ptc

DIGITAL TRANSFORMS PHYSICAL

ONSHAPE BEST PRACTICES FOR FRC

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FRC 6329 Design & Strategy Mentah

New England FIRST Mentor Conference

WHO AM I?

Drew Bennett

FIRST EXPERIENCE:

- **Team 4564:**

  - Student   2013-2016
  - Dean's List Finalist   2015
  - CAD Mentor & Drive Coach   2017-2022

- **Team 6329:**

  - CAD and Strategy Mentor   2023-Present

- **Team 3467:**

  - CAD Mentah + Big Chatter   2023-Present

WHAT I DO:

- **Onshape Education Solutions Engineer @ PTC**

  - Technical Services, Webinars/Demos, Curriculum

  - K-12 Partnership Management (like FIRST)

- **Certified Onshape Professional**

- **Design Lots of Robots**

TODAY'S TOPICS:

- Preseason Setup

- Overview of Top Down Design

- Part Studios & Performance

- Assemblies & Performance

PRESEASON SETUP

AKA THINGS TO THINK ABOUT NOW, NOT ON JANUARY 4TH

EDUCATOR PLAN

- Make sure you're on the Educator Plan!

- Creates a single location for all team-owned documents and makes sharing simpler.

- Sign up with a team-wide account (CAD@team9999.com) as the owner.
  - Mentors can share login for admin purposes.

- Currently adds simulation and release management; more features in the future 👀

- There's a blog with good instructions!
 - I wrote it :)
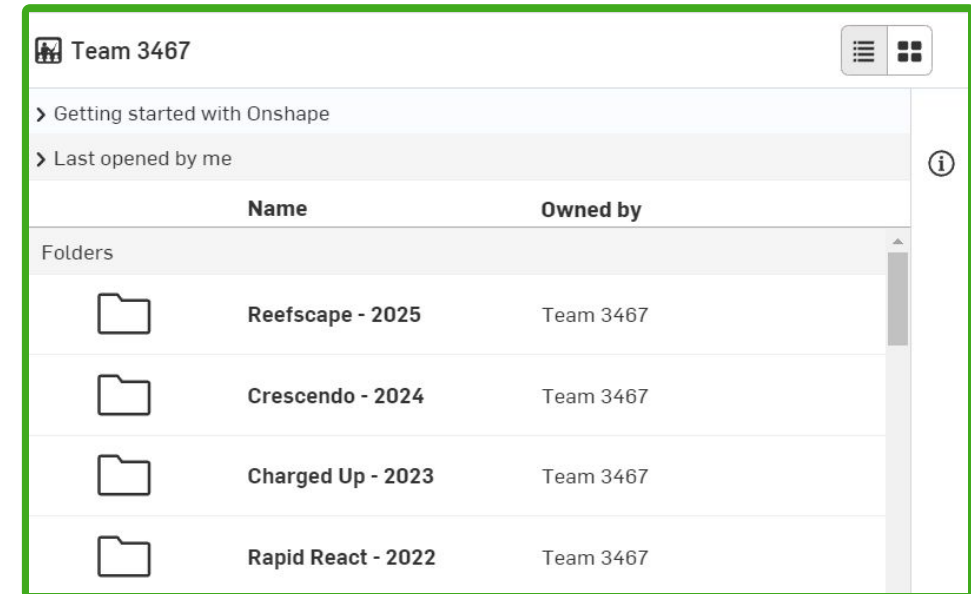
DOCUMENT STAGING

- You can set up your document structure before the season so everyone is familiar with it.

- Recommended setup:
  - A clear top-level document that will house the full assembly as well as the driving sketches
  - A document for each subsystem.
    - Set up 4-5 and add more if needed

- Make sure everyone has access!
 - Easy with Educator Plan!
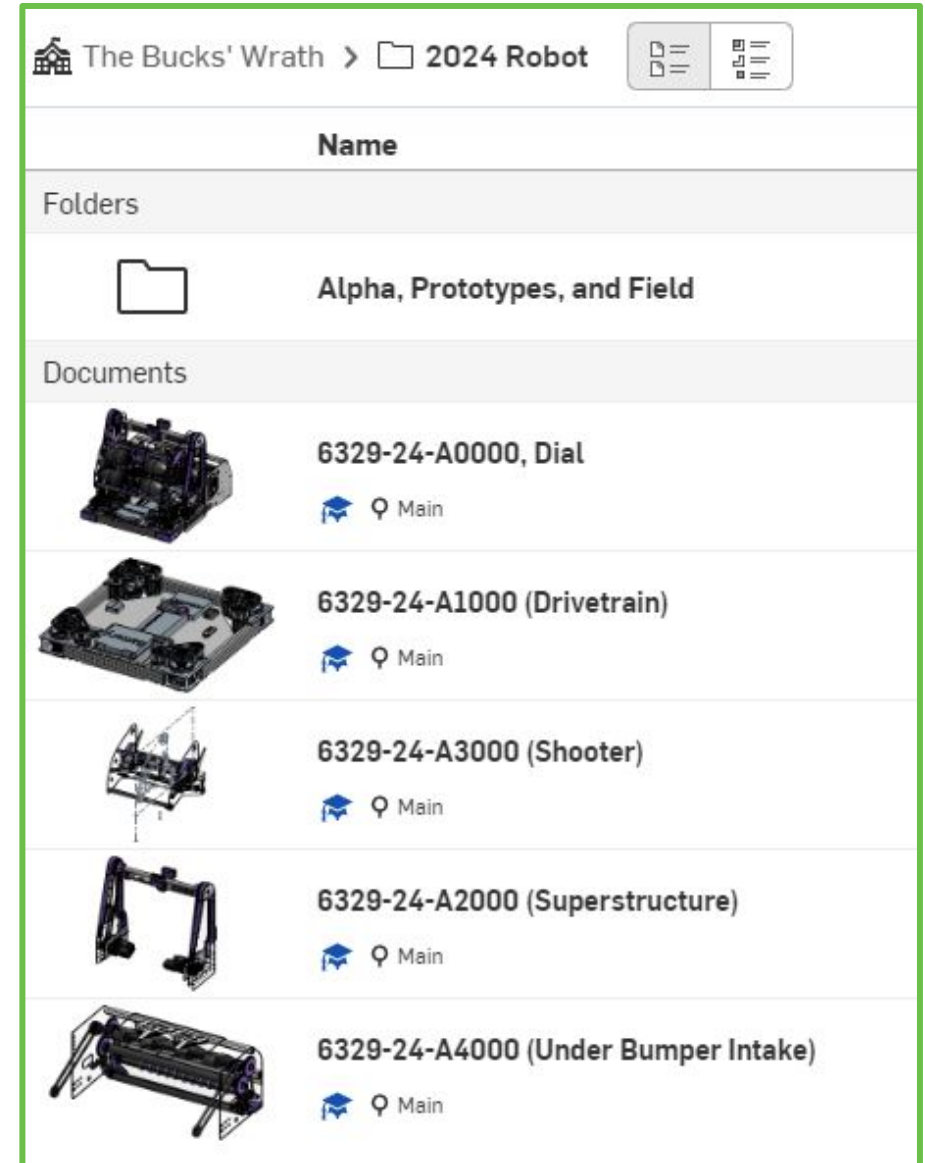
PARTS LIBRARIES

- Everyone likely knows about it, but make sure every team member has the MKCAD Library App.

  - It's also helpful to have the library documents labeled - instructions on Onshape4FRC.com

- Create a document (or multiple) to contain parts your team commonly uses from McMaster, DigiKey, etc.

  - Reduces clutter in robot documents and ensures everyone is using the same parts.

- FRCDesign.org has links to simplified models - good for load times.
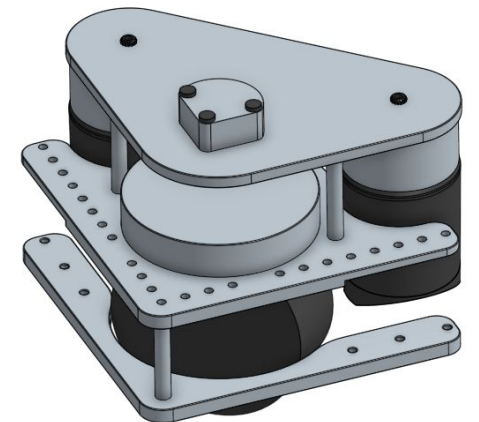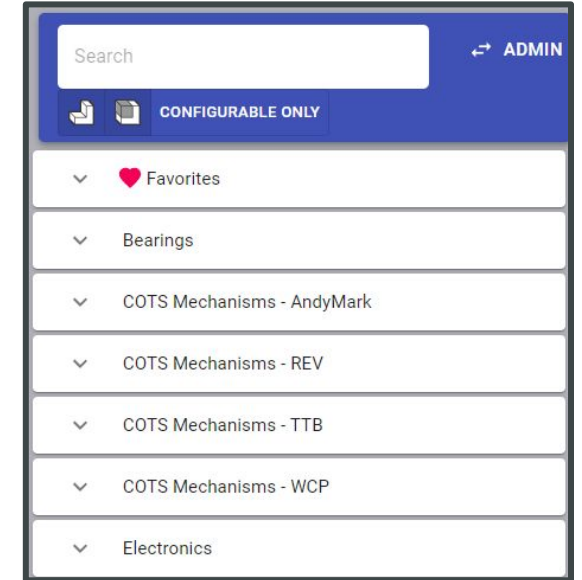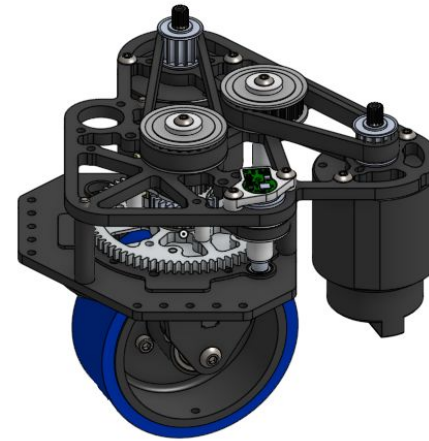
KrayonCAD - BRAINSTORMING TOOLS

- This doesn't really fit here, but it is worth becoming familiar with before the season.

- Heavily configurable simplified assemblies that can be stuck together.

- Useful as a spaceclaim tool.

- Very useful to describe an idea to the broader team.

  - Pair with "similar to Team XXXX's mechanism from YYYY year"

- It's in MKCAD!

Models from Team 3847 and Team 3467
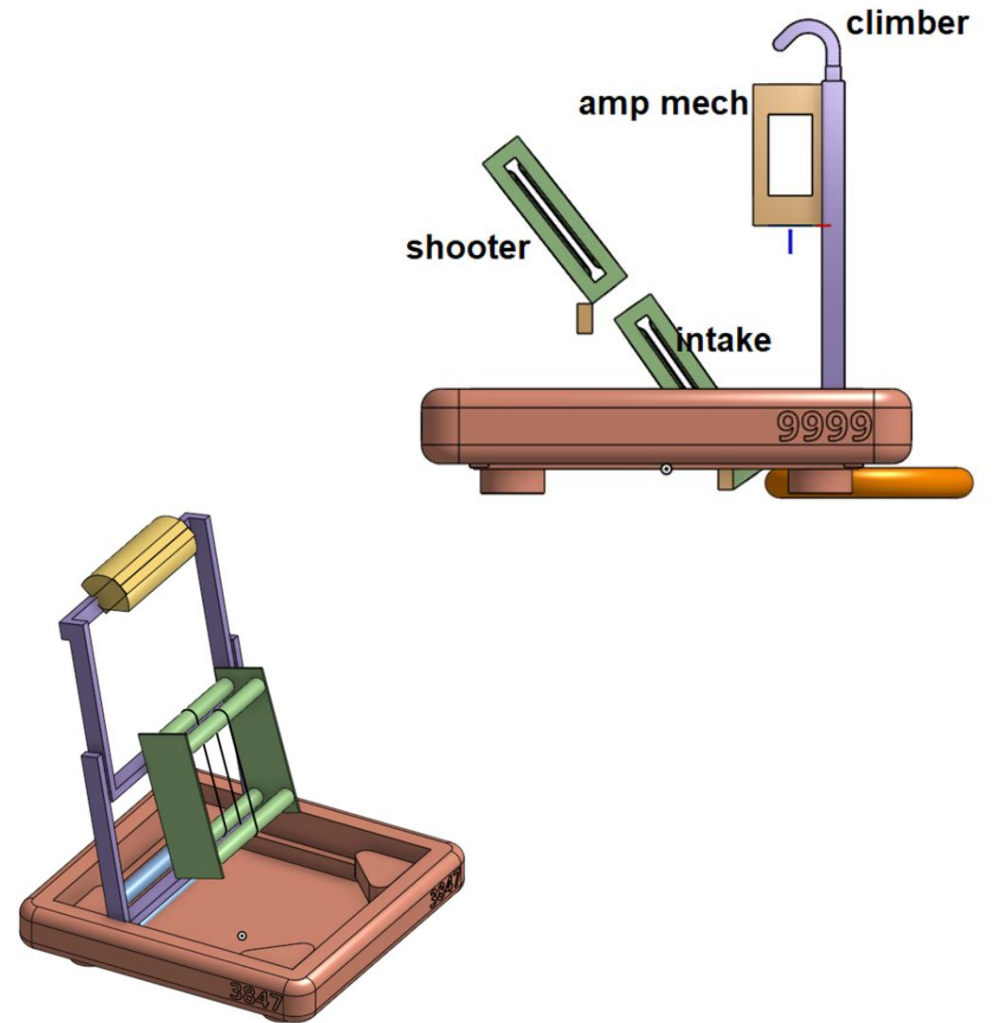
SET UP YOUR SYSTEMS

- Establish how design feedback is given.
  - Slack? Teams? Messenger Pigeon?
  - Onshape Comments?

- Determine your manufacturing processes
  - Who downloads parts?
  - How do you keep track of parts?

- Who will own each subsystem?
  - Establish ownership and accountability

TOP DOWN DESIGN

IT'S GOOD FOR YOU, I PROMISE

TOP DOWN DESIGN OVERVIEW

Start from a series of sketches and adding more complexity as you work down the feature tree.
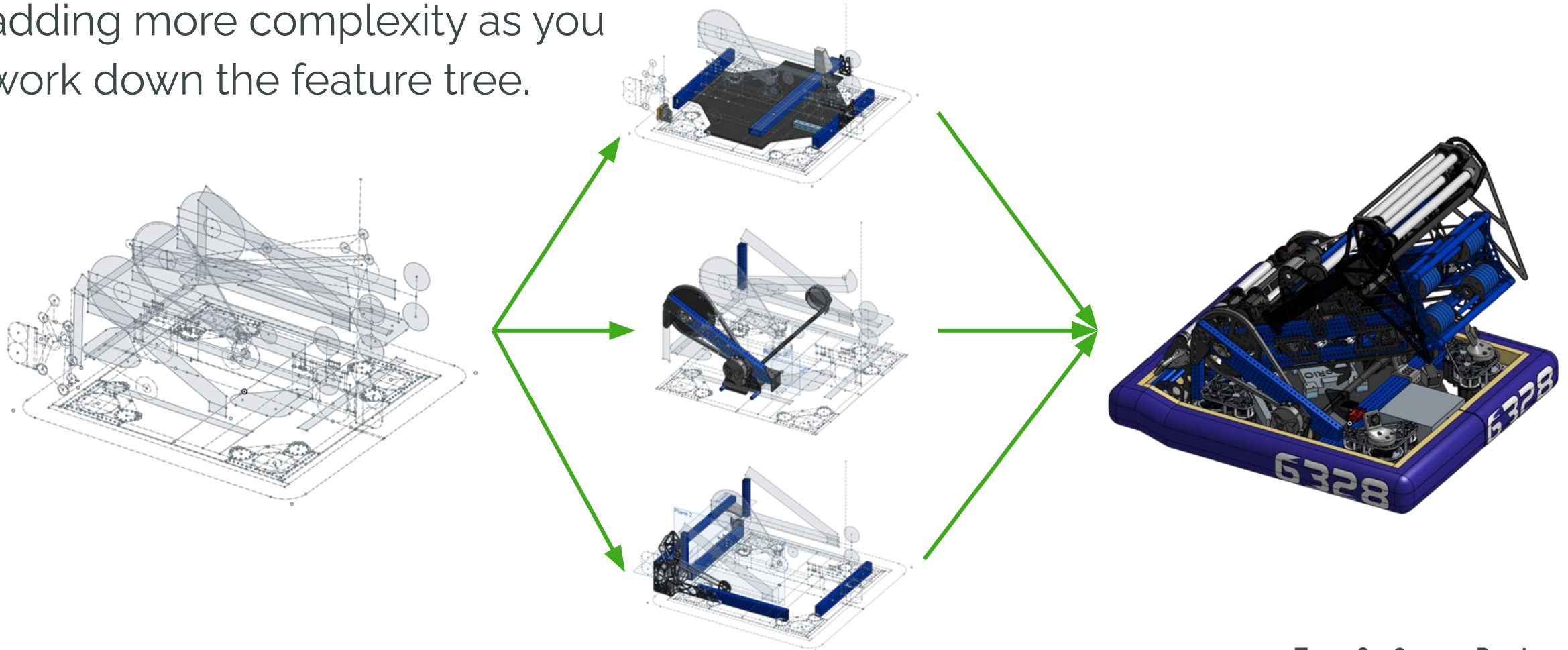
TOP DOWN DESIGN: DRIVING SKETCHES

- Once the team has prototyped/proven mechanism concepts, sketch the framework of the design.

- Capture:
  - Drivetrain dimensions
  - Mechanism mounting locations
  - Pivot locations
  - Flywheel/intake roller locations
  - Critical size constraints on geometry

- **Draw sketches as they actually are.**

- Use the Top plane as your "floor" reference and origin as the X/Y center.
  - Easy measurements + Easy CoG
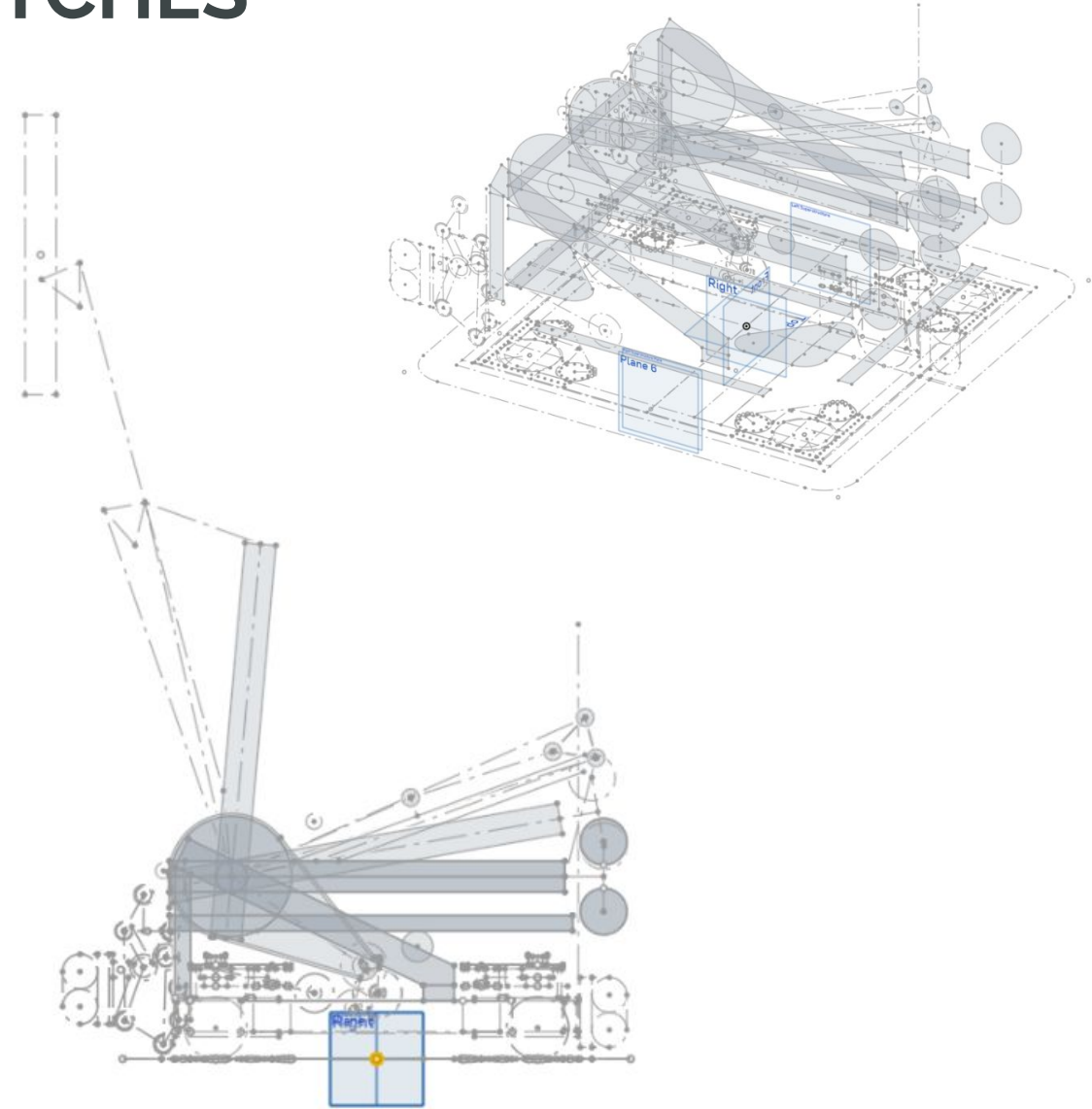
TOP DOWN DESIGN: PARTS

- Derive the driving sketches into a part studio in each of your subsystem documents.

- The driving sketches will set relevant sketch planes; sketch elements can be constrained to them as well.

- Major benefits:
  - Everyone is working from the same source.
  - Parts are modeled where they need to be in space.
  - If driving sketch updates, all subsystems can reflect that.
  - Assembly is so much easier.

Team 6328, 2024, Presto
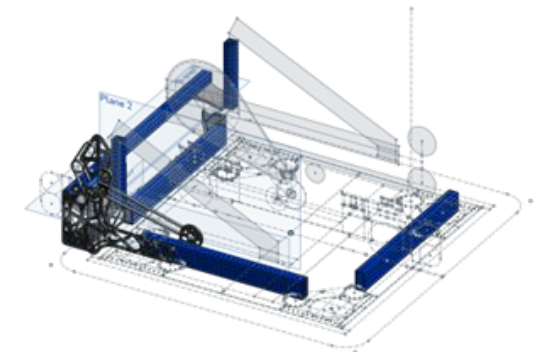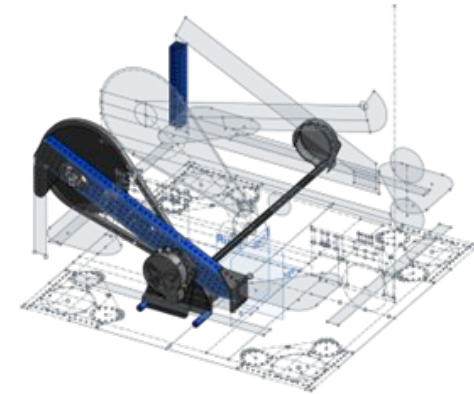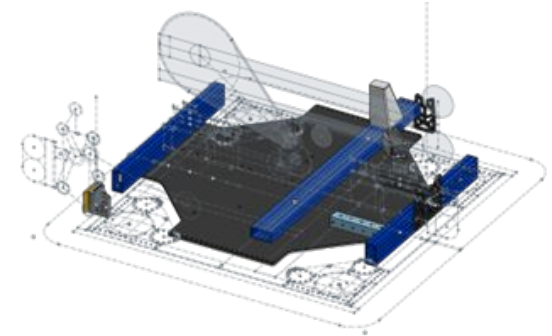
ONSHAPE DOCUMENT FLOW
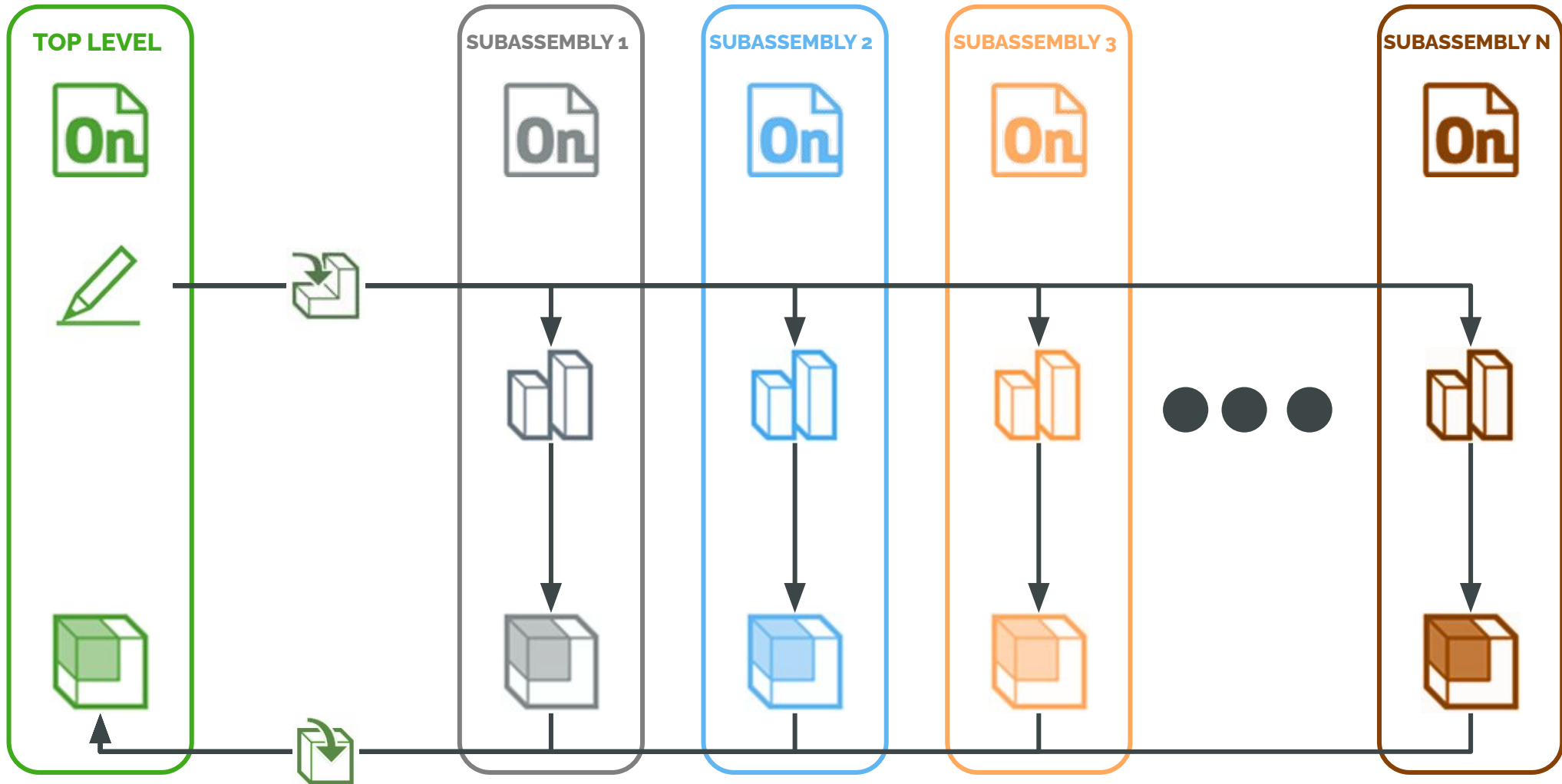
PART STUDIO PERFORMANCE

MULTI-PART PART STUDIOS

- Modeling multiple unique but connected parts in one Part Studio is a major Onshape advantage.

- When using top-down design and parametric practices, designs are robust to high-level changes.

- Staying organized is key:
  - Use Feature Folders for like parts
  - Use the Rollback Bar to keep features for the same part(s) together

PART STUDIO ORGANIZATION

GOOD ORGANIZATION

Filter by name or type

Features (206)

> Default geometry
> Reference Sketches
> Shooter Plates (6)
  - Right Side Shooter Plane
  - Main Extrusion Sketch
  - Main Extrusion
  - Ø 0.201 in THRU
  - Mirror 1
  - Origin
> 1x1 Cross Tubes (3)
> 1x1 Cross Tube Support (13)
> 1/2" Rounded Hex Supports (2)
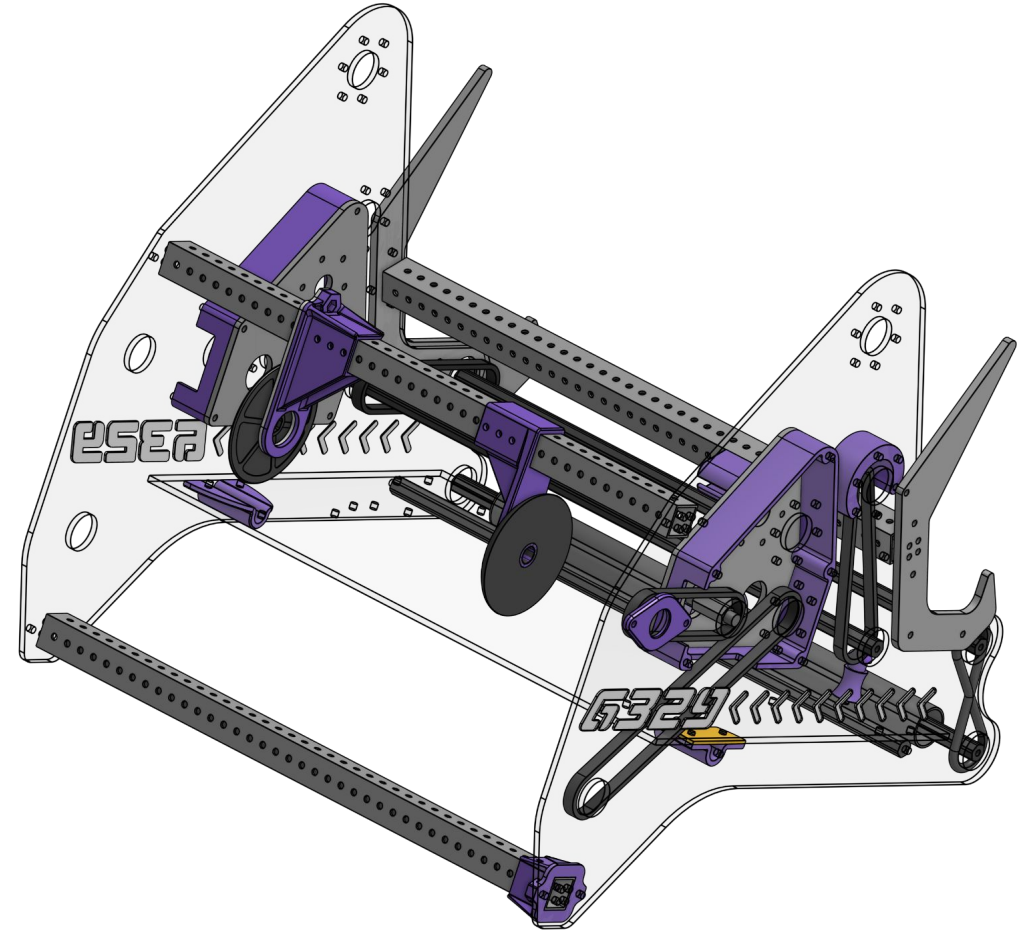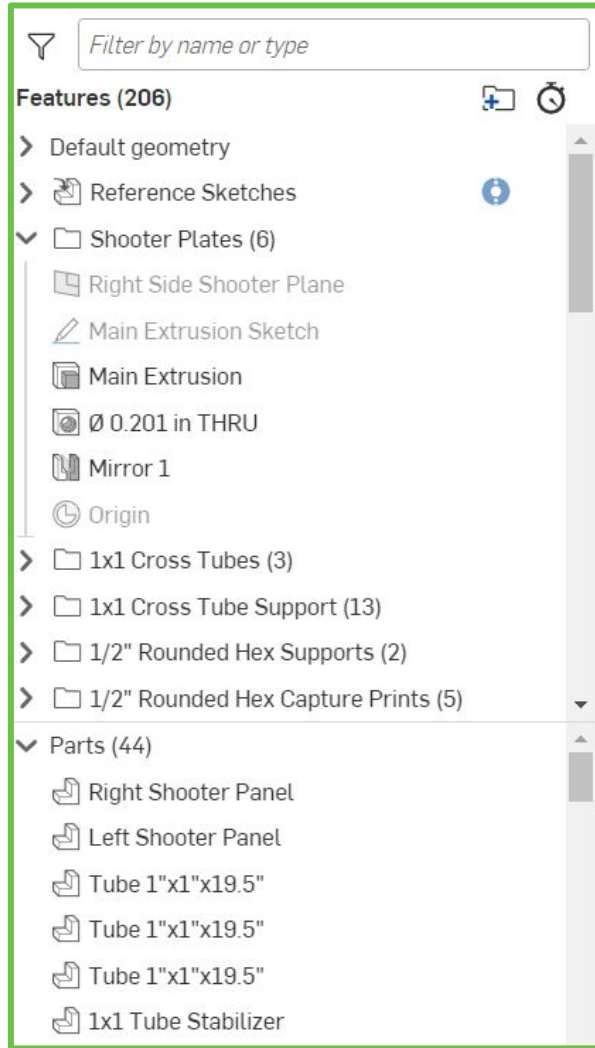> 1/2" Rounded Hex Capture Prints (5)
> Parts (44)
  - Right Shooter Panel
  - Left Shooter Panel
  - Tube 1"x1"x19.5"
  - Tube 1"x1"x19.5"
  - Tube 1"x1"x19.5"
  - 1x1 Tube Stabilizer

SOME ORGANIZATION

Filter by name or type

Features (31)

> Default geometry
  - Bottom Drive Tubes Plane
  - Drive Tubes Sketch
  - Extrude 1
  - TC Tube Converter 1
  - Mate connector 1
  - Bottom Bumper Plane
  - Sketch 1
  - Extrude 2
  - Fillet 1
  - REFERENCE SKETCH
  - SHOOTER REFERENCE
  - INTAKE REFERENCE
  - Sketch 2
  - EI Extrude Individual 1
> Parts (16)
  - Tube 2"x1"x17.5"
  - Tube 2"x1"x17.5"
  - Tube 2"x1"x17.5"
  - Tube 2"x1"x17.5"

NO ORGANIZATION

Filter by name or type

Features (187)

> Default geometry
  - Sketch 1
  - EI Extrude Individual 1
  - TC Tube Converter 1
  - Sketch 2
  - Extrude 1
  - Sketch 3
  - Extrude 2
  - Sketch 4
  - Extrude 3
  - Motor Spacing
  - Extrude 4
  - Mirror 1
  - Sketch 7
> Parts (35)
  - Tube 2"x1"x17.5"
  - Tube 2"x1"x17.5"
  - Tube 2"x1"x17.5"
  - Tube 2"x1"x17.5"

PART STUDIO PERFORMANCE

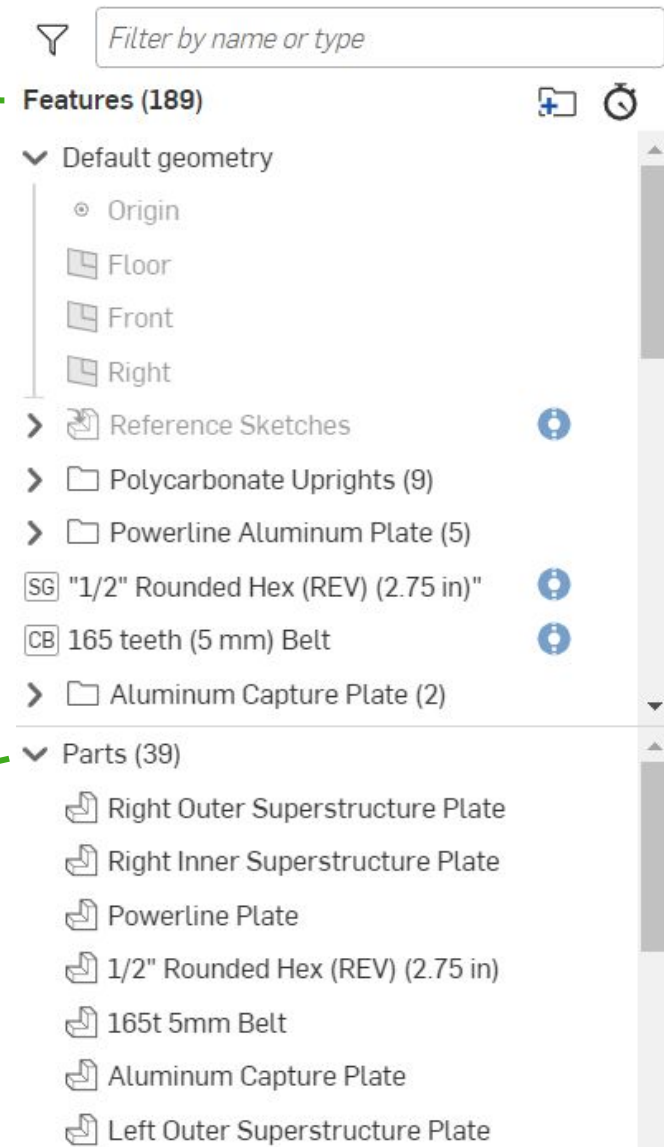- As Part Studios contain more and more parts and features, performance may/will decrease.

- Try to keep features to less than 250.

- Try to keep parts to less than 20.
  - This one is a very loose guideline.

- **Keep regeneration time to less than 10 seconds!**

PART STUDIO PERFORMANCE

- Use the ⏱ **Show Regeneration Time** tool to see what features are taking up the most time.

- Common Culprits:
  - Tube Converter (thousands of holes)
  - Spur Gear or Pulley tools
  - Complex Patterns
  - Complex sketches with imprinting on

- As you're modeling parts, keep track of what is taking the most time and remedy as you go.

#	Feature name	Time
118	Li Lighten 1	300ms
63	Ø 0.205 in THRU	285ms
106	Sketch 30	176ms
1	Reference Sketches	160ms
6	Ø 0.205 in THRU | ⌄Ø 0.41...	134ms
4	Ø 0.205 in THRU	126ms
34	Ø 0.205 in THRU	120ms
28	Extrude 4	103ms
30	Extrude 5	88ms
7	Ø 0.375 in THRU	84ms
15	Ø 0.375 in THRU	80ms
16	SG 1/2" Rounded Hex (REV) (2...	78ms
25	TC Tube Converter 1	72ms
37	Fillet 5	68ms
44	Ø 0.205 in ↕ 0.58 in	59ms
36	Fillet 4	54ms
40	Fillet 11	52ms
136	Ø 0.144 in ↕ 0.58 in | ⌄Ø 0...	52ms
108	Extrude 35	49ms
39	Fillet 8	48ms

Regeneration times

Total regen time: **4.50s**

PART STUDIO PERFORMANCE

- There are usually parts that can be created in their own part studio.

- **Primary parts** are the critical parts of a mechanism driven by the master sketch.
  - Shooter plates, elevator uprights, etc

- **Secondary parts** rely on the primary parts to set their geometry.
  - Gussets, hex shafts, some tubes, etc

- **Tertiary parts** are custom components we need, but don't really rely on the geometry.
  - Gears, pulleys, camera mounts, etc

Team 131, 2024, Double Time
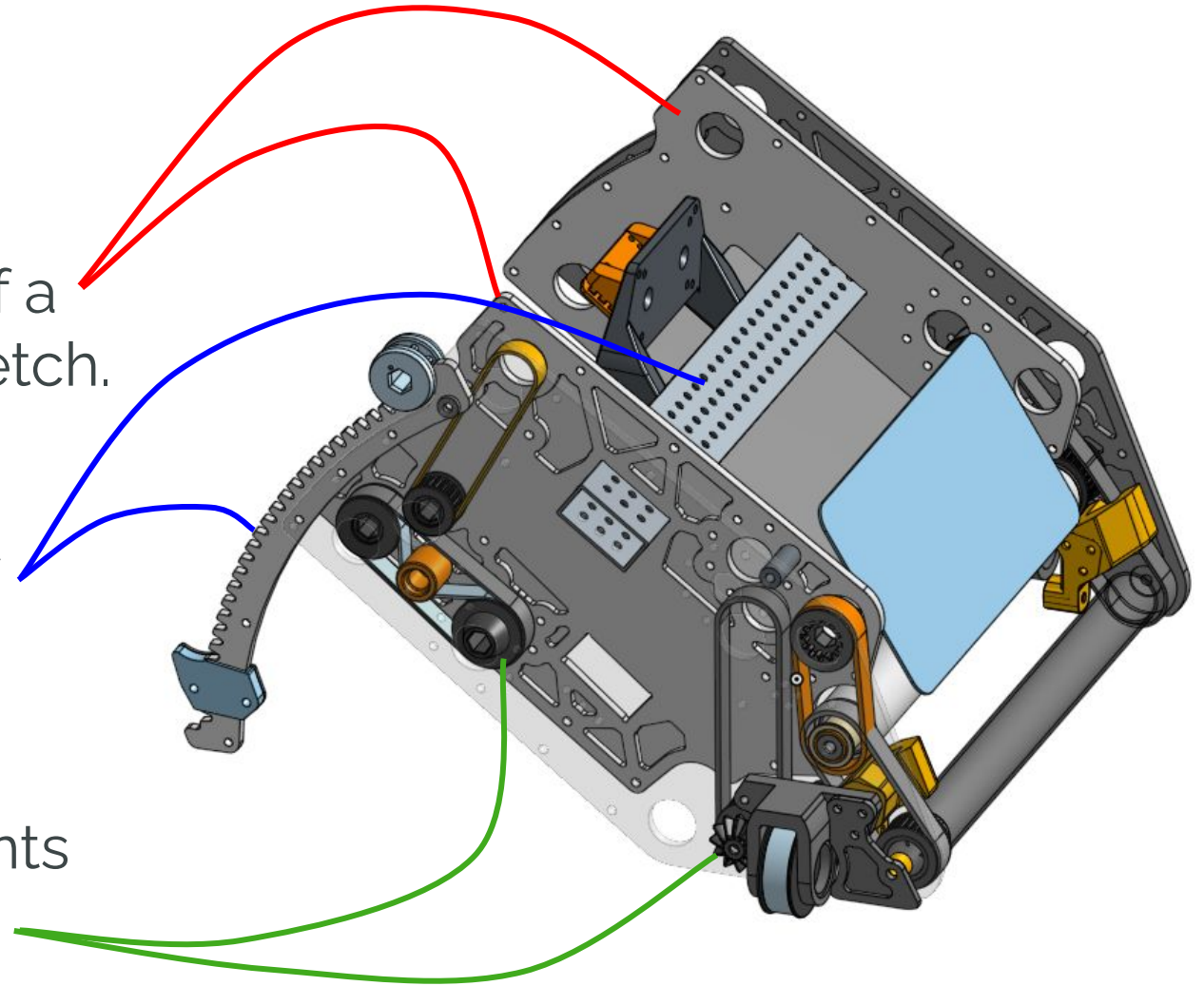
PART STUDIO PERFORMANCE

- If tertiary (or even secondary) parts are driving up regeneration and causing problems, make a new Part Studio.

- **Derive** in the relevant parts from the main Part Studio and build around them.

- Assembly will be easy as parts all still have same origin.

- Requires good naming/organization but can greatly increase performance.

- Is a judgement call on when to split.

REGEN TIME: 31s

REGEN TIME: 25s

REGEN TIME: 2.5s

Team 131, 2024, Double Time
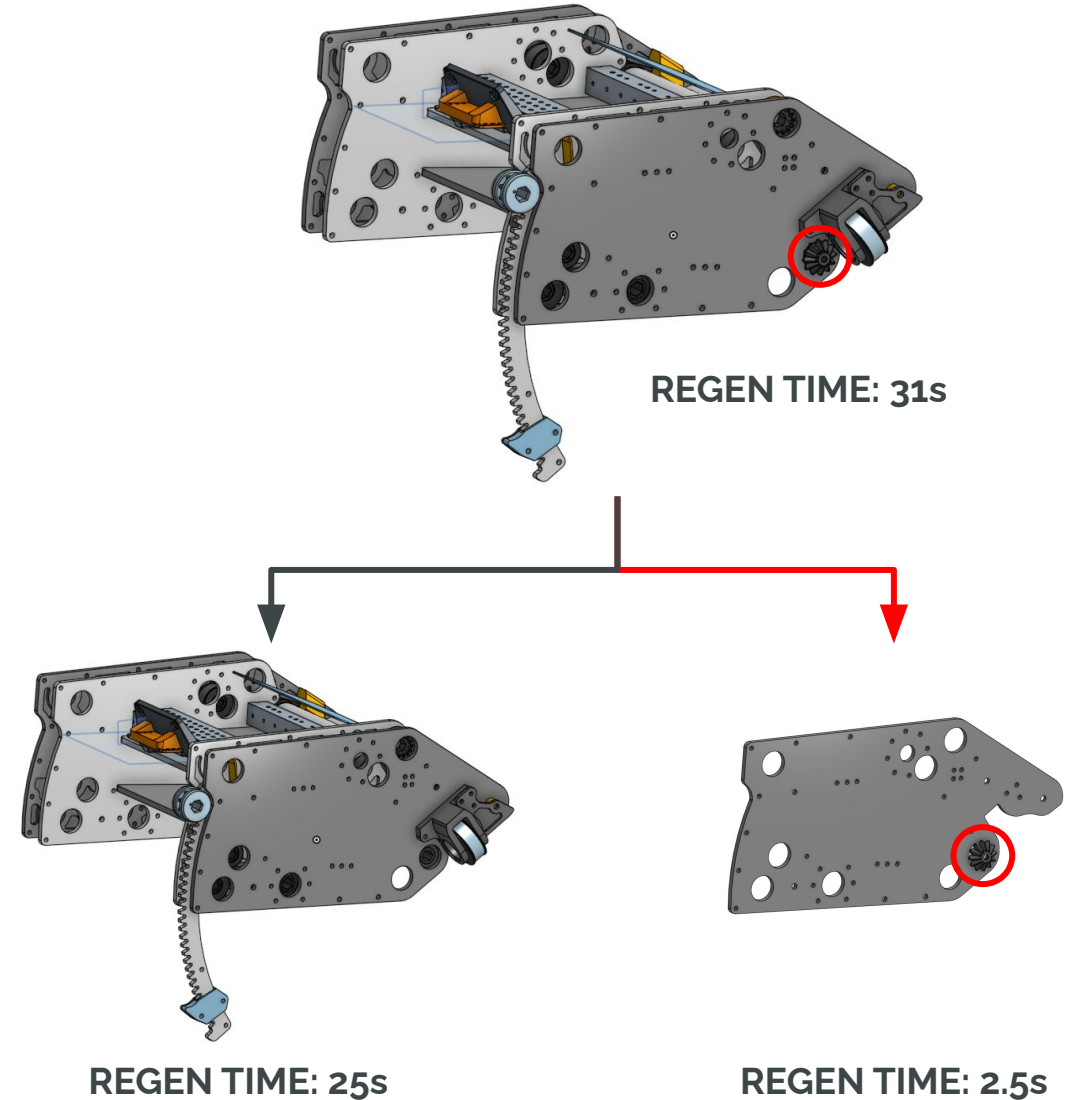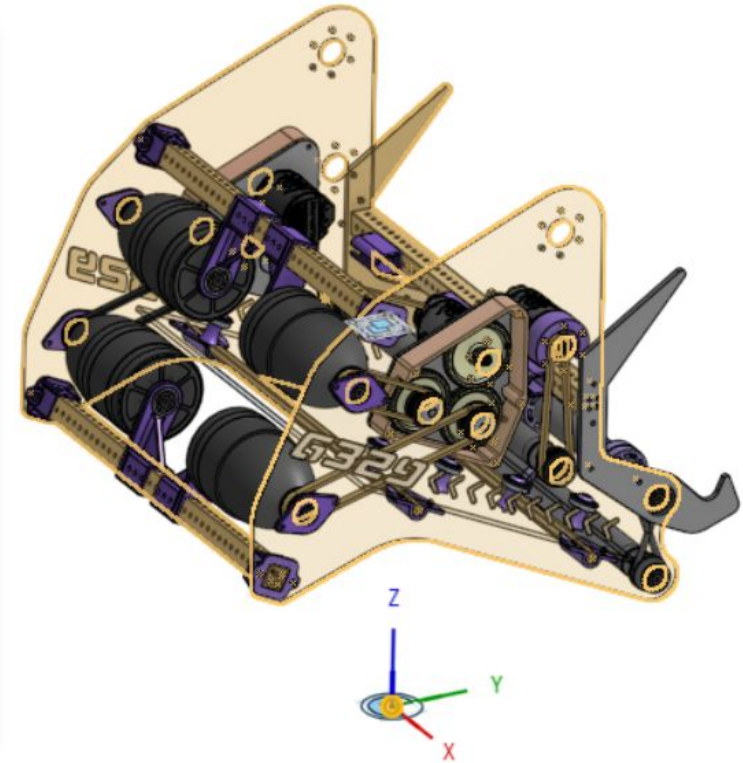
ASSEMBLY PERFORMANCE

ASSEMBLIES

- Once parts are modeled, combine them with COTs components to make subassemblies.

- Once subassemblies are completed, combine them all together for the finished robot.

- A complete, accurate assembly allows you to measure CoG, check for clearances, and plan for electronics and maintenance.

Team 6329, 2024, Dial

MAKING ASSEMBLIES EASY

- When Part Studios are inserted in their entirety without moving, they will insert together in reference to the origin.

- Parts that move as one unit should be **Group**ed ⊡ .
  - Loads faster, updates with Part Studio.

- Right click and "Add mate connector to instance origin" creates a mate connector that can be fastened to the origin.
  - When subassemblies are combined, mate these together and everything lines up.

Group 1

Instances
Tube 1"x1"x19.5" <1>
Right Shooter Panel <1>
Tube 1"x1"x19.5" <2>
1/2" ThunderHex (19.5 in) <1>
Left Shooter Gearbox Shell <1>
Left Shooter Panel <1>
Right Shooter Gearbox Shell <...
Tube 1"x1"x19.5" <3>
1/2" ThunderHex (19.5 in) <2>
120t 3mm Belt <1>
120t 3mm Belt <2>
180t 3mm Belt <1>
100t 3mm Belt <1>
Pine Tree Climb Hook <1>

ASSEMBLY PERFORMANCE

- Top-level assemblies of complex FRC robots can become very slow.

- The major things to monitor are:

  - Number of unique parts

  - Number of primitives

  - Number of assemblies/PS in the document

- Note that assemblies inserted into other assemblies in the same document will load slower as they are not versioned and update instantly.

Performance

Tab performance

Mate solve time : 297ms

Total instances (1,822)

Category	Count
Top level instances	9
Total subassemblies	108
Total parts	1,713
Total surfaces	1
Unique subassemblies	36
Unique parts	459
Unique sketches	0
Unique surfaces	1
Tangent mates	0
Mate limits	22

Tab graphics

Primitives (6,089,121)

Primitive	Count
Triangles	5,016,014
Vertices	317,585
Lines	284,639
Edges	271,469
Faces	199,414

ASSEMBLY PERFORMANCE

- Primitives are the triangles, edges, and vertices your GPU needs to render to show the assembly.
  - Note: Make sure that your web browser is set to use your secondary GPU if you have one!

- Not a hard limit, but under 5 mil is good.

- To reduce primitives:
  - Use simplified components
  - In part studio, set tessellation qualities to medium (can be turned up in assembly)
  - Suppress components you don't need
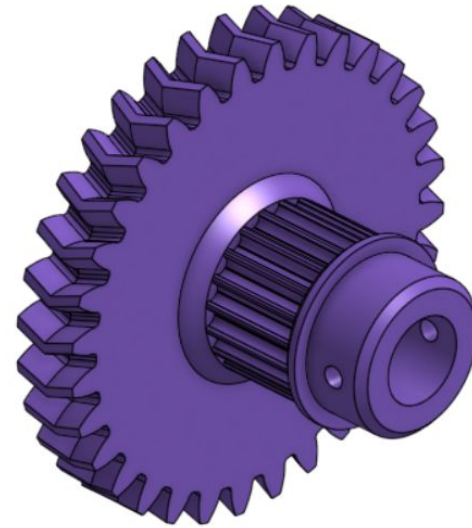
Auto (Fine)

36,677 prim.
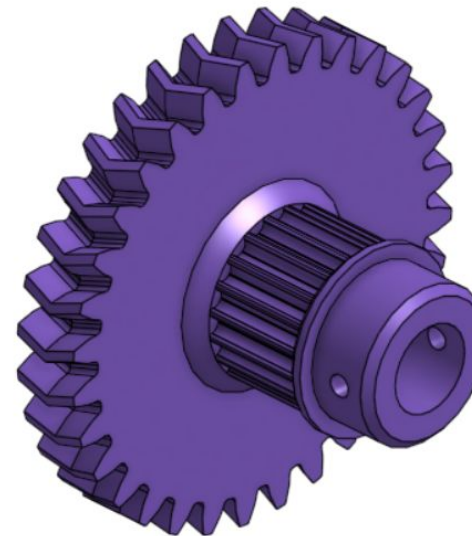
Medium

17,958 prim.

ASSEMBLY PERFORMANCE

- Each unique part has its own data that needs to be loaded and tracked by your device.

- Copied parts are loaded once and the graphics are copy/pasted as needed.

- You need whatever number of parts you need, but be mindful about:
  - Using overly-complex models for COTs parts
  - Don't use bolts/rivets unless checking for clearances

OVERALL DOCUMENT PERFORMANCE

- Tabs in an Onshape document are loaded in parallel.

- If you have multiple large assemblies at the top-level, initial load time is long.

- Instead of an assembly with the robot, an assembly with robot + field, etc...
  - Create a new document and insert both field elements and the robot there
  - Insert field elements in the top-level robot assembly and then suppress when not needed!