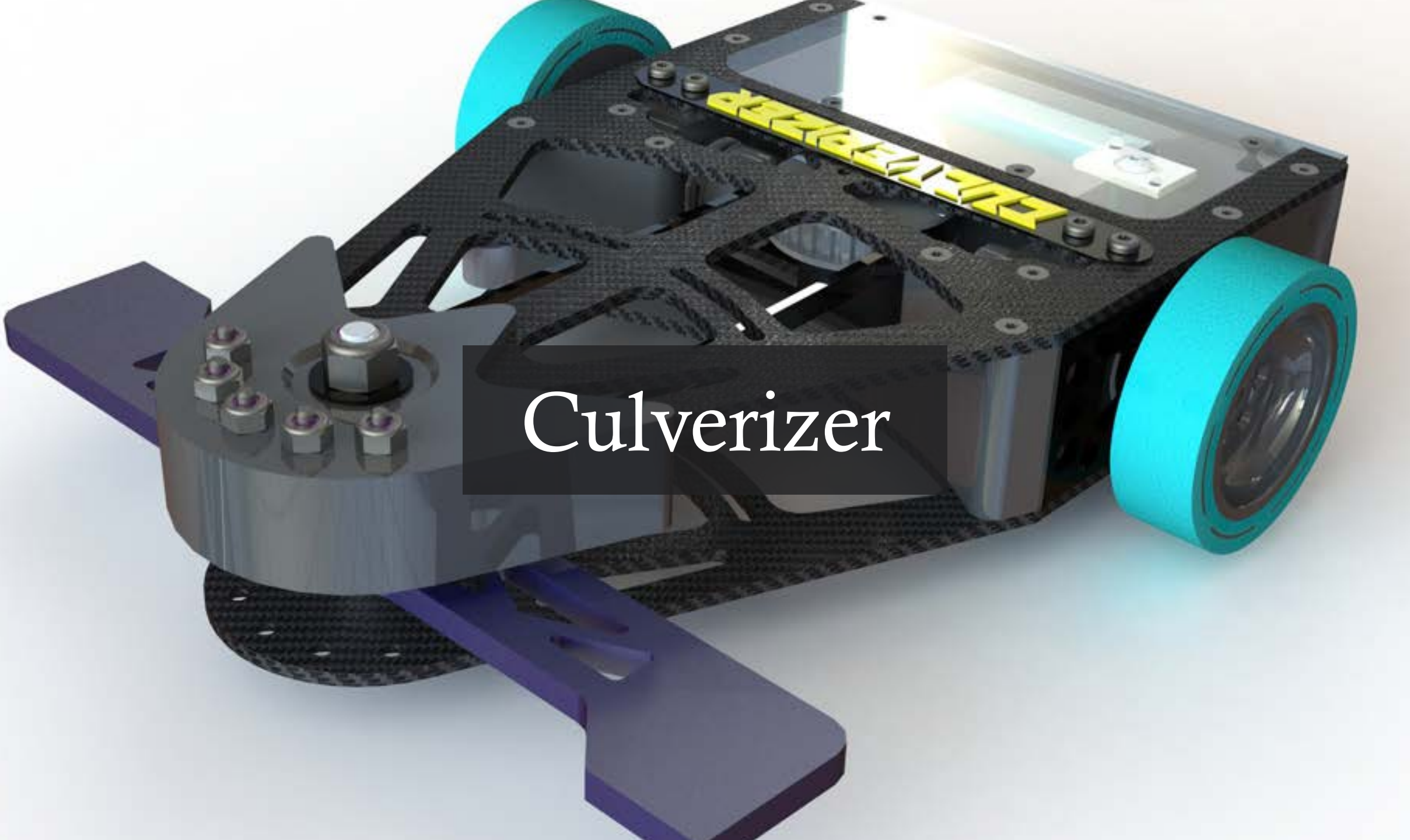
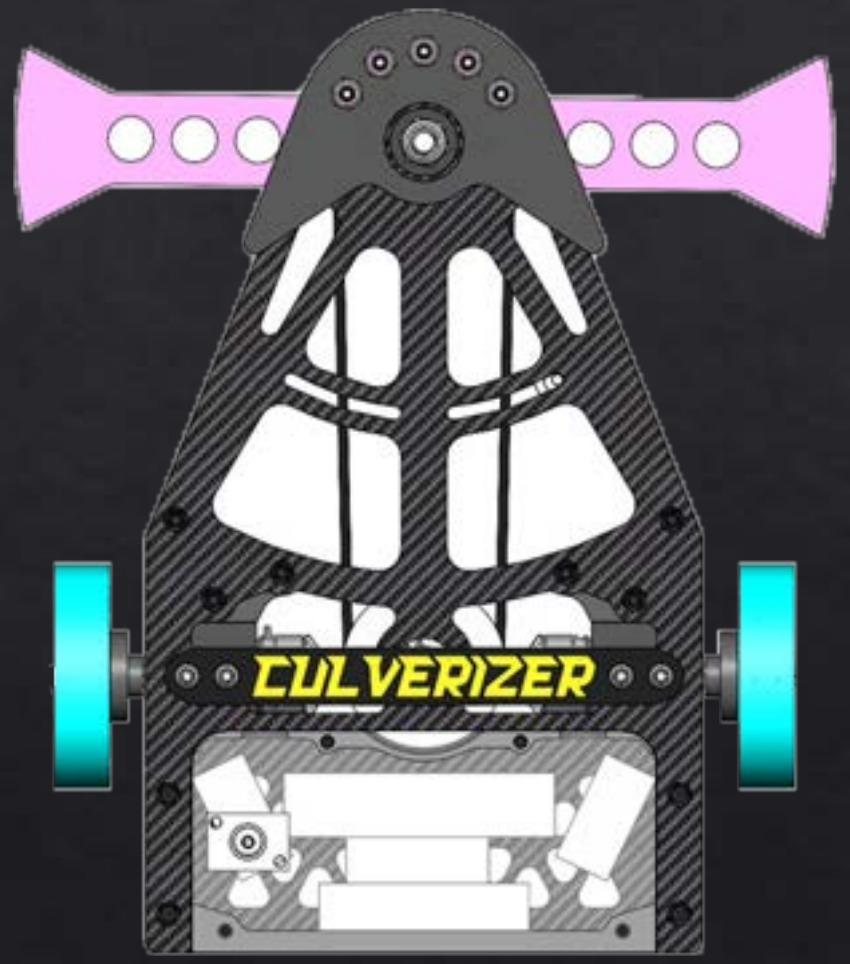
Manan Singh

Engineering Project Portfolio


Culverizer

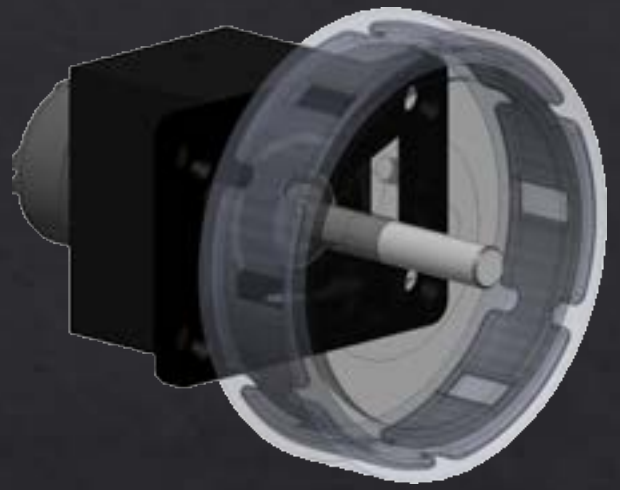
Culverizer – 3lb Combat Robot

- I designed and built Culverizer, which utilizes a heavy horizontal blade to batter and disable its opponents
- Carbon fiber plates give the chassis rigidity and hold weapon assembly
- 3D printed 95A TPU body flexes to absorb and disperse impact energy
- The TPU acts as ablative armor, designed to take damage and protect inner electronics



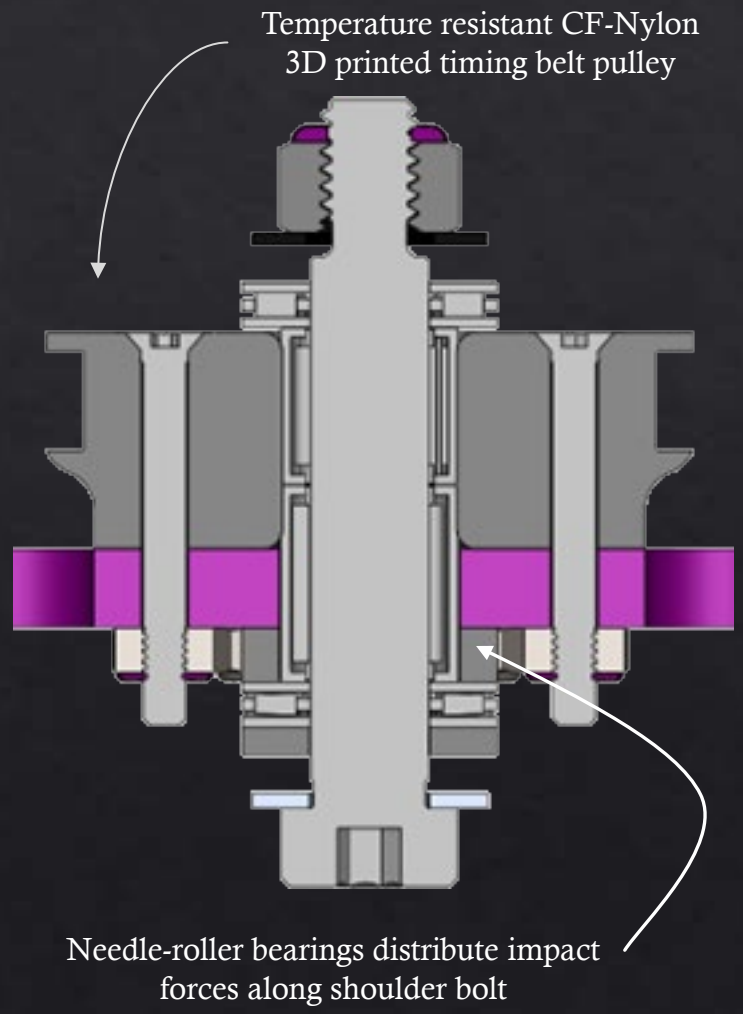
Culverizer – Drivetrain

- I used 2 brushless gearmotors to direct-drive the robot at 10.5 ft/s, enabling the bot to box-rush and engage opponents immediately
- The drive motors are shock-mounted with TPU, allowing drive motors to deflect and redirect energy away from the gearbox, preserving its lifespan
- Created custom molds to cast 2.5” OD TPU-core wheels with 40A Urethane treads
  - Urethane provides high traction and acceleration, while adhering to the TPU well
  - The TPU core absorbs impact energy and increases wheel and gearmotor durability



Culverizer – Weapon System

- 1400 kv motor @ 14.8V with a 6:5 belt reduction spins weapon blade at 340 mph
- Weapon blade stores a max of 1300J of energy
- While this iteration of the weapon system has been the most effective, I'm currently working on improvements to increase its reliability and energy transfer
  - Next iteration will replace 3D printed pulley with aluminum V-belt pulley, allowing the weapon system to slip on high impacts and reduce angular impulse delivered to the weapon motor
  - Aluminum pulley will transfer torque through a spline to avoid putting screws under shear forces



Culverizer - Competition

- Built 2 copies to be prepared for tight turnaround times between matches
- Competed at 3 tournaments with an all-time match record of 15-8
- Watch it in action! -> Culverizer vs Surgical Procedure

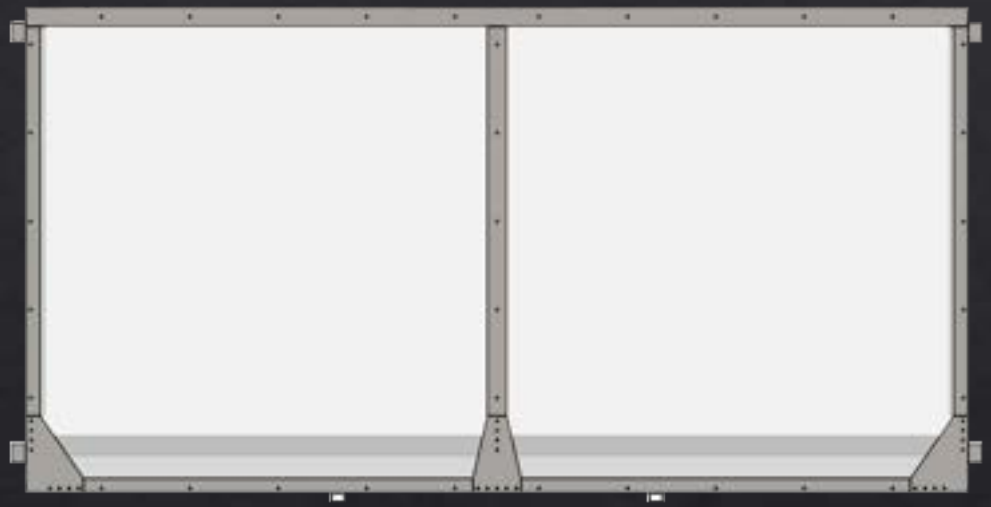
Beetleweight Arena

Beetleweight Combat Robotics Arena

- I was assigned to lead the development and construction of a new arena for 3-lb combat robots for the Purdue University combat robotics club
- Design requirements and constraints:
  - Large footprint for robot combat - 64 square foot minimum
  - Easy to assemble, transport and store as our competition venue and workspace are 4 miles apart
  - Quickly serviceable in case of damages throughout the tournament
  - High visibility from all angles
  - Double-walled polycarbonate panels with an air-gap to safely contain combat robots
  - Negative pressure ventilation system to extract fumes in case of battery fire
  - $10,000 budget

Beetleweight Arena - Construction

- I came up with a design totaling $7,000, saving $3,000, that meets all the necessary requirements, while prioritizing serviceability and ease of assembly
- 8’ long, 8’ wide, 4’ tall arena stands 3’ above the ground providing ample space for combat at a comfortable viewing height
- The entire frame is assembled and disassembled without use of fasteners, enabling rapid setup
- Double-layered plywood floor provides a safe, durable, and smooth driving experience



Each frame has a ~4’x8’ footprint and can be transported flat-packed on a 4’x8’ trailer

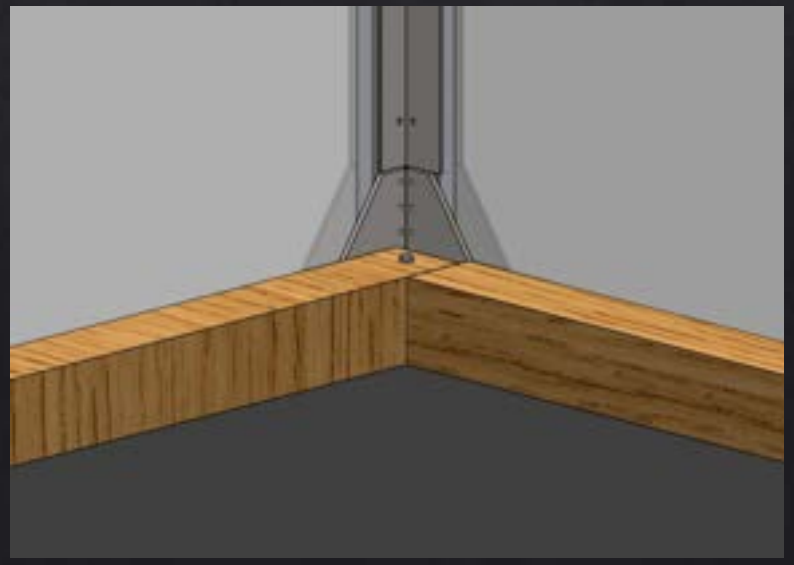
Frames assemble by being stacked at peg & tube joint at vertical bracket

Beetleweight Arena - Safety

- Safety is the highest consideration in the design of this arena, guiding the decisions I made
- Double layered ¼” polycarbonate panels have a 1” air-gap to minimize damage to the outer layer and reduce the chance of a breach
- An 800 cfm fan can pull out all air within the arena in ~20 seconds, extracting toxic LiPo battery fumes in the event of fire
- Sensored door lock changes the arena lights from white to red when the doors are unlocked

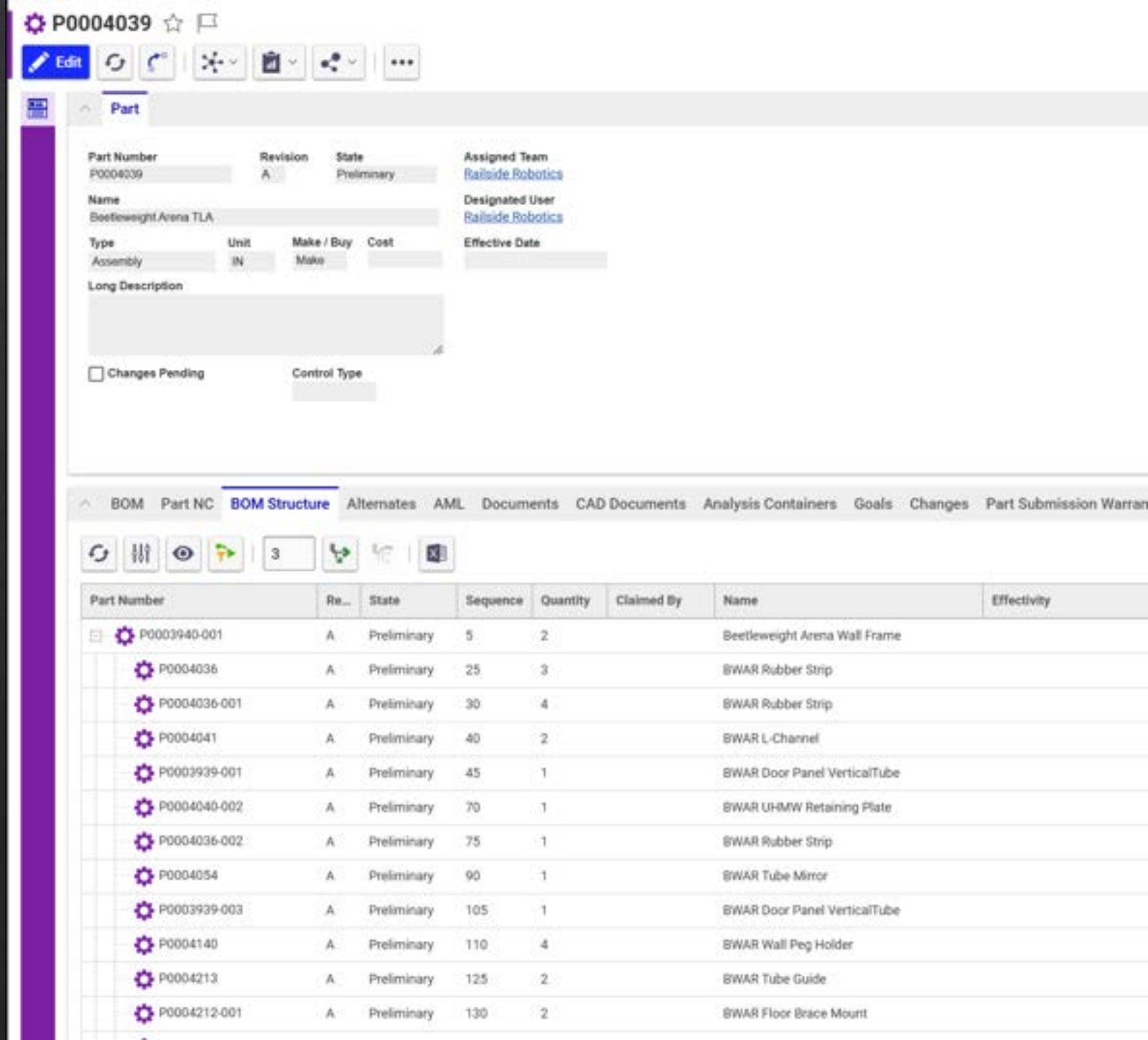
Beetleweight Arena - Serviceability

- Polycarbonate panels are inserted from the top and can be replaced in less than 10 minutes
- Polycarbonate panels bisected to save costs; replacing a 4x8 panel is much more expensive than a 4x4 panel
- Consumable wood kickplates limit gashes and scrapes from damaging polycarbonate
- Floor panels can be inserted through the door and replaced in 20 minutes



Arena - PDM

- We're using the Aras Innovator PDM system to collaborate with other club members on the design and share data for manufacturing
- I trained members on understanding and utilizing the PDM software
- Using PDM to link part drawings for manufacturing to their Part Documents



Beetleweight Arena - Manufacturing

- Considering the scale of this project, after completing the design, the next biggest challenge for me has been managing the arena's manufacturing
- Leading a team of 10 members in manufacturing over 40 unique parts
- Using part drawings to ensure consistent and accurate parts are made
- Utilizing CNC Mills, laser cutters, and welding to construct the steel frame