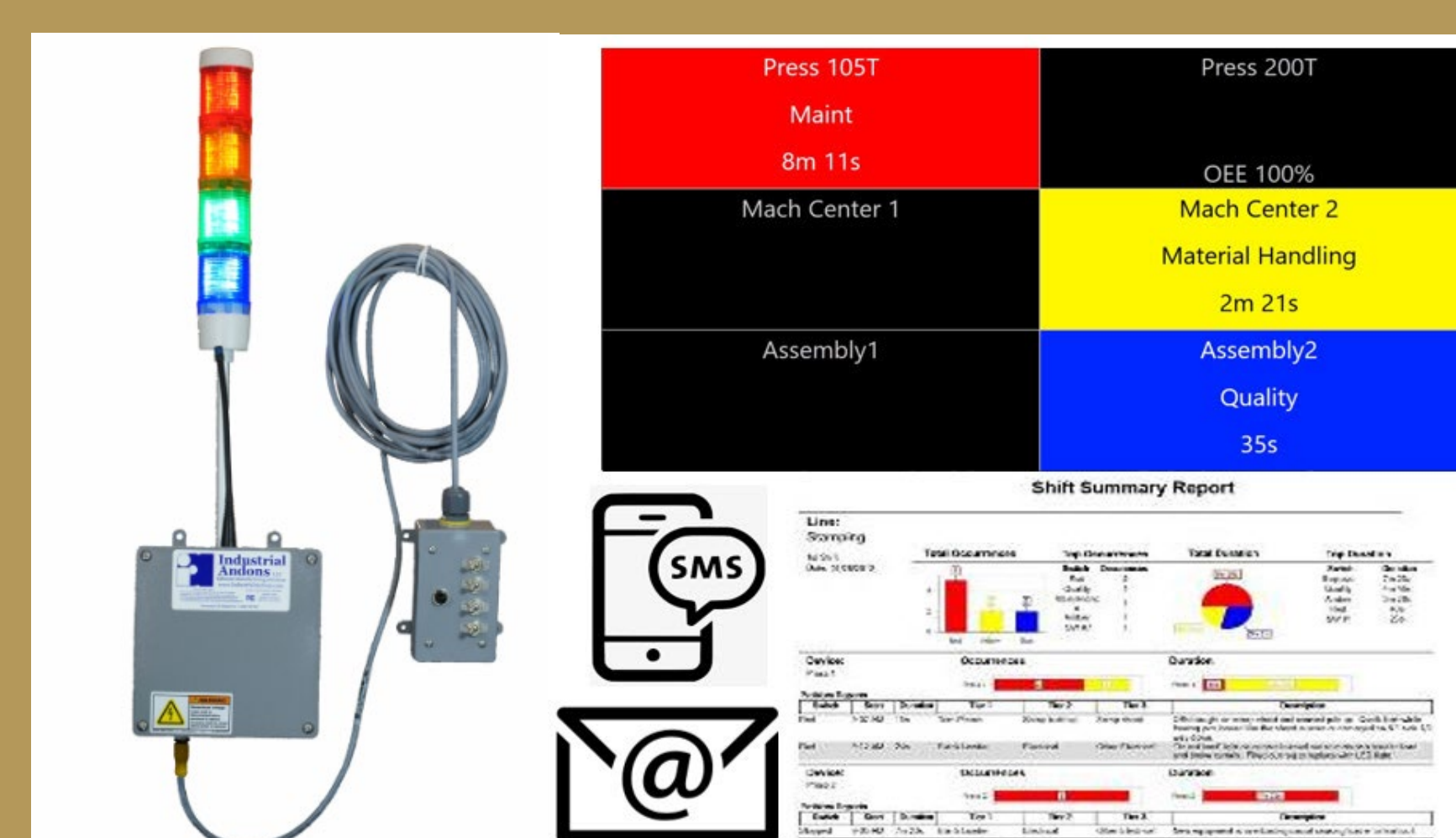
When drilling metal, pecking is important for a multitude of reason. This is the most common misuse case and the one we are focusing on currently. We aim to detect other types of misuse such as an overheated drill bit or



Programming Languages Used

Moving Forward

- Continue to work on algorithm for detection of misuse that is high accuracy, applicable to other machines and loadable onto a PLC controller
- Build out our electrical shutoff box, which will power the entire computer system and handle automatic shutoff of mis-used machines



- Integrate out system with the Andon and SFV (Shop Floor Viewer) Software courtesy of Industrial Andons for our dashboard and usage-tracking

Rework

We faced numerous setbacks on implementation mainly relating to

- Incorrect sensor selection, continuous signals instead of digital were needed. We changed some sensors out mid-project
- Parsing sensor signals properly in through Arduino C++ Code
- Developing a functioning algorithm to detect misuse from sensor data

Possible applications

The key of this project is it turns manual machines into modern, sensor packed machines. We can use this system on manual equipment in the makerspace to have digital twin dashboard representations of:

- Manual Mills & Lathes
- Bandsaws
- Table Saws

Team



- Team: Will West & Luke Frederick
- Project Sponsor: Abhi Sharotry
- Instructor: James Davison