Regional Door Manufacturer

Layup Table for Process Improvement in Door Manufacturing

Western Carolina University
School of Engineering + Technology

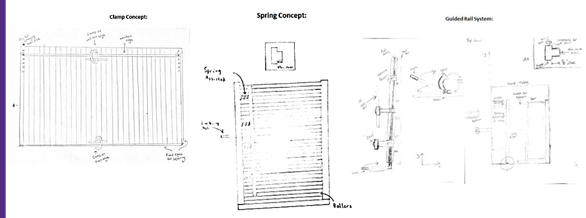
Original Objectives

- Evaluate current layup table design and door assembly process
- Modify or redesign current table layout to reduce material and operator variations
- Build functional prototype for future integration into current production line
- Test functionality of prototype with regards to compliance to given requirements
- Successfully implement prototype at the manufacturing facility

Requirements

Req #	Requirement	Description	Verification	Status
1	Cycle time	Current cycle time of 24 seconds per door must not be increased	Demonstration	Unable to test due to Covid-19
2	Scrap rate	Reduce scrap rate below current level (4%)	Validate	Unable to test due to Covid-19
3	Squareness	Diagonal measurements must be within 1/8" of each other	Measurement	Unable to test due to Covid-19
4	Bowing	Fixturing system minimize scrap due to outward bowing	Measurement	Accounted for in design Unable to test due to Covid-19
5	User friendly	Operators must interact well with the table	Demonstration	Accounted for in design Unable to test due to Covid-19
6	Reliable	Same results no matter the operator	Validate	Unable to test due to Covid-19
7	Safety	No physical injury to operators	Validate	Accounted for in design Unable to test due to Covid-19
8	Integration	New system must integrate with current manufacturing process	Demonstration	Accounted for in design Unable to test due to Covid-20
9	Quick adjustment	Stay within 60 seconds between batches	Measurement	Unable to test due to Covid-21
10	Product protection	Mechanical fixture designed to avoid damage to door components	Validate	Accounted for in design
11	Ease of product transition	No extensive effort in transportation of the doors post assembly	Validate	Accounted for in design
12	Accomodates Standard Size Door Dimensions	Must accomodate doors 2' to 3' in width and 96" to 72" in height	Validate	Accounted for in design

Concepts

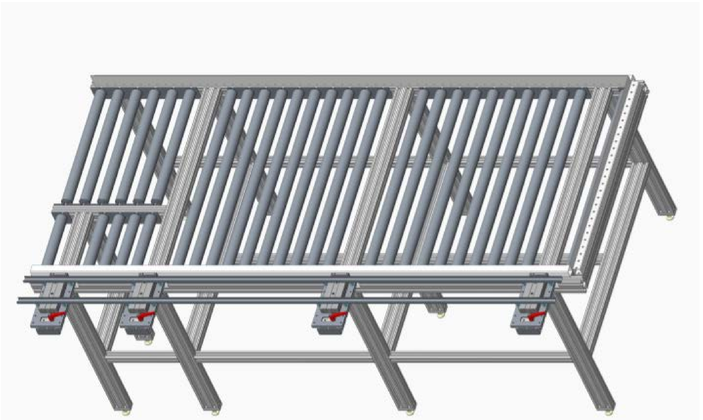


	Concept Analysis			
Quantitative Requirements (Weight)	Clamp Concept	Spring Concept	Guided Rail System	Pnuematic Rail System
Width > 24 in. (1.0)	1	1	1	1
Length > 72 in. (1.0)	1	1	1	1
Cycle time < 24 sec (1.0)	0.8	0.9	0.8	1
Scrap rate < 4% (1.0)	1	0.7	1	1
Squareness < 1/8 in. deviation (1.0)	1	0.7	1	1
Batch switch time < 60 sec (1.0)	0.9	1	0.8	1
Total	5.7	5.3	5.6	6
Comments				
Qualitative Requirements (Weight)				
User friendly (L-M-H)	H	H	H	H
User-safe (L-M-H)	H	H	H	H
Product Protection (Yes, No)	Y	Y	Y	Y
Ease of Product Transition (L-M-H)	M	M	M	H
Reliability (L-M-H)	H	M	H	H
Ease of Integration (L-M-H)	H	H	H	H
Reduces bowing (L-M-H)	H	M	H	H
Comments				
Risks (Likelihood/Impact)				
User-Safety (L-M-H)	L/H	L/H	L/H	L/H
User-Fatigue (L-M-H)	L/M	L/M	L/M	L/M
Long Term Accuracy (L-M-H)	L/H	M/H	L/H	L/H
Cycle time increase (L-M-H)	L/H	L/H	L/H	L/H
Scrap rate increase (L-M-H)	L/H	L/H	L/H	L/H
Long Term System Reliability (L-M-H)	L/H	M/H	L/H	L/H
Comments				
Cost (low to high)	Medium	Lowest	Medium	Medium
Issues		May not correct bow		

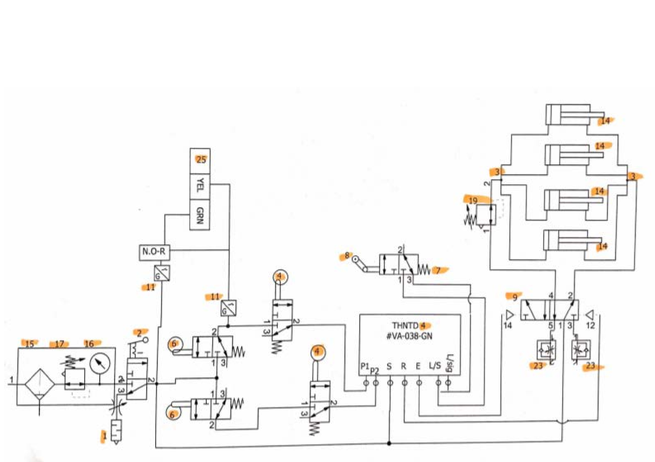
Problem Statement

The Sponsor is a high-volume prefab door manufacturer. The company's facility produces custom and standard sized doors. Due to variations in material components and inconsistencies with operator assembly, additional material has been added to the edge components of the door. This excess material is machined in an automated process to square the door. This addition and machining of edge material adds waste to the process. Furthermore, if the door fails squareness specifications at the end of the process, it will be scrapped. The desired scrap rate is not to exceed 2%. The Sponsor has requested modifications or redesign of the build table to reduce variability in the layup process by squaring the door through mechanical means (fixturing, guides, pneumatics, suction, other) without increasing cycle time. Producing a higher rate of products that meet or exceed specifications and reducing waste material will have a positive financial impact.

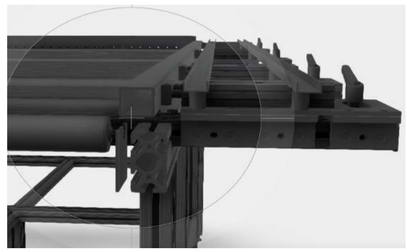
Final Design



STRUCTURAL DESIGN
- 80/20 frame
- Drop-in rollers to accommodate a variety of door lengths
- Translating actuator "carriage" to accommodate a variety of door widths
- Rollers to provide ease of transition.



CLAMPING "CARRIAGE" BAR DESIGN
- Pneumatic compressive force to reduce bowing
- Mechanical brake lever on all four slides
- Actuators synchronized to ensure no racking
- Two hand no tie down to ensure safety of operators



* On March 16, 2020 classes and labs were closed to students due to the COVID-19 Pandemic. Without access to fabrication and testing equipment, Objectives and Deliverables were modified accordingly.

Modified Objectives*

- **Functional Prototype**
  - Solution: Existing assemblies, custom fabricated parts, pneumatic components, and remaining raw material to be packaged and delivered to whichever party is tasked with project completion moving forward.
- **Operational Training**
  - Solution: Team will develop a document containing details on table operation. This will be included as a deliverable in the documents and relevant files.
- **Test Plan & Report**
  - Solution: The team will provide a testing plan with details about testing procedure. Images and other documents needed for testing procedure clarification will be provided as a deliverable.
- **Senior Capstone Symposium**
  - Solution: A digital symposium poster presentation will take place of previously scheduled public demonstration.

Summary

What we will provide to sponsor:
- CREO part/assemblies for layup table
- 80/20 components for layup table assembly
- Pneumatic circuit diagram
- Pneumatic components
- Relevant project files including BOM

Due to Covid-19 we will also provide:
- More in-depth testing plan
- Instruction document for layup table assembly
- Instruction for Pneumatic system assembly
- Inventory Documentation

Team & Acknowledgements

Students:
George Hickein
B.S.E – Engineering Technology
Levi Auman
B.S.E – Engineering Technology
Adam Griffin
B.S.E – Mechanical
Olivia Witham
B.S.E – Mechanical
Mentor:
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