



Executive Summary

The University of Texas at Arlington is developing a mobile Lean Innovation and Continuous Improvement Lab to deliver hands-on, industry-aligned training across the Dallas–Fort Worth region. Built in collaboration with nationally recognized universities, the lab features a LEGO-based aircraft manufacturing simulation that mirrors the growing aerospace sector in North Texas. This platform enables students, faculty, and industry partners to practice Lean principles, systems thinking, and data-driven problem-solving through activities such as continuous improvement, waste analysis, and workflow optimization.

This project also finds key improvements in layout and work-line balancing for future students to explore in a future Lean course.

Background

Project

This project focuses on developing a mobile Lean Lab at UTA to support experiential learning in industrial engineering. Through a LEGO-based assembly simulation, users can evaluate system performance, identify waste, and apply Lean tools such as line balancing, standardization, and process optimization.

Why Lean Matters:

- Reduce waste in processes
- Improve efficiency and productivity
- Enhance product quality and consistency
- Improves workflow and overall system performance

Key Features

- Mobile and portable lab setup
- Interactive, hands-on learning environment
- Scalable for classroom and industry use

Target Users:

- Industrial, manufacturing and system engineering students
- Faculty and researchers
- Industry partners and community programs

References

Auburn University. Tiger Motors Lean Manufacturing Laboratory.
Samuel Ginn College of Engineering.

Coursework: IE 4344, IE 4340, IE 4339, IE 4308, IE 4343, IE 3343

DMAIC - Define

Problem Statement:

Construct a simulated LEGO aircraft assembly line for future use as an IMSE Lean Lab, identifying key factors of process improvement for curricula.

Table 1. Stakeholder Matrix

Stakeholders	Power	Legitimacy	Urgency	Type
Dr. Rahman	High	High	High	Definitive
IMSE Department	Medium	High	Medium	Definitive
Students	Low	Medium	Low	Dependent
Industry Partners	Low	High	Low	Dependent

Figure 1 shows the current set up for the Mobile Lean Lab, a portable pegboard, supported by 3-D printed inserts, transferrable from classrooms and third-party demonstrations. ABET engineering standards for budget limits, scheduling, portability, material replacement, and human factors of were also considered for the design of the system.

Stakeholders defined in Table 1 define the requirements for the system. While students and industry will use the system, Dr. Rahman and the IMSE department define the constraints and curriculum direction that the project should take.



Figure 1. Assembly Line Design

DMAIC - Measure and Analyze

To determine baseline cycle times for each workstation and the entire assembly process, a 10-minute production run is conducted. Time spent working is documented in Figure 1.

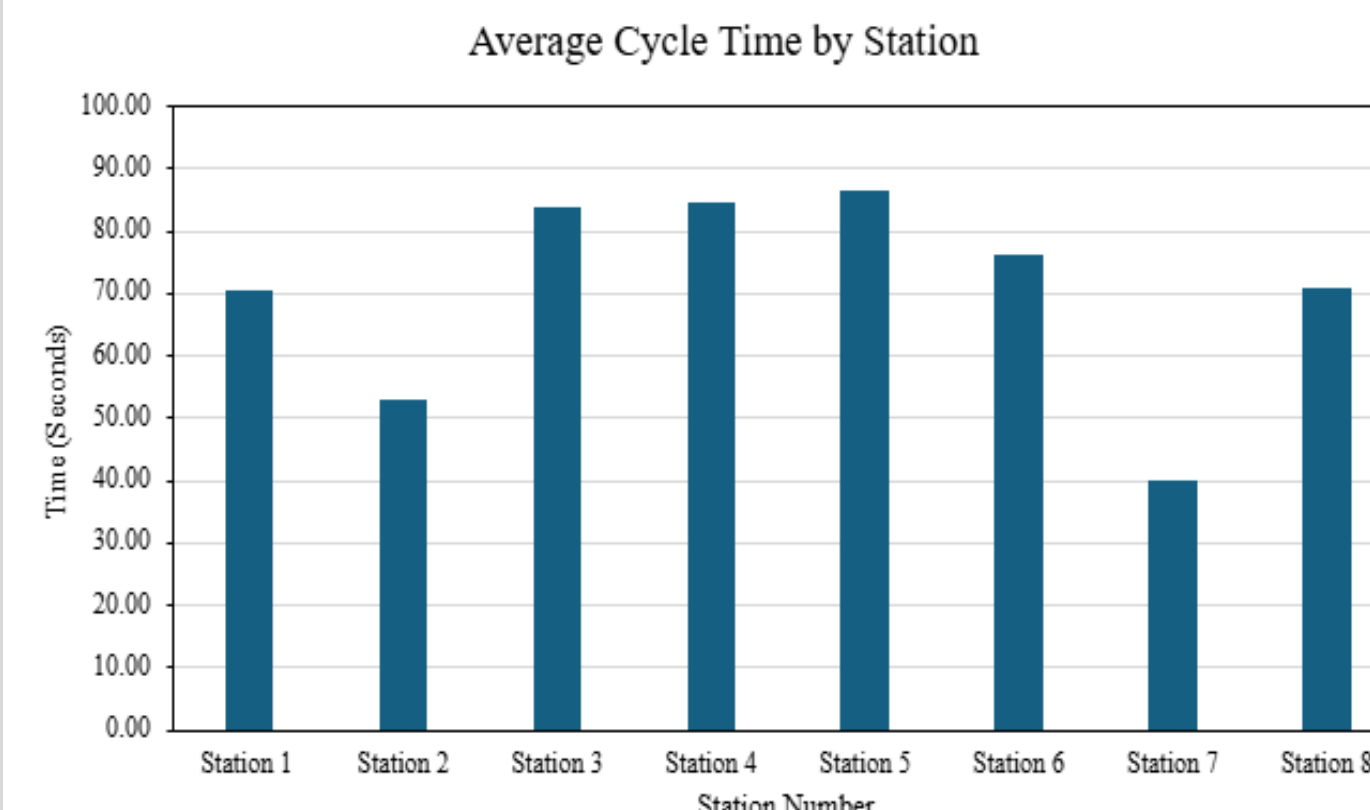


Figure 2. Average Station Cycle Time

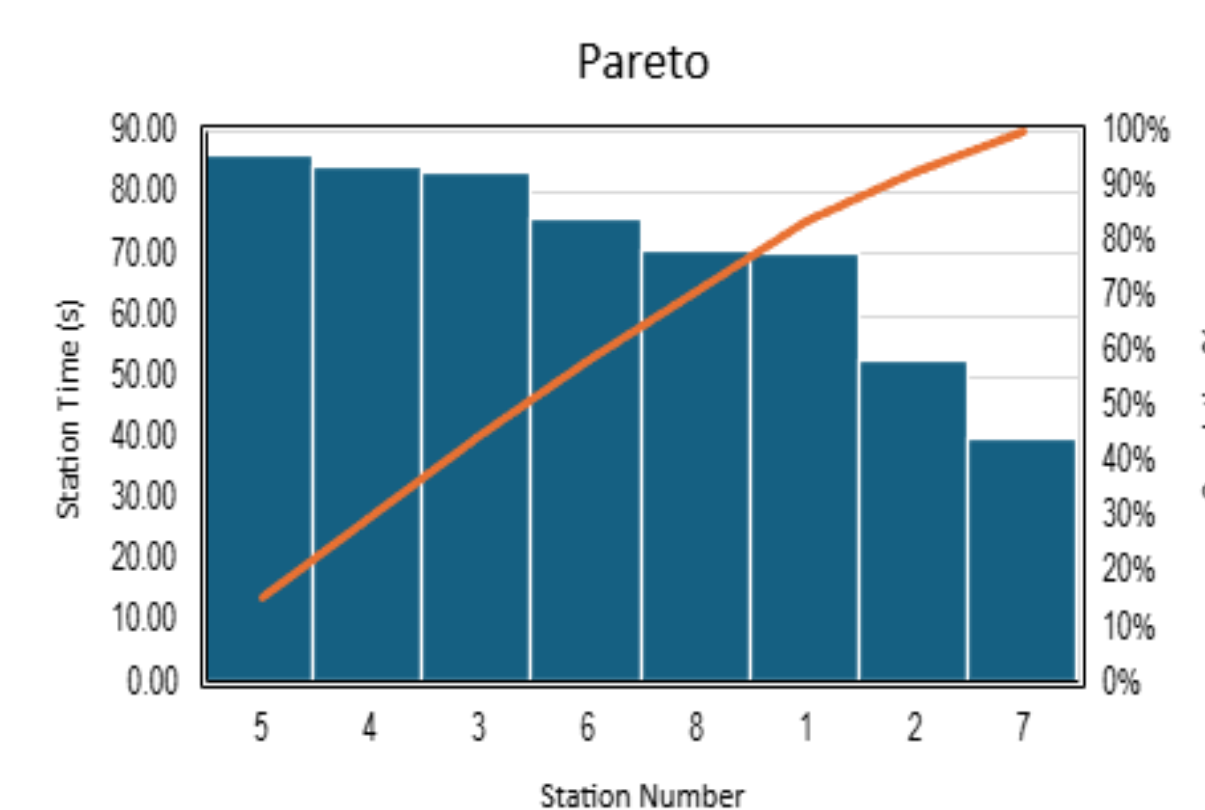


Figure 3. Station Pareto Chart

Stations 3, 4 and 5 have the highest cycle times, and stations 7 and 2 are underutilized, having lots of downtime. While stations are separated by sequential building steps in the LEGO instruction booklet, distributing parts equally may reduce the idle time for underutilized stations

Quality issues were observed during the assembly process, including incorrect placement and loose parts. Two similar curved white parts switched placements during assembly, as shown in Figure 3.

The part bin layout was a source of pain for lots of these issues. Incorrect part placement occurred since both white parts were placed within the same bin. Additionally, bins were not placed in the sequential order of assembly for a station. This additional time locating a part could be eliminated from placing bins in order according to their steps.



Figure 4. Incorrect (right) and Correct (left) part placement

DMAIC – Improve

Improve Phase Summary

- Established a reliable baseline for assembly line performance
 - One worker assigned per station
 - Ensured consistency in working pave, timing methods, and WIP management
 - Collected baseline performance data

Improvement 1: 5S – Sort, Set in Order, Shine (Workstation Organization)

- Allowed workers to organize LEGO bins based on personal workflow
- Bins rearranged on pegboards for better accessibility
 - Organized by sequence
 - Smaller/ detailed parts placed in easier-to-reach positions

Results:

- Increased production output
- Decreased defects in final production

Improvement 2: Line Balancing

- Redistributed work from high-utilization stations to high-idle stations
- Applied Lean line balancing principles to equalize workload
- Identified key constraints
 - Some tasks could not be reassigned due to sequence or part accessibility limitation
- Results:
 - Same number of jets produced
 - Defects reduced to **zero**

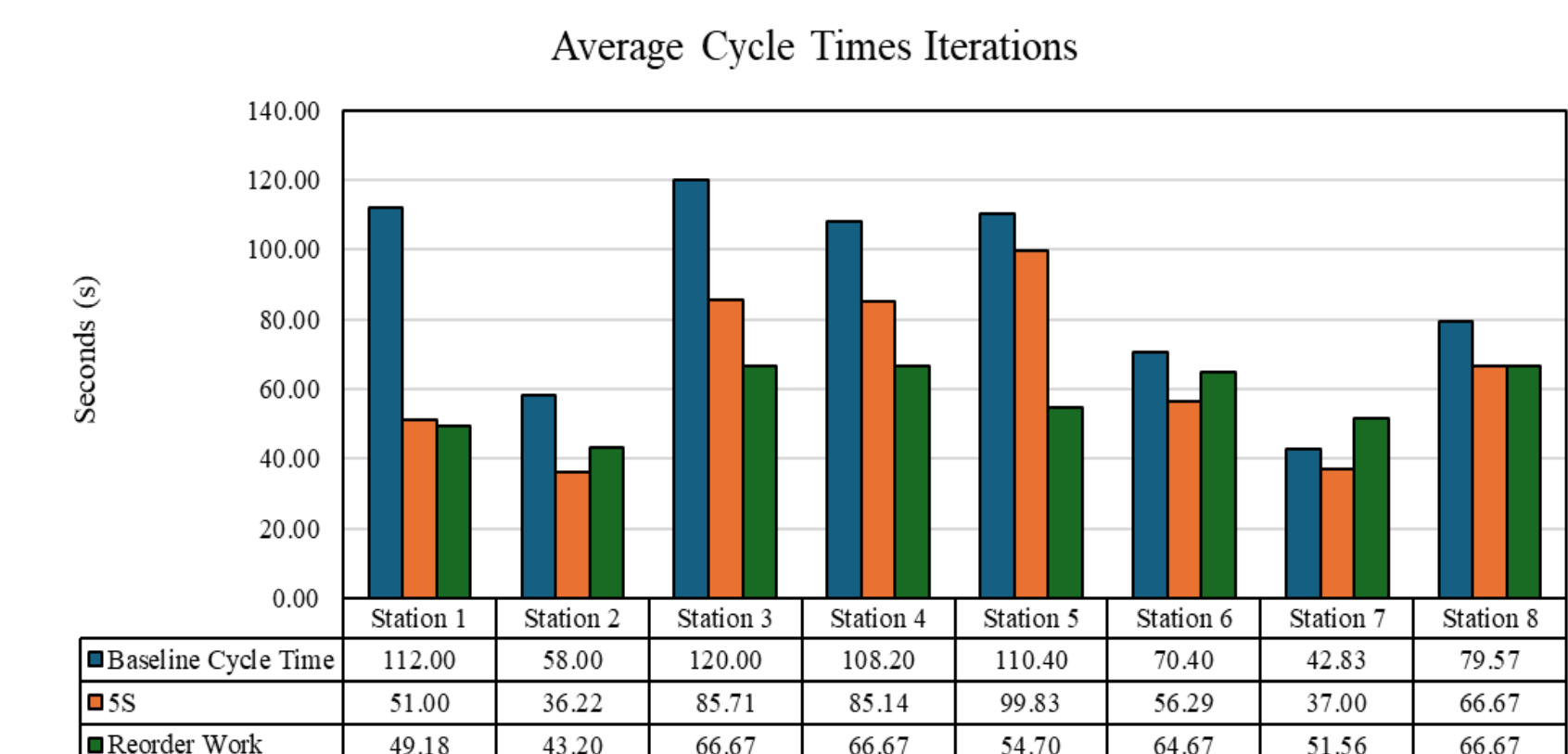


Figure 5. Average Cycle Time Iterations

Control and Future Work

As we move into the final stages of the project, the team has two remaining iterations planned to refine both the permanent and mobile Lean Lab designs. These iterations will focus on redistributing work more efficiently across team members to accelerate progress while ensuring that each subsystem layout, workstation design, curriculum materials, and mobility features receive dedicated attention. A key enhancement in these final cycles is the integration of quality control measures, including standardized inspection checklists, clearer build instructions, and controlled inventory procedures to reduce variation and prevent missing or damaged LEGO components. These improvements will allow us to validate the consistency, repeatability, and instructional reliability of the simulation before final deployment. The remaining iterations will also help confirm that the lab meets stakeholder expectations, aligns with ABET standards, and is ready for long-term instructional use.