Showcase Presentation: Blade Grinding Device

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- Manual Blade Repair

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- Rendering of Device

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- Suction Leg Assembly
- Three-Axis Gantry and Grinding Head Functionality

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- Control Concepts
- Control Flowline
- LabVIEW GUI
- OpenBuilds Control Software GUI

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Turbine Blade Damage

- Wind turbine blades are responsible for harnessing kinetic energy to convert this into usable energy.
- Turbine blades are not invulnerable to the elements. The integrity of the blade can be compromised by lightning, rain, and airborne debris.
- If a turbine blade becomes damaged, its effectiveness is reduced and may require repair.

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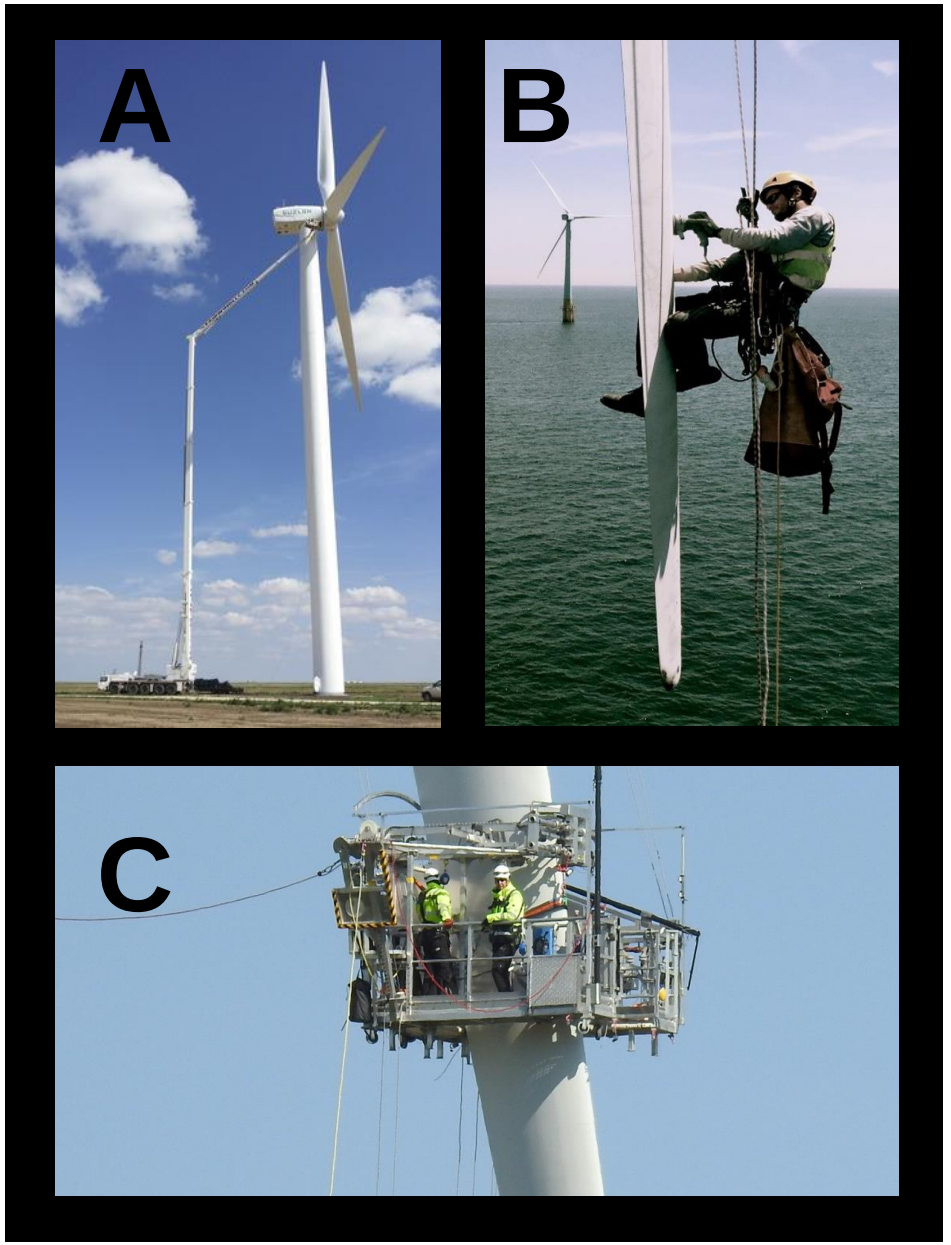
Manual Blade Repair

- Technicians access the blade to be repaired typically in one of three ways; using a boom lift to bring technicians directly to blade damage **(A),** by accessing the blade with ropes tied to the nacelle **(B)**, or with a blade-climbing platform mounted via cables from the nacelle **(C)**
- Once the technician reaches the damaged location, they must assess the damage
- They then begin grinding through the surface paint, contour filler, fiberglass and balsa core. This process is completed with an angle grinder
- After up to 12 hours of grinding the technician can begin to replace each layer by hand



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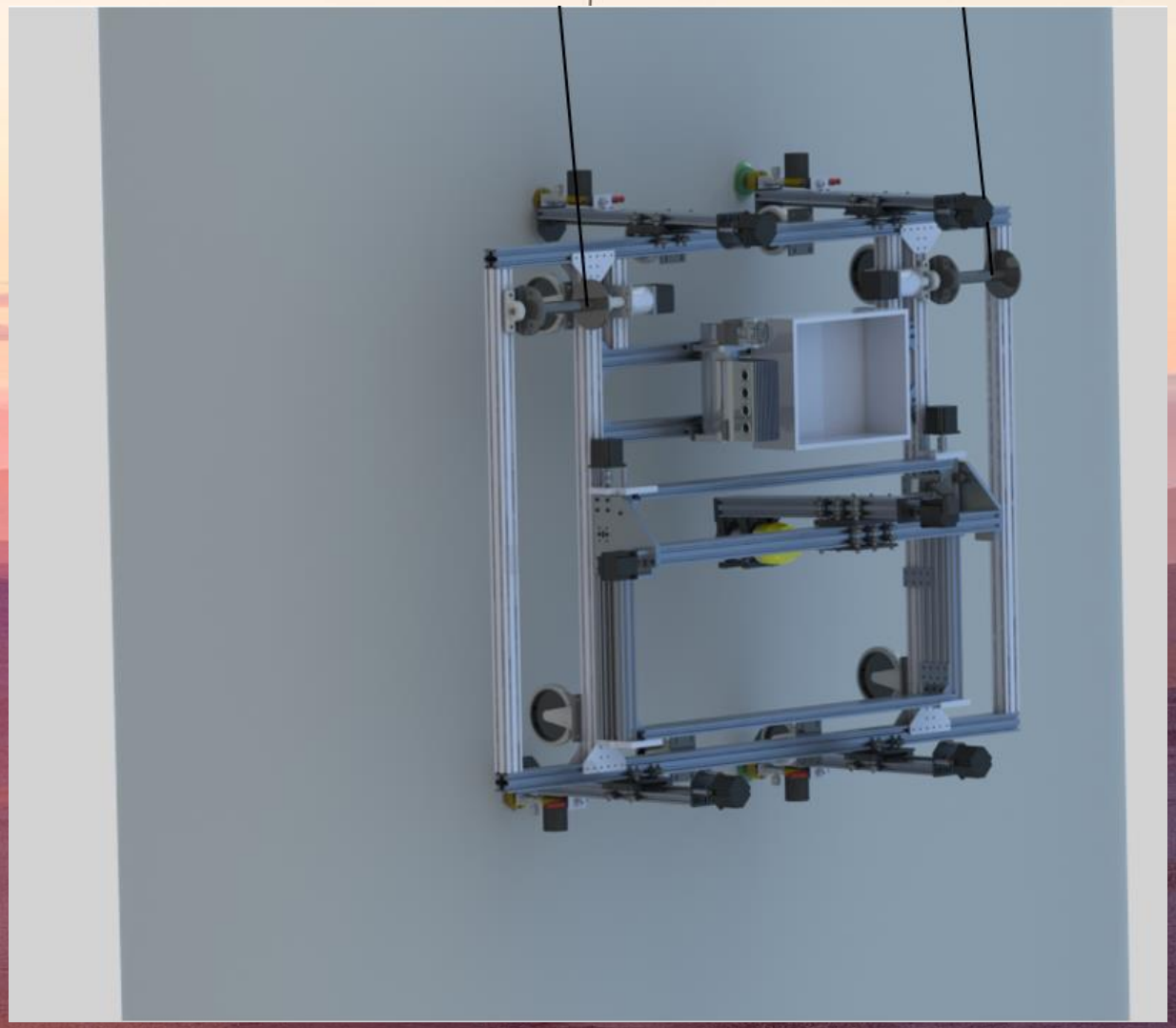
Design Intent

- The purpose of this project was to design a device that could carry out the grinding portion of a blade repair consistently and automatically

- The device that the team has designed and created is able to relieve the technician of grinding. The device allows for a technician to conduct a repair from a safe distance, limiting exposure to irritants and reducing the difficulty of a grind as well as ensuring consistent and accurate results



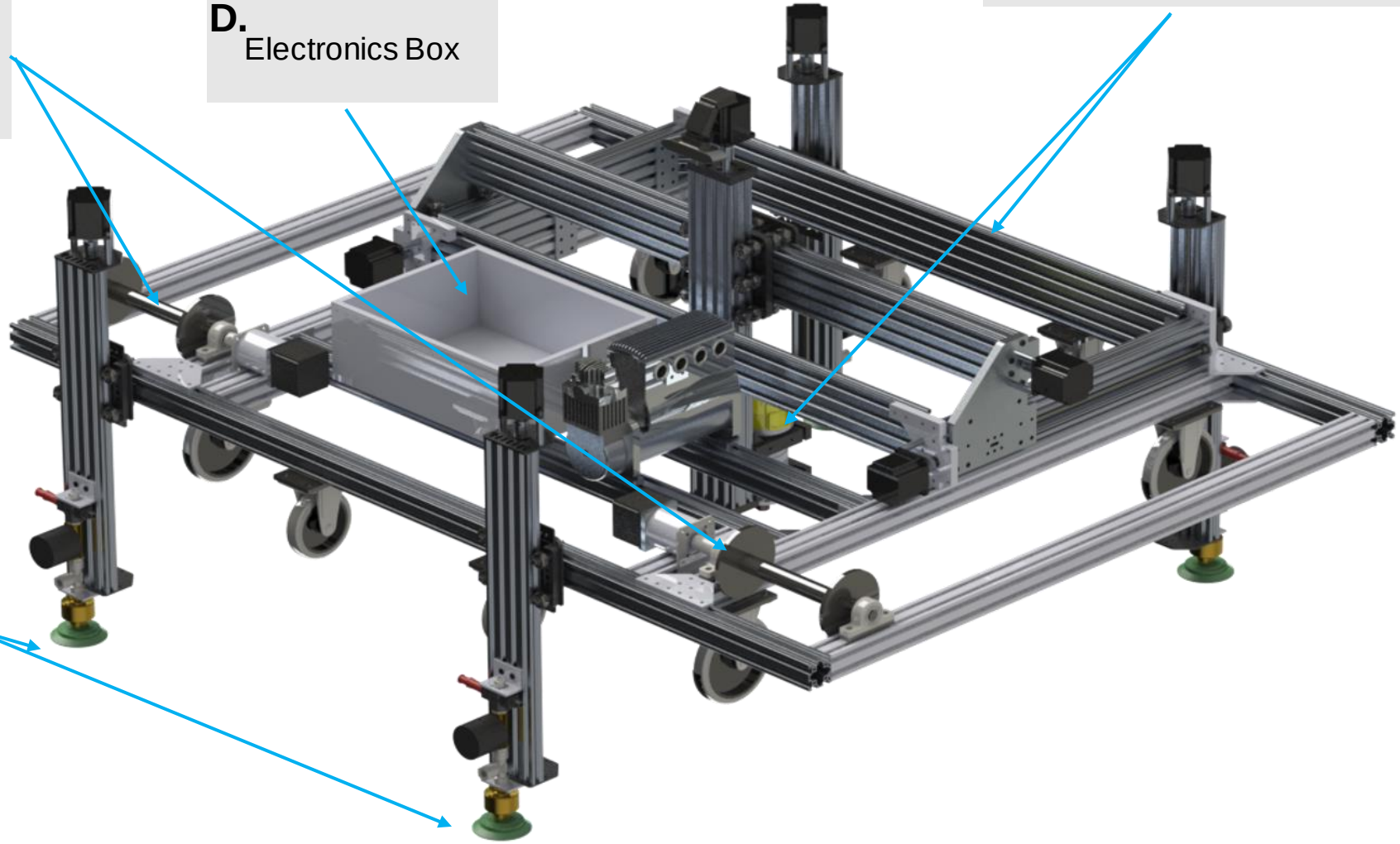
Rendering of Device

A. Vertical Navigation System

B. Suction Cup Legs

C. 3-axis Gantry and Grinder

D. Electronics Box



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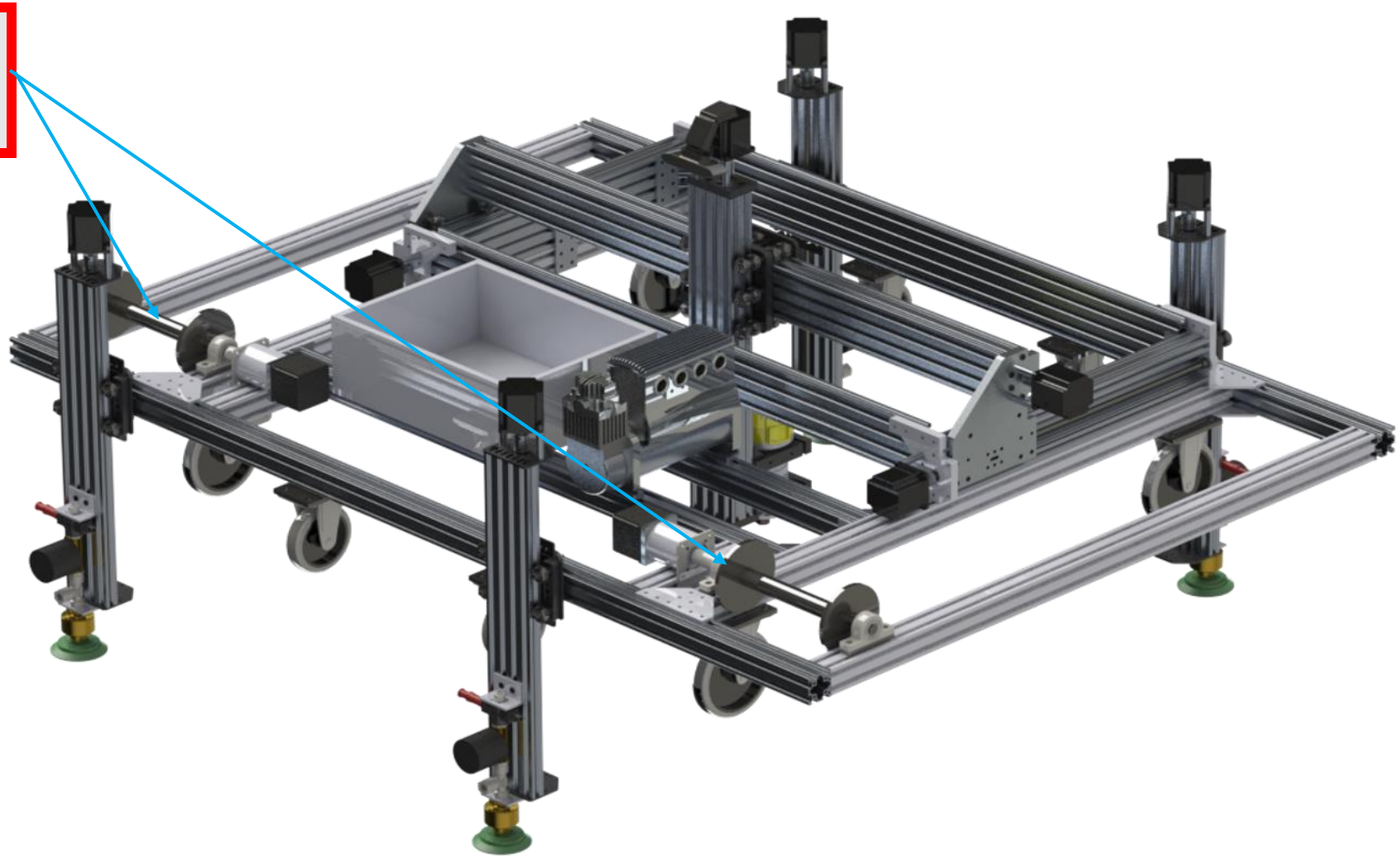
Rendering of Device

A. Vertical Navigation System



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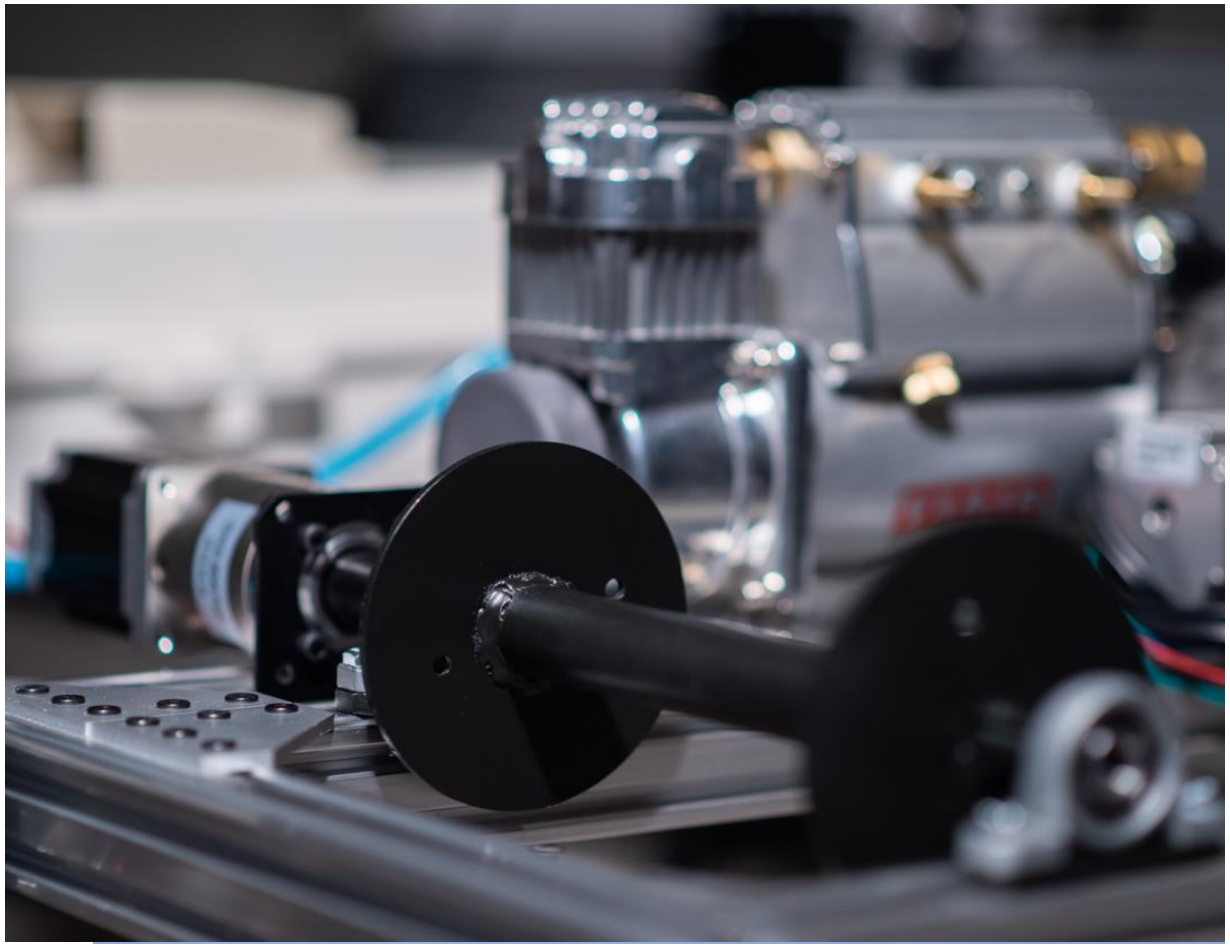
Vertical Navigation

- The two winches on board, carry the device up and down the length of the turbine blade
- This allows for damage to be reached at any position along the blade



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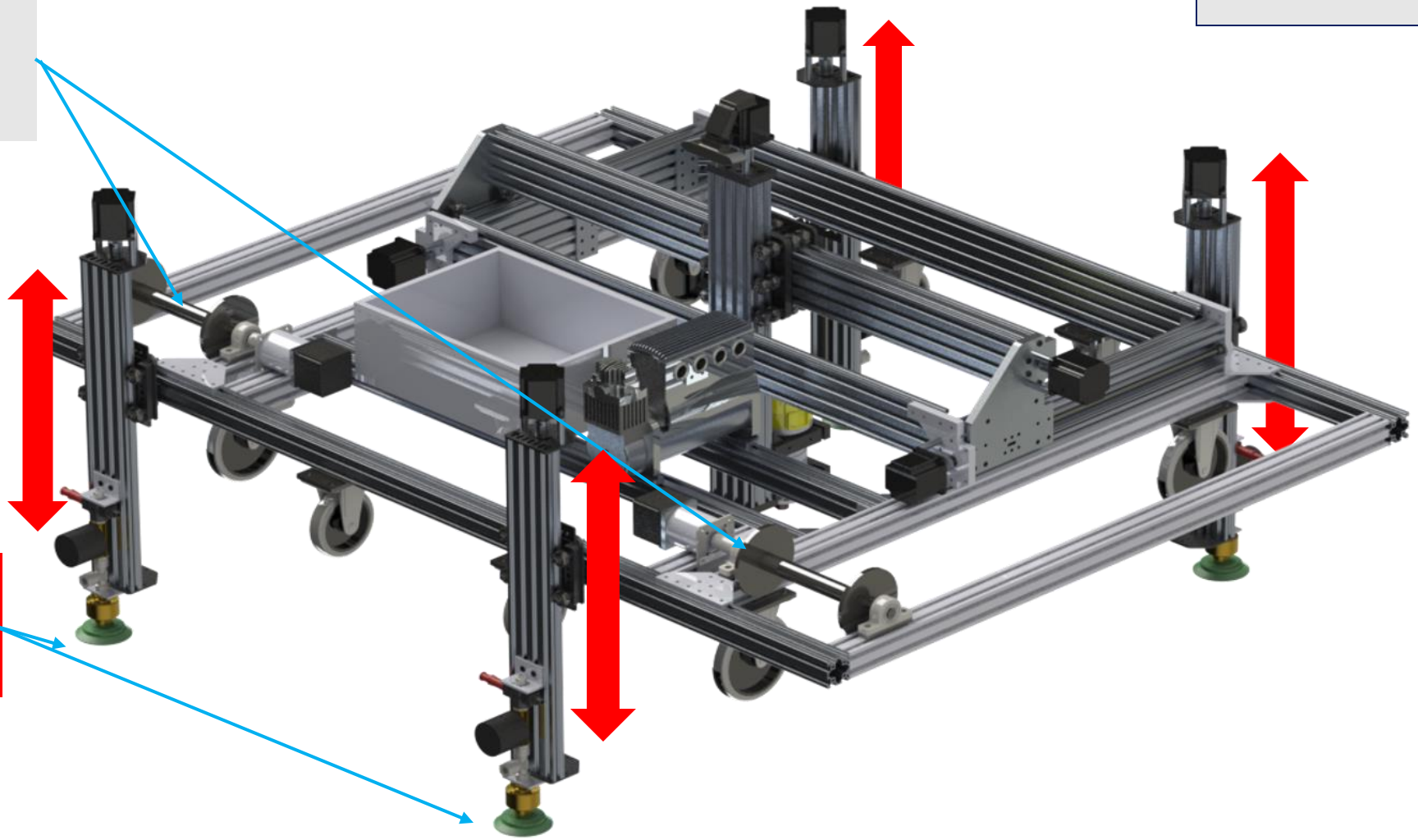
Rendering of Device

Indicates Motion

A. Vertical Navigation System



B. Suction Cup Legs

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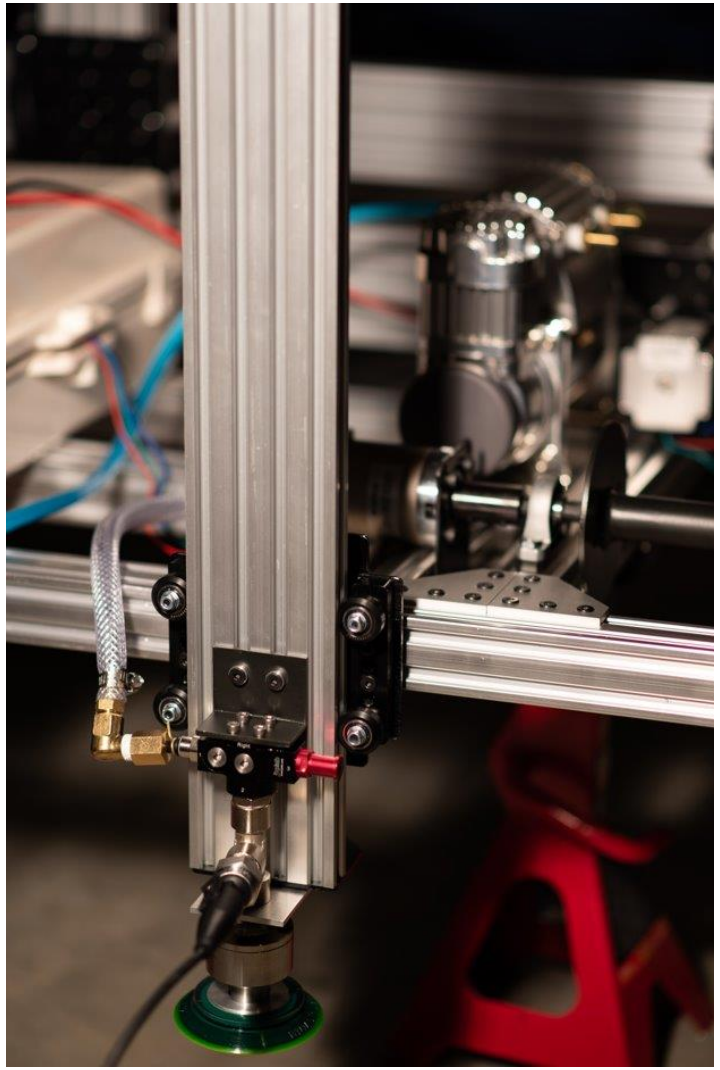
Suction Leg Assembly

- The legs are attached, one on each of the four corners of the device. (shown to right)
- The legs move vertically via the LabVIEW interface. The legs can be adjusted to match the varying widths of the blade
- Suction cups allow for the device to attach to the surface of the blade when conducting a grind



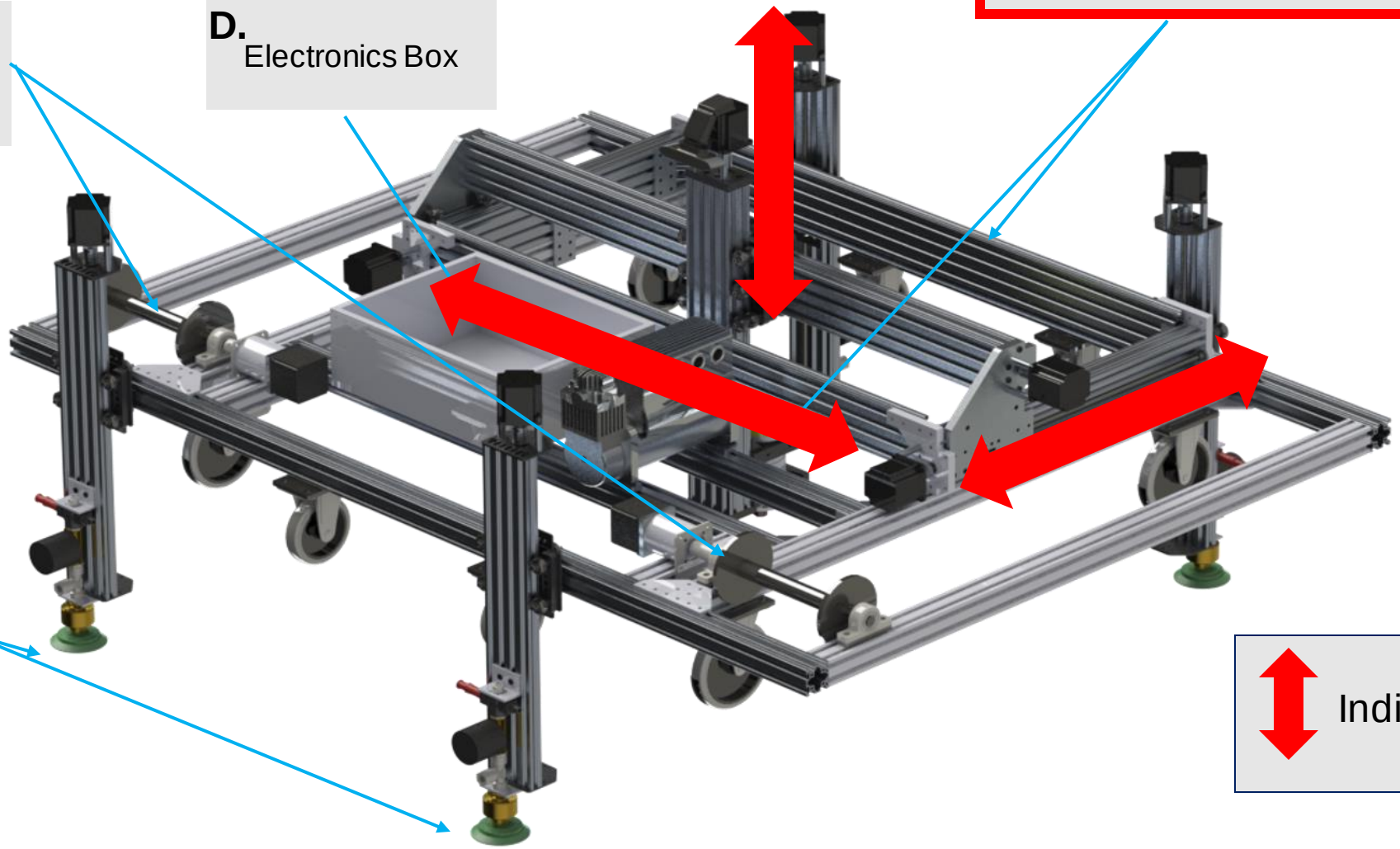
Rendering of Device

A. Vertical Navigation System

B. Suction Cup Legs

C. 3-axis Gantry and Grinder

D. Electronics Box



Indicates Motion

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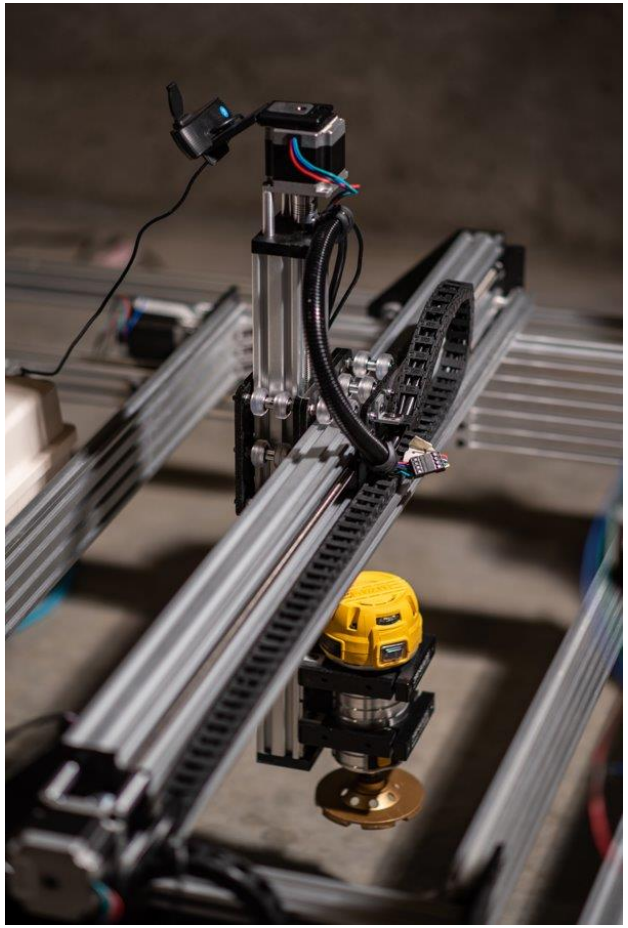
Three-Axis Gantry and Grinding Head Functionality

- The diamond cup grinding tool is attached to a router that is controlled by the three-axis gantry
- The gantry is controlled by OpenBuilds control software. This affords the user control of the grinding head in three dimensions in order to ensure an accurate grind that removes damage with adequate margins



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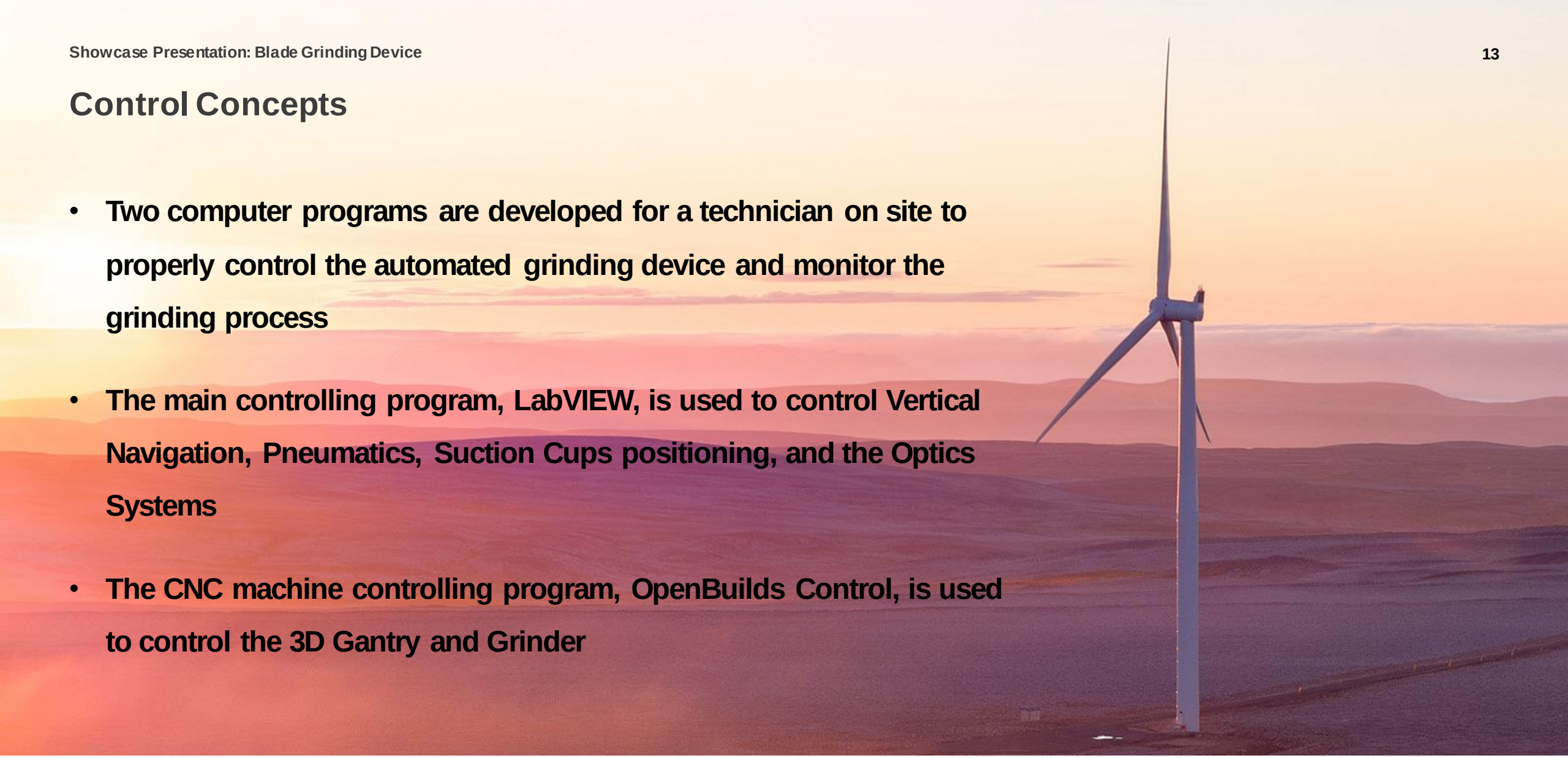
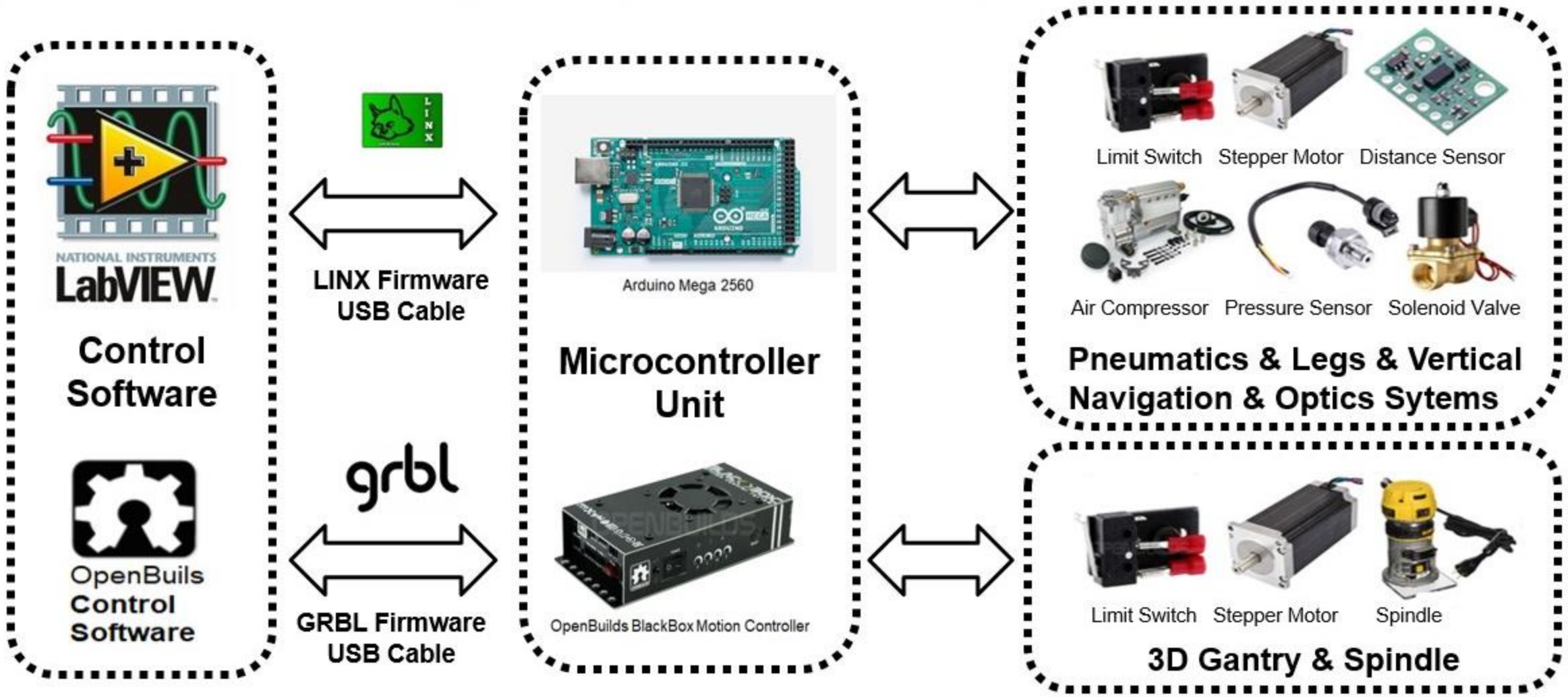
Control Concepts

- Two computer programs are developed for a technician on site to properly control the automated grinding device and monitor the grinding process
- The main controlling program, LabVIEW, is used to control Vertical Navigation, Pneumatics, Suction Cups positioning, and the Optics Systems
- The CNC machine controlling program, OpenBuilds Control, is used to control the 3D Gantry and Grinder



Control Flowline



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LabVIEW GUI – Used By The Technician During Operation

Select Ports to Arduino and Camera

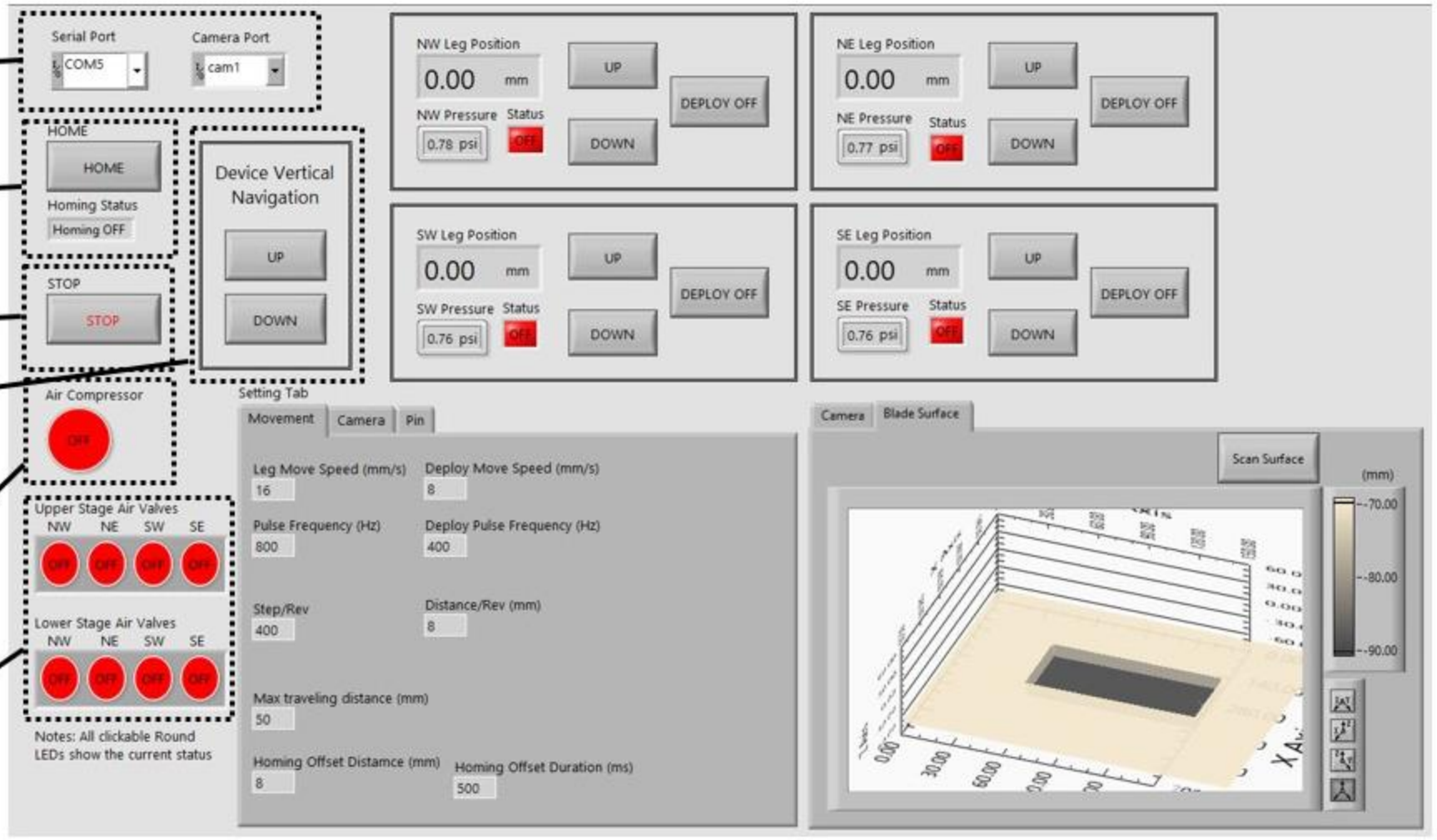
Reset the positions of all legs

Stop all operations

Control bottoms for vertical navigation for whole device

Air compressor power switch

Switches for all solenoid valves



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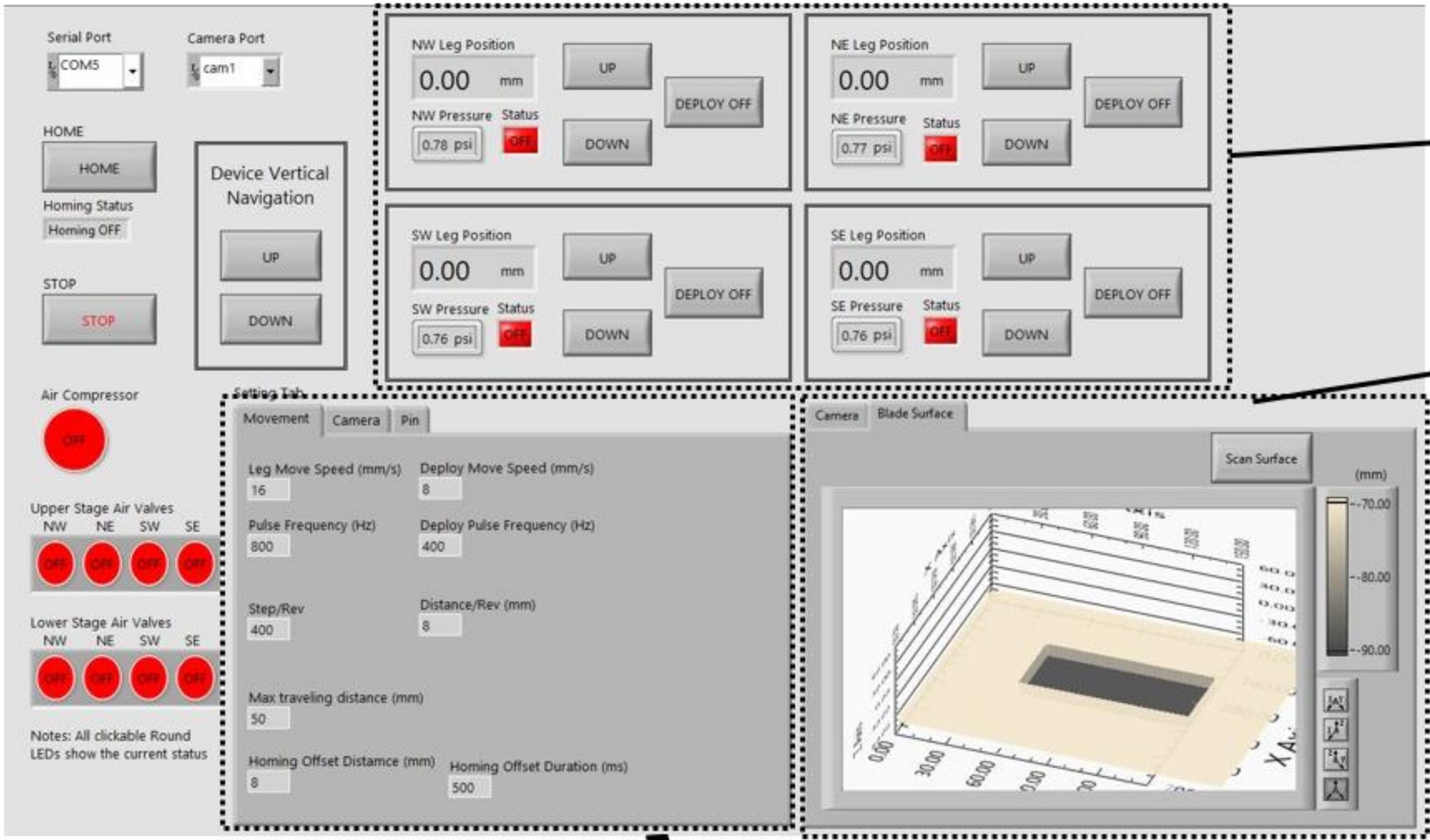
LabVIEW GUI – Used By The Technician During Operation



Control panel for legs that shows leg position, suction cup pressure and control bottoms

Camera feedback and blade surface mapping from laser sensor

Setting tab for motor movement, camera and pin

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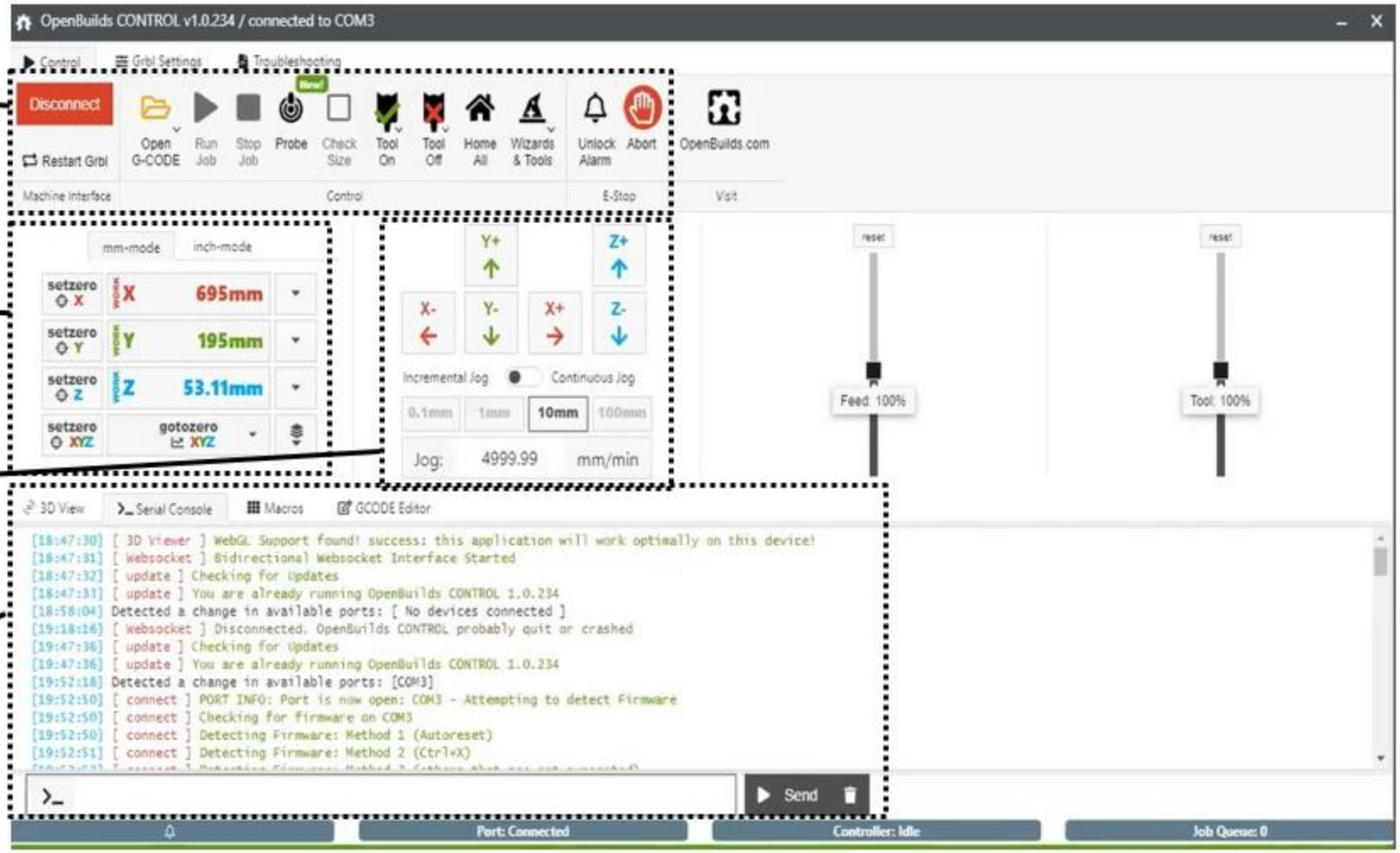
OpenBuilds Control Software GUI

Connection with gantry control box, operational bottoms and emergency stop

Grinder head position indicator in XYZ

Manual controls for moving the grinder head in XYZ

Serial console and 3D view of the grinder head position and pathway



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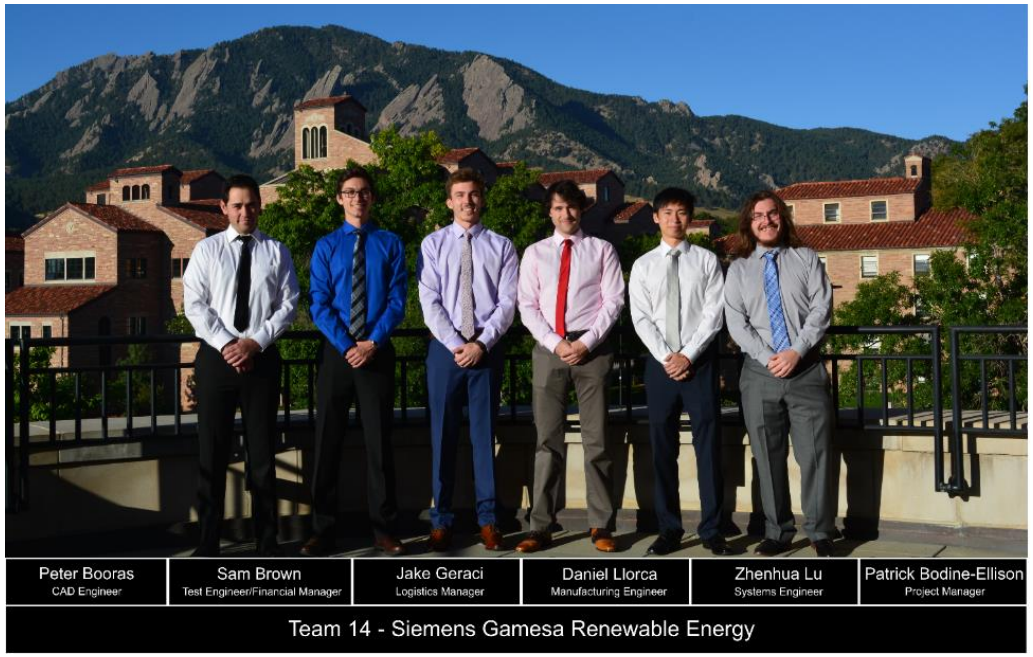
Autonomous Blade Grinding Device

- The team invested countless hours into designing, programming, manufacturing, and assembling this device. It was an interdisciplinary endeavor that sought to solve a complex problem. Ultimately, this device is extremely versatile in that it can tackle any sort of damage effectively, though designed with a minimalistic approach in mind. Though this prototype still requires testing to further iterate and improve the design, the team has laid a baseline with which to design an even more effective device. The team would like to extend a sincere thank you to all parties involved, as without their support, this project would not have been possible.



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