3D Printing Retrofit Package for a Coordinate Measuring Machine

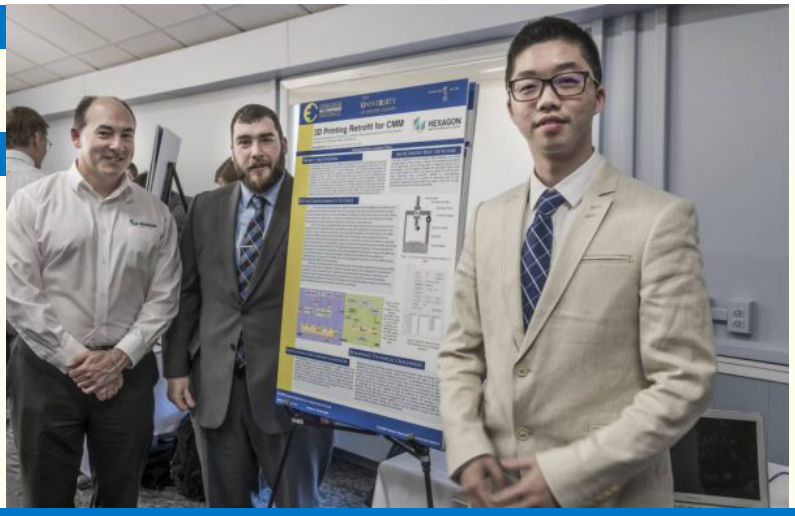
hexagonmi.com/en-US

TECHNICAL DIRECTOR:

Jonathan O'Hare

TEAM MEMBERS: (L to R)

Jonathan O'Hare
Michael Tougas (C & CS)
Xiaotian Chen (E)



PROJECT MOTIVATION:

A time demanding factor of ensuring that a product is created to exact design specifications is the designing, engineering, and manufacturing of the fixtures that will hold it in place during the measurement process. The motivation of this project is to provide a retrofit package to add the capability of 3D printing to a Coordinate Measuring Machine (CMM). Adding the capability to 3D print an object on a CMM will allow users to leverage the size and precision of a CMM to design and print large format 3D prints. The intent of developing this package is to provide the means to 3D print the fixtures that will secure the product being measured by the CMM. This project will begin as exploratory research and expand into proof of concept design, testing, and demonstration.

ANTICIPATED BEST OUTCOME:

The anticipated best outcome for this project is a fully functional proof of concept 3D printing retrofit package for the CMM that provides an interface and a 3D print head assembly. The interface shall have the capability of using a 3D drawing file as a selectable input, slicing the 3D drawing into layers, translates the layers into movement commands for the print head and the CMM, and sends them to their respective devices. The 3D print head assembly shall be mountable to the existing CMM design. When installed the output shall be a usable 3D printed object.

IMPLICATIONS FOR COMPANY AND INDUSTRY:

The implications of the BEST outcome will result in a patent and a niche market that utilizes the size and capabilities of CMMs to perform 3D printing. Additionally, by leveraging the capability to create the required fixtures for measuring a product will provide a cost saving method to owners of the system. Most CMM functions require an operator, however, 3D printing does not and as such it can be performed during the natural downtime of the system increasing productivity. On a broader spectrum, this package will help set Hexagon equipment apart from their competitors, more than it already is.

PROJECT OUTCOME:

The Anticipated Best Outcome was achieved: We successfully designed and tested a proof of concept as required.

KEY ACCOMPLISHMENTS:

Power User Interface: A user interface allows the user to interact with the respective parts of the retrofit package. This interface provides the means to connect to and control the CMM.

Hardware Components: The hardware components for the 3D printer retrofit package were ordered, assembled, wired, and tested to ensure they met the minimum requirements for the scope of this project. These components included the printer assembly, the Arduino controller, the PCB heat bed, and the power supply.

Machine Mounting: A mounting assembly was fabricated that allows for the print head assembly to utilize the existing probe head mounting system. This allows for simple installation and removal of the printer retrofit package and does not require any modifications to the CMM machine, which is one of the marketing requirements. A diagram of the installed retrofit package can be seen in Figure 1 and an image of the installed print head can be seen in Figure 4.

G-Code Translation: A method has been developed that allows the created g-code translator to parse out the required information as it relates to the extrusion process and the movement path and create files designed to be read by the interface during operation, as seen in Figure 3.

Communication Methods: A serial connection was configured for communication between the Arduino and the user interface to allow for control of the print head assembly while reading the extrusion file. A TCP/IP connection was configured for communication between the interface and the CMM to allow for control of the CMM while reading the movement file.

Optimization: The Arduino and the interface codes have both gone through an optimization process to help reduce the impact of delay during operation which would cause a loss of synchronization during the print job.

Printing: Prints were made to demonstrate the viability of future development of this project. The prints were successful in showing progress, promise, and future development hurdles.

Testing was performed on the various aspects of the retrofit package. Some of these tests include object printing, timing evaluation, path evaluation, and translation accuracy.

DELIVERABLES:

Software Documentation were created to describe the operation, purpose, and potential modifications to the existing software. The documentation also provides a high level description of each function in the software for the purposes of understanding for future developers.

Operating Instructions provided directions for installing and operating the retrofit package.

Wiring Diagrams were created to provide a functional schematic for the retrofit package to aid in future development of product, a simplified version of the system wiring diagram in Figure 2.

Testing results have been collected and analyzed. The test results will be used to identify future development needs.

B**ill of Materials** have been created and provided to Hexagon listing all of the materials and resources that went into the development of this proof of concept design.

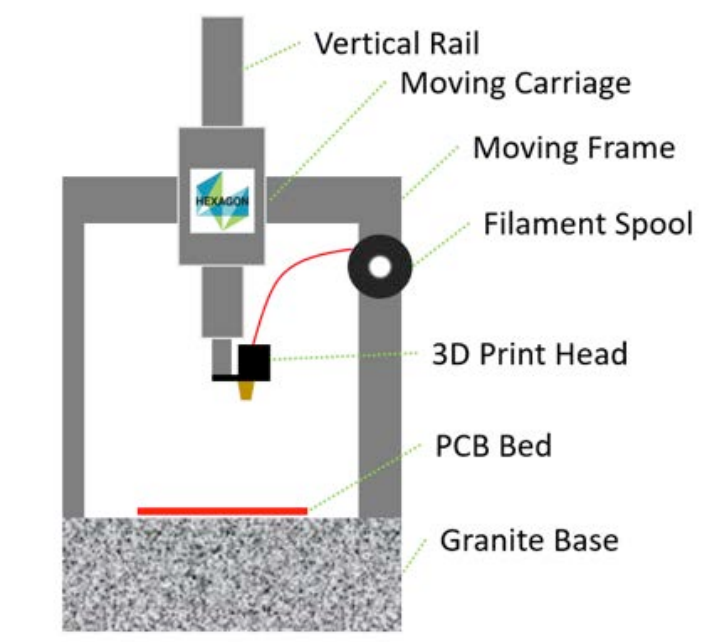


Fig 1: The CMM with the BEST outcome deliverable 3D printing retrofit package.

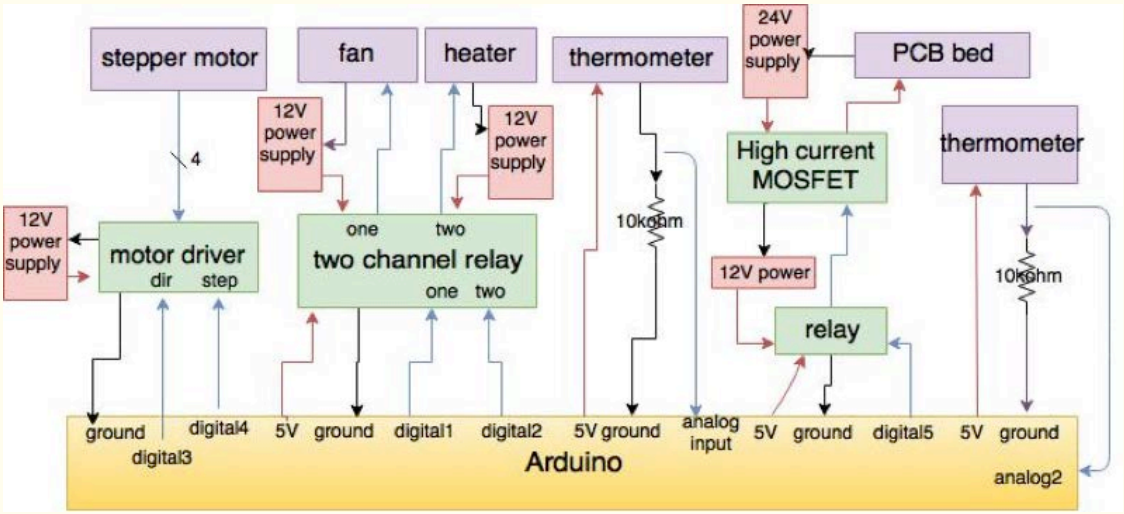


Fig 2: Wiring diagram for the 3D printer retrofit package.

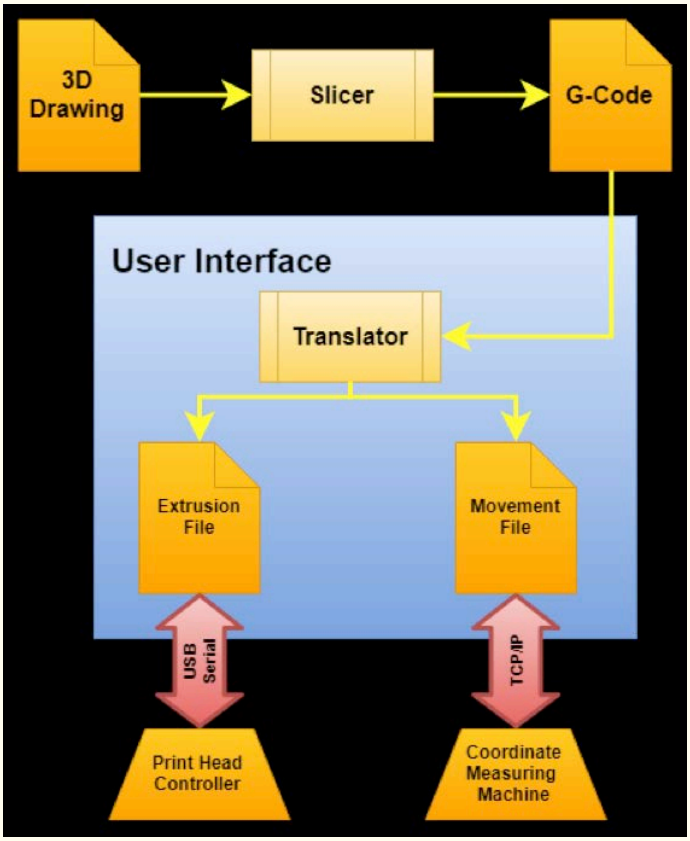


Fig 3: Program flowchart for user interface.

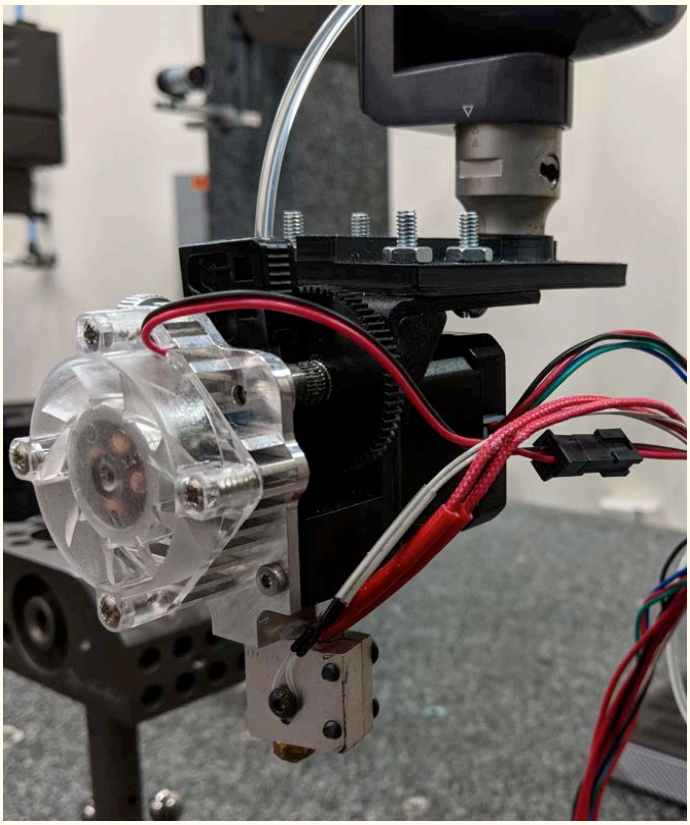


Fig 4: Picture of 3D printer retrofit package installed on the CMM.