



# Get Started Designing with CAD



PLYMOUTH-CANTON  
COMMUNITY SCHOOLS  
GLOBALLY FOCUSED. LOCALLY CONNECTED.

Into The Deep Reveal Workshop

September 7, 2024



# Agenda

- Introduction
- Why Use CAD?
- CAD Options
- Practical Examples
- Training Resources
- Wrap-Up



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# Introduction

My name is Eric Suydam, and I will be taking you through the different CAD options available to you as a new team, or if your team is interested in migrating to a different option, along with some demonstrations.

I have been mentoring FTC teams here in the Plymouth-Canton community for about 6 years now. I live in Canton, and have two children in High School. I work at Ford Motor Company, and my education is in Mechanical Engineering.

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# Why Use CAD?

Computer-Aided Design (CAD) is a fundamental part of the Design process in the FTC competition, and an integral part of modern Engineering.

CAD is an indispensable part of modern product development and manufacturing. As part of FTC, CAD is important because:

- It demonstrates knowledge of the engineering process
- It allows for checking of dimensions, and ranges of motion before lengthy builds (and re-builds)
- When integrated into the process, it provides:
  - What parts and materials are needed in which quantities — a **“Bill of Material”**
  - What manufacturing processes are needed, like cutting dimensions, drilling locations, or 3D printing — a **“Bill of Design”**
  - What assembly steps to follow, in which order if it is important - A **“Bill of Process”**
- Judges during the competition want to know!



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# CAD Options

A very good resource for people & teams trying to decide which CAD system to use is the Robot Building Resource page on firstinspires.org

<https://www.firstinspires.org/> > Programs > First Tech Challenge > Game and Season > Robot Building Resources > CAD Resources:

[https://ftc-docs.firstinspires.org/en/latest/cad\\_resources/index.html](https://ftc-docs.firstinspires.org/en/latest/cad_resources/index.html)



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# AutoDesk TinkerCAD

TinkerCAD is free software from AutoDesk. It is usually used through a web browser; there is also an App on the iPad App Store.

<https://www.tinkercad.com/>

In 2022, Infinity Tech used Tinker CAD to package our parts, making sure that everything could fit into the robot within the 18" cube starting requirement:



# AutoDesk TinkerCAD

## Best For

- Simple Models
- Creating things with the intention that they will be 3D printed
- Use on computers with limited processing power or limited ability to install software (i.e., Chromebooks)

## Not Good For

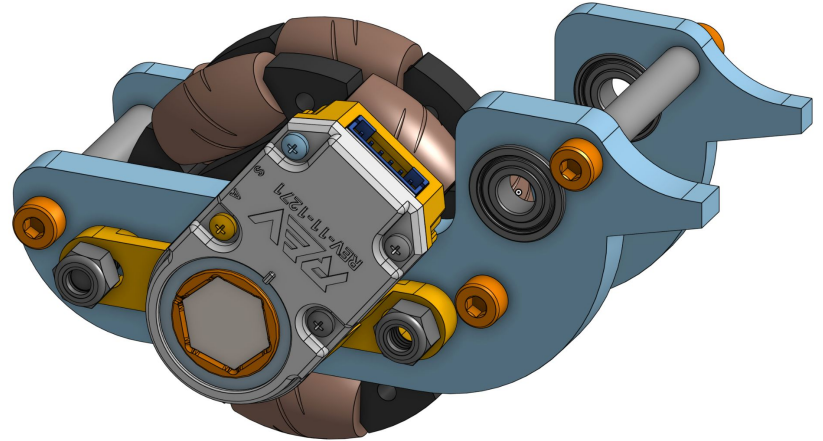
- Accurate alignment of parts
- Verifying 3D movement of joints (tedious)
- Working with content in .STEP format. TinkerCAD only reads .STL format.
- Team collaboration
- Real-time collaboration

# PTC OnShape

OnShape is commercial, professional software from PTC. PTC is a long-time supporter and sponsor of FIRST programs.

<https://www.onshape.com/>

In 2022, we were looking for examples of odometry wheel or “dead” wheel designs. This was a model that an FTC team shared:



# PTC OnShape

## Best For:

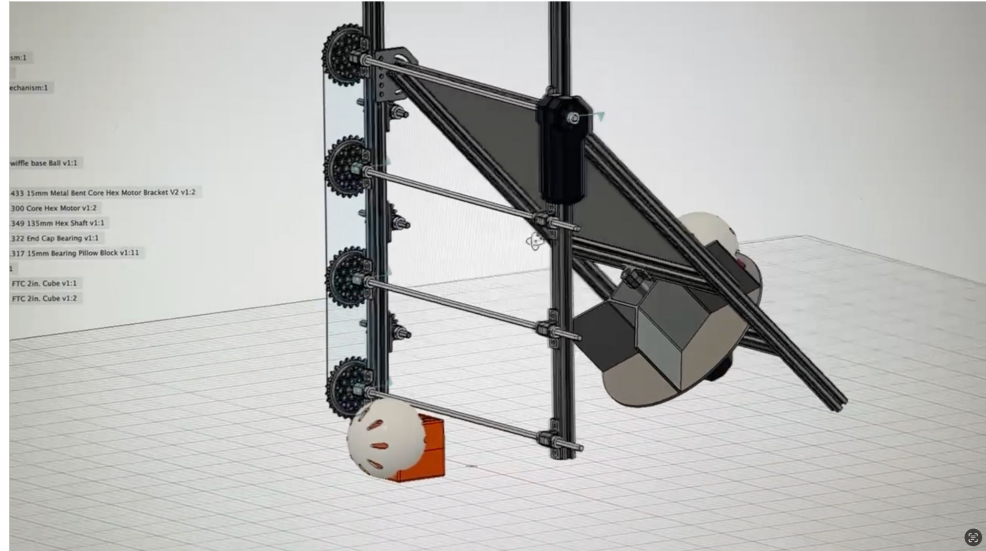
- Full-featured CAD software that doesn't require a computer that can install software (OnShape is completely cloud-based)
- Situations where you want or need real-time collaboration
- Use as a very good .STEP to .STL file converter!

## Not Good For:

- Situations where you will not have reliable internet access
- Long-term use if you plan to join the High School robotics team (although basic skills and fundamentals of CAD will still be useful)

# AutoDesk Fusion360

- Fusion 360 is a commercial, professional software suite from AutoDesk. Educational licenses are available for free for FIRST teams, but the process to get a license is a bit tricky. Fusion 360 is the software that the High School (i.e., FRC) uses; there are high school mentors available.
- In 2023, Infinity Tech decided to invest the time to learn Fusion 360. We started creating an object sorting device as a summer project connecting our Design, Build, and Programming teams:



# AutoDesk Fusion360

## Best For:

- Long-term use if you plan to join the High School robotics team
- You have access to a computer that can install software and is powerful enough to run it
- You want to be able to simulate component movement (i.e., 'joints')
- Team-based management of models

## Not Good For:

- You only have access to a Chromebook, or a computer without the ability to install software on it
- Casual usage
- Real-time collaboration
- You hate maintaining software updates! (it tends to update on a weekly basis)

# Software Registration Tips

All of these alternatives are free for FTC team use, but some are harder to register for than others:

- TinkerCAD doesn't require anything other than an email and password
- OnShape requires a free Educational Account. Go to <https://www.onshape.com/en/education/> and click on "Create an Account"
- Fusion360 was difficult to create Educational Accounts at the Middle School Level. AutoDesk links the student .edu email account to specific, authorized schools and only the PCEP High Schools are currently recognized. To work around this, Infinity Tech created a mentor account associated with the team email. The email and password are shared with the Design team members.



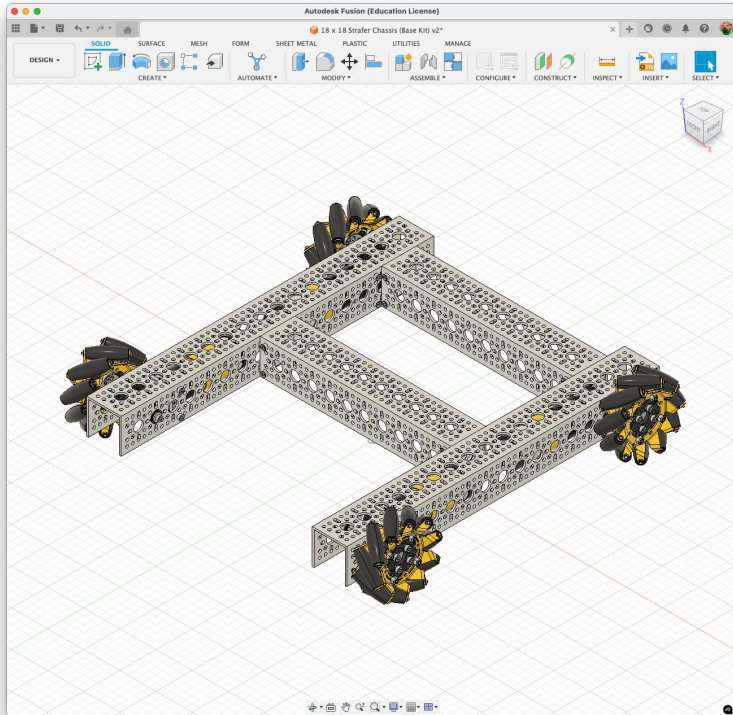
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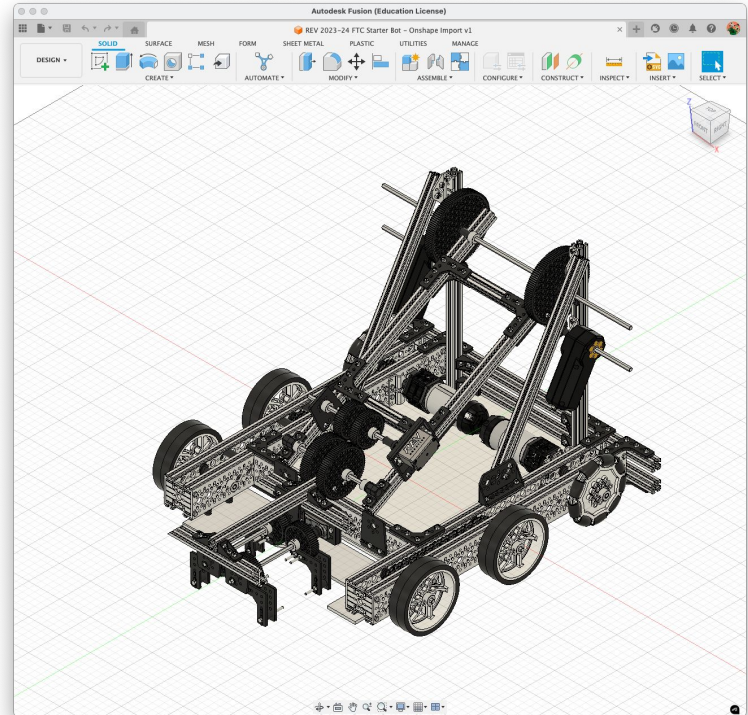
# Examples

# Start with a Completed Model

Gobilda's Strafer Chassis model



REV's 2023-24 FTC Starter Bot model



# Add Components

All of these sites have 3D models of the parts they sell that you can download and import into your model for free:

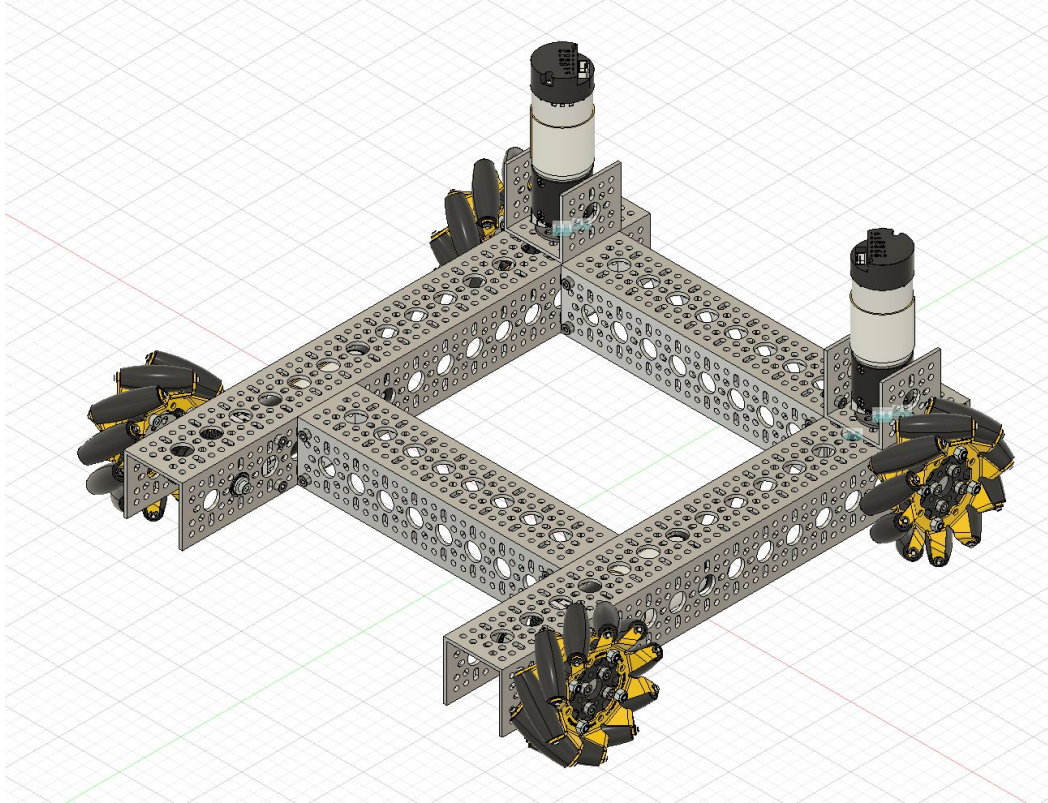
- REV Robotics <https://www.revrobotics.com/>
- Gobilda <https://www.gobilda.com/>
- AndyMark <https://www.andymark.com/>
  - Note that AndyMark sells the Competition Field and Game Pieces - very helpful!
- Pitsco <https://www.pitsco.com/>
- McMaster-Carr <https://www.mcmaster.com/>
- Misumi <https://us.misumi-ec.com/>
- 3D Content Central <https://www.3dcontentcentral.com/>



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# Example: Make the Gobilda Strafer Chassis Smaller



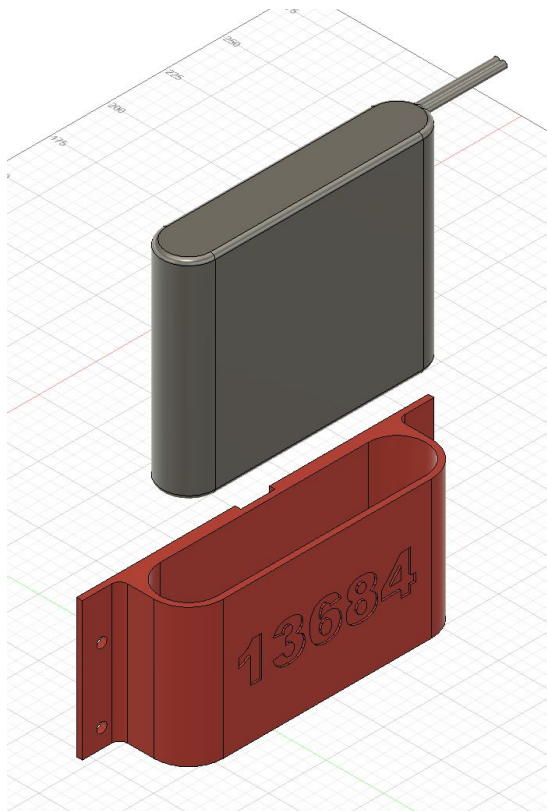
- The standard Gobilda Strafer Chassis footprint is 449 mm x 453 mm (17.7 in x 17.8 in), just smaller than the 18 in x 18 in starting size
- The challenge was to see if we could make the footprint smaller; this version is 401 mm x 405 mm (15.8 in x 15.9 in)



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# Create a Custom Part



## Examples:

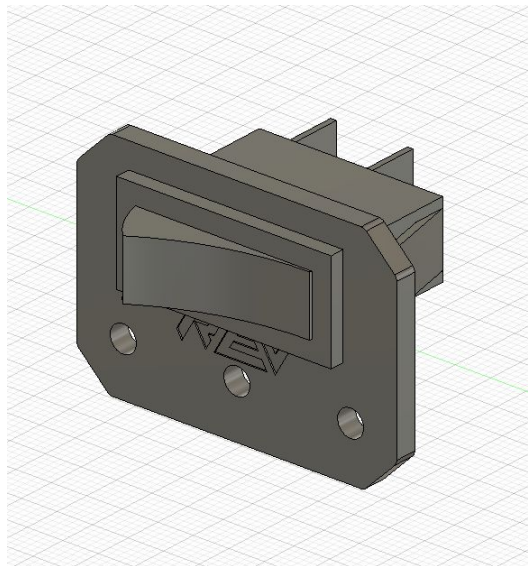
- a part to hold the REV slim battery pack that can be 3D printed
- A part that the REV power switch can be inserted in to instead of the original switch plate



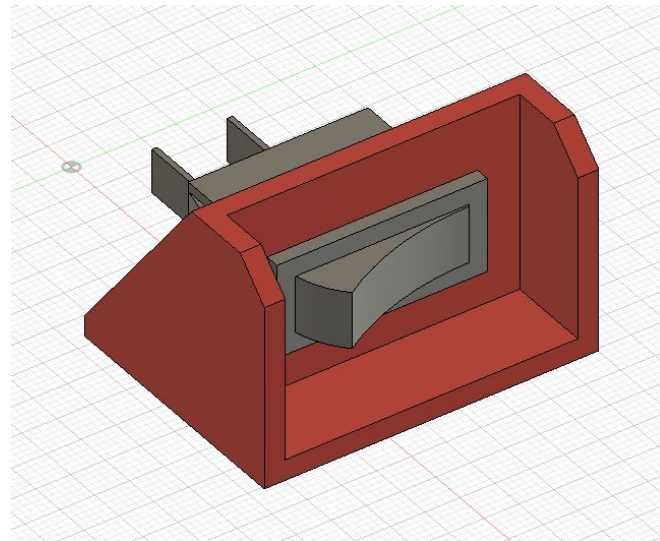
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# Create a Custom Part



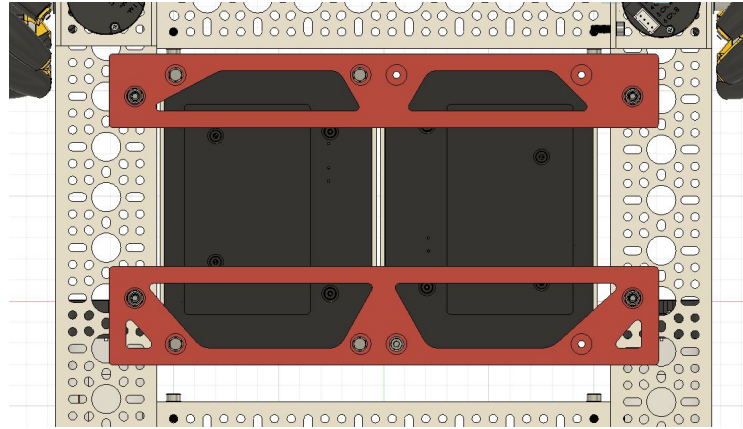
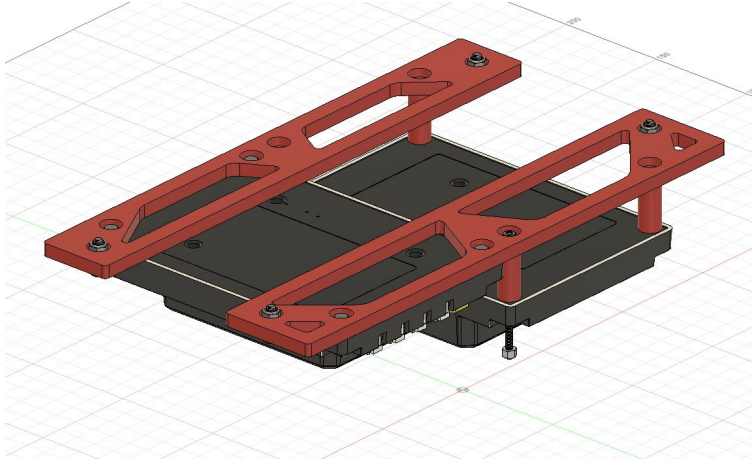
- A part that the REV power switch can be inserted in to instead of the original switch plate



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# Create a Custom Part



3D-printed  
bridging  
parts to  
hold the  
Control  
and  
Expansion  
Hubs



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# How to Learn

Both PTC and Autodesk have tutorial videos for free:

PTC OnShape: <https://learn.onshape.com/>

- I recommend:
  - <https://learn.onshape.com/learn/learning-path/introduction-to-cad>

Autodesk Fusion 360: <https://www.autodesk.com/learn/ondemand/collection/self-paced-learning-for-fusion>

- I recommend:
  - <https://www.autodesk.com/learn/ondemand/curated/introduction-to-fusion>
  - <https://www.autodesk.com/learn/ondemand/curated/mechanical-assemblies-fundamentals>
  - <https://www.autodesk.com/learn/ondemand/curated/sketch-basics>



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# Wrap-Up

Adding or stepping up your team's CAD is a good way of:

- Incorporating the Engineering Process (Plan > Do > Check > Adjust)
- Learning a new skill
- Avoiding lengthy re-builds

Good luck this season!



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