Automated Blade Grinding Device for Wind Turbines

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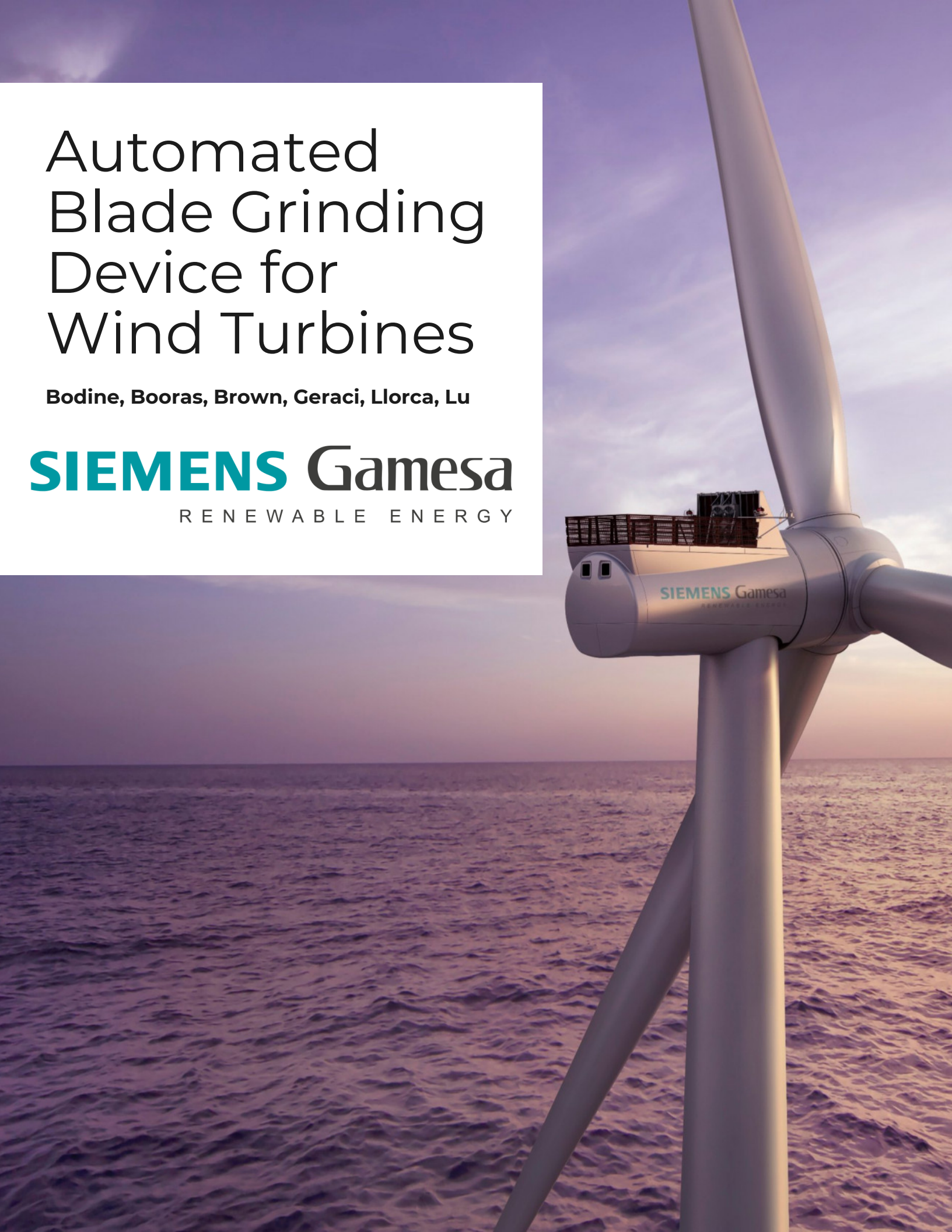
SIEMENS Gamesa
RENEWABLE ENERGY



When Wind Turbines Blades are Damaged

Photo: Blade damage

Wind turbine blades can take a beating, operating 24/7 in the harshest of environments. If blades are damaged the repair process can be costly, tedious, and even dangerous for the technicians involved.

When blades need to be repaired, technicians must assess the damage, remove the damaged materials, and re-build and paint the fiberglass blade structure all while the blade remains mounted on the turbine.

This process is lengthy, averaging between 15-30 hours per repair. The grinding portion is among the most important, with strict requirements on quality, speed, and safety.

In order to resolve these issues, our student design team worked with **Siemens Gamesa Renewable Energy** to develop an automated solution to the most dangerous part of wind turbine blade repair, blade grinding.

Our automated blade grinding device is designed to perform this grinding operation remotely in three steps: **ascension**, **surface mounting**, and **precision grinding**.

A Three Part Solution

Photo: Testing the blade grinding device

The blade grinding device is designed to grind away damaged material from a wind turbine blade surface. In order to do this safely and accurately it performs **three sequential operations**.

The **first operation** the device must perform is ascending up the surface of the blade to where the damage on the blade is located. To do this the device uses two stepper-motor controlled winches spooling paracord that is anchored to the top of the wind turbine nacelle.

During ascension a set of non-marking caster wheels keep the blade surface safe from being scraped by the device's aluminum frame.

Once aligned with the blade damage the device starts the **second operation** of mounting itself securely to the blade surface. To do this the device uses suction cups attached to movable legs that can adjust to the irregular surface of the blade.

The device's control system monitors the pressure inside each of these suction cups and regulates use of its vacuum pumps in order to conserve energy while ensuring a secure connection to the blade surface.

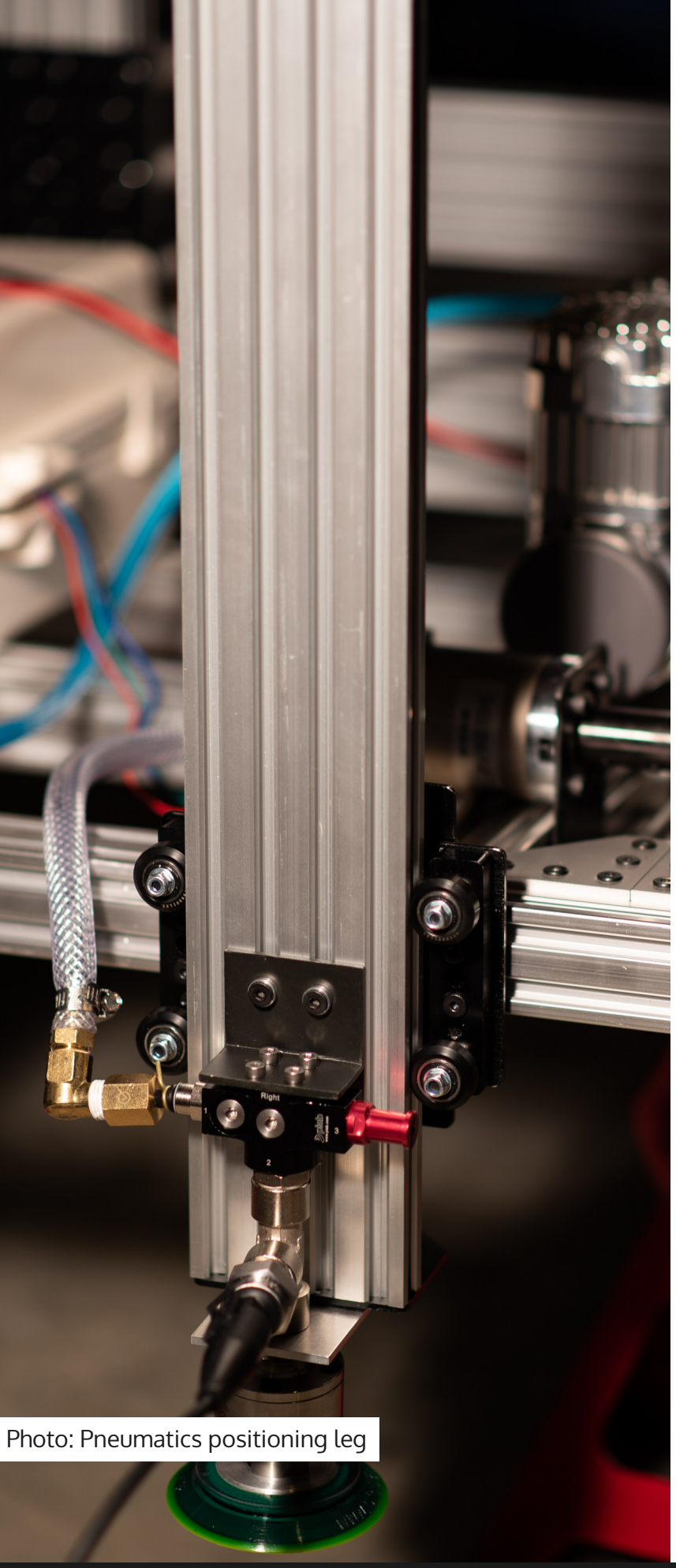


Photo: Pneumatics positioning leg

Precision grinding is the key to the function of the device. It carves away at the blade material using a CNC router.

For the **third operation**, after the device has been aligned with the blade damage and has secured itself to the blade it utilizes a laser distance sensor to map the blade surface and develop a grind path covering the entirety of the damage.

The grinding device, a CNC router system designed using open source components from OpenBuilds, is fitted with a diamond cup wheel bit to grind away at the composite blade material while keeping wear on the device low.

This precision grinding method allows blade damage to be removed with the utmost accuracy. This leaves the surface ready for a technician to reapply the balsa wood and fiberglass layers in order to get the turbine up and running again and supplying clean energy to homes around the world.

The Design Process

Good design starts with a team that truly cares about finding a solution to a meaningful problem.

The problem at hand, the safety of technicians working on clean energy solutions, means a lot to all the members of our tight-knit engineering team. In order to develop the highest quality and most innovative solution possible the team started the design process with rapid brainstorming that resulted in the **development of pretotypes**, a type of pre-prototype product used to test out simple ideas quickly.

After pretotyping and subsequent prototyping the team settled on a solid idea for the design of the blade grinding device. The team then created countless **new iterations of the design**. These new iterations each improved upon the last using feedback from real wind turbine technicians and industry professionals in the world of design and manufacturing.

When the design was finalized, the team coordinated to **turn the theoretical into the real**. Long hours machining parts, wiring electronics, and testing functionality lead to a fully assembled blade grinding device. Additionally, The hard work and innovation put in to this design has lead to the **pursuit of a patent** from Siemens Gamesa Renewable Energy.

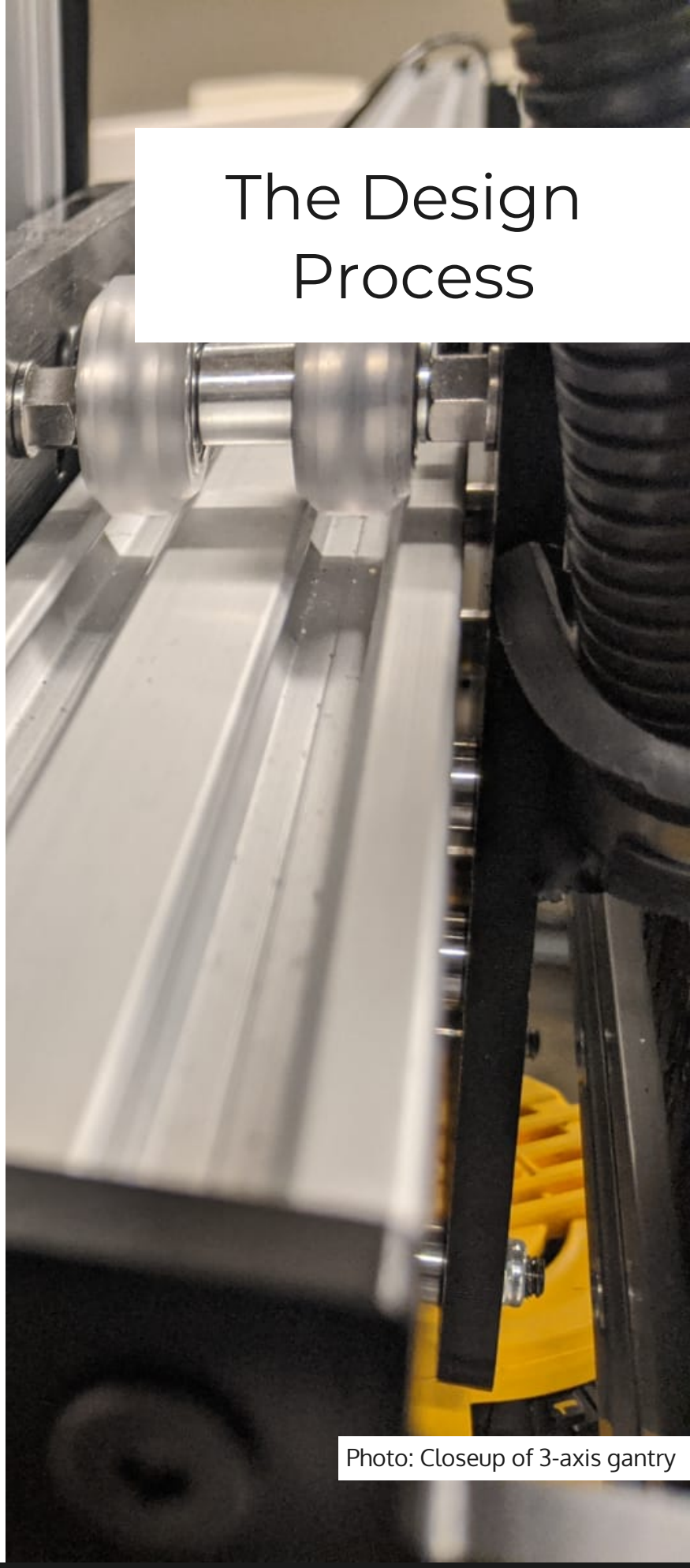


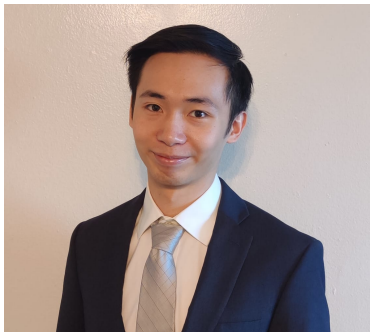
Photo: Closeup of 3-axis gantry

Meet Our Engineering Team

Sam Brown - Test Engineer/Financial Manager

Sam Brown is a senior at the University of Colorado Boulder where he is finishing his mechanical engineering degree. His interests lie in engineering design and manufacturing. Sam's role as the financial manager as well as test engineer as well as other supporting roles, enabled the team to procure necessary components and test them. Whether working on cars or creating steel sculptures, Sam loves creating with his hands. Sam is actively seeking work in design and manufacturing.

Zhenhua Lu - Systems Engineer



Zhenhua Lu is a senior year student at the University of Colorado Boulder, where he is pursuing bachelor's degrees in mechanical and electrical computer engineering. As the system engineer in this project, he divided the project into several subsystems that have individual requirements, designed and constructed the whole electrical system and user interface. Participated in lots of engineering projects of various topics, he has experience and knowledge in multiple fields, including electronics, circuit, control system, machine learning, computer vision, HCI via program, component design and material testing.

Peter Booras - CAD Engineer

Peter Booras is a senior at the University of Colorado Boulder where he is pursuing a Bachelor's degree in Mechanical Engineering. During this project, Peter was responsible for creating a 3D model of the device. With help of his team and countless hours in SolidWorks, Peter was able to create a comprehensive model of the device. His interests pertain to engineering design, manufacturing and fabrication. When not doing school, Peter runs a small general residential contracting business on the side. Upon graduating Peter is actively seeking positions in design and manufacturing.

Patrick Bodine-Ellison - Project Manager

Patrick Bodine-Ellison is a mechanical designer and maker interested in renewable energy, fluid mechanics, and art. In the world of engineering he uses his knowledge to solve real world problems related to renewable energy and the environmental impact of man made combustion. In addition to his engineering pursuits Patrick hopes to find a junction between art, design, and engineering to share his passion for mathematics and engineering with others.

Jake Geraci - Logistics Manager

Jacob Geraci is a senior at the University of Colorado at Boulder where he is completing his bachelor's degree in mechanical engineering. Through his role as Logistics Manager on this project, Jacob acted as the point of contact between the design team and client. He is interested in pursuing mechanical design and consulting. In his free time, Jacob enjoys working on cars and motorcycles.

Daniel Llorca - Manufacturing Engineer

Daniel Llorca is a senior at the University of Colorado Boulder where he pursued a bachelor's degree in mechanical engineering. Daniel was the manufacturing engineer, a role which allowed him to spend time in the machine shop creating the parts necessary for the completion of the project. Daniel is interested in manufacturing and machine design, especially within the realm of aerospace. Upon graduation, Daniel intends to go on to become a Marine Corps officer.