

WPI

Automated Tool Prep/Crib

Ryan Wheeler, Eric Willcox, Sergey Zolotykh

Advisors: Craig Putnam, Lifeng Lai, Stephen S. Nestinger

Acknowledgements: David Ephraim, Joe St. Germain, John Graham, Kurt Evans



Abstract

This MQP has two goals that aim to show the feasibility of automating some tasks for General Electric Aviation. The first goal was to design a system capable of changing used end mills within a tool holder used by CNC machines. The second was to create a method to automatically keep track of the location of all tool holders as well as keep a log of all jobs on which they have been used. The end results showed that both are possible and with more work could be implemented in a working system.

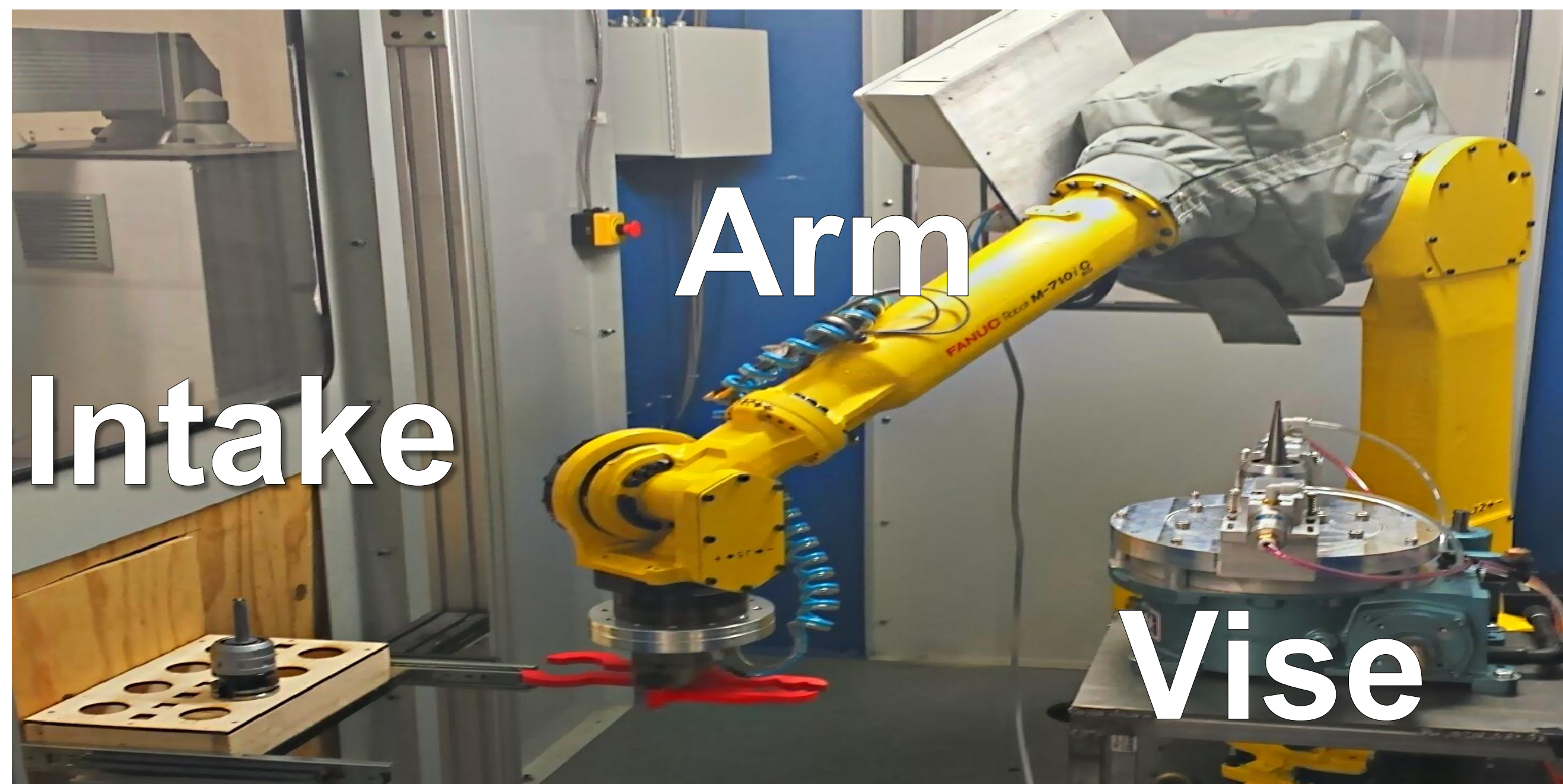
Background

General Electric Aviation (GE) seeks to automate the tool changing process for their CNC machines. They currently have multiple workers that spend the day going to CNC machines and changing end mills for other jobs. They are looking to automate the process of removing and replacing end mills in tool holders.

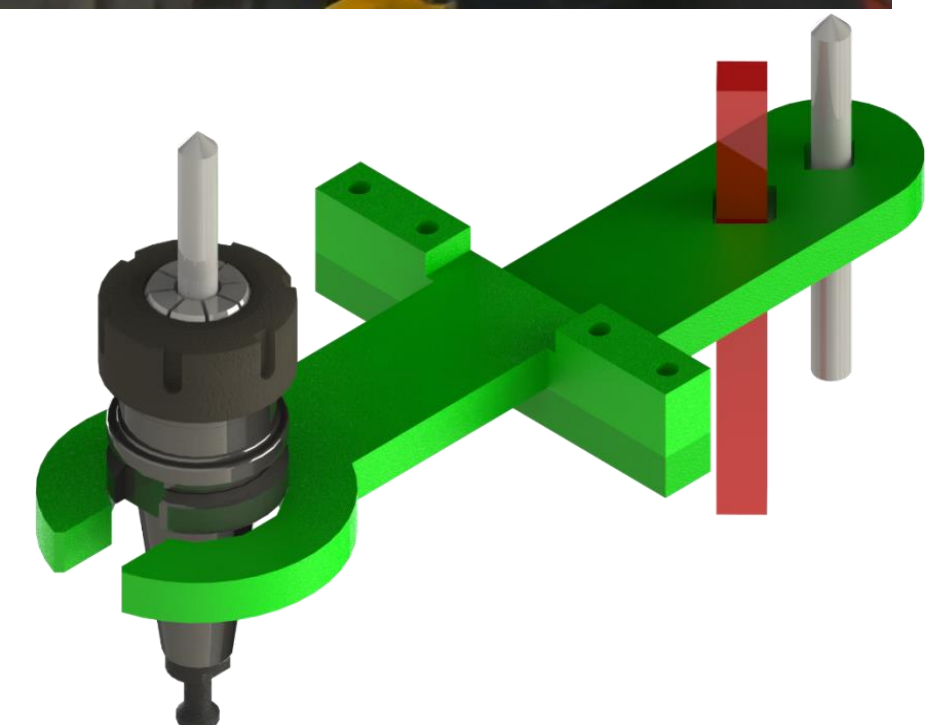
GE would also like to be able to track job histories of individual tool holders that are in use. A current problem they face is when one wears out or is damaged, they may not immediately notice it. This allows the tool holder to go through other machines, potentially ruining anything it mills.

Methodology

Intake and outtake of the work cell is done with a drawer that is attached to the work cell. A worker pulls it out, loads it with a used assembly and a new end mill within a sheath, then closes it.



A custom vise was constructed to facilitate changing the end mill. The vise holds the tool holder, and is able to loosen and tighten the collet nut. A gripper was designed to be able to hold the tool holder, end mill, and sheath.

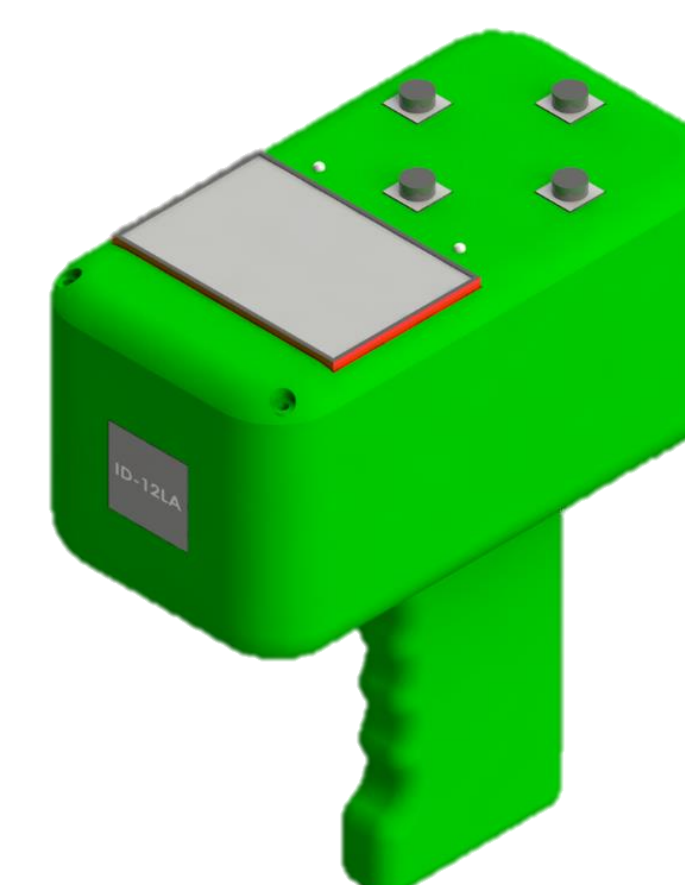


Project Objectives

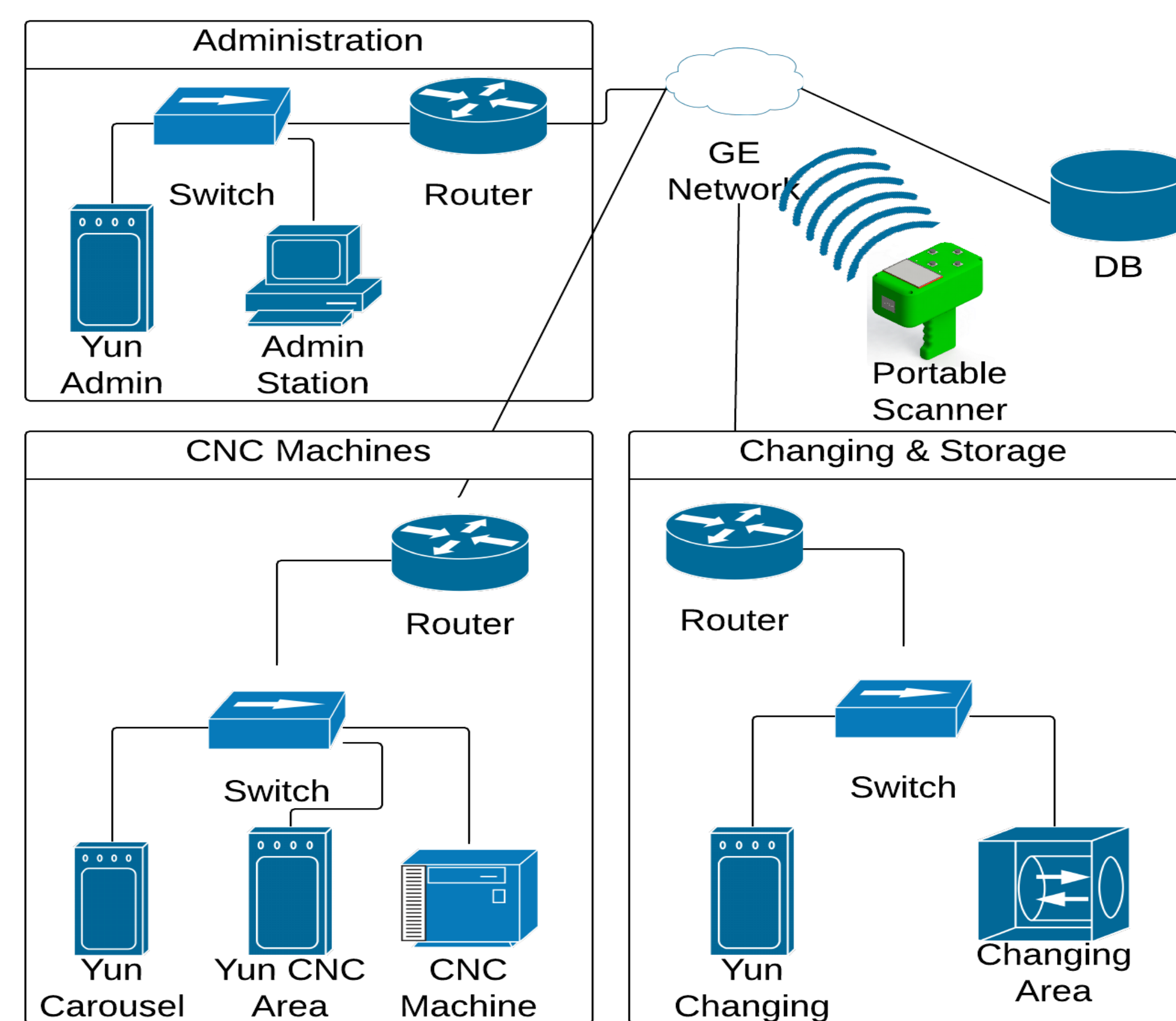
- Replace end mills in tool holders and store completed assemblies
- Dispense new tool holder and end mill combos to a worker when needed
- Ability to track tool holders and pertinent information about them

RFID-Based Tool Tracking

Tracking of tool holders is done by RFID tags. The tags are read in with RFID readers located around the facility. When tags are read, database entries are added or modified to reflect information such as; location, job history, total time used, and length of installed end mill. All of this information is modified autonomously without requiring input from a worker. A worker can view a tool holder's database entry by either navigating to a website or by using a custom-designed portable hand scanner.



When a tool holder begins and ends a milling job it is scanned so that the time used can be entered into the

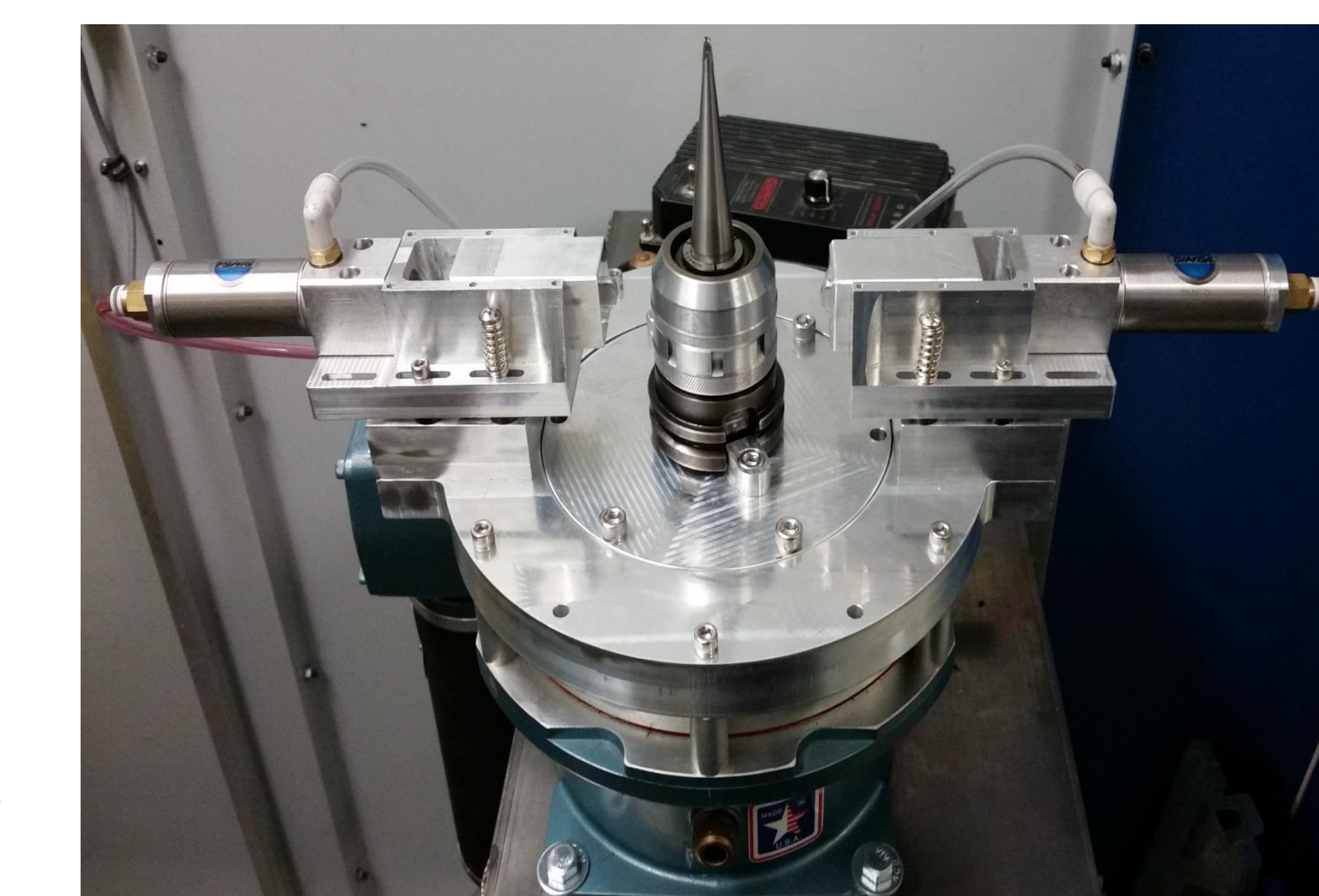
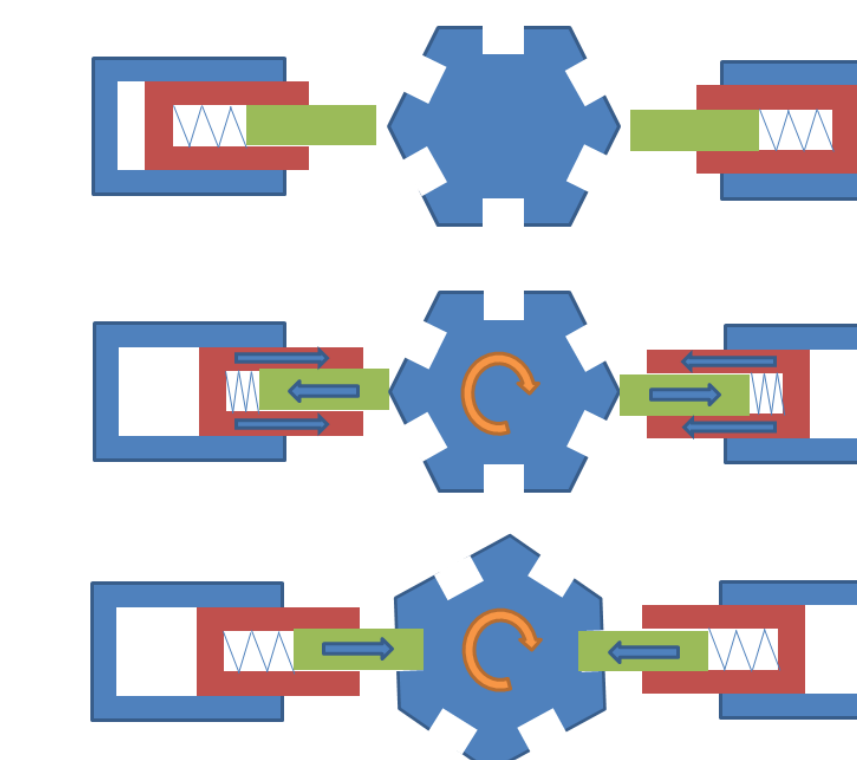
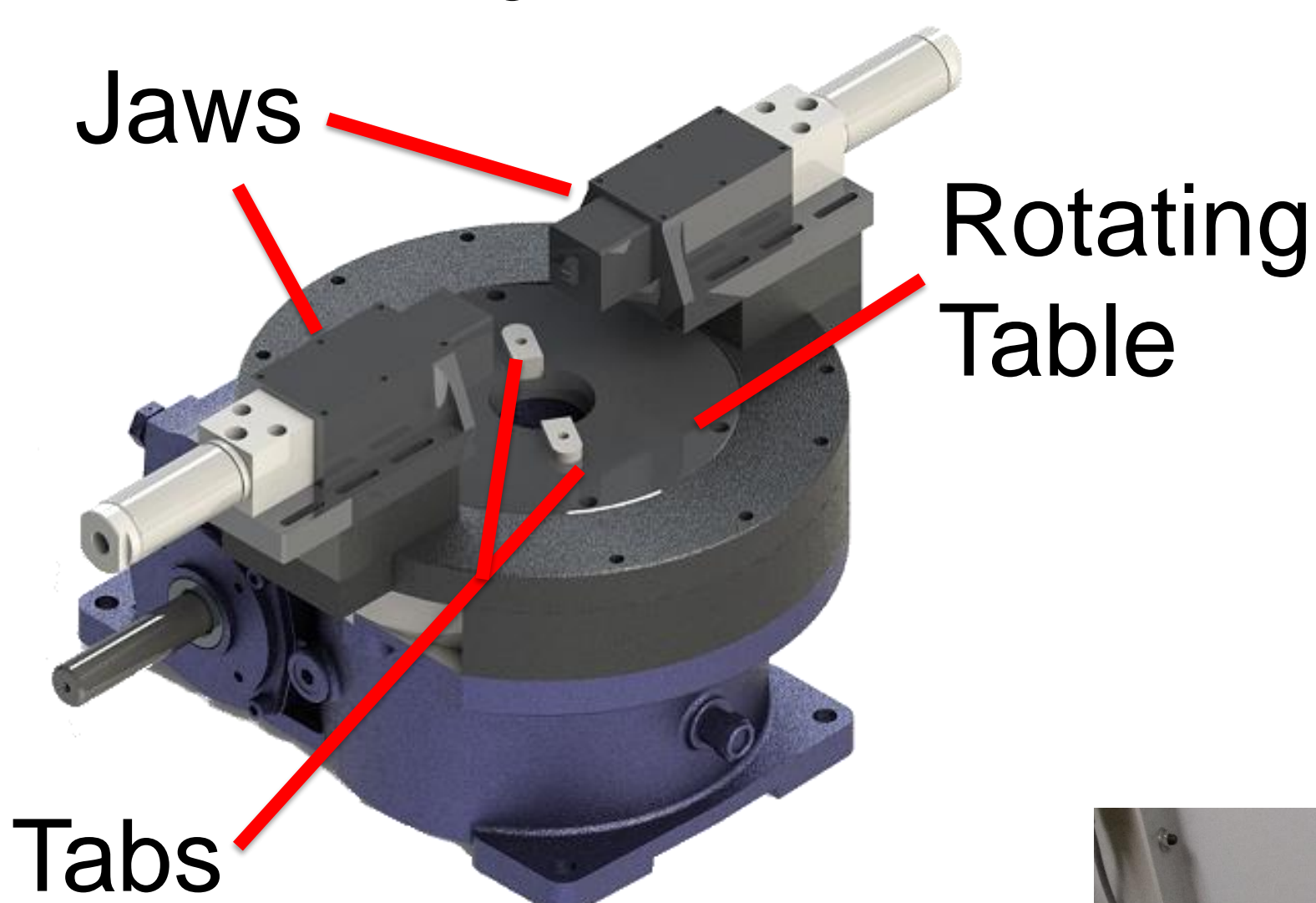


database. There are also scanners located in the changing station and storage rack so that a location of the tool holder is always known.

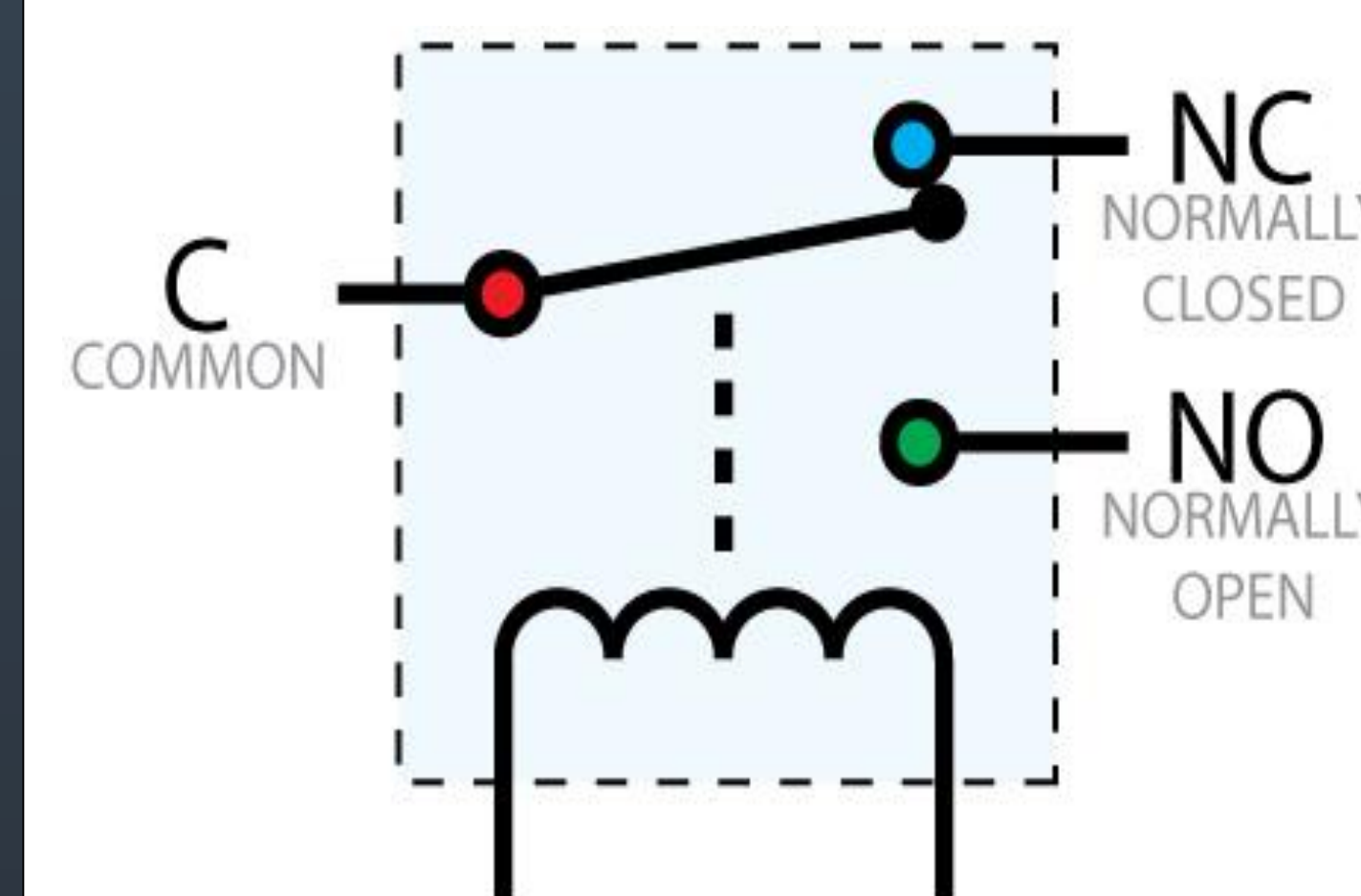
The admin station is able to scan any tool holder in order to add it or modify its entry. The tag scanned is sent to the website where an employee can view it and modify it as needed.

Vise Sub-System

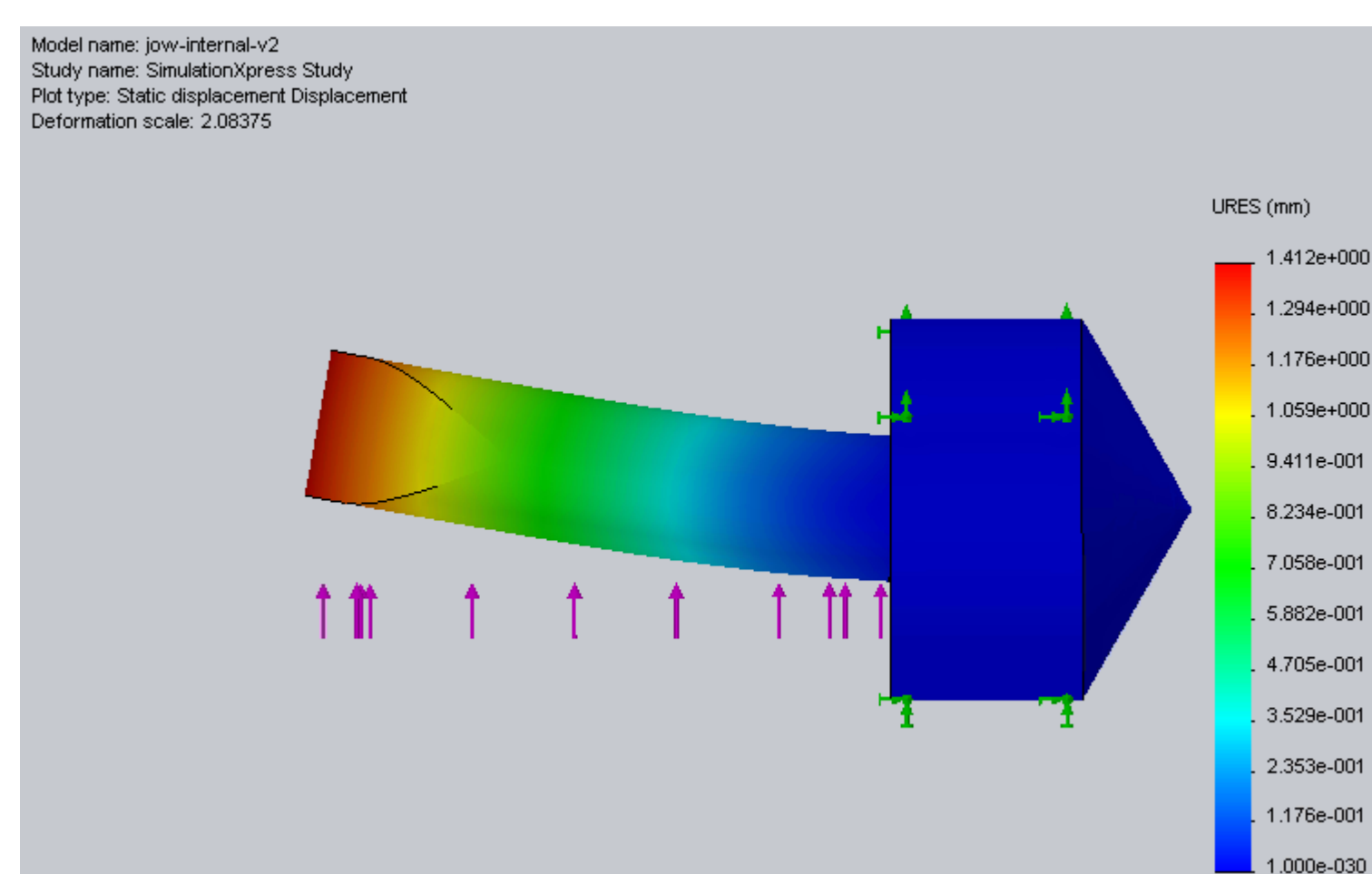
The tool holder gets placed into the vise and sits in two tabs that hold it in place. The jaws then extend and hold the collet nut to prevent it from rotating with the base. The inner table then begins to rotate the base of the tool holder and the jaw pins snap into the channels on the collet nut as shown in the right image. The collet nut can then be loosened or tightened as desired.



Relays are used to control the direction of the vise motor. The relays are connected directly to the robot controller which either stops or rotates the vise based off of the operation needed at the time. The motor will then rotate for a set amount of time to manipulate the tool holder as required.



Jaw Pin Strength



Analysis was performed on the small jaw pin that holds the collet nut in place while rotating the base of the tool holder. The results were a deformation of 1.5 mm over the length of the pin. However, through physical tests we have seen that most of the pin is held in place by its casing which causes it to deform less.

Conclusions & Recommendations

- Vise design is feasible for changing end mills
- RFID solution can reliably track everything requested
- Expand for more tool holders and end mills
- Redesign vise transmission system to be continuous
- Replace RFID Arduino solution with an industrial solution with further range and application-appropriate tags