

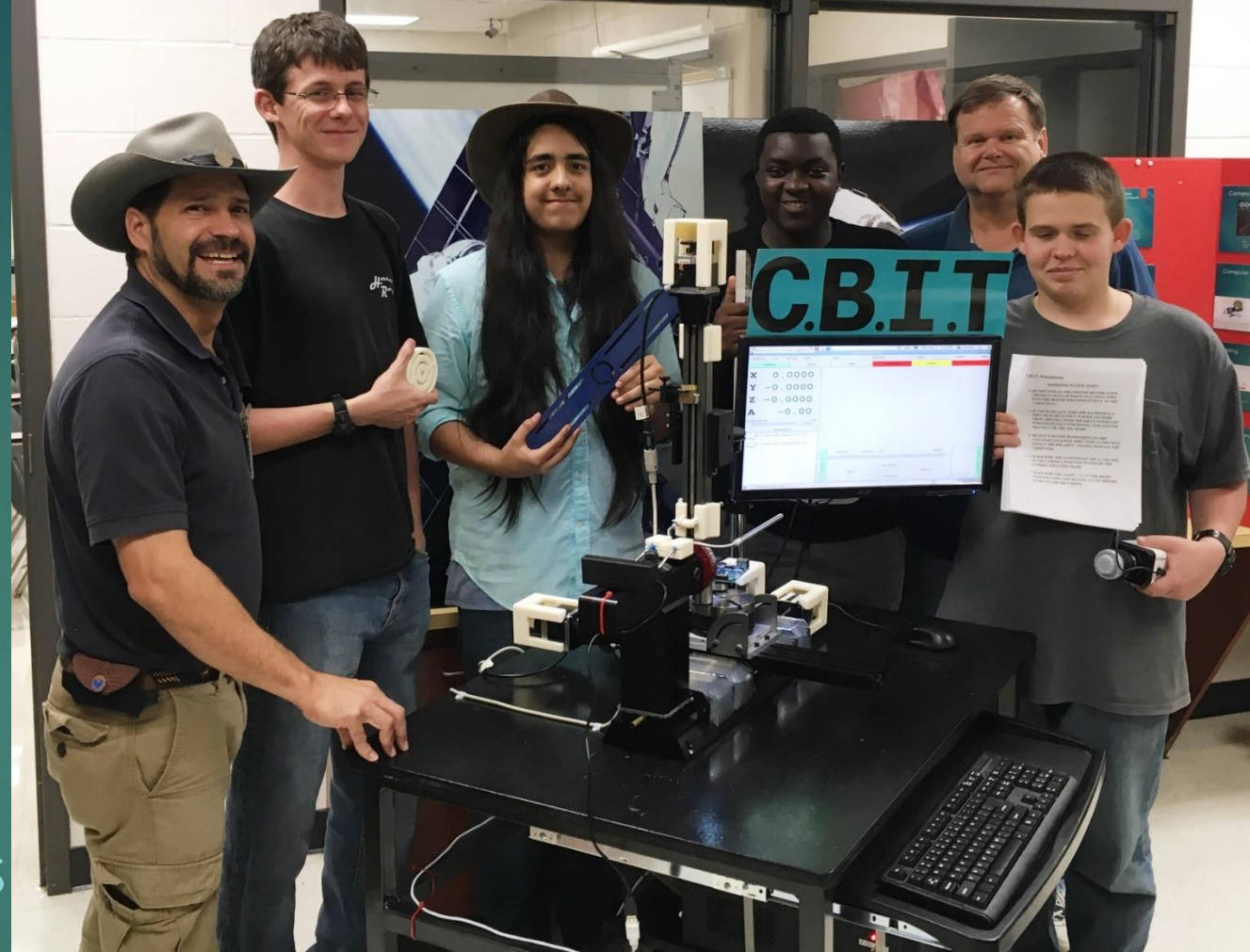
HUNCH CBIT (Circuit Board Inspection Table)

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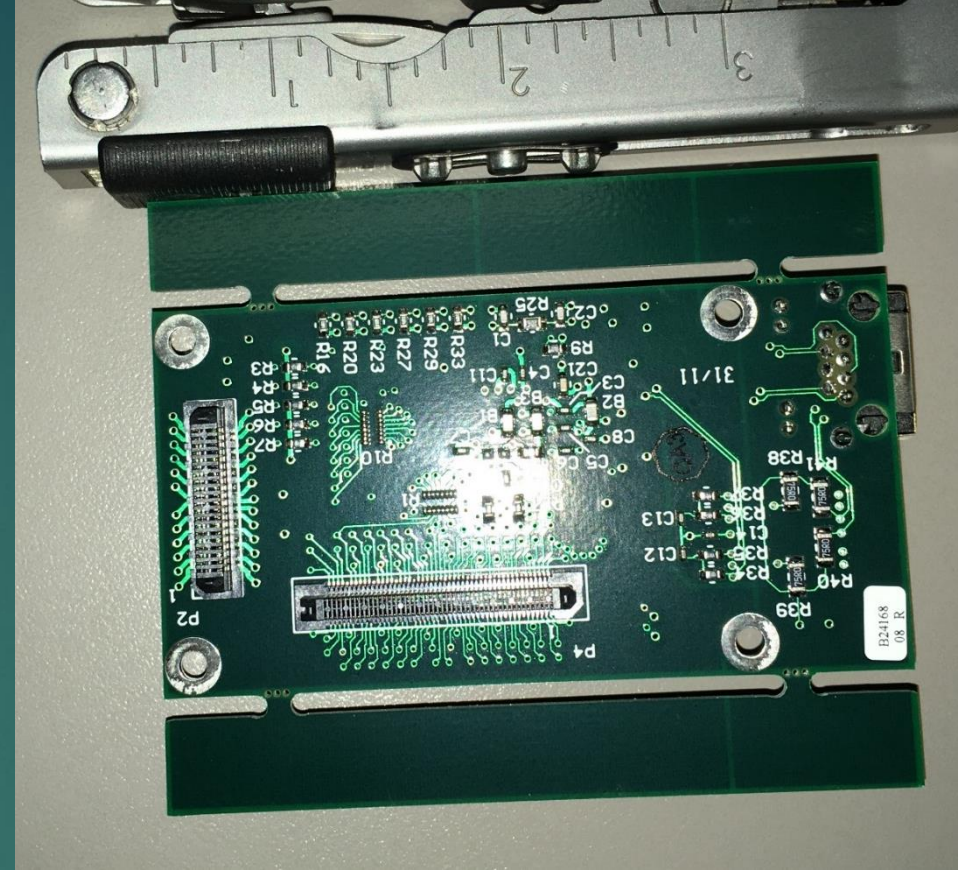
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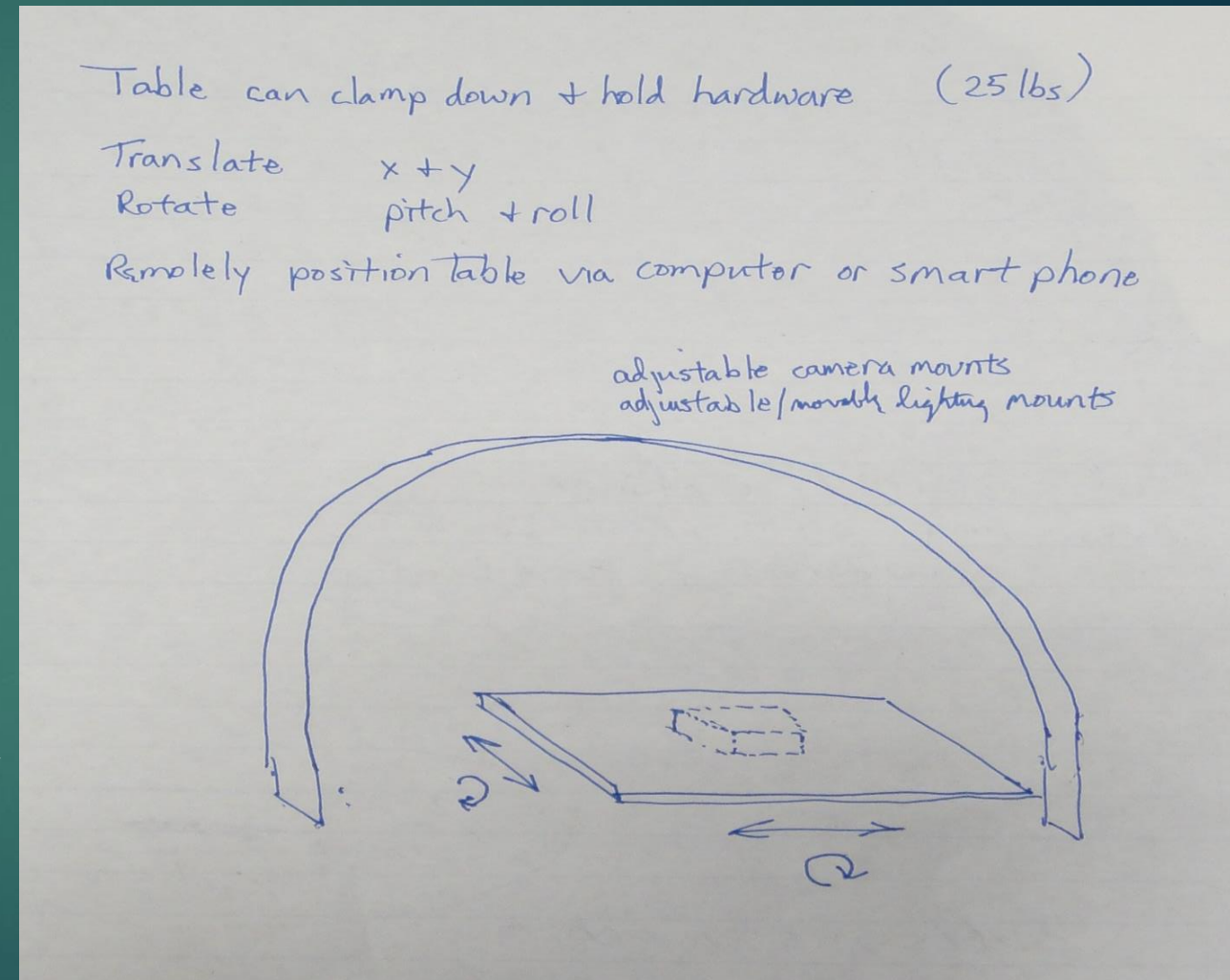
Problem:

- ▶ NASA is purchasing specific circuit boards from a company in Oklahoma. These components have very specific quality requirements that need to be met to ensure functionality when installed. To maintain the company's certification and quality standards, some boards are periodically inspected by a NASA employee immediately after assembly. Unfortunately the NASA employee may not live close to the plant where the boards are manufactured and has to drive 2 hours to do the inspection and 2 hours to get home. This costs a lot of time and effort for both the NASA inspector and difficulties for the company if the inspection doesn't happen as scheduled.
- ▶ NASA was looking for a way to cut down the travel for the inspector but maintain high standards for quality.



Project:

- ▶ Design a visual inspection table that will allow an inspector to view a circuit board (or other parts) from a remote location other than where the parts are located.
- ▶ The inspector needs to be able to control the inspection table and the cameras at the work site from the remote location.
- ▶ Should be able to handle a circuit board 12" x 12"
- ▶ Needs to have smooth motion so the camera isn't jerky and has fine resolution to see imperfections on circuit boards or other components.



Design ideas

- ▶ The first idea students had was to use what they were already familiar with—Vex robotics. They were already familiar with building robots that could be controlled remotely so why not work with available materials.
- ▶ Unfortunately the VEX motion does not need to be slow and steady for robotics competitions. Although the first prototype fit the needs of motion and visibility for a camera, it was not steady enough for the inspection of very small solder joints and connections without having a lot of jerky motion in the cameras.
- ▶ After rejecting the vex idea, the team went over to the machine shop to compare the motions available on the milling machines and realized that a small milling machine could fit all the requirements with a few modifications.
- ▶ The team searched through several different small COTS milling machines, different cameras, lighting systems, computer compatibilities, and software needs to find a combination that would fit NASA's needs and still have versatility.

Mill, Computer, camera and 4th axis

The basis for the CBIT is a small milling machine with the milling motor removed and replaced with an HD video camera. It has a smooth x, y and z axis driven by variable speed motors that can jog .001" at a time if needed.



This high resolution camera will allow close inspection of the circuit board solder joints by moving it closer or further away from the circuit board by using the z-axis of the milling machine

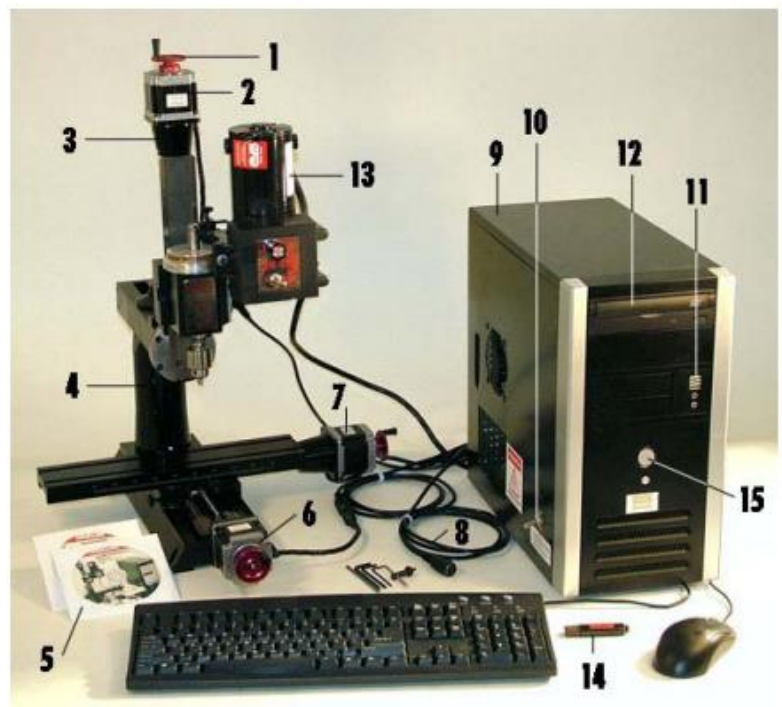
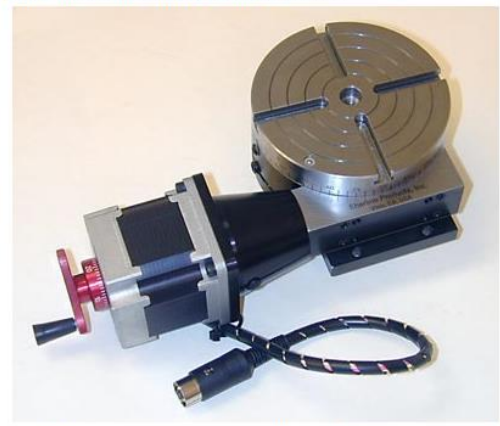


FIGURE 1.1

- System components:**
- 1) 1-5/8" manual handwheel
 - 2) Z-axis stepper motor
 - 3) Stepper motor mount
 - 4) Sherline vertical mill with standard accessories (Model 2000 mill shown)
 - 5) Backup Linux/EMC2 installation CD, Sherline instructions CD
 - 6) Y-axis stepper motor
 - 7) X-axis stepper motor
 - 8) Cable for optional A-axis (CNC rotary table) connection
 - 9) Computer with keyboard, and mouse
 - 10) On/Off switch for stepper motor power supply
 - 11) USB drive ports (front)
 - 12) CD-RW drive
 - 13) DC spindle motor
 - 14) Included USB Flash Drive
 - 15) Power On/Off (Smaller button below is "Restart" button)

Optional 4th axis rotary table with stepper motor, P/N 8730



The P/N 8730 rotary table with stepper motor installed and ready to plug in as the 4th or "A" axis. (Click on photo for larger image.)

The Sherline P/N 3700-CNC combined with a P/N 67127 stepper motor now has a combined part number of 8730 so you can easily order a 4th axis for your CNC mill. The pre-wired plug on the stepper motor plugs right in to the "A" axis cord coming from the computer, and the EMC software has 4-axis capability as well. Should you need rotate a part to cut gear teeth, splines, radial hole patterns, etc., the rotary table will make such jobs possible. Also available among accessories are a fixture to hold the rotary table in a vertical position (P/N 3701), a more advanced fixture that can hold the table at any angle from 0° to 90° (P/N 3750) and an adjustable tailstock that allows parts held vertically in either fixture to be held between centers (P/N 3702).

The rotary table will allow the user to rotate the circuit board to get the view desired.

Linux and Team Viewer

The computer that runs the milling table, runs off Linux. The control screen for the milling table can be viewed and controlled real time by any computer using Team Viewer software.

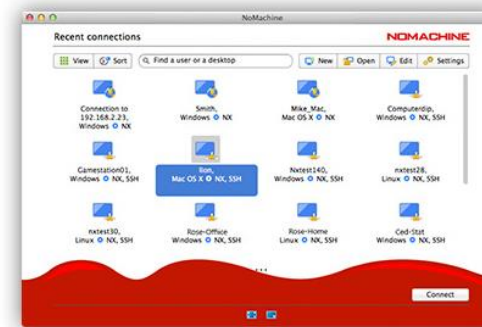
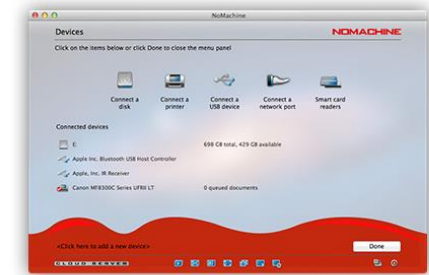


Meet with others where you work

Your desktop is where you work. Open your desktop for others to join in. Let your friends collaborate on the documents you are working on, share the files you need, help with troubleshooting the problems you are experiencing. All securely and under your control.

Use any device

Your folders, drives and devices, travel across machines in a snap. Print a file located on the remote computer to a local printer. Or do the opposite. Plug in any device into the other desktop. Pendrives, scanners and all your disks are ready to use as if they were physically there.



Travel to any desktop

Travel from your desktop to any NoMachine-enabled computer at the speed of light. NoMachine is the fastest remote desktop you have ever tried. In just a few clicks you can reach any computer in the world and start working on it as if it was right in front of you.

Work with any content

Don't feel limited. Enjoy live audio and video from your remote PC. Watch DVDs, the TV, Hulu or YouTube videos from wherever you are. Or render your animated models. Whether you are an artist or an engineer, your favorite software is always with you.

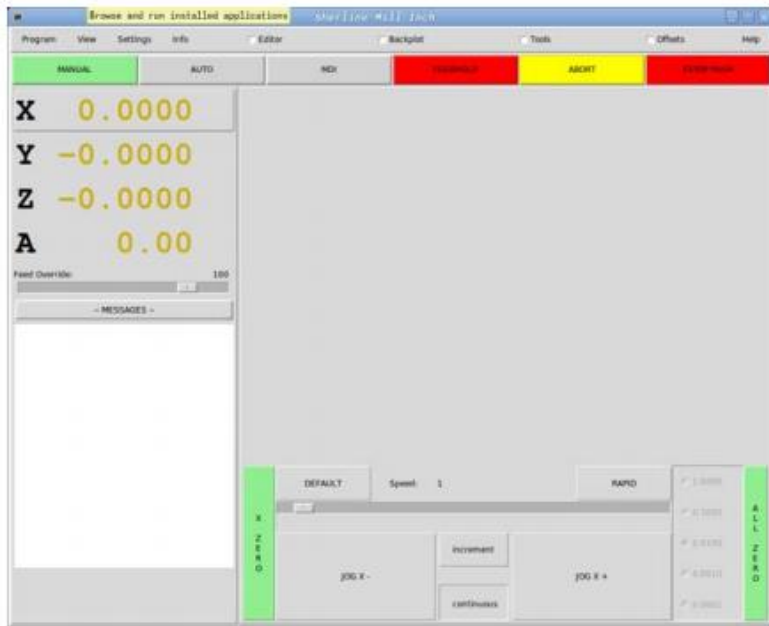
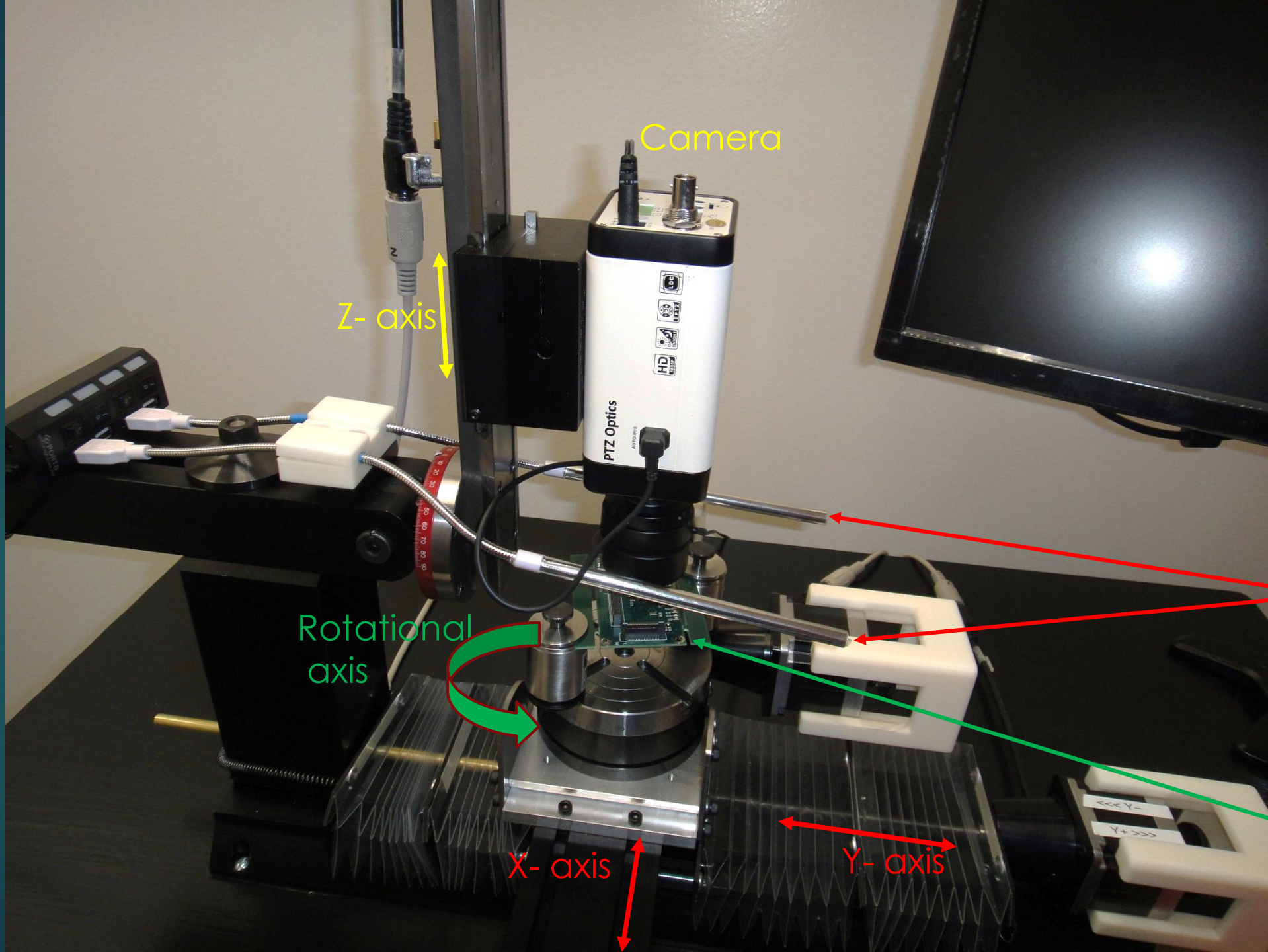


FIGURE 1.4—The control panel screen

The screen is laid out in sections. The first row is the menu bar across the top. Here you can configure the screen to display additional information. The small buttons that are located left center of the command indicate that they control the large blank section of the

Assembly

- ▶ After presenting the idea to NASA, the students were approved for buying the \$6,000 of equipment to demonstrate a new method of inspecting parts.
- ▶ When the equipment arrived, a new team had to work the task of assembling the components and making all of it work together.
- ▶ Although the team had planned out most of the big ideas, some of the assembly and getting it all to work together was more difficult than initially believed.
 - ▶ A different table was needed.
 - ▶ Safety bumpers were needed to prevent equipment from being damaged.
 - ▶ Software was complicated by firewalls and district protocols.



Camera

Z- axis

Rotational
axis

X- axis

Y- axis

All of this can be controlled from a remote computer or phone while viewing the image from the camera.

LED Lights

Circuit board

Student Innovations

Mechanical stops to prevent damage to hardware

Students wrote the operational procedures and warnings for the system.

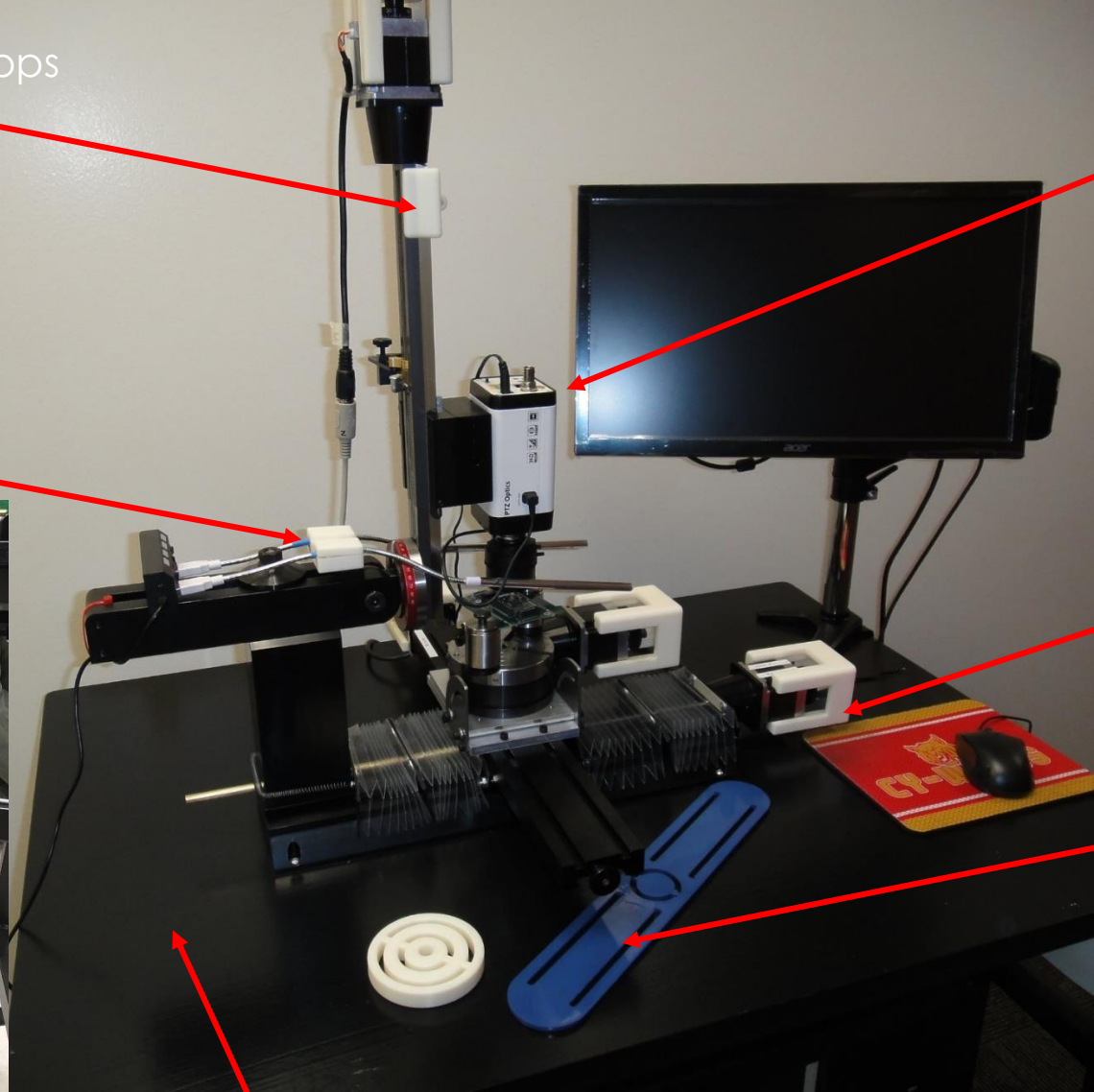
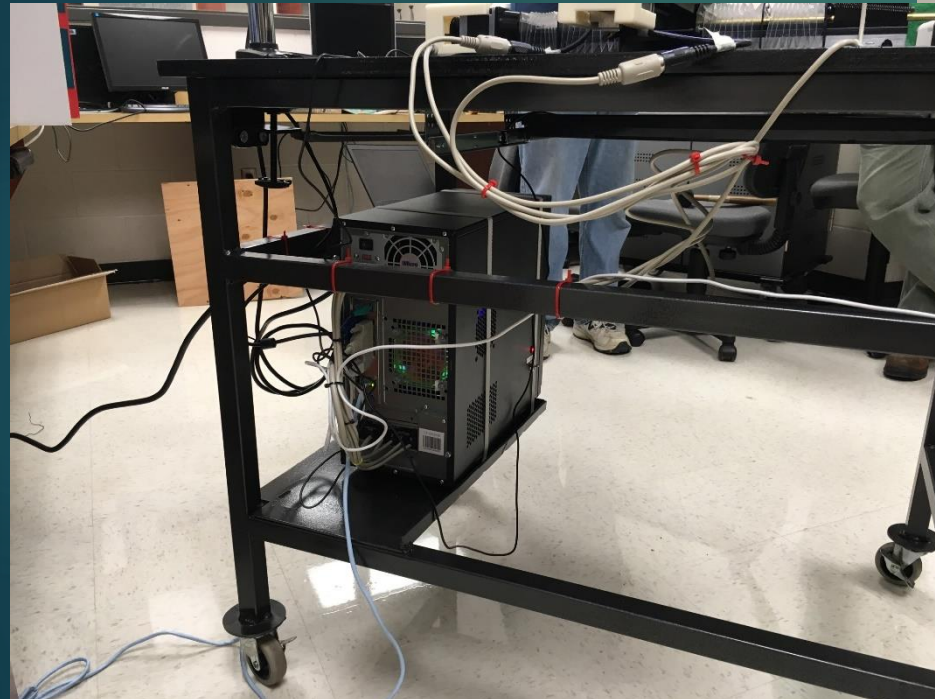
Holder for the LED lights

Camera is integrated with the internet for viewing from anywhere with internet connection.

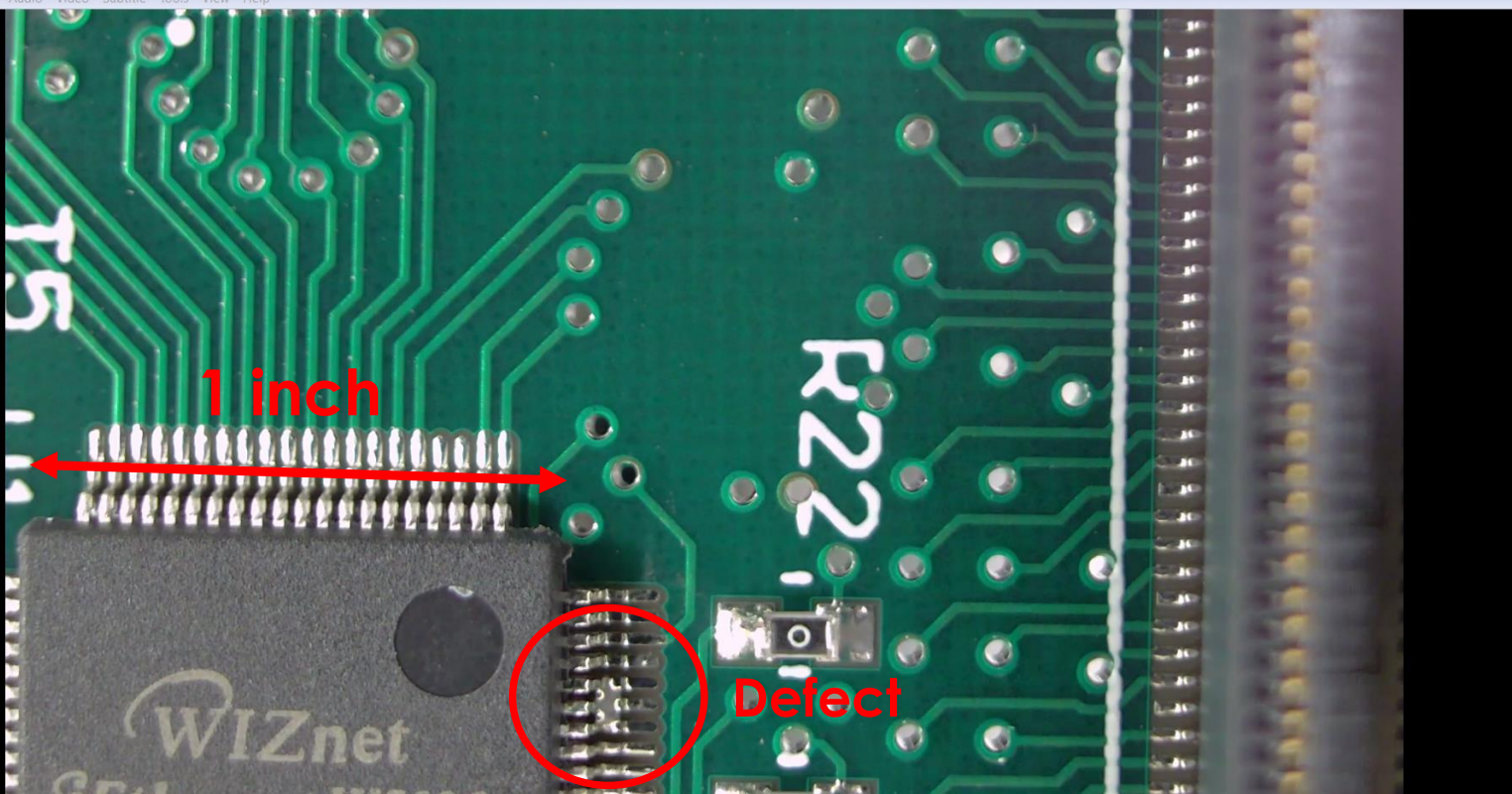
Bump shields for the hand cranks (3)

Steel bases that would allow for multiple sizes of circuit boards or other hardware to be held securely on the CBIT using magnetic or screw based holders.

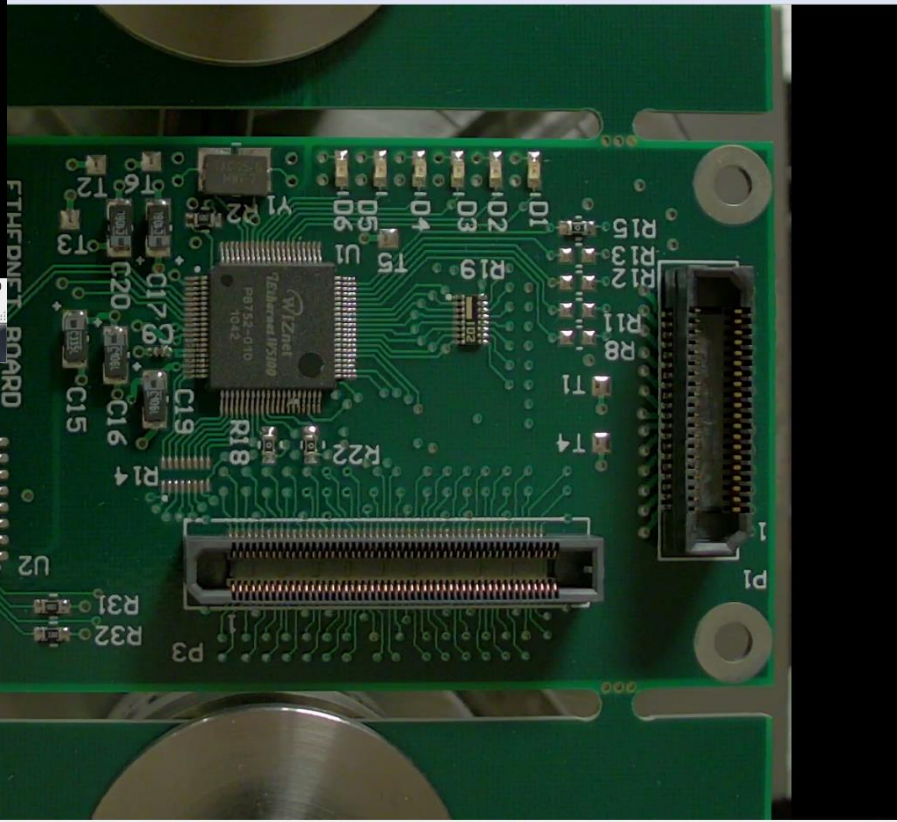
Specialized table to hold the computer and components (key board, mouse, screen), milling machine.



Integration of the Linux software for the milling machine and the Team Viewer. The operator could run it from anywhere with internet connection.

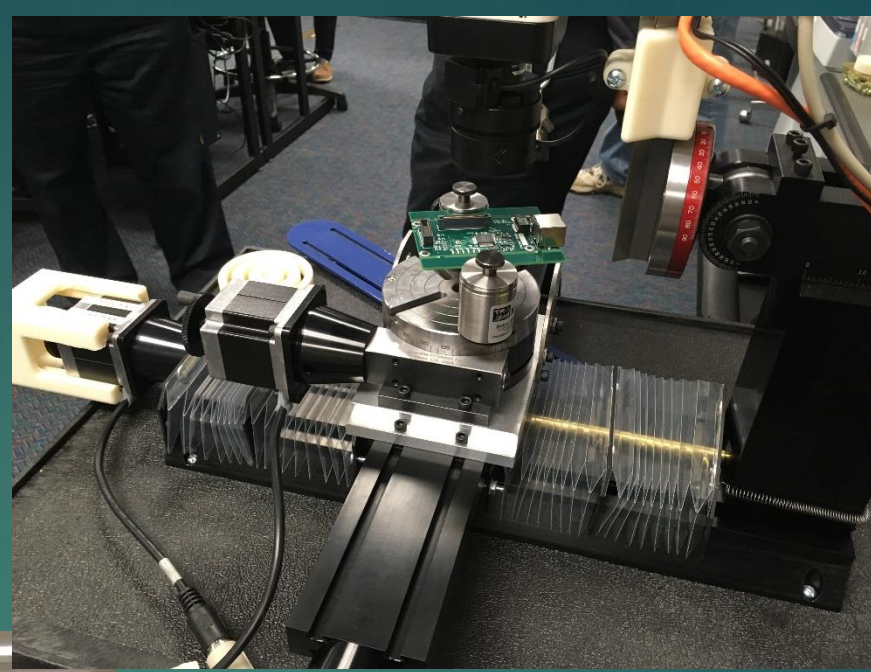


Screen Capture of pictures from the Camera



► These images could fill the whole screen for more detailed inspection and be recorded for viewing later.

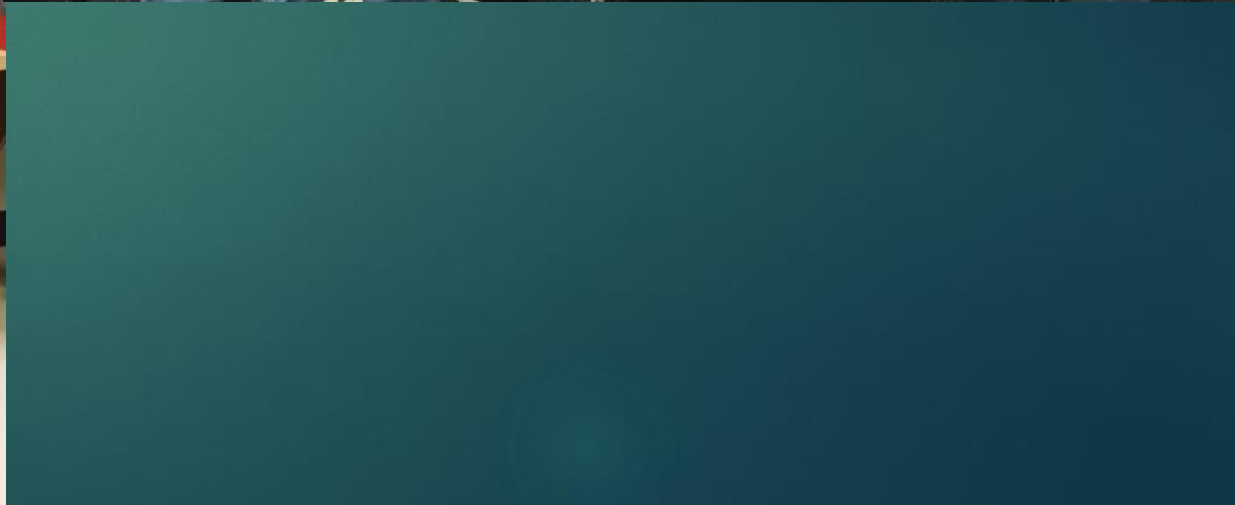
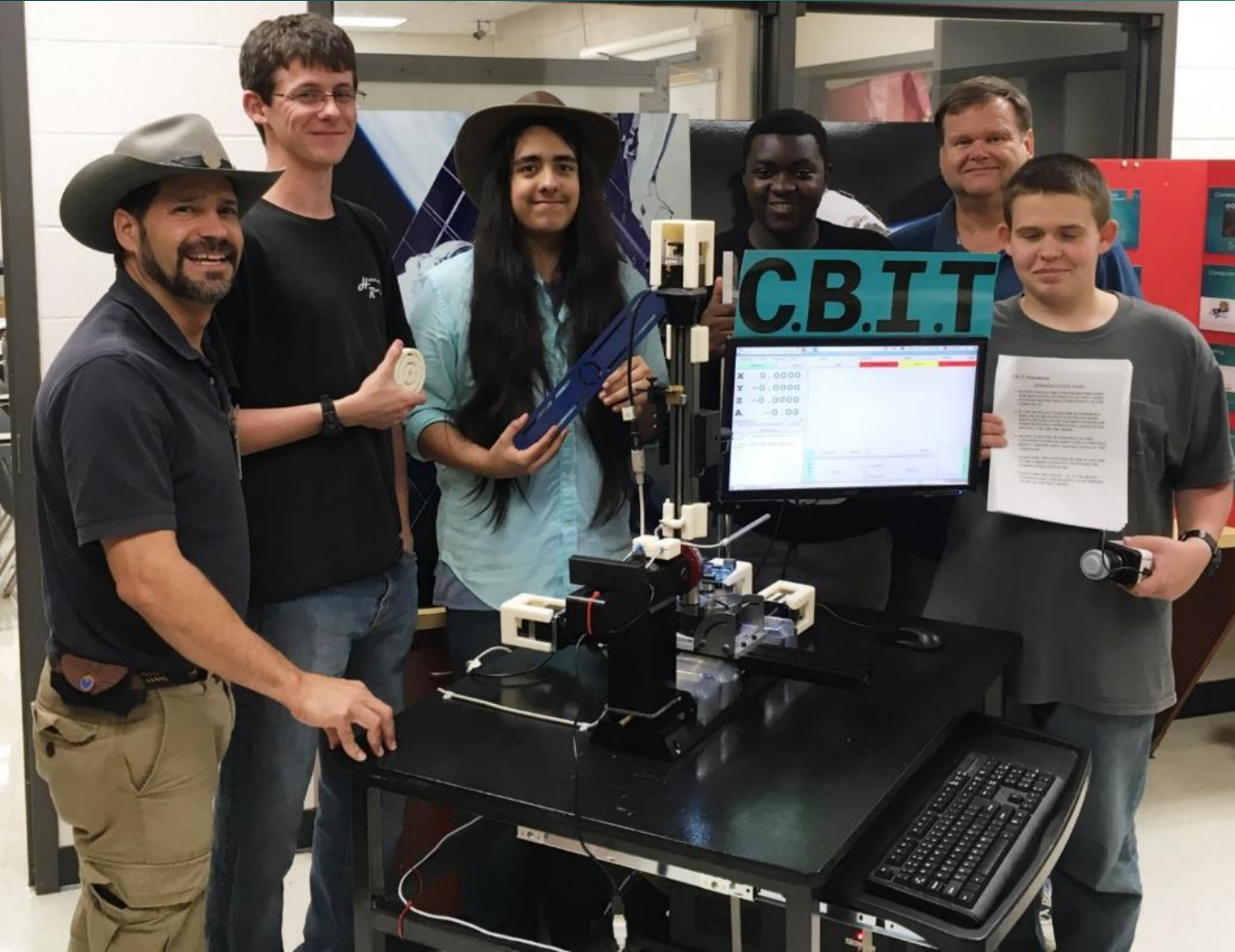
First Demonstration of CBIT



Hardware Development



- Students researched the hardware and software
- Students assembled hardware and made alterations to make camera fit.
- Small COTS Milling Machine with Machine Code programming capability—Sherline
- COTS camera—PTZ Optics
- T-nut attachment to mill
- Student designed and 3D printed stops for hardware on mill
- Student designed and built options for holding samples on mill
- Student written procedures and cautions
- Teacher/Student built rolling table



HUNCH students working on the CBIT and Machinists were recognized by the Space Station Program Control Board by Kirk Shireman Manager of the ISS and Dan Hartman Deputy Manager of the ISS. Astronaut Mike Fossum, also at the meeting, is also a big fan of HUNCH students working on NASA projects.

