Midwest Textiles – Process Optimization

Midwest Textiles – First Break and Unloading

Andres G. Gonzalez Fitch
Arturo Torres
Daniel Villalobos

Senior Design (IE-4266)

12/04/2025

Team Members

Andres G. Gonzalez Fitch

Simulation and modeling

Arturo Torres

Expertise in material handling

Daniel Villalobos

Project Analysis & Content Development

Introduction

Mid-West Textile LLC

Mid-West Textile LLC is one of the largest textile recyclers in the U.S.

Used clothing markets outside the U.S. handle around 30 million lbs. annually, with Mid-West Textile contributing to exports reaching countries in Africa, the Caribbean, Central America, Eastern Europe, Pakistan, India, SE Asia, and South America.

In El Paso, TX, Mid-West Textile operates three main distribution centers:

- Cotton
- Paisano
- San Antonio

UTEP

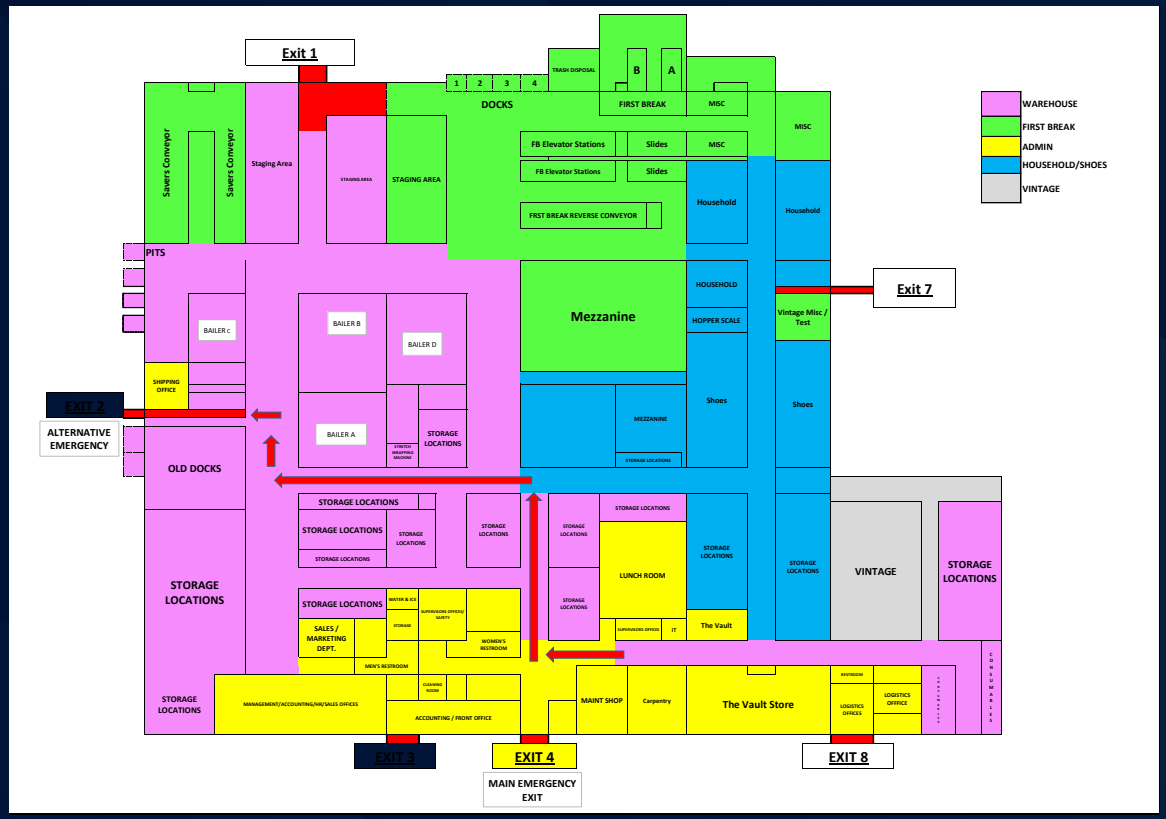
Background

Mid-West Textile LLC specializes in **sorting, recycling, and repurposing textiles** across multiple departments.

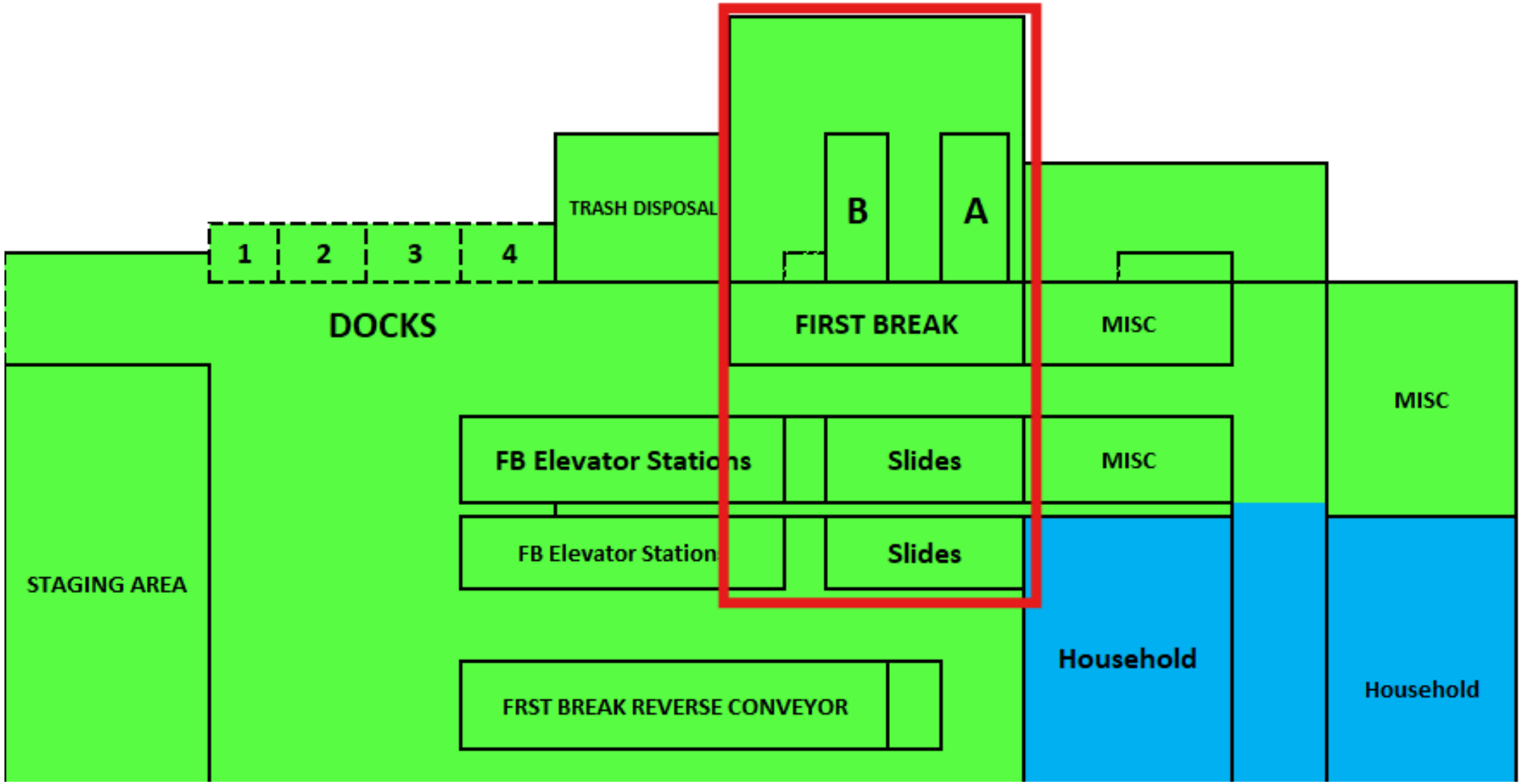
Used items are often delivered to donation centers trough a plastic bag with a variety of items, not only clothing in where companies like Mid-West Textiles LLC find the opportunity to sort donations and distribute it to wholesalers.

Mid-West Final Products

Layout



San Antonio Distribution Center counts with 113,600 ft^2. It is divided by warehouse, first break, admin, household/shoes and Vintage areas.

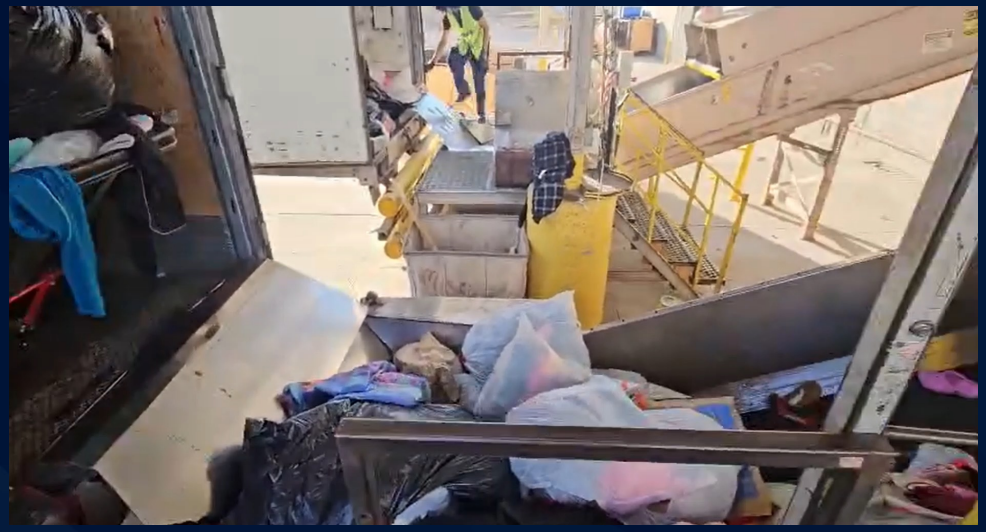

TRASH DISPOSAL
B
A
1
2
3
4
DOCKS
FIRST BREAK
MISC
MISC
FB Elevator Stations
Slides
MISC
FB Elevator Station
Slides
STAGING AREA
Household
Household
FRST BREAK REVERSE CONVEYOR

The Problem (Top View)

Material handling

The Problem (Floor View)

Unloading



Sorting

Problem Statement

The current unloading process for textile donation trailers shows **imbalanced material flow and inefficient.**

Unbalanced loading of material handling system

- The **diverter arm** prioritizes the short slide (1:3 ratio), causing uneven workloads between workstations.
- The **conveyor (long side)** remains underutilized (~66% use) while the **slide station** becomes overloaded.
- Trailer unloading averages **5–8 hours**, extending shift durations and limiting throughput to **≈2.6 trailers/day.**

Problem summary:

Unbalanced flow and outdated PLC logic reduce unloading efficiency, increase idle time, and prevent full system utilization.

Problem Objective

Develop a **simulation-based improvement strategy** to optimize unloading and material movement efficiencies through logic reconfiguration and flow balancing.

Company goals

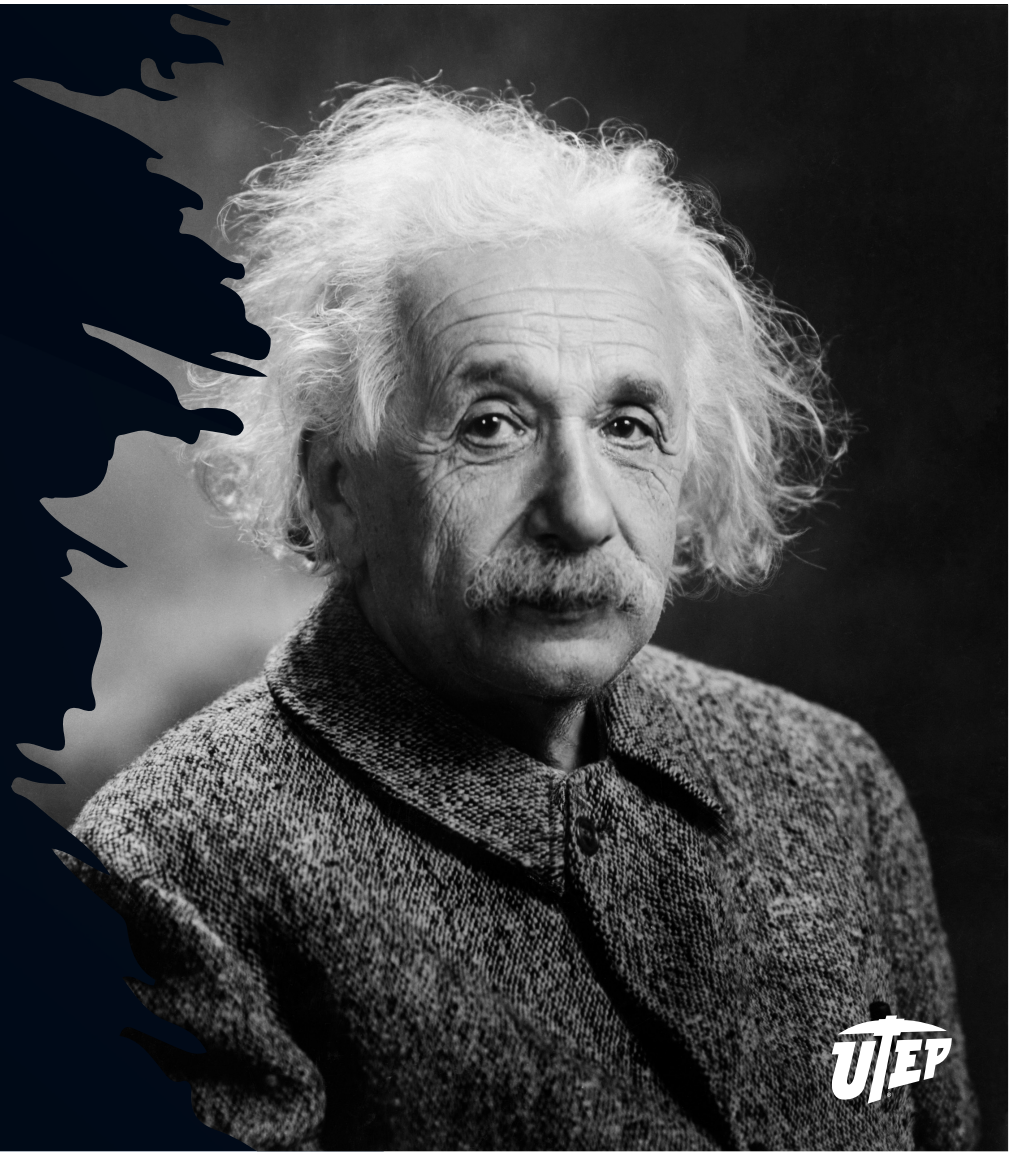
- Balance flow between slide and conveyor (target 1:1 ratio).
- Reduce trailer unload time by at least 20%.
- Increase conveyor utilization to 95% and eliminate idle periods.
- Maintain safe operation by ensuring conveyor movement is always attended.
- Validate improvements through simulation before physical PLC implementation.

Project Constraints

- **Fixed equipment layout:** conveyor and slide positions cannot be modified.
- **Constant motor speed (60 Hz):** conveyor speed is not adjustable.
- **Limited staff:** only two unloaders and four sorters (two per workstation) in a dock.
- **Operational window:** 8-hour shift (goal: reduce unload time without extra labor).
- **Trailer capacity:** fixed at ~1,500 bags per 53-ft trailer (~45,000 lb).
- **PLC logic change only:** physical modifications or automation upgrades excluded.

“A problem cannot be solved from the same level of thinking that created it.”

~Albert Einstein



Data recollection (Interior)

Height: 10 ft

Top View

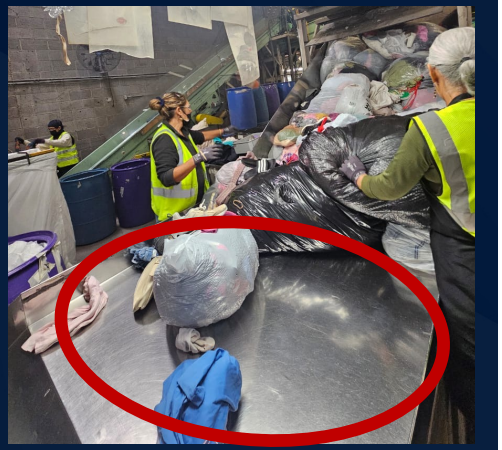
Floor View

Main observations (Interior)

1. Arm (Diverter) predetermined position

2. Buffer conveyor inefficient utilization

3. Conveyor workstation space availability

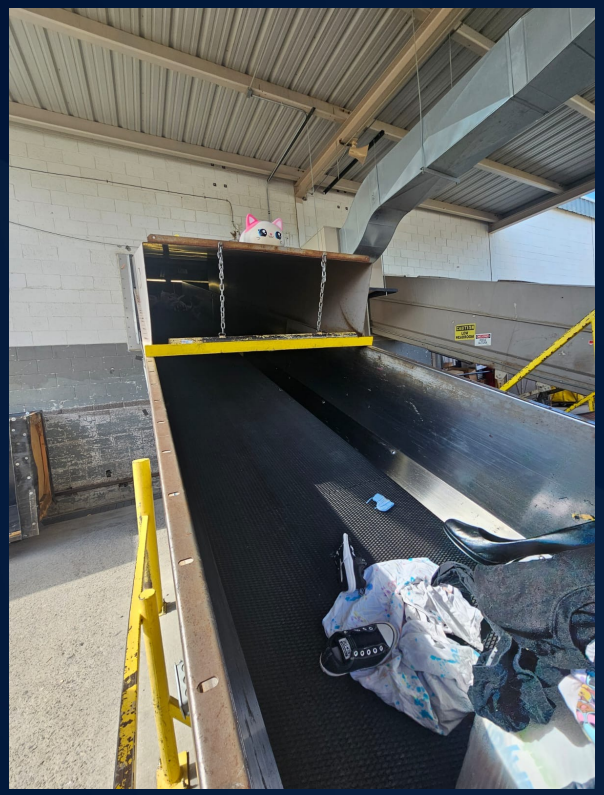


Data recollection (Exterior)

Trailer

Unloading point

Infeed conveyor



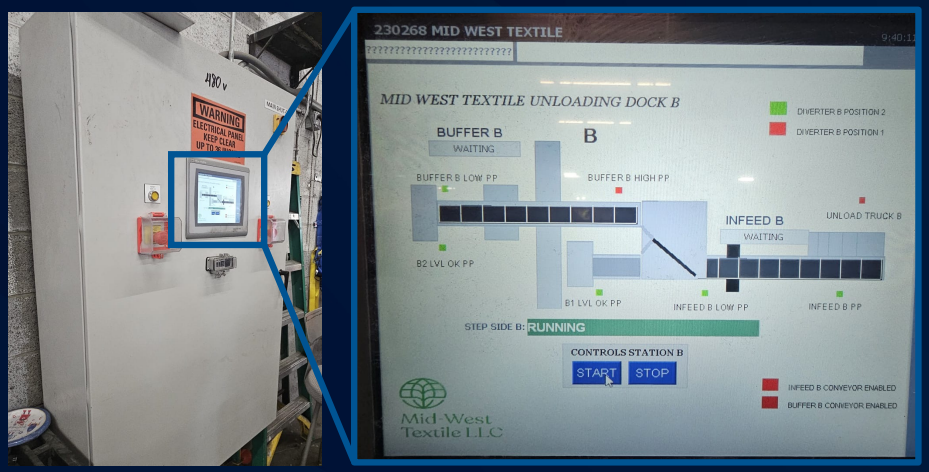
Main observations (Exterior)

4. Infeed conveyor inefficient utilization

5. Unattended unloading point

Programmable Logic Controller (PLC) and Sensor Control Overview

PLC System



PLC controls 3 main components based on sensors:

1. Infeed conveyor - Exterior
2. Arm (Diverter)
3. Buffer conveyor - Interior

Note: Conveyor speed is fixed (60 Hz) and not a variable in this experiment, as motion is controlled by sensor input.

Sensor specification

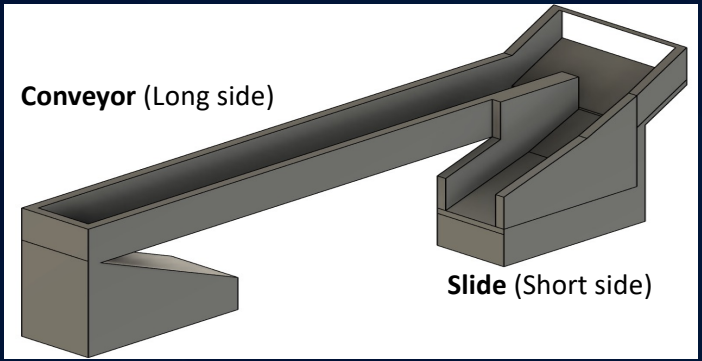
Eaton 1451E-6547

Eaton Photoelectric Sensor, Polarized Retroreflective, Forward Viewing, Output (green), power (yellow), alignment (red), M12, 250 mA at 10-40 Vdc, 4 pin, NPN/PNP open collector outputs, 10-40 Vdc

General specifications	
PRODUCT NAME	Eaton Enhanced 50 photoelectric sensor
CATALOG NUMBER	1451E-6547
UPC	782116111275
PRODUCT LENGTH/DEPTH	4.01 in
PRODUCT HEIGHT	1.81 in
PRODUCT WIDTH	1.91 in
PRODUCT WEIGHT	0.6 lb
WARRANTY	3 year
COMPLIANCES	CE Marked
CERTIFICATIONS	CSA Certified

Interior Conveyor and Slide Layout: Design & Product Flow

Isometric View - Right



Conveyor dimensions (LxW):
29 ft x 3 ft

Conveyor capacity in bags:
Around 30 bags (1,050 lbs)

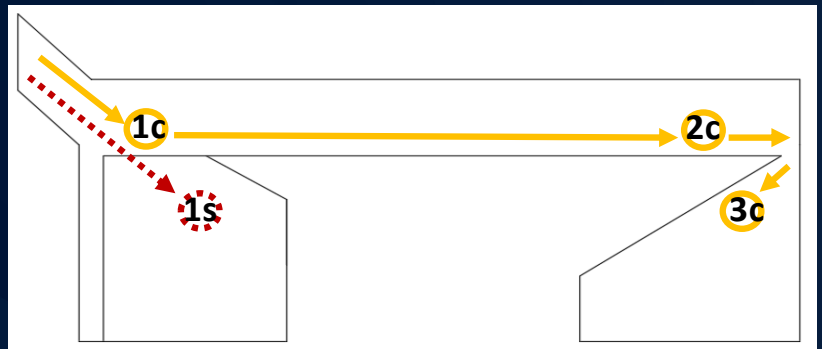
Slide dimensions (LxW):
13 ft x 3 ft

Top View

The conveyor system follows two distinct flows:

- Slide (red)
- Conveyor (yellow)

Side View - Left



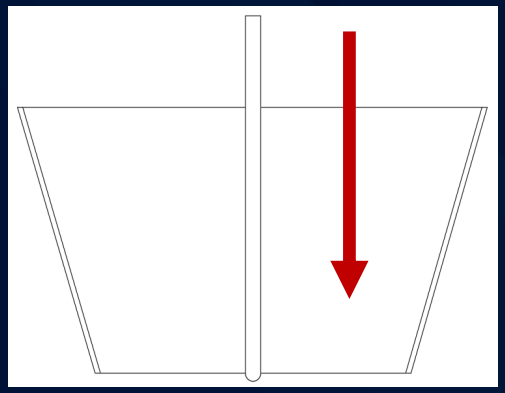
(Sensors labeled as: 1s = slide; 1c–3c = conveyor)

Sensor locations (side view):

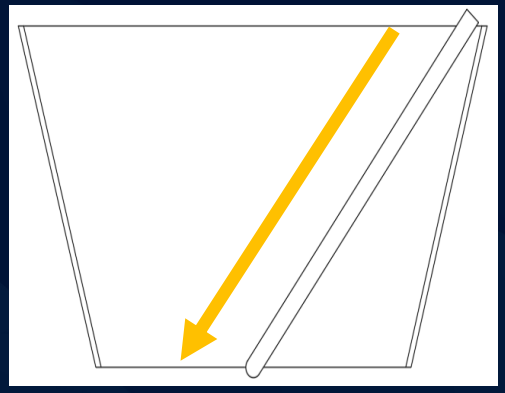
- Slide (short side): 1 sensor
- Conveyor (long side): 3 sensors

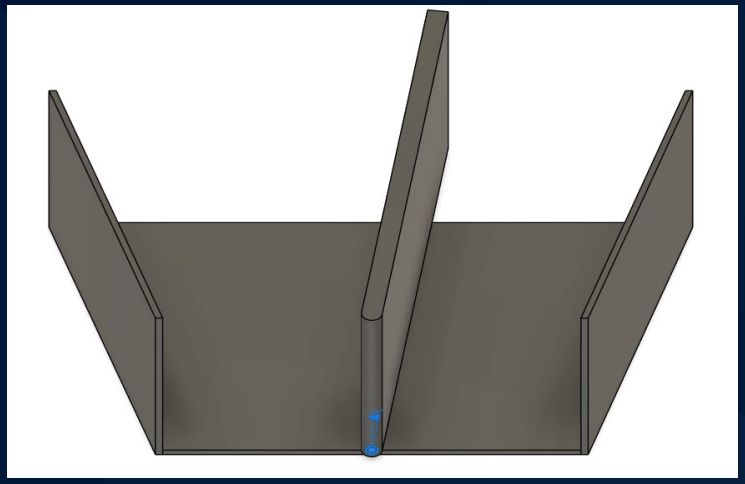
Arm (Diverter): Operation Logic and Design

Arm predetermined:



Arm "opening":





Arm Function Logic:

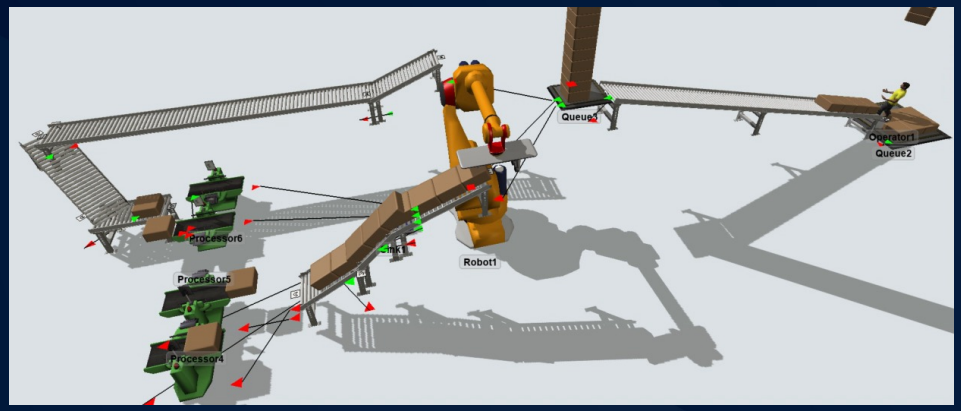
- Feeds the slide (short side) when the slide sensor detects an empty position.
- The diverter arm opens only if the PLC receives no signal from the three conveyor sensors (long side).

Current Condition

Operational Metrics

- **Daily throughput goal**: ≈ 2.6 trailers/day
- **Unload time**: 5–8 hours per trailer
- **Trailer lines advanced/hr (of 13):** 2.5-1.5 lines/hr
- **Average trailer**: 53 ft, ~45,000 lb (~1,500 bags)
- **Progress tracking**: 13 trailer lines ≈ 115 bags per 4 ft (~3,460 lb)
- **Docks:** 2 total (A and B)
- **Workstations**: 4 total → 8 sorters (2 per station – 4 per dock)
- **Sorter expectation**: 483 bags/shift (~14,500 lb)

Simulation Layout – Exterior and Interior Conveyor & Slide



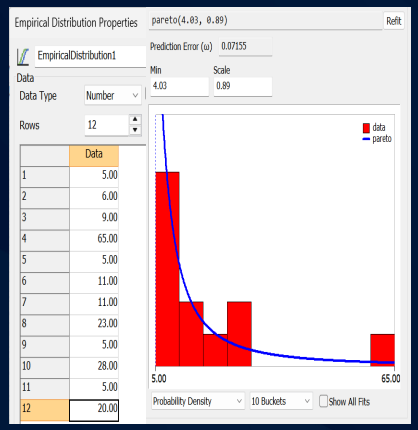
Sorters speed

Pareto distribution:

- **Min** (Xm = 4.03s)
- **Shape** (α = 0.89)

Interpretation:

- Sorters **cannot finish in less than 4.03 s** per bag.
- Since **α < 1**, a few tasks take **much longer**, but most are **fast**.
- **Average observed time: ~16.1 s** per bag.



PLC – Arm Opening

- PLC output creates a **1:3 flow ratio** (long : short).
- Slide sorters overloaded; conveyor sorters slow to match pace.
- **Long conveyor capacity: ~30 bags (~1,050 lb)**.
- **Conveyor refill rate capacity: ~8 bags/min**.
- **Arm reopening delay: ~13 minutes** → ~104 bags (~3,120 lb) idle.
- **Conveyor feed time: 20 seconds**
- Causes **uneven resource use** and **delays trailer unload.**

Recommendations Summary: Exterior vs. Interior Operations

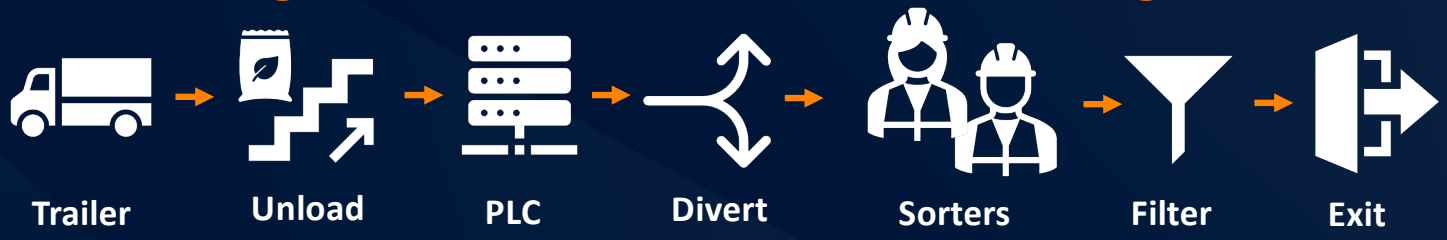
Exterior:

- Begin unloading with 1 operator at the conveyor pace.
- Add a 2nd operator and cart at mid-trailer for efficiency.
- Maintain at least 2 active piles to prevent empty conveyor gaps.
- Keep the unloading point always attended - conveyor movement depends on sorter flow (~16 bags/min).

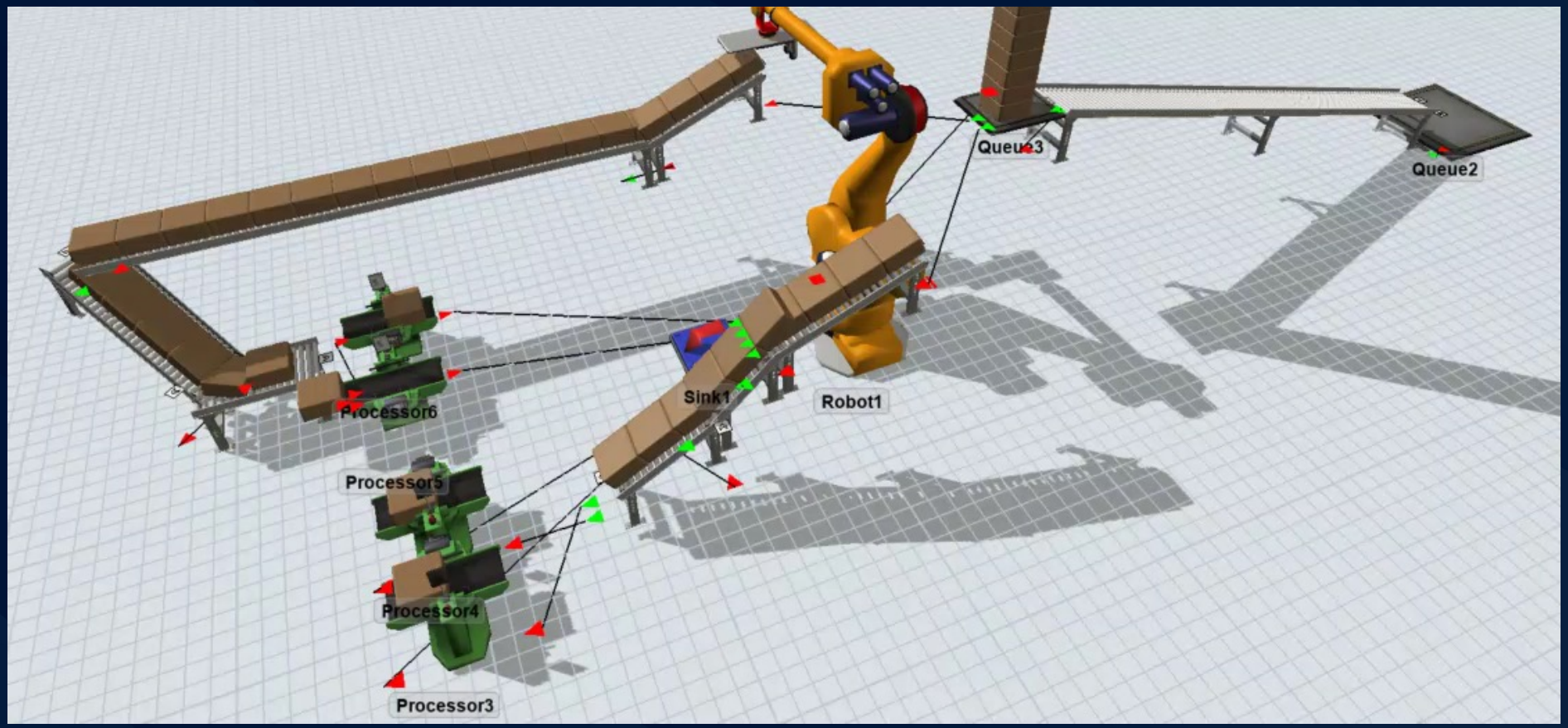
Interior:

- Modify PLC logic: Arm (Diverter) should prioritize the buffer conveyor, using the slide as a relief valve when no WIP is detected (~every 2.5 min).
- Encourage sorters to utilize all workstation space to maintain equilibrium between the slide and interior workstations.

High level process flow diagram



Proposed Solution (Simulation)

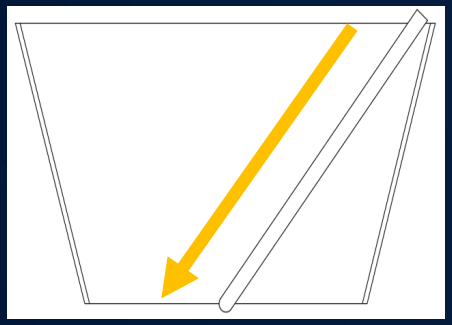


Preparation

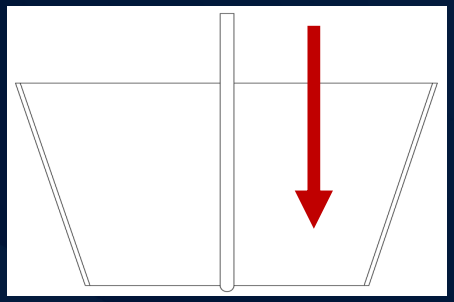
1. Distributed unloading and supervision

2. Modified arm opening predetermination

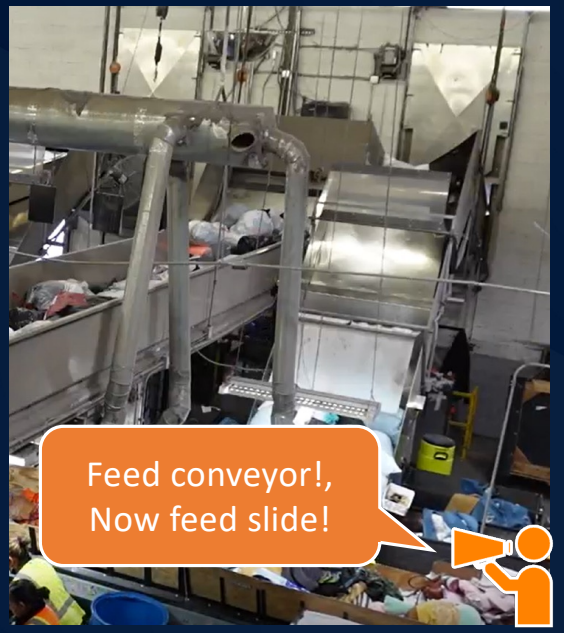
Arm predetermined:



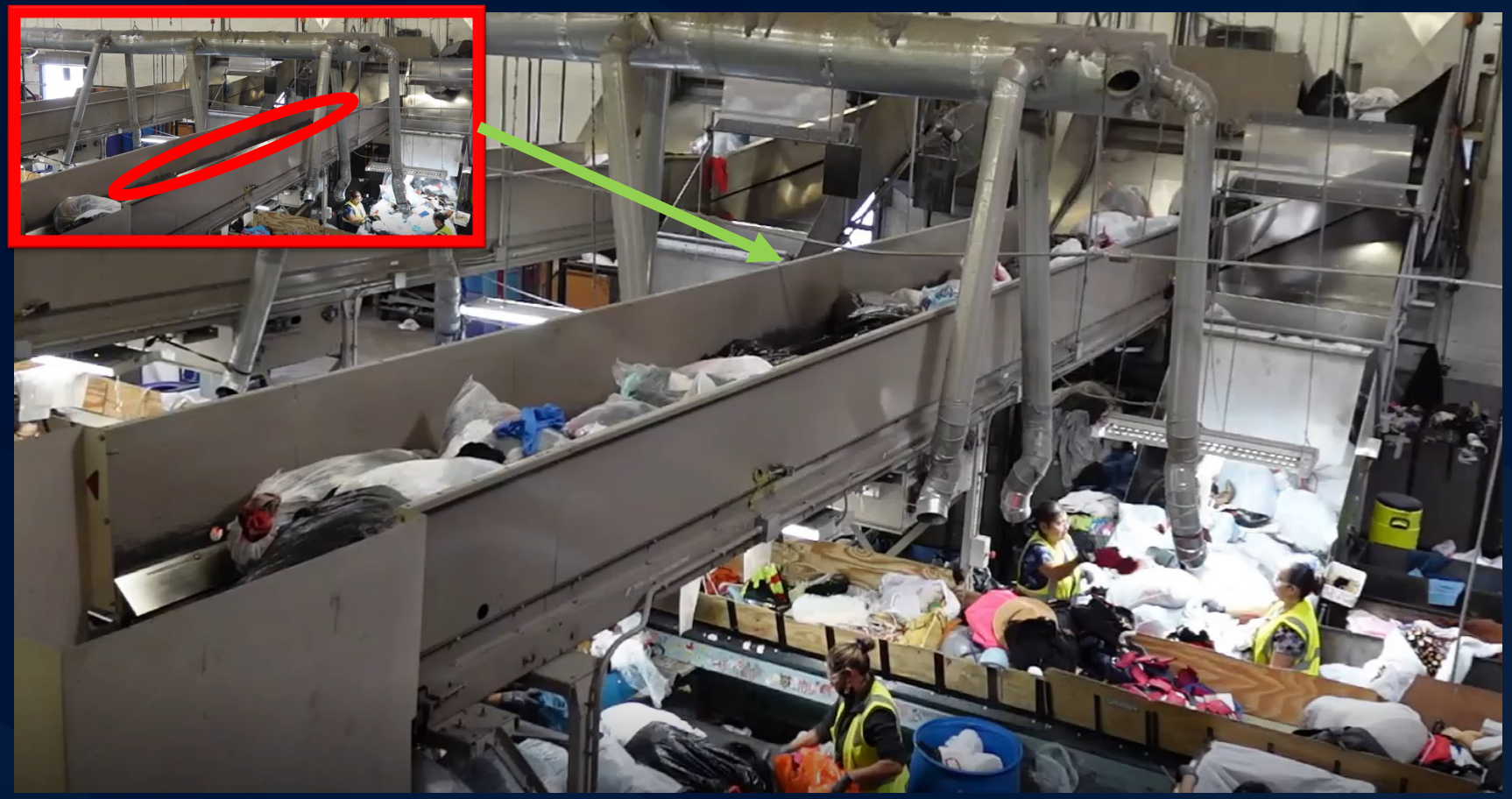
Arm "opening":



3. Communication to simulate new PLC feeding logic

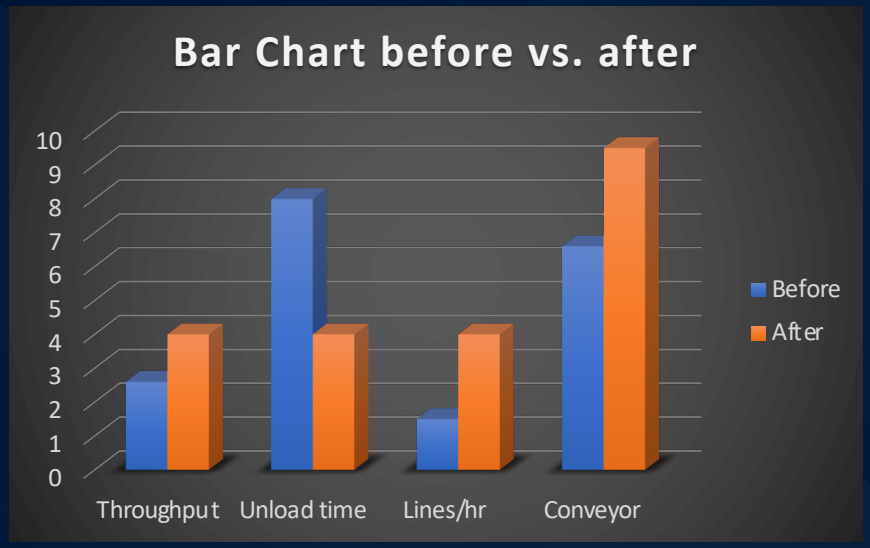


Proposed Solution (Live)



Results

KPI:	Before	After	Δ
Trailer throughput (units)	2.6	**4↑**	+ 54%
Trailer unload time (hr)	5 – 8	**3.5 – 4 ↓**	- >20%
Trailer lines advanced/hr (of 13)	1.5 – 2.5	**4↑**	+ >60%
Conveyor utilization (%)	66%	**95%↑**	+ 29%
Distribution ratio	1:3	**1:1**	Balanced



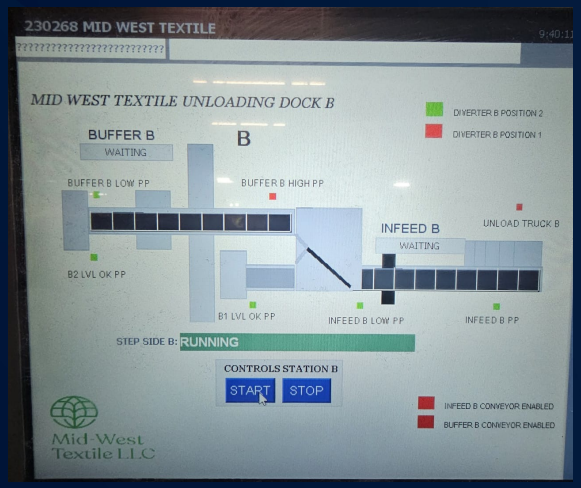
Key takeaway: Balanced flow and PLC logic change reduced unload time by at least 20% and nearly doubled throughput.

Additional recommendations

1. Install camera system to replace mirrors

Improves visibility of PLC behavior and station pace.

2. Separate PLCs for Dock A and B



Allows independent operation when one dock is down.

3. Add end-of-shift checklist and sheet-metal lubrication

Prevents items from sticking, reducing line stoppages.

MidWest Textiles feedback

Karla – Production Manager

“Uneven distribution wasn’t new, but our team analyzed it in detail.”

Veronica – Team Leader

“Four of thirteen lines were cleared in just one hour. Impressive teamwork!”

Martin – Maintenance Manager

“Thank you for coming in, we needed your insight from the exterior”

Special thanks to UTEP Faculty and Mentors

Arunkumar R. Pennathur – Director Industrial Engineering Undergraduate Program

MD Fashiar Rahman – Assistant Professor and Associate Director of RIMES

Selim Molla – PhD Student and Teaching Assistant

MID - WEST TEXTILE CO.
"Operating Fundamentals"
SAFETY— Nothing is more
QUALITY— Delivering
VALUE — Getting all
PRODUCTIVITY—

Thank you