Heat Treat Load

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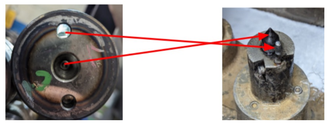
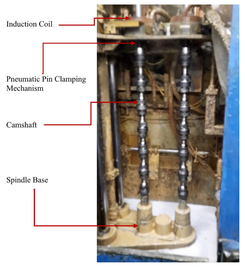
Background

Engine Power Components (EPC) is a company that manufactures camshafts. The lobes and bearing surfaces of each camshaft need to be hardened. The scope of this project involves the automation of the loading and unloading process of one particular model of camshaft into, and out of, an induction hardening heat treat machine. The current process is manual.



Pin Alignment



Heat Treatment Machine

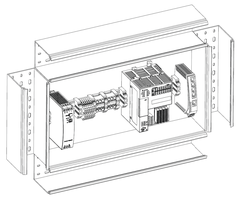
Successful automation of the process will allow the operator to utilize their time for other workplace duties, reduce or eliminate physical strain on the operator that is present in the current process, and reduce the amount of human error inherent in the manual process.

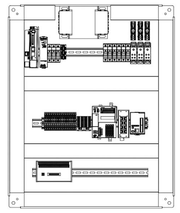
Key Specifications

- The system must read the serial number from each camshaft and record their location into EPC's factory software.
- The system loading and unloading process should have a machine efficiency of 60 seconds or less.
- Each component in the system must have a minimum payload of 40 pounds.
- The user interface with the system needs to have an activation method.
- The system must fit within the space provided (roughly 12ft x 16ft x 12ft).
- The system must use applicable machine guarding and utilize an emergency stop when the guarded area is entered during machine operation.
- The system must be able to be manually loaded and unloaded.
- The system must have a minimum automated run time of one hour.
- The system must segregate parts for inspection purposes.

Control Cabinet

A control cabinet will be used to house the Programmable Logic Controller (PLC), HMI, emergency stop, ethernet switch, and different power adapters for PLC, sensor, and HMI use. This will be accomplished by use of a DIN rail system.



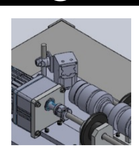


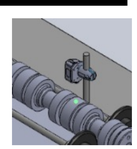
Industrial Robot

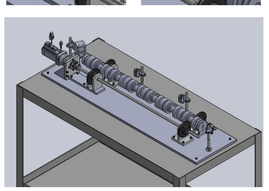
The industrial robot chosen for this project was a Fanuc M-20iB/25. The primary reason for this selection was the availability and cost. To be a viable option, the robot was required to have a minimum payload capacity of 40 lb. The Fanuc M-20iB/25 was found to have a payload capacity of 55 lb. Therefore, the chosen robot was found to meet all requirements.

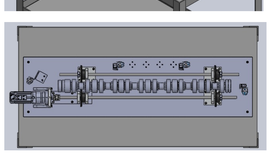
Part ID and Alignment

A similar automated process at EPC places a camshaft on an assembly to rotate a camshaft and scan a QR code. Once the camshaft is positioned by the robot on the assembly, the shaft will be rotated until the three sensor outputs are closed, which indicates the through hole is oriented in the desired position, and the QR code has been scanned.



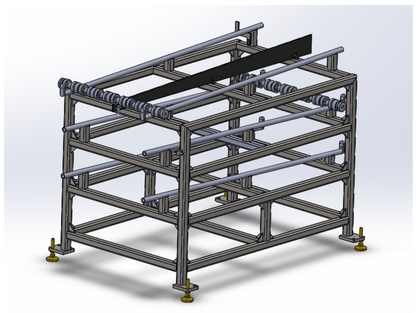


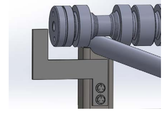


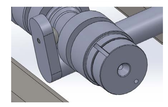


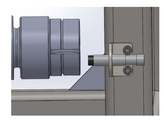
Gravity Rack

Other machines in the EPC plant utilize a gravity rack system to funnel camshafts into a work cell. An industrial robot then grabs a camshaft and loads it into another machine. The robot then unloads the camshaft onto a bottom gravity rack system. The rails will be set at a 2-degree angle to allow the shafts to roll. The input rack will be on the top and angled in the opposite direction as the output and test output racks. The output rack will be in the middle of the frame followed by the test rack at the bottom. The test rack has a height off the ground of 22.25". The frame will be set on leveling feet to ensure the rack is at the desired angle. At the end of each rail, an end cap will be placed to stop the shafts.



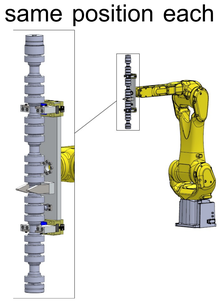




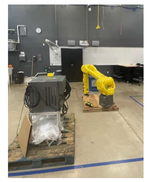


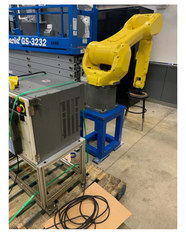
End of Arm Tooling

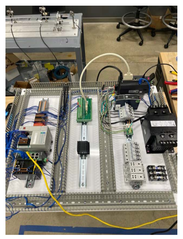
The design for the End of Arm Tooling (EOAT) is a proven design utilized by EPC on other automated cells throughout their factory. It is mounted to the end of the robot arm and is used to grip a camshaft while it is maneuvered between the input/output rack, and the induction treatment machine. The EOAT needed to be designed in a way that made it capable of picking up each camshaft in the same position each time while holding it securely.
The gripper jaws were designed with a V-shaped profile that serves to center the camshaft. The gripper jaws and the alignment guides were also designed to be easily removable so that they could be replaced when worn and no longer provide reliable alignment.

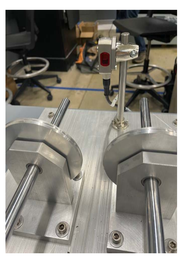


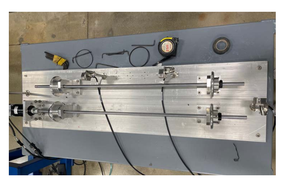
Prototype & Build











Oversights Identified

- Identifying orientation of thru hole on camshaft so that it can be properly aligned onto the lower spindle