971 CAD: Complex, Accessible, Detail Oriented

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Hello Friends!

- Intro
  - 971 Class of 2019
  - CAD, Outreach, Awards!
  - Not a professional mechanical engineer/FRC mentor
    - Not done learning about CAD/design

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CAD vs Design: What's the Difference?

- CAD
  - Software (i.e. Solidworks)
- Design
  - Creating something for a specific purpose
  - Physics & mathematics to optimize functionality

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What happens on Day One of Build Season?

- Strategies/Potential Mechanisms
- How do we know if a specific mechanism will work?
  - What are our design constraints?
  - What do we want the robot to be able to do?

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Ask Specific Questions!

- How tall does the arm need to stack 2 high on a losing scale?
- Where will we put the wheels on our intake so the cube doesn’t get stuck?
- What kind of material would grab the cube well?

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How do we answer these questions?

- Prototyping:
  - Where will we put the wheels on our intake so the cube doesn’t get stuck?
- CAD:
  - How tall does our arm need to be to reach the scale?

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Crayola CAD

- Block CAD
- Rough sketches, blocks, representations
- Understand different designs
    - Feasibility, packaging, necessary components, etc

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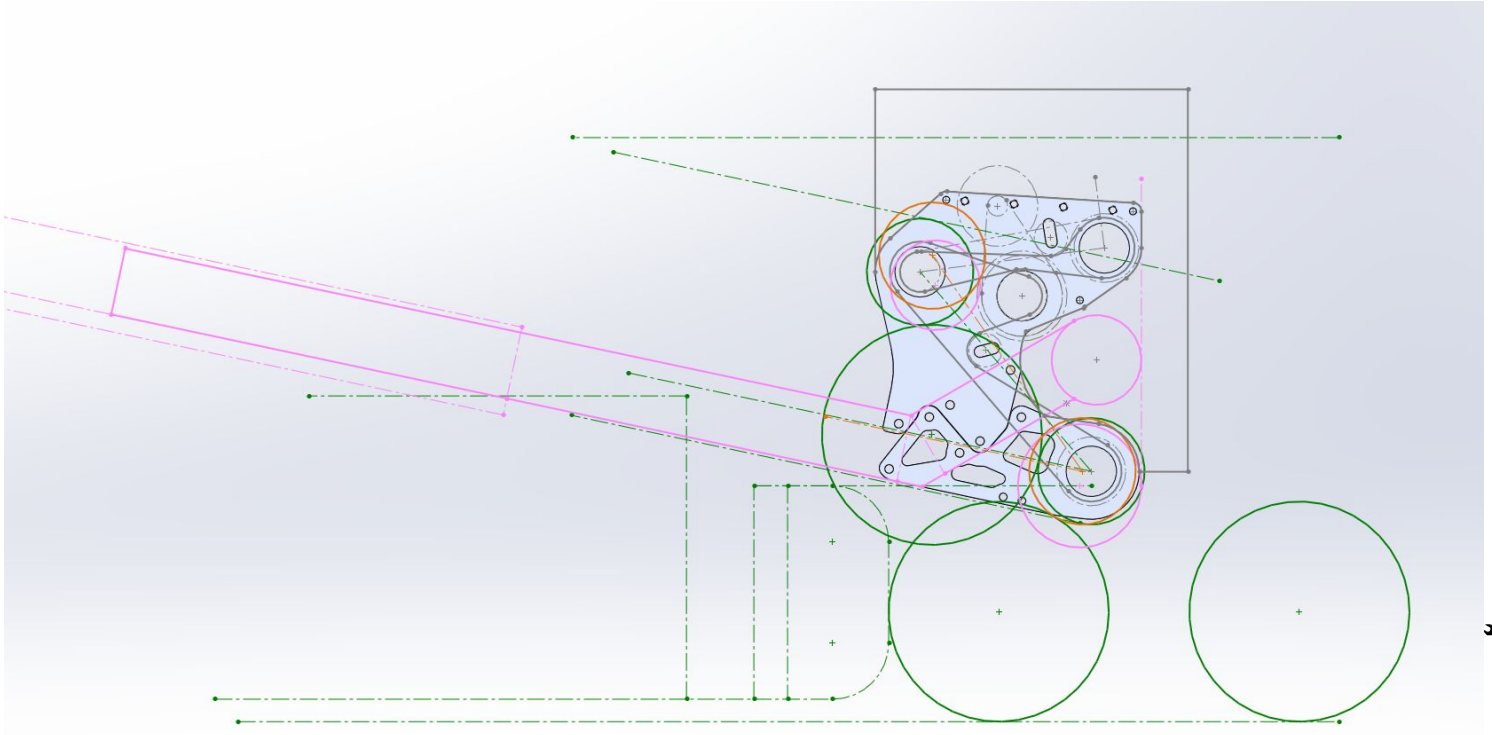
Where do all the different components of the intake go?



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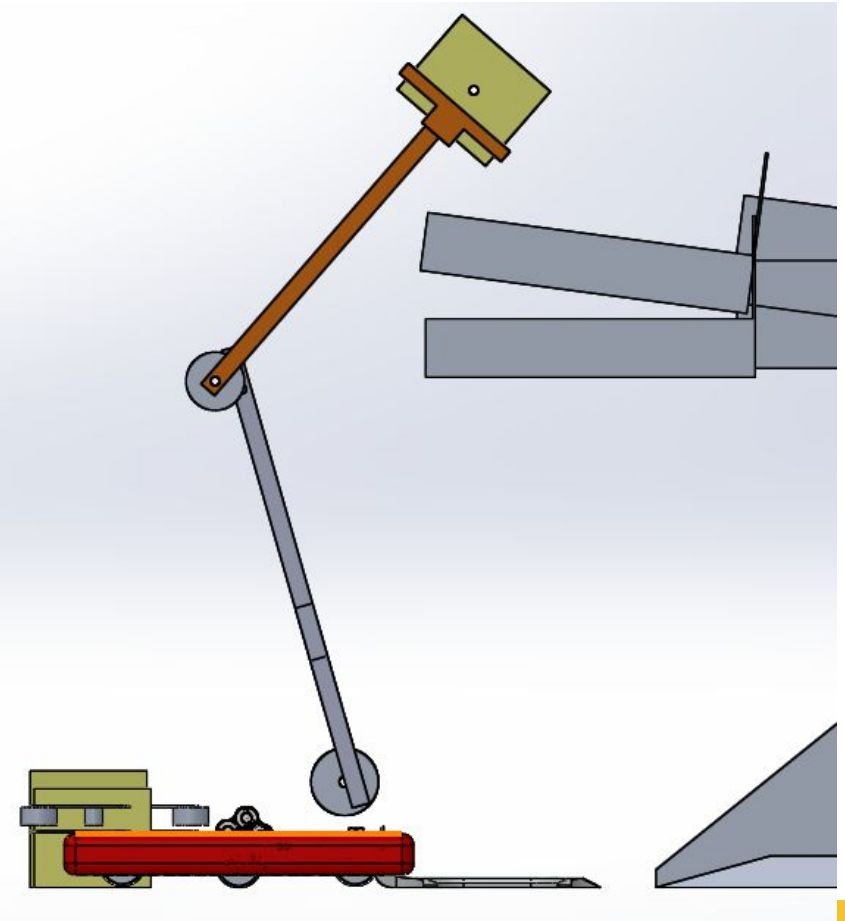
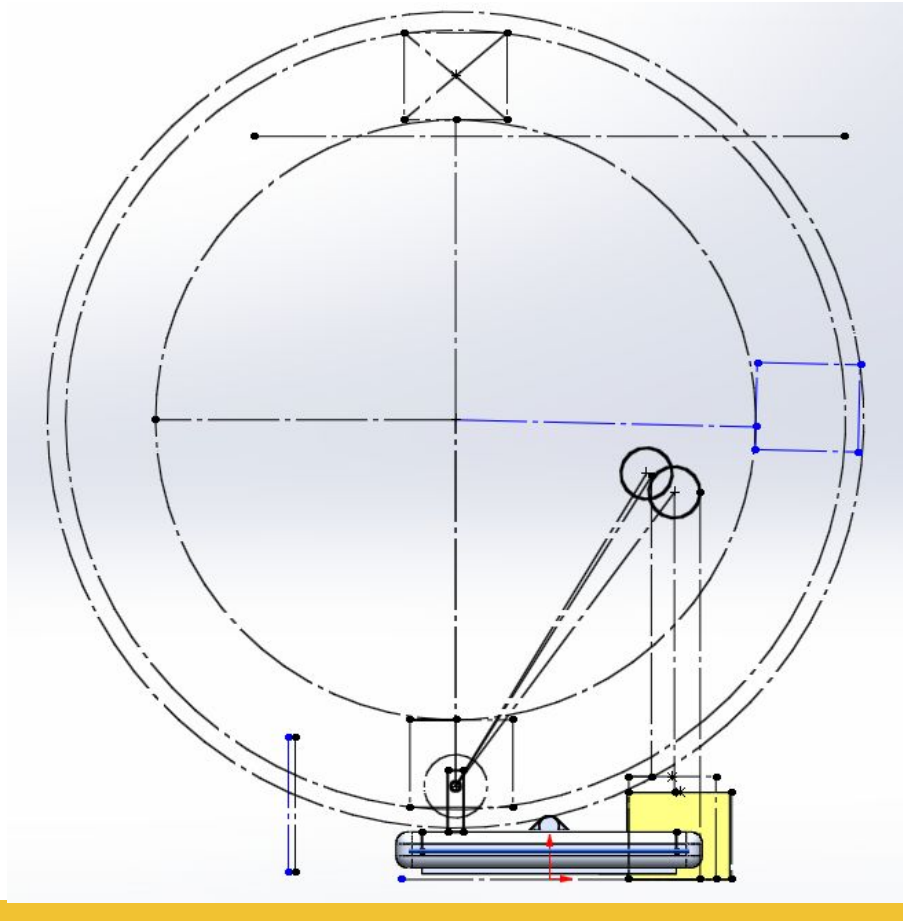
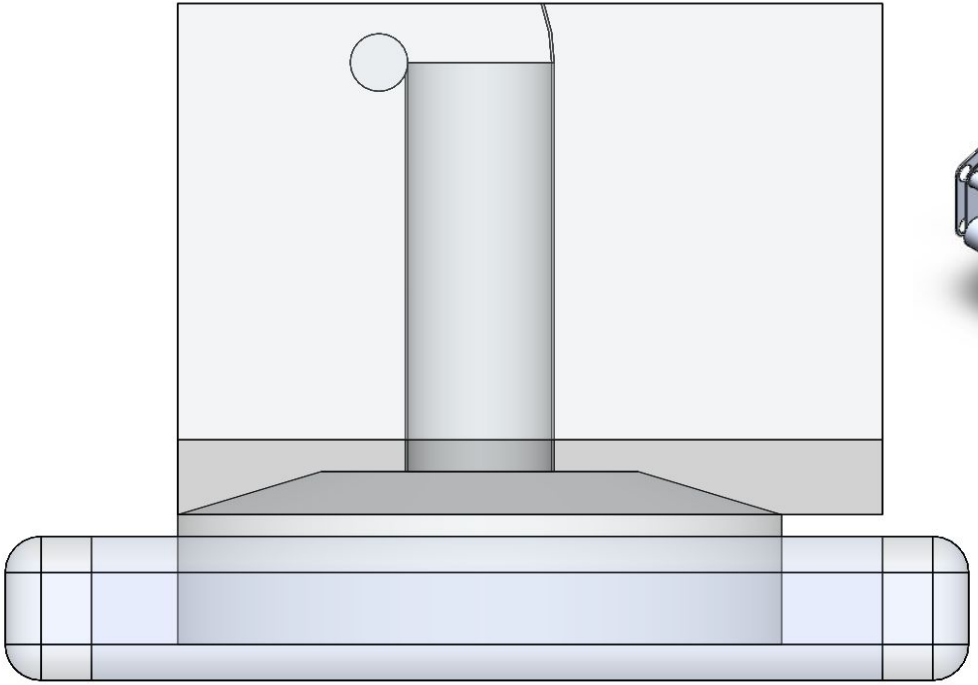
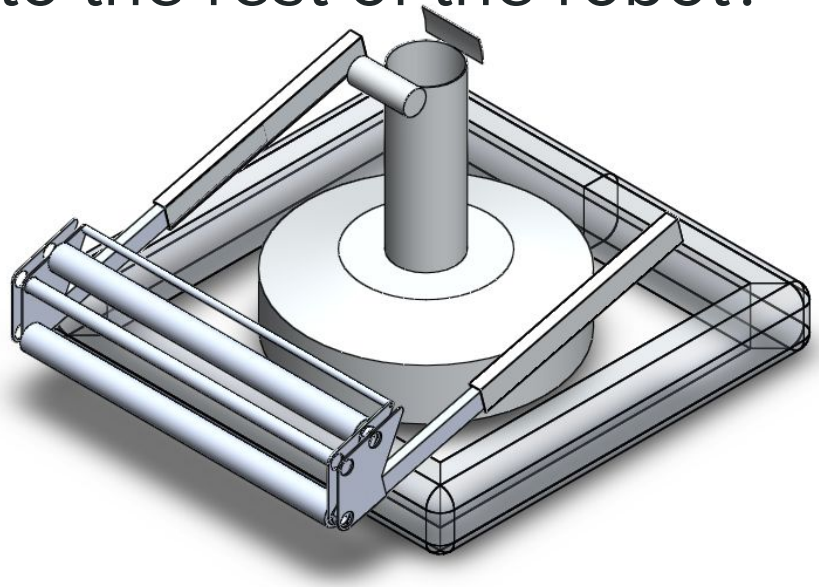
How tall does our arm need to be to reach the scale?





Where will the serializer fit into the rest of the robot?





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So, we know what mechanisms we want. What's next?

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What is Geometry in CAD?

- More detailed planning of specific mechanisms
- Often in a 2D sketch
- Relations and dimensions to everything that we care about
    - I.E. other mechanisms, the ground, components, etc
- Math! Probably.

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How does geometry work with Crayola CAD?

- Geometry, Crayola CAD, and prototyping work side by side to determine an effective design.
- Geometry = more specific “hows” of a mechanism

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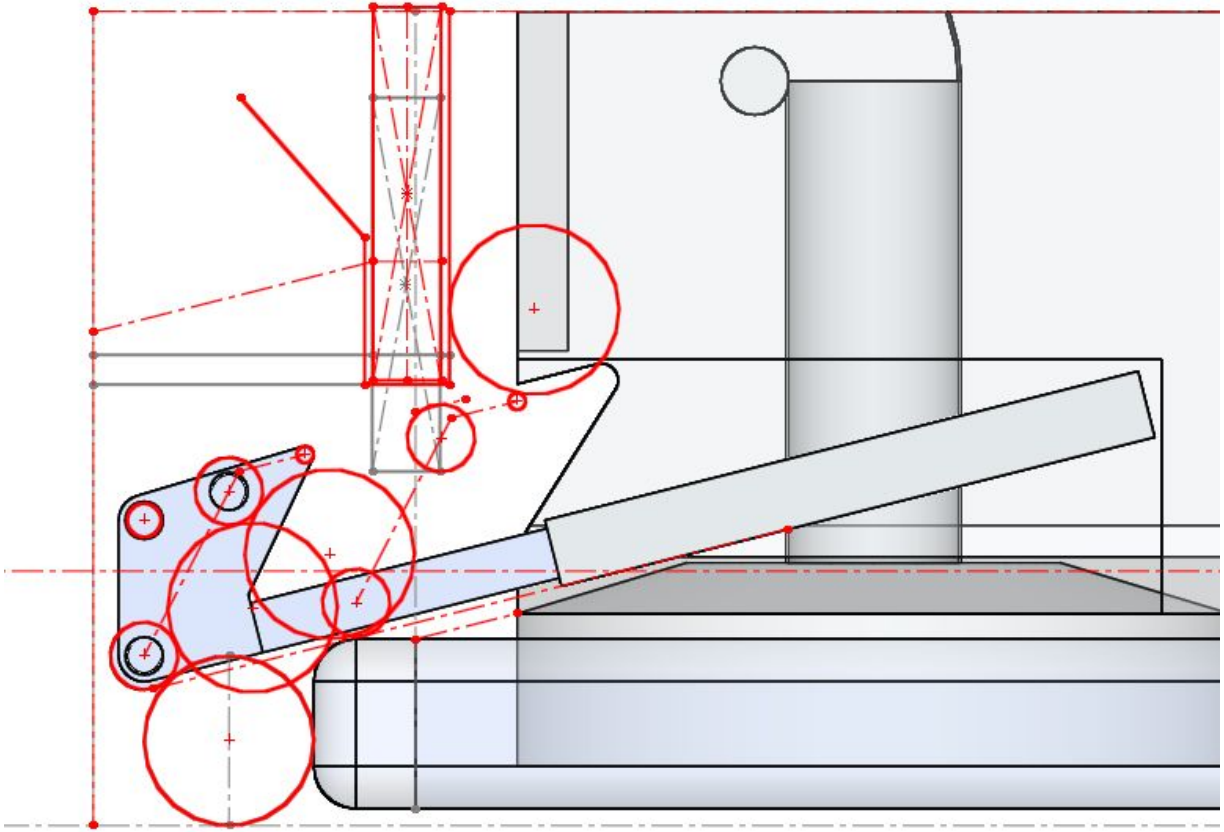
How far will the intake need to extend? What will the roller geometry look like?



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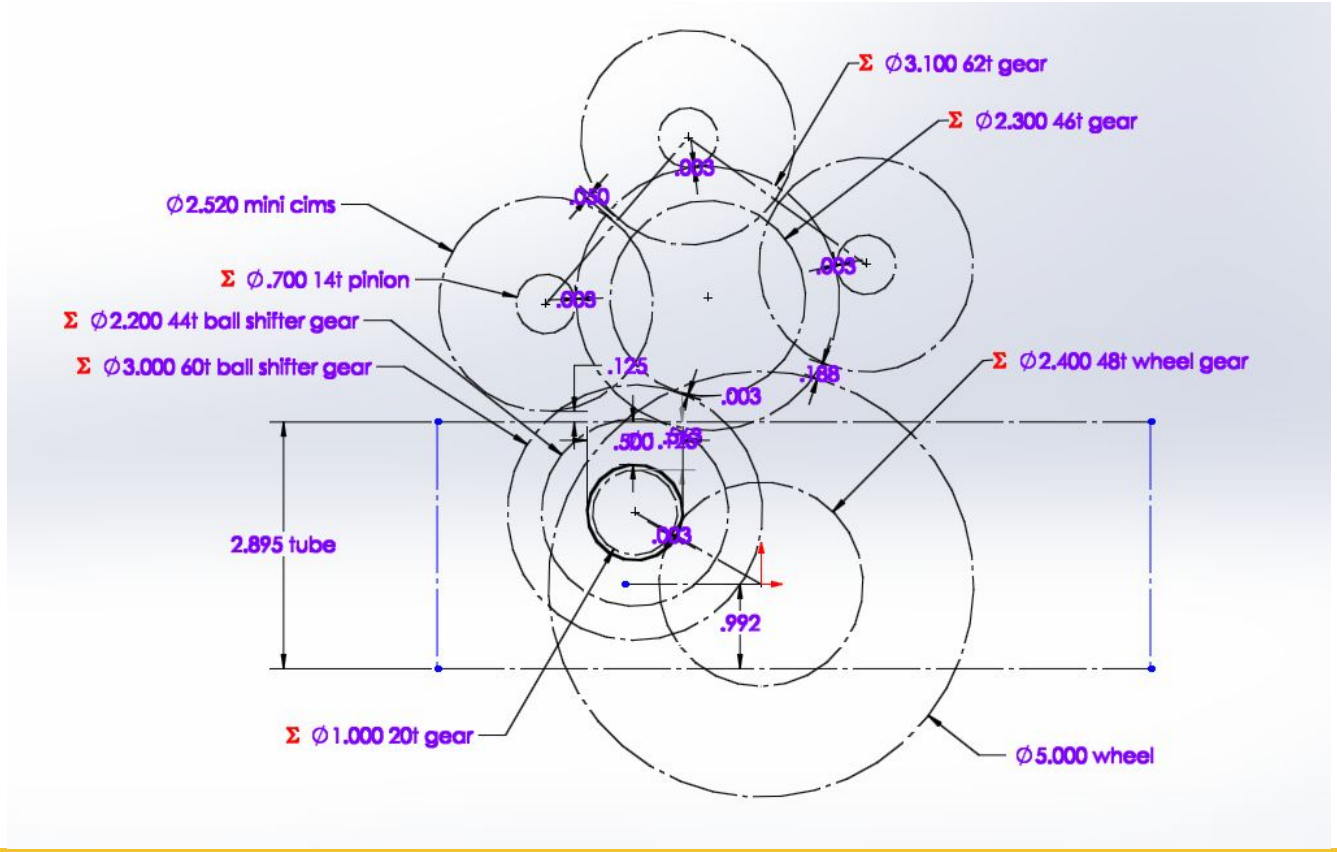
How will all the gears in a gearbox fit together?



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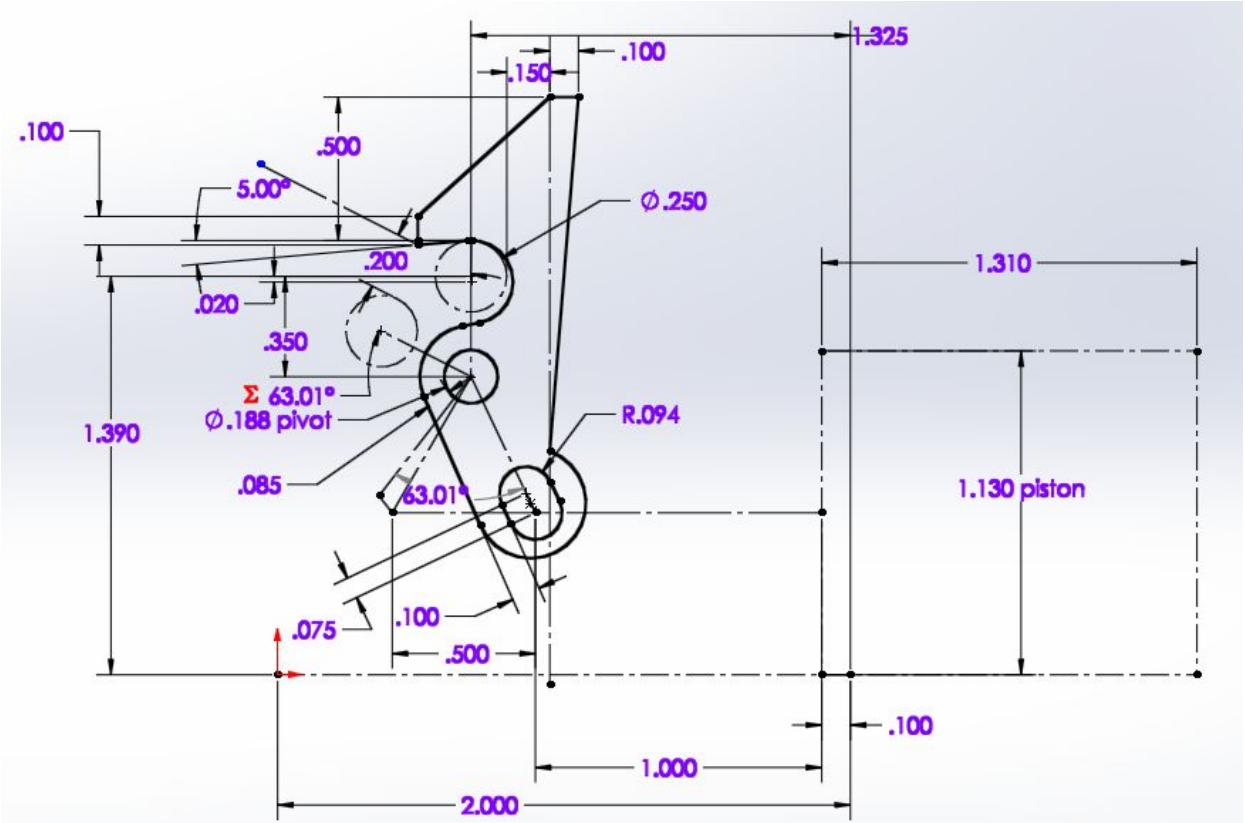
How will the pneumatics work to hold the lift securely? What will the latch profile look like?



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Multibody Parts

- Single Part
- Good for custom gearboxes
- Less arbitrary dimensions

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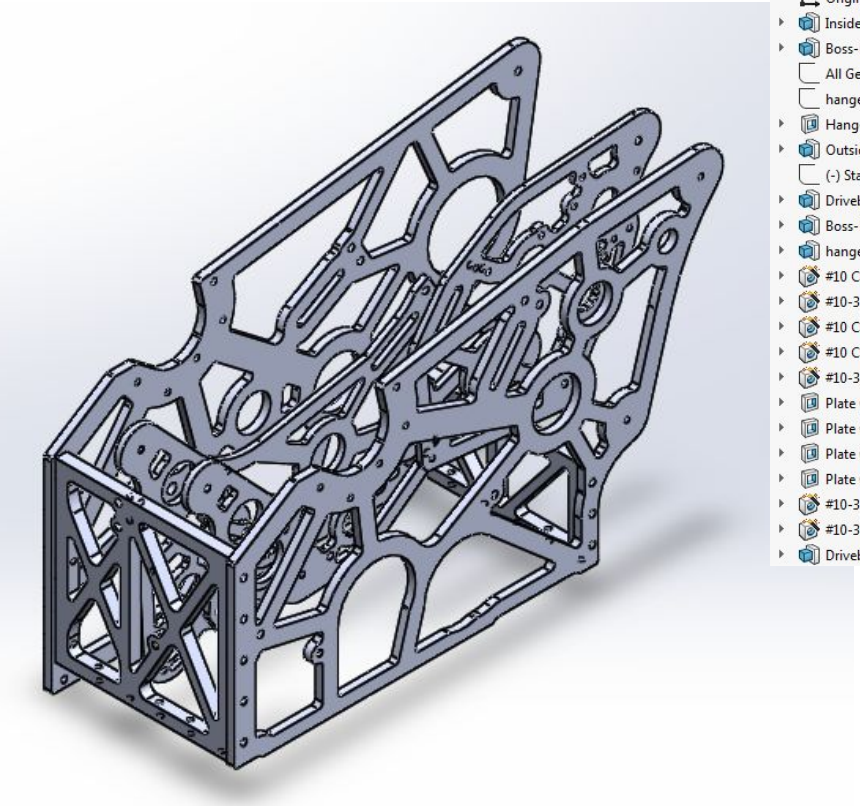
2018 Arm Gearbox



- 971-18-P-0057_Arm Gearbox Plat
  - History
  - Sensors
  - Annotations
  - Equations
  - PC High Viscosity
  - Front Plane
  - Top Plane
  - Right Plane
  - Origin
  - Inside Plate
  - Boss-Extrude2
  - All Gear Hanger Sketch
  - hanger gearbox sketch
  - Hanger Gearbox Holes
  - Outside Plate
  - (-) Standoff Location Sketch
  - Drivebase Mount Blocks
  - Boss-Extrude5
  - hanger gearbox other plate
  - #10 Clearance Hole8
  - #10-32 Tapped Hole6
  - #10 Clearance Hole1
  - #10 Clearance Hole2
  - #10-32 Tapped Hole1
  - Plate Contour 1, inside
  - Plate Contour 2
  - Plate Contour 3
  - Plate Contour 4
  - #10-32 Tapped Hole2
  - #10-32 Tapped Hole3
  - Drivebase Side Mounting Holes
  - #10-32 Tapped Hole4
  - #10-32 Tapped Hole5
  - #10 Clearance Hole3
  - #10 Clearance Hole4
  - #10 Clearance Hole5
  - #10 Clearance Hole6
  - #10 Clearance Hole11
  - Boss-Extrude13
  - M4 Clearance Hole1
  - 775 clearance 1
  - CirPattern1
  - 775 clearance 2
  - CirPattern2
  - Cut-Extrude6
  - CirPattern3
  - Fillet2
  - Cut-Extrude7
  - CirPattern4
  - Fillet3
  - Cut-Extrude8
  - Fillet4
  - CirPattern5
  - #10-32 Tapped Hole7
  - Boss-Extrude15
  - #10-32 Tapped Hole8
  - Boss-Extrude14
  - #10-32 Tapped Hole9
  - #10-32 Tapped Hole10
  - #10 Clearance Hole9
  - #10-32 Tapped Hole11
  - Left-right midplane
  - Mirror1
  - CrvPattern1
  - #10 Clearance Hole10
  - #10-32 Tapped Hole12
  - #10-32 Tapped Hole13
  - CrvPattern2
  - #10-32 Tapped Hole14
  - #10 Clearance Hole12
  - #10-32 Tapped Hole15
  - #10 Clearance Hole13
  - #10-32 Tapped Hole16
  - Cut-Extrude10
  - Fillet5
  - Fillet6
  - Fillet8
  - Cut-Extrude11
  - Fillet7
  - Mirror2
  - Cut-Extrude12
  - Fillet9
  - Cut-Extrude13
  - Fillet10
  - Cut-Extrude14
  - Fillet11
  - Cut-Extrude15
  - Fillet12
  - Cut-Extrude16
  - Fillet13
  - Fillet14
  - Fillet15
  - #10-32 Tapped Hole17
  - #10-32 Tapped Hole18
  - Body-Delete/Keep 1
  - Boss-Extrude17
  - Body-Delete/Keep 4
  - Boss-Extrude18
  - Coordinate System2
  - Boss-Extrude19
  - Body-Delete/Keep 5
  - Body-Delete/Keep 6
  - Body-Delete/Keep 7
  - Boss-Extrude20
  - Coordinate System3
  - Boss-Extrude21
  - Body-Delete/Keep 8
  - Boss-Extrude22
  - Coordinate System4
  - Body-Delete/Keep 9
  - Boss-Extrude24
  - Coordinate System5
  - Boss-Extrude25
  - Body-Delete/Keep 10
  - Boss-Extrude26
  - Coordinate System6
  - Boss-Extrude27
  - Boss-Extrude28
  - Coordinate System7
  - Boss-Extrude29
  - Boss-Extrude30
  - Cut-Extrude17
  - Boss-Extrude31
  - Sketch147
  - Boss-Extrude32
  - Cut-Extrude18
  - Boss-Extrude33

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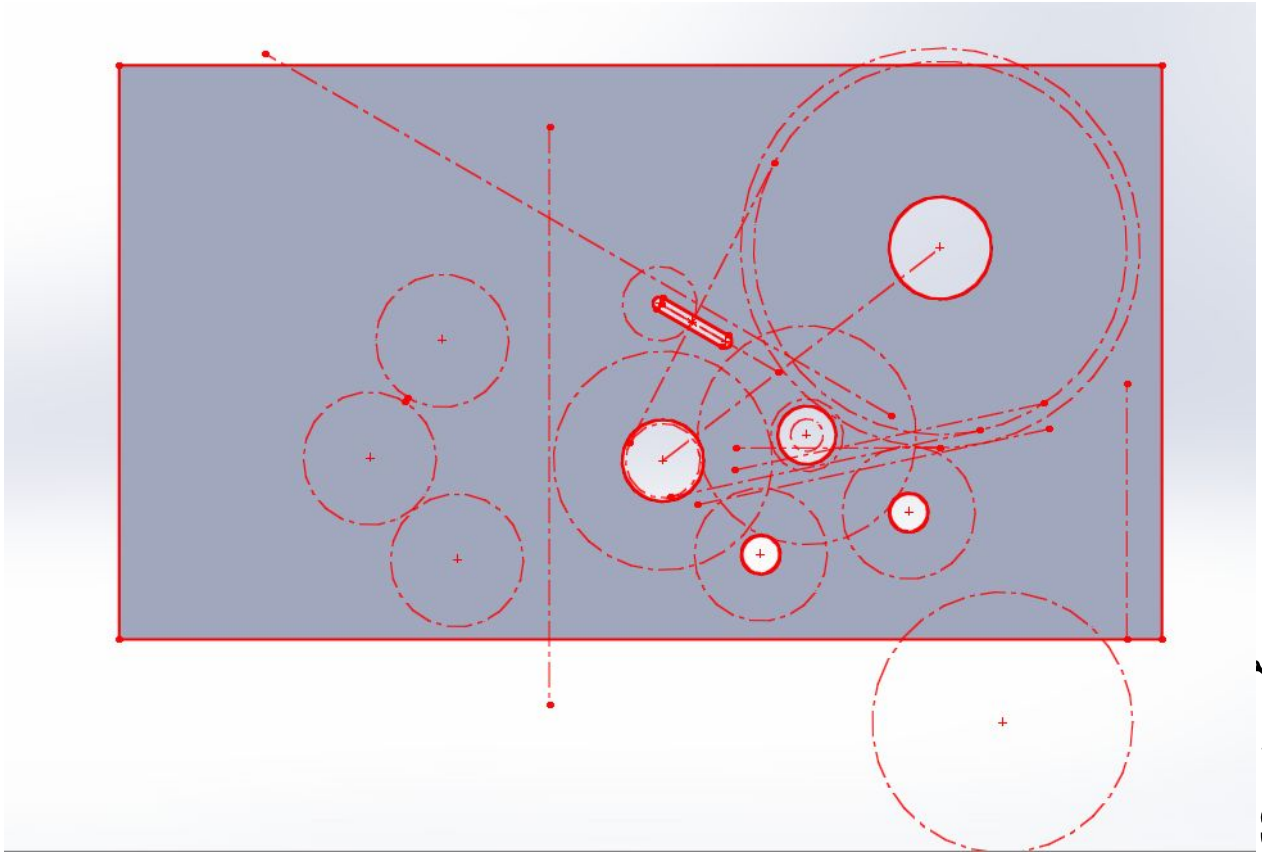
2018 Arm Gearbox



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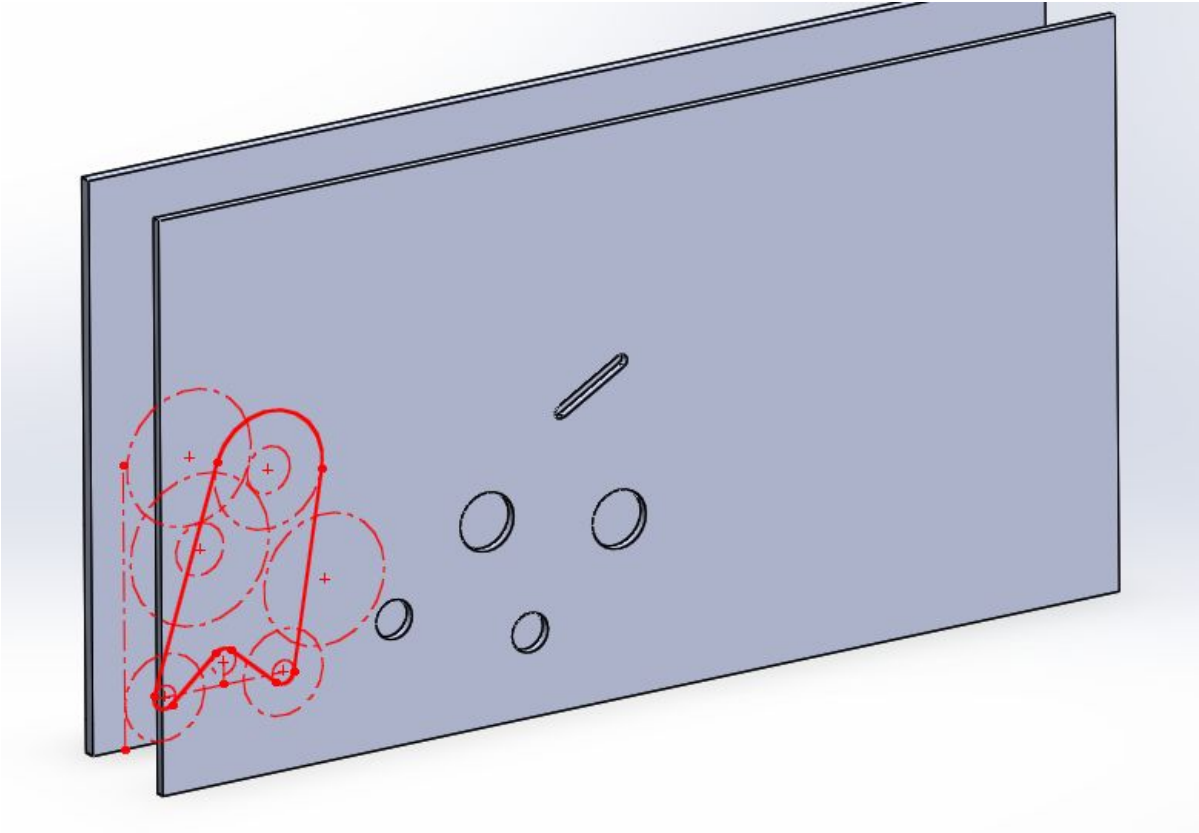
2018 Arm Gearbox



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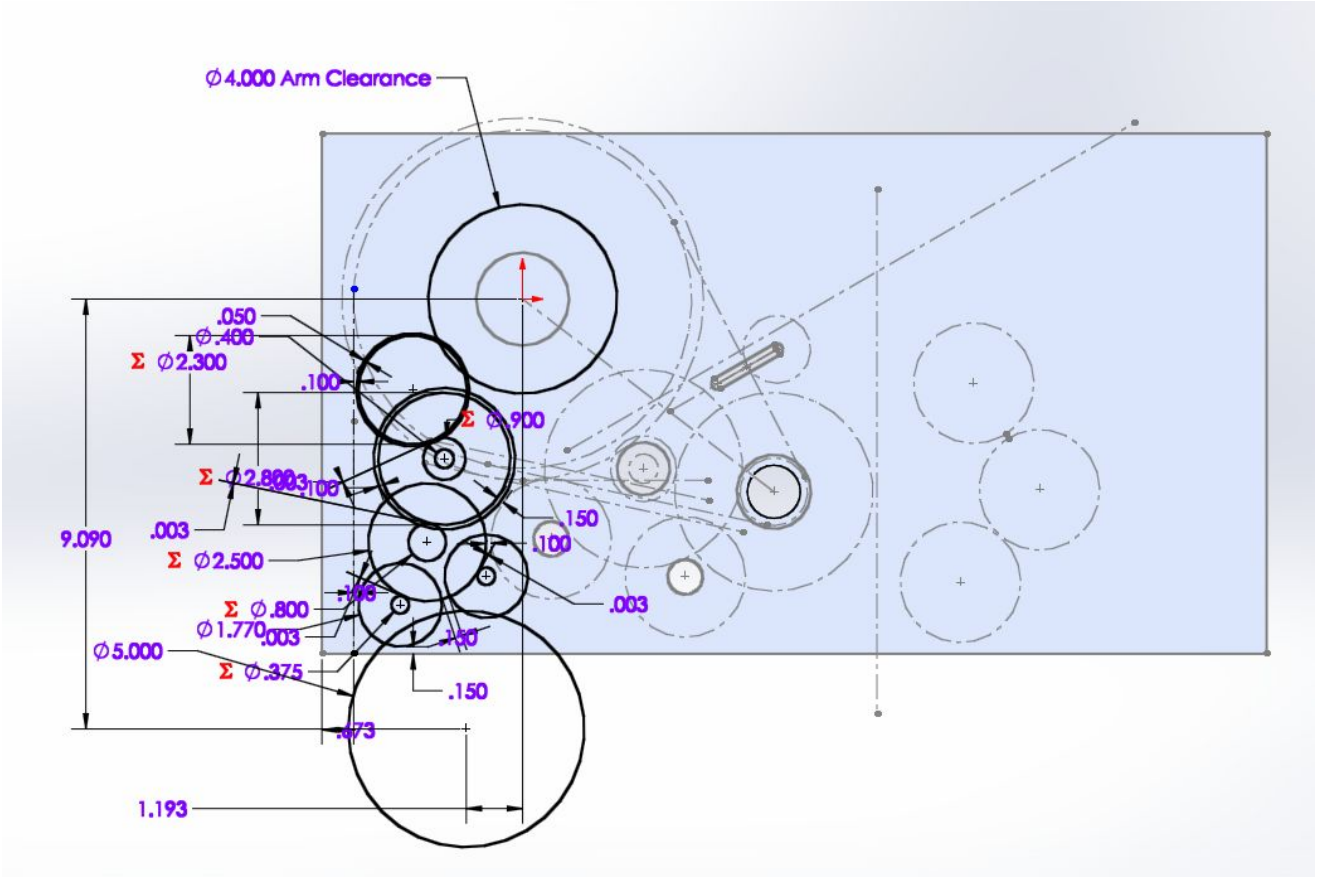
Why did we use multibody parts in the arm gearbox?



Only gears

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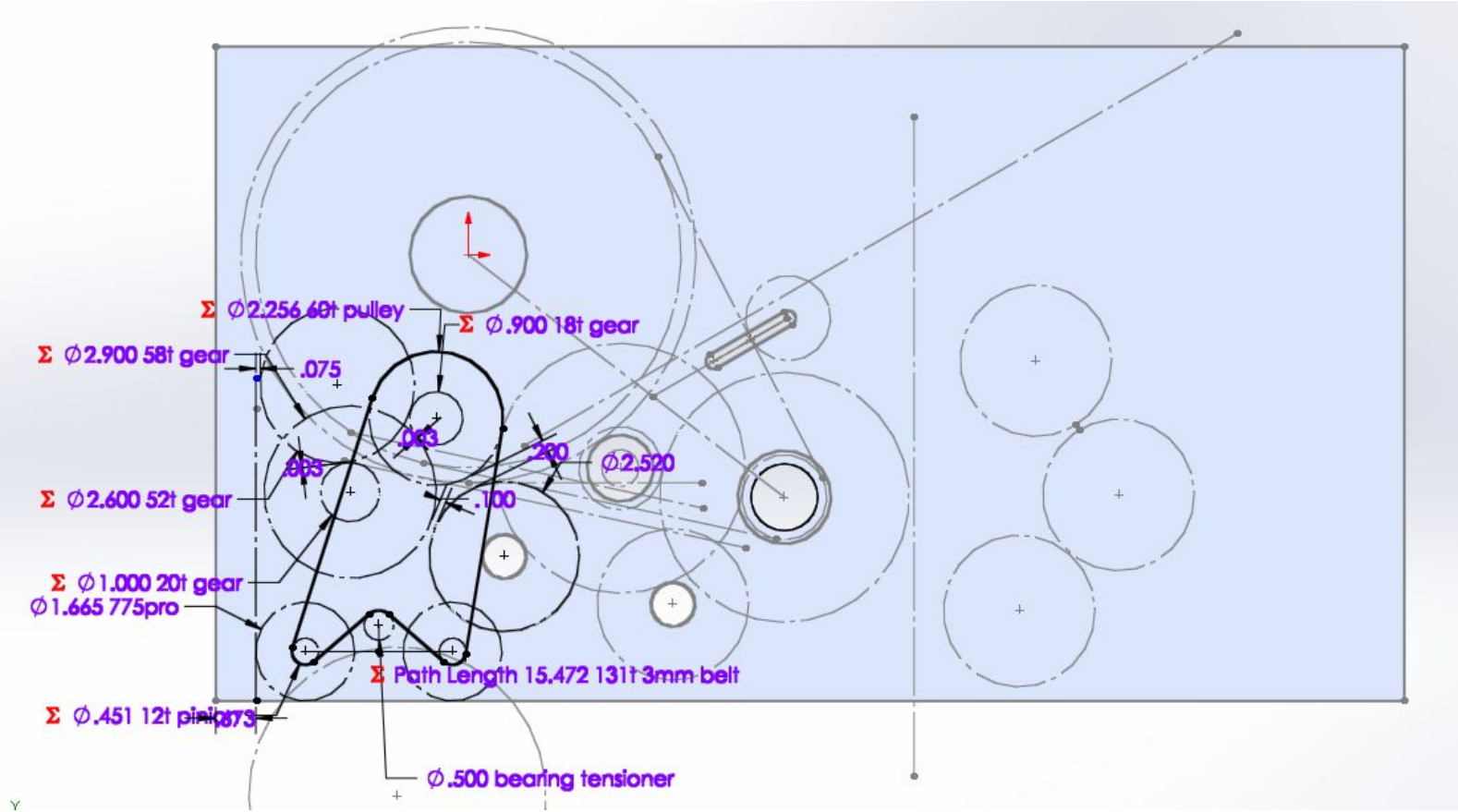
Why did we use multibody parts in the arm gearbox?



Gears and belts

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Multibody Parts

- What are some challenges we face?
  - Sometimes parts can be large and messy, can take forever to load. At the same time, the part is easily modifiable.
  - Hard to know when to use them and when not to

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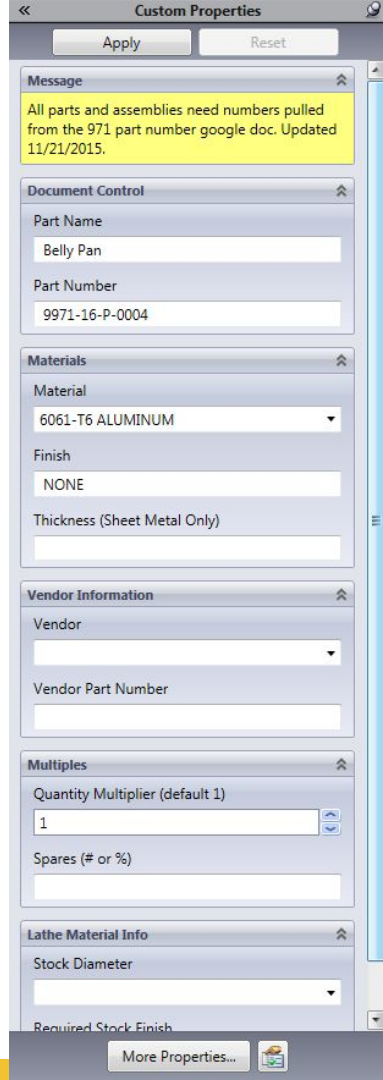
Parts Management/Parts Library

- Accessibility
- COTS Parts and the Parts Library
- Parts list and custom properties



How do we use Solidworks to iterate on our designs?

- Everything needs to have a reason!
- Don’t just make features to make them :P
- Top-level sketches
- Dimension what you care about, not just arbitrarily
- Make it easy to go back and modify the design

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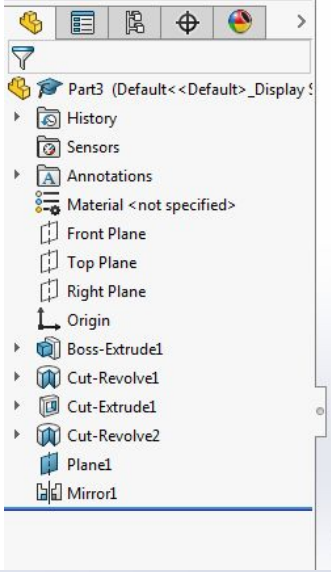
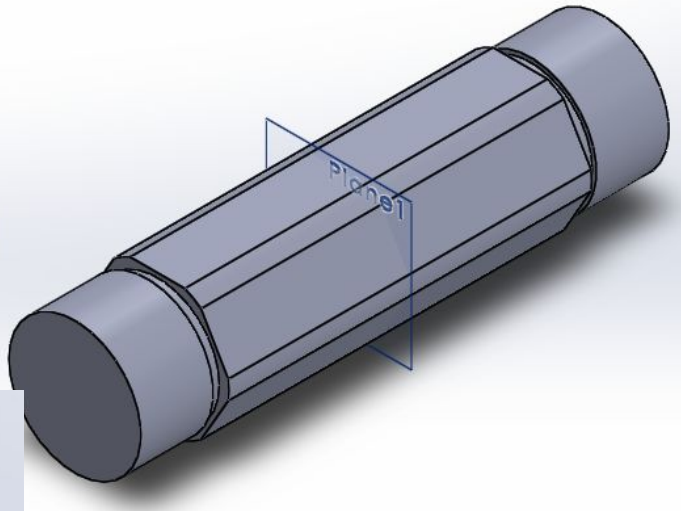
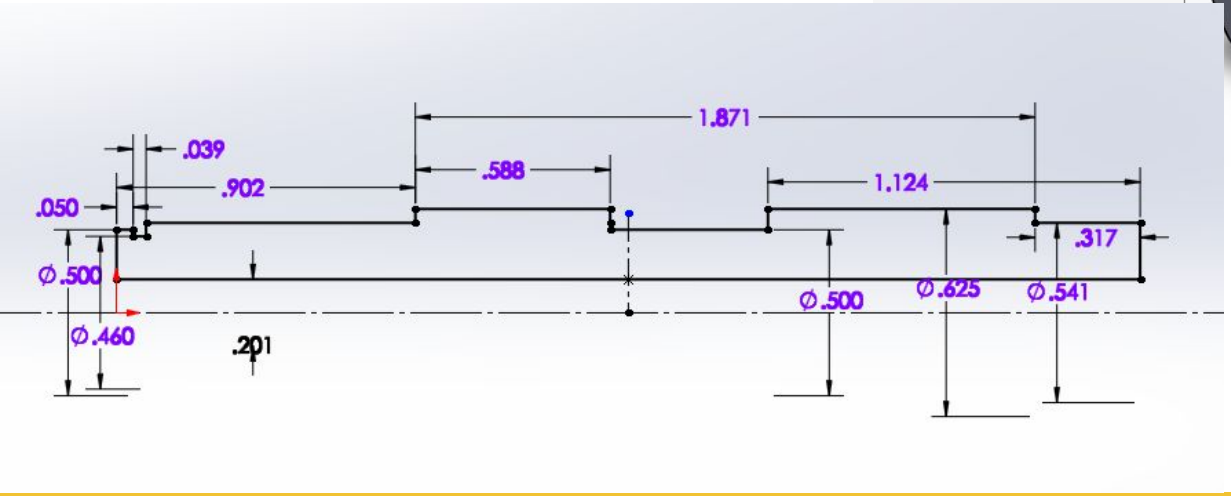
Simple Example







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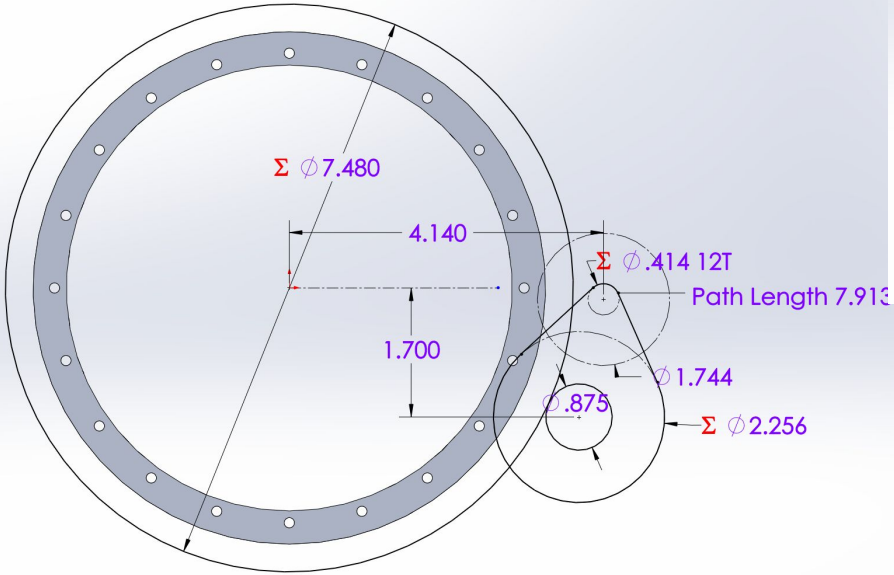
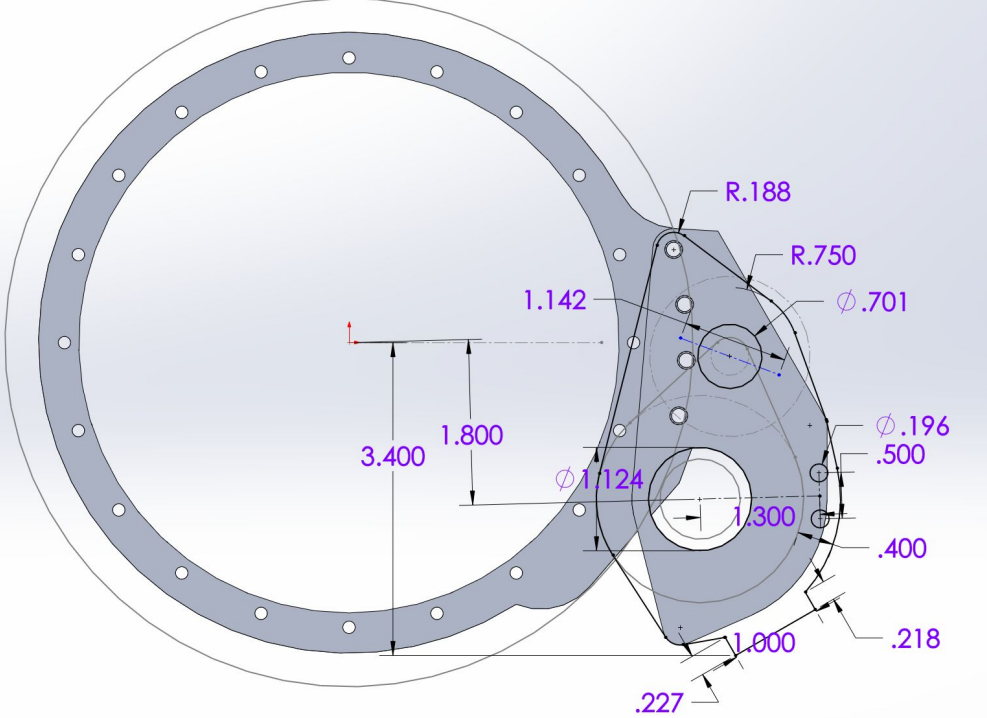
Less Simple Example





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Iteration

- All 971 mechanisms go through iteration
- Don’t always know exactly how a mechanism will work in real life
- Important to know that iterating on mistakes is the best way to learn

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Thank You!

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