

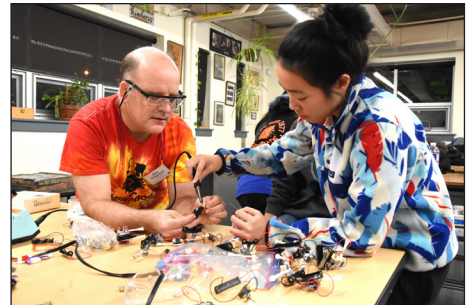


LIGERBOTS ROBOT DESIGN PROCESS

PRESEASON TRAINING AND IMPROVEMENTS

Hands-on Projects

- LigerBots preseason training starts with projects that get new members working hands-on in the shop, with robot components, as fast as possible. In the fall, LigerBots run training sessions in many of our 20 team skill areas, including ten in technical areas. Examples from 2022 include:
 - Strategizing, brainstorming mechanisms, and prototyping the mechanisms for a previous FRC game.
 - Building and testing our first competition-ready swerve drive.
 - Prototyping new mechanisms to handle an array of game pieces.
 - Using simulations of mechanisms to write training software for Arduinos, and then test it on the previous year's robot.



LigerBots coach teaches a first-year to solder.



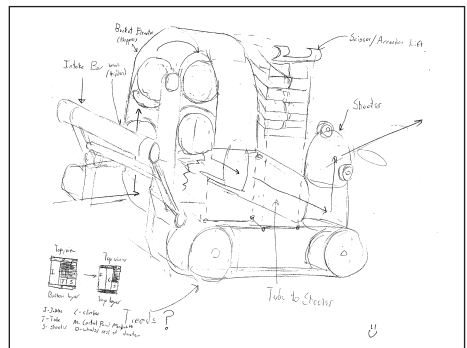
LigerBots veteran teaches a first-year to use the CNC mill to precisely drill a hole.

Game Analysis

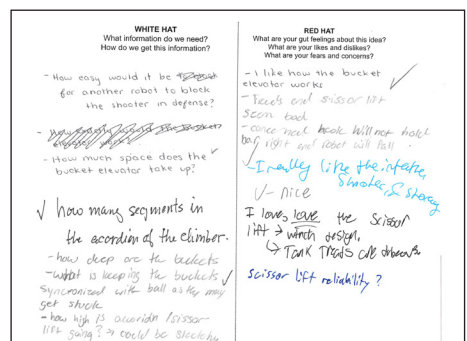
- Veteran LigerBots choose videos of matches from the previous several seasons of robot games. Team members, especially first-years, are invited to watch these videos in a group and think about robot design and game strategy before the new build season.

Improvements to Manufacturing Processes

- Creating an internal bill of materials (BOM) for sub-projects, to improve project management.
- Training students on the lathe to expand manufacturing capabilities.
- Rebuilding one of our lathes to restore it to a usable condition.
- Preparing students to mill metal during build season with projects using metal tubing.
- Using 3D printing to manufacture complex parts suitable for solving many robot design problems.
- Teaching students how to do computer assisted manufacturing (CAM) in Fusion 360.
- Using team-built electrical and pneumatic test benches to help us prototype electrical wiring and pneumatic mechanisms.



Sketch of a potential robot design.



Critiques of above sketch.

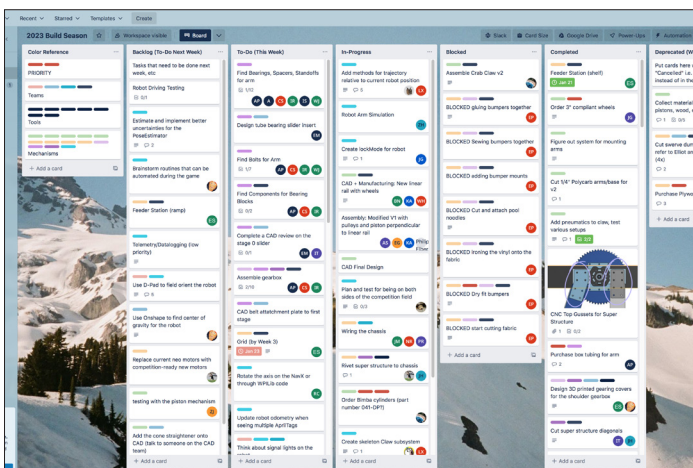
ITERATIVE ROBOT DESIGN

Design Week

- **Day 1:** Right after the game kickoff, the team meets in small groups to analyze the game and discuss potential robot capabilities and advantages.
- **Days 2 and 3:** We continue in our small groups to brainstorm mechanisms that best implement our strategy.
- **Day 4:** Our build leaders meet to review team comments about mechanism designs and decide which mechanisms to prototype. Other team members are encouraged to listen to the discussion so that they learn how to lead the process in the future.
- **Days 5–7:** We split into build groups to start prototyping.

Robot Design and CAD

- Game strategy determines our priorities. The robot is built to best fit our strategy, rather than the strategy changing to accommodate the robot we build.
- Students design and CAD the robot structure and begin prototyping mechanisms starting on day five of design week.
- After design week, mechanism groups begin detailed design and CAD of each promising mechanism.
- A CAD model of the entire robot is completed as quickly and thoroughly as possible.



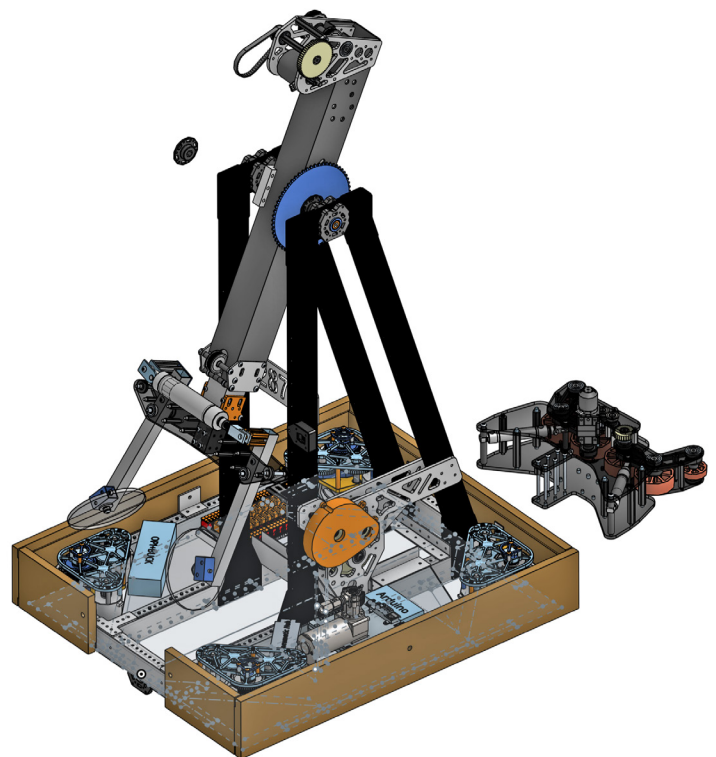
Part of the 2023 Trello board.

Prototyping and Continuous Improvement

- Prototypes are built of materials as identical as possible to materials used in the final mechanisms, allowing more realistic test results.
- LigerBots continue to test, redesign, and prototype mechanisms.

Project Management

- Mechanism groups with student leaders are formed during build season, allowing every LigerBot to concentrate on and feel ownership for one part of the robot. Fluidity of groups ensures the team's needs are always filled.
- A project management system, centered around an online Trello board for project planning and staffing, allows students to find tasks that need completing and track progress.
- The Trello board is supplemented by daily stand-up meetings and weekly group integration meetings, ensuring that the team is working toward its goals.



LigerBots 2023 robot CAD, in progress.



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