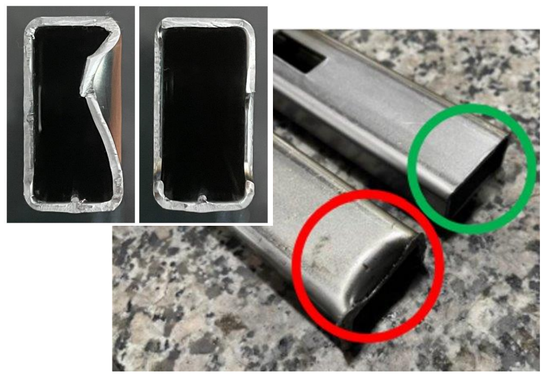
Washkewicz College of Engineering

Real-Time Inline Quality Inspection System



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Background

- Welser Profile manufactures steel roll formed parts.
- For a given product line, the shearing mechanism, used to cut the parts to the desired length, malfunctions irregularly such that the ends of some of the parts are crushed and as a result are not up to the specifications set by the customer.
- Welser Profile would like to implement a system that would identify and remove damaged parts automatically during production.
- Objectives: [1] Design a reliable, robust, and undemanding inline inspection system so to reduce man-hours dedicated to additional part inspection and quality control. [2] Manufacture and implement a working system that adds on to the end of the current production line.

Process

Brainstorm

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Design

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Source Components

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Fabricate & Assemble System

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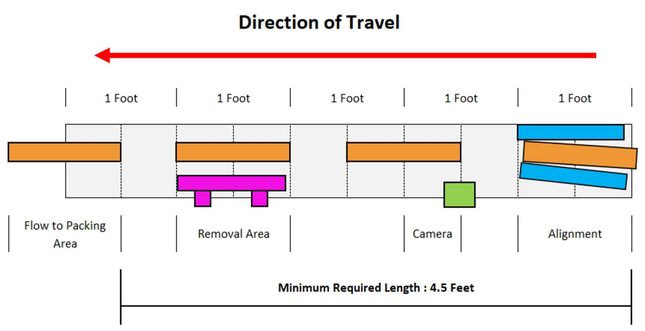
Test & Troubleshoot

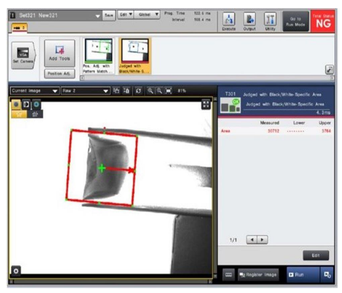
System Design & Parts Flow

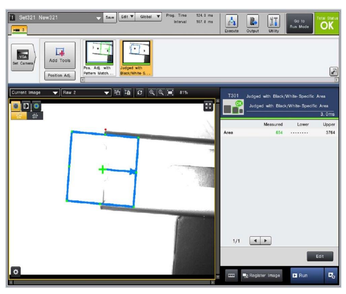
- Parts will flow along a 6 ft conveyor.
- When the front of the part passes by the laser sensor, it will send an input signal to the Keyence vision controller.
- The controller will send a timed output signal such that the system camera takes a picture of the entire part; the controller will assess the quality of the part (checking specifically the front end and back end of the part).
- If the controller sends a signal indicating that a part is bad, the PLC will send an appropriately timed signal to the solenoid such that the pneumatic cylinders will extend and knock the bad part off the conveyor system.
- Otherwise, pressurized air will hold the cylinders in the retracted position.

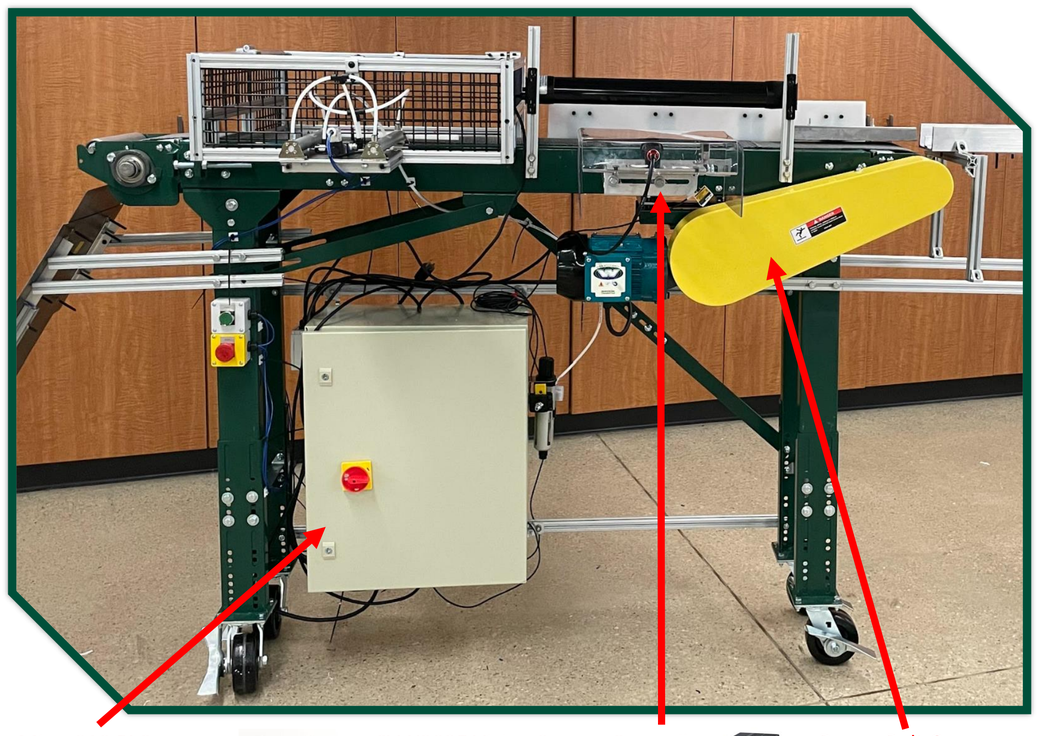


Vision System

- The Keyence vision camera works by counting the number of dark pixels present in a specified location of the captured picture.
- Proper lighting is critical – a damaged part will cause a shadow to be cast such that there will be more dark pixels than for a good part.
- The Keyence controller enables the operator to set the parameters of how few dark pixels are allowable before the part is considered damaged.



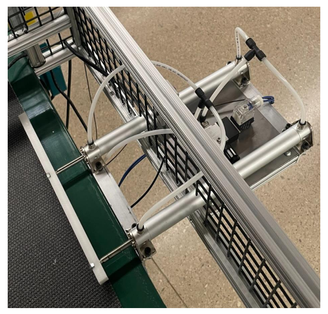


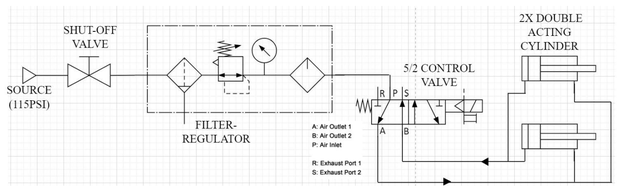


Micro810 PLC — CV-X302F Vision System Controller — Power Belt Conveyor

Pneumatics

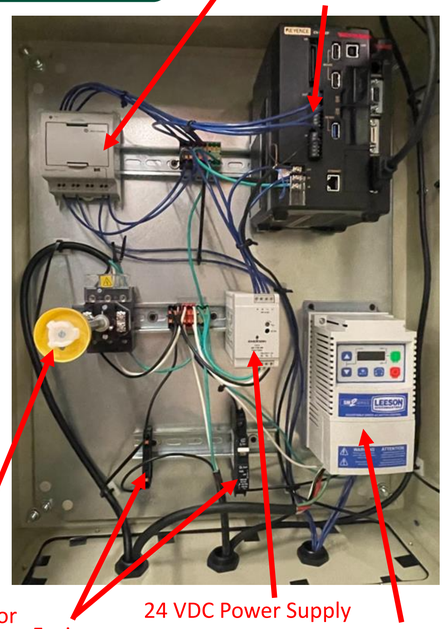
- In the "normal position," the solenoid is not energized, and pressurized air holds both double-acting cylinders in the retracted position; the good part will continue down the conveyor.
- When the solenoid receives an electrical signal, the flow path shifts such that the cylinder rods extend, and the pusher bar knocks the bad part off its course into a separate collection bin adjacent to the conveyor.





Electrical

- Start and stop buttons are wired to operate two main systems: the conveyor (via the motor VFD) and the inspection system related items (which includes the laser sensor, Keyence controller, light bar, PLC, and solenoid-operated control valve).
- Proper wiring and fusing ensures that expensive system components are protected from current overflow.

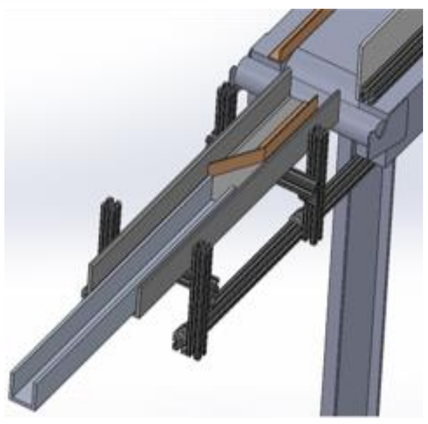


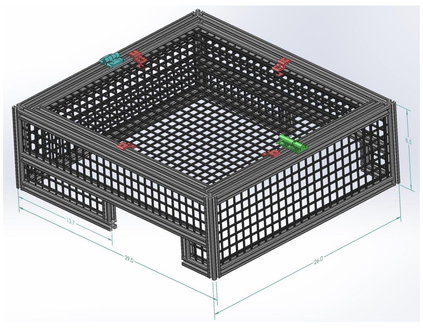
VDC POWER SUPPLY	
CURRENT INPUT (CI) @ 120VAC	1.200
MULTIPLIER (M)	1.250
DESIRED FUSE (CI*M)	1.500
CATALOG FUSE CHOSEN	1.500

CV-X 302F CONTROLLER	
OPERATING CURRENT (OC)	2.400
MULTIPLIER (M)	1.250
DESIRED FUSE (OC*M)	3.000
CATALOG FUSE CHOSEN	3.000

Accessories

- A "let-off" system aids in transitioning parts from the shearing mechanism to our quality system conveyor, in addition to aligning parts according to the needs of the Keyence camera.
- A safety cage is situated around the pneumatic part removal system to prevent injury; the door at the top hinges open in the event of jamming or needed maintenance.





PLC Ladder Logic

- A ladder logic program was encoded into the PLC such that the air cylinders would fire at the appropriately delayed time.
- Because the air cylinders are situated down stream from the Keyence camera, a "virtual queue" was designed if a second damaged part is detected prior to the code completing execution for the first damaged part.