The Club:

Utah Student Robotics (USR) is a student-led club at the U focused on competing at the NASA Lunabotics competition. We organize the club into three sub-teams: Mechanical, Electrical, and Software. (Systems is kind of a fourth). Mechanical designs and builds the chassis, electrical makes the boards and manages the electrical system, and software selects hardware and programs controls and communication; pretty self-explanatory. Members of systems help coordinate between teams and document the design process for NASA, and typically are on another sub-team as well. Together, we are USR.

The Contest:

As a part of the Artemis missions, NASA wants to establish long-term presence on the moon. The NASA Lunabotics competitions let NASA crowdsource ideas from rising students from across the nation. It has been shown that there is ice buried in craters on the moon, and to investigate ice retrieval, NASA tasked students with creating a robot that can traverse a lunar-like environment and mine gravel and deposit it in a collection sieve. This was the goal for the 2021-2022 Lunabotics competition.

Here's how it went:

During my first year on USR, I was a member of the Mechanical and Systems sub-teams. USR already had most of a robot design from the 2020-2021 competition which had been virtual due to COVID-19. As a part of Mechanical, our first order of business was establishing new constraints according to competition guidelines with the Systems team. After we knew our constraints, we created a decision matrix to decide what parts of the robot design we wanted to change from last year, and what we wanted to keep the same. For the parts we changed, we decided on an alternative.

Now, we could get started on actual design work. The team leads gave out assignments, and we got to work designing and CADing the new parts of the robot. The CAD model was done in SolidWorks, which we get access to through the College of Engineering at the U.

My first task for USR was to maximize the robot arm length based on the new size criteria. It just took some simple trig and a little time in SolidWorks, but now our robot would easily be able to reach the deposition sieve, which had been a concern from the previous year’s design.

My main contributions:

Holders, Covers, misc 3D-printed parts, redesigning the rocker-bogie to be made of aluminum tubing.

CDR:

Halfway through the year, we had our Critical Design Review. This is a holistic review of the robot design with everyone in the club, as well as with some advisors and experts. CDR lets us ensure compatibility between sub-team systems, and improve our design with the advice of our experienced faculty.

Originally, we had been planning on making the new aluminum rocker-bogie by welding together cut aluminum tubing. During CDR, we realized that this would be rather difficult, and switched to using fastening plates instead. Additionally, we were going to need dust prevention measures for the arms to prevent them from gunking up. (BP1 simulant is pretty nasty!) A picture containing LEGO, toy

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Second semester was spent finishing design revisions from CDR, ordering parts and preparing inventory, and oh yeah, building the robot.

                                    This work was spread out over the course of the semester, and we faced delays from supply chain issues and COVID shenanigans. We kept

                                    busy doing outreach and Systems work, but finally, it all culminated in Proof of Life.

Proof of Life is video proof of a working robot, and it was our ticket to the competition. Any team that didn’t submit a Proof of Life video was eliminated. It was our hard deadline. The week before Proof of Life, we were frantically preparing. The robot still wasn’t completely assembled, and we were waiting on the ME machine shop to waterjet the plates for the new Rocker-Bogie. Even after we finished assembling the robot, Electrical still needed to finish connecting everything, and Software needed time to test and troubleshoot controls. We geared up, and got ready to work.

We ended up pulling an all-nighter on the last night before Proof of Life was due to finish assembly and record the video. But we made it. The Bukavac (our robot) was alive! We were going to the Kennedy Space Center in Florida.

Florida:  
We made it to Florida in mostly one piece. Well, all of us except for the robot. It made it in many pieces. Unfortunately, due to shipping costs and reliability concerns, we had to disassemble the robot and have a small group drive to Florida with it, while the rest of the team flew. This meant that once we got to Florida, it was game time. We had to reassemble the robot in a couple hours, as well as install a few new additions we had made since Proof of Life. One of these was a spring-loaded arm extender that I designed!

Finally, it was time to do our first competition run. Evan, the team President, and Trevor, Electrical lead, loaded into bunny suits and placed the Bukavac into the BP1 competition pit. The run started—and we kinda just sat in place. Unfortunately due to software issues, we weren’t able to complete the initialization sequence and our wheels didn’t deploy properly, and so we couldn’t really move around. But we still showed some of our cool features while we had the chance!

The next day, we had a couple hours to troubleshoot and make improvements. We gave software time to fix initialization (the Teensy microcontroller was being called before it actually had time to boot up), and we made a few other last minute adjustments. Then, about 30 minutes before our final competition run, one of our motor controllers blew… No problem, we had a backup! It also blew… We frantically went around to other teams, seeing if any of them happened to have an extra motor controller that was the same model, no luck. We last minute tried to change to an older motor controller, but software wasn’t able to find a version of the code that supported it. With the competition moderators about to disqualify us for time, we hurriedly switched the robot to 2-wheel drive and started the second run.

The Bukavac initialized! The wheels deployed, and the drum arms were lifted. The arms extended (go spring-loaded arm system!) and the main microcontroller got fried. Wait what. There had been a spark. In our haste to start the 2nd competition run, one of the wires to our main motor got misrouted, and when the arms extended, it got pulled out of its connection and shorted the whole electrical box. We were dead, and our electrical system was fried…

Ultimately, we got a grand total of 0 mining points during the competition. Through a series of unfortunate events, we didn’t even really move from our starting position in either run. However, despite our poor performance in mining, we still got 3rd place in overall points for the Joe Kosmo Award for Excellence! The competition wasn’t only judged by mining performance, but also on Systems documentation and planning, presentation work, and club outreach. We performed well enough in these other categories to still get 3rd, and hey, we learned a lot. Next year, we’re coming for 1st!