Assembly Lab: In-Lab Activities

Introductions and Definitions

This lab has several main objectives.

1. Introduce several different ways to think about the quality of designs
2. Provide hands-on experience with the assembly of different mechanical systems
3. Create an opportunity for students in each lab section to get to know one another

Previous courses you may have taken as an engineering student have focused on the theoretical aspects of design and provided you with a robust set of tools that you can use to analyze and predict the behavior of mechanical systems. In this lab we will start preparing you to be a successful engineer who can create mechanisms to solve real-world problems.

To earn full points on this lab you will need to turn in a postlab to gradescope that answers all of the questions shown in bold. (Individual Assignment)

A set of all postlab questions is included at the end of this document.

Section 1: Design tips presentation

As the lab starts, your TA will give a brief presentation that will cover several different aspects of design thinking. The slides they are presenting can be found here: https://canvas.illinois.edu/courses/59581/files/18402866?wrap=1 . As they present, consider the following question:

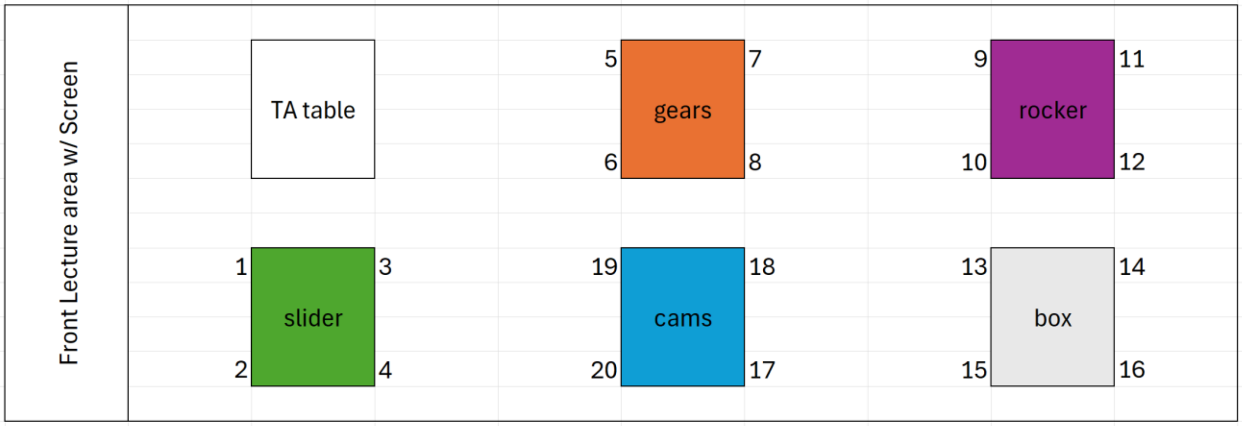
Are there any themes that a lot of good designs have in common?

Section 2: Assembly activity

After your TA has finished presenting, you will have to opportunity to assemble a few different mechanical systems. As you complete each activity, introduce yourself to your classmates, and discuss the strengths and weaknesses of the system you are tasked with assembling.

Each chair has a card on it indicating where you are sitting, and where you will move when you rotate. Following this rotation is important to ensure that you can meet all of your classmates, which may help you identify who you would like to work with in your project.

The following diagram shows the number of each seat.



At each seat you will see a card that shows where you will move for the next activity.

The card will look like this:

You are at seat 4
When you finish, rotate to seat 12

This means that if you are sitting at seat 4 (working on the slider) once you finish you will move to seat 12 (working on the rocker)

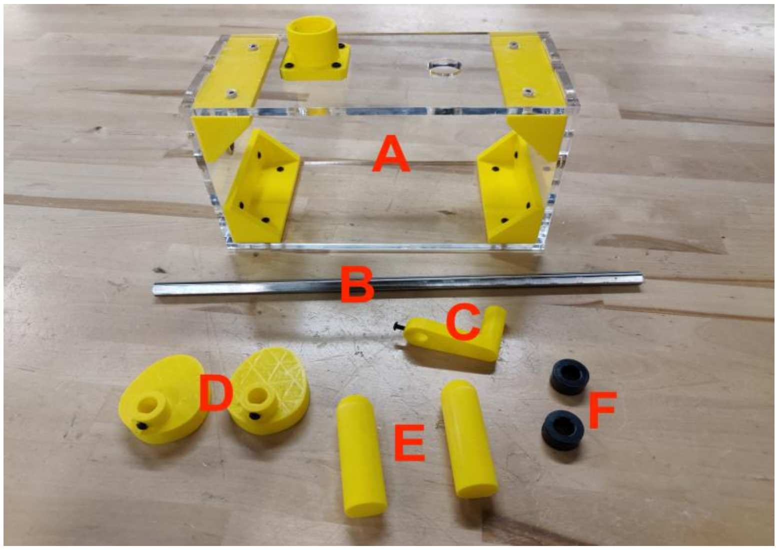
When you move to seat 12 you will see something that looks like

You are at seat 12
When you finish, rotate to seat 20

This means that if you are sitting at seat 12 (working on the rocker)once you finish you will move to seat 12 (working on the cam)

Section 2.1: Cam

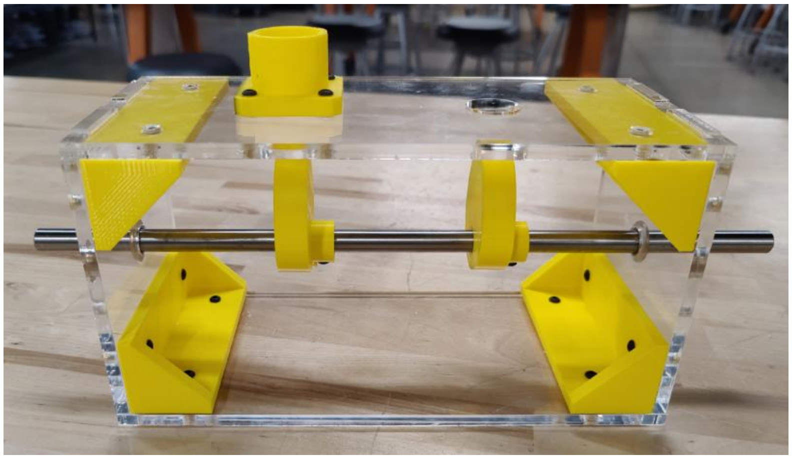
At this station, you will assemble a Cam/Follower mechanism.



Components:

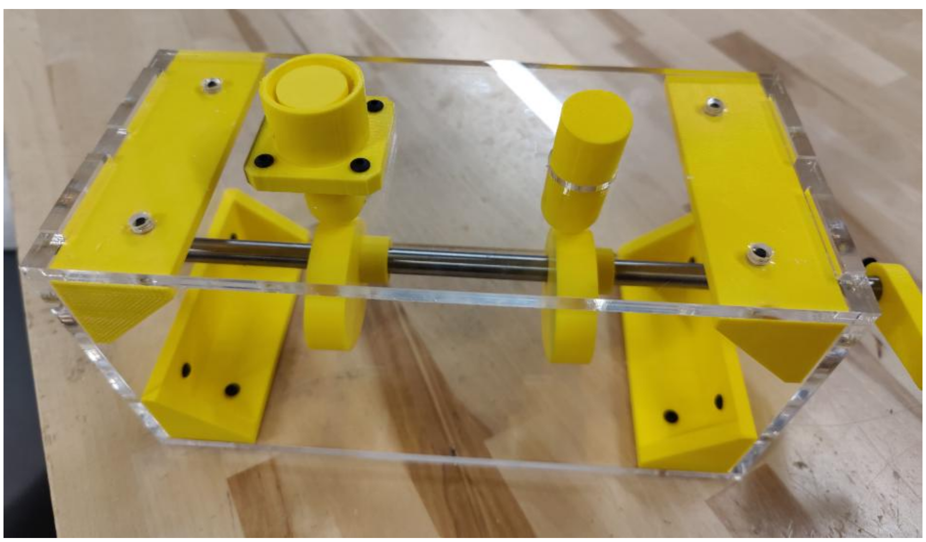
A. Box
B. Shaft
C. Crank handle
D. Cams (2)
E. Followers (2)
F. Shaft collars (2)

Step 1. Slide the shaft through one side of the box. Slide the two cams through the shaft from inside the box. Then, slide the shaft out the other end.



Step 2. Secure the shaft into place using the shaft collars. Then, attach the crank to one side, again gently tightening the screw on the D-Shaft.

Step 3. Slide the cams such that they lie directly below the openings at the top and fasten the set screws to the flat portion of the D-shaft to hold them in pace. Then, insert the followers through the openings at the top.



Step 4. Rotate the crank a few times. Answer the following question:

Do you notice anything different about how the two followers move and react to the cams?

Step 5. Take a look at the two follower slots.

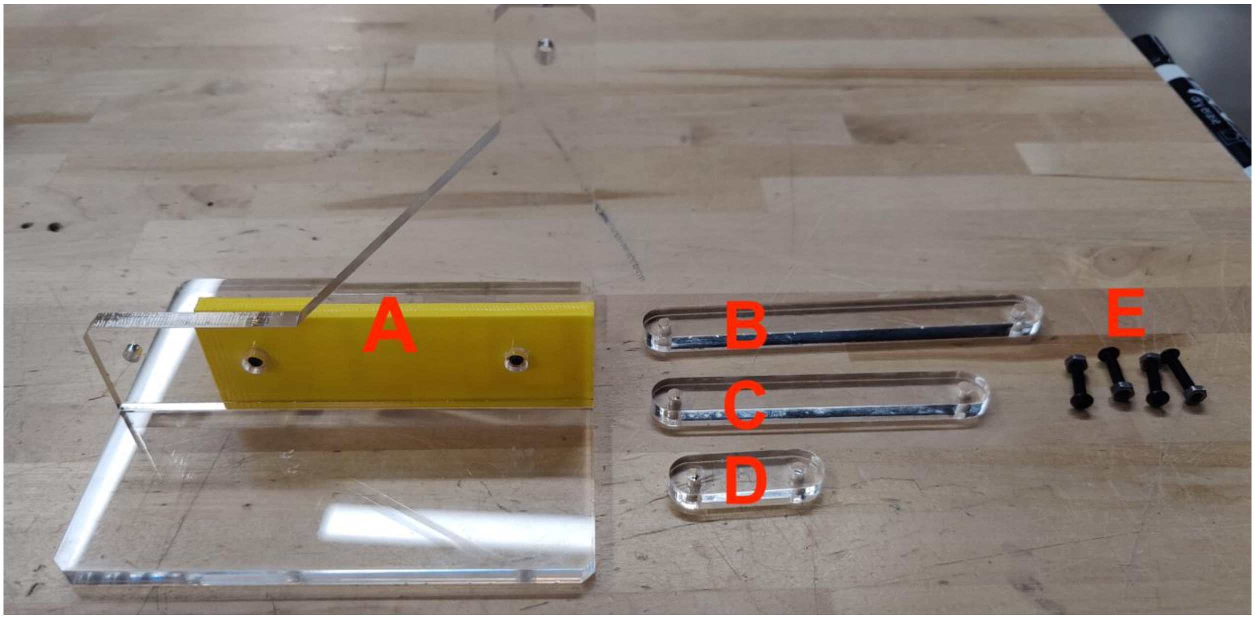
Do you notice any key differences?

How do you think such design choices may affect the operation?

Step 6. Disassemble the shaft to prepare it for the next group.

Section 2.2a: Crank Rocker

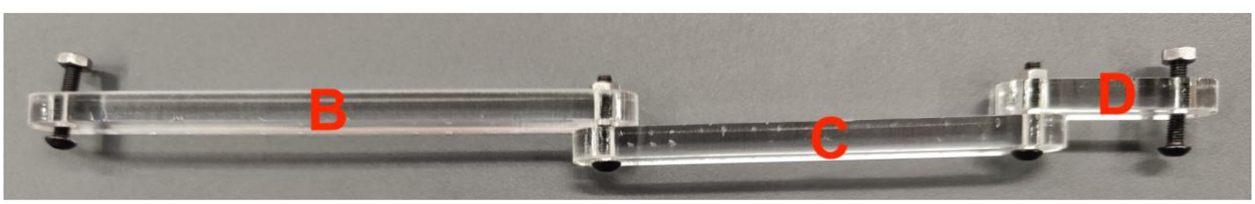
At this station, will assemble 2 different crank-rocker mechanisms. 2 people should follow the directions listed here in section 2.2a, while 2 people should follow the directions listed in section 2.2b



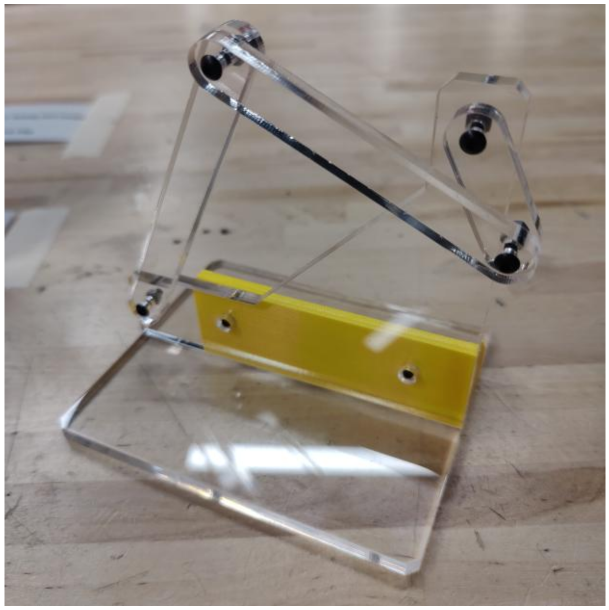
Components:

A: Stand
B: Long link
C: Medium link
D: Short link
E: Nuts (4) / Bolts (4)

Step 1. Assemble the linkage as shown:



Step 2. Mount the linkage to the stand as shown:



Step 3. Rotate the crank a few times.
Additionally, rotate the crank that was created in 2.2b a few times

How does each crank feel?

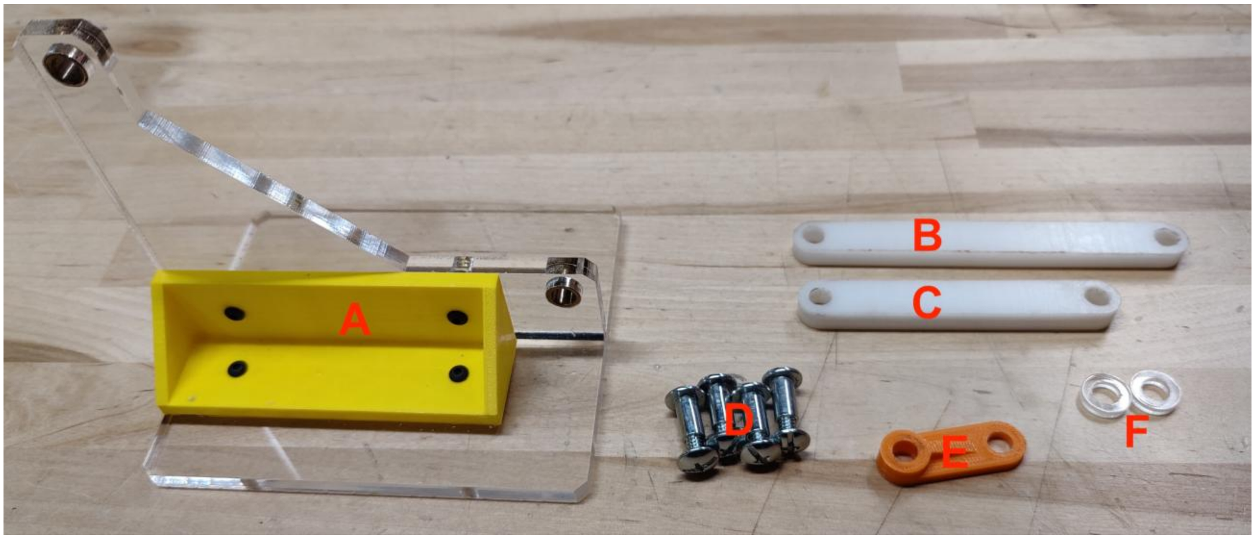
What are the primary differences between 2.2a and 2.2b?

How do these differences impact the performance of the crank?

Step 4: Disassemble everything for the next group

Section 2.2b: Crank Rocker

At this station, will assemble 2 different crank-rocker mechanisms. 2 people should follow the directions listed here in section 2.2b, while 2 people should follow the directions listed in section 2.2a.



Components:

A: Stand
B: Long link
C: Short link
D: Barrel fasteners (4)
E: Crank
F: Spacers (2)

Step 1. Assemble the linkage as shown:

Step 2. Mount the linkage to the stand as shown:

Step 3. Rotate the crank a few times.
Additionally, rotate the crank that was created in 2.2a a few times

How does each crank feel?

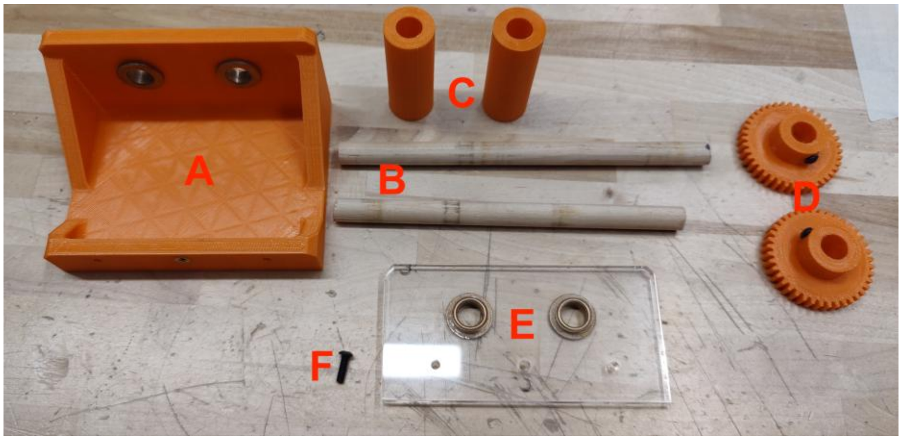
What are the primary differences between 2.2a and 2.2b?

How do these differences impact the performance of the crank?

Step 4: Disassemble everything for the next group

Section 2.3a: Gear Train

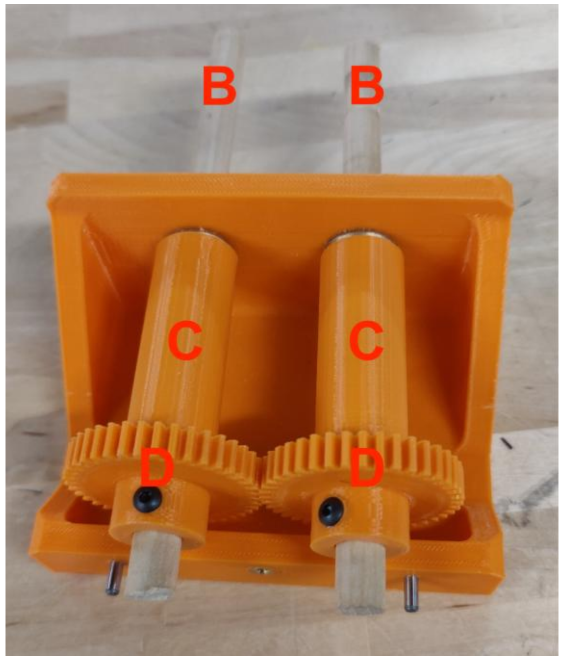
At this station, will assemble 2 different gear mechanisms. 2 people should follow the directions listed here in section 2.3a, while 2 people should follow the directions listed in section 2.3b.



Components:

A: Frame
B: Wooden dowels (2)
C: Spacers (2)
D: Gears (2)
E: Acrylic plate
F: Mounting screw

Step 1. Slide the two wooden dowels through the bushings (brass cylinder) on the orange frame. Then, on each shaft, insert a spacer, followed by a gear. Gently fasten the set screws on the gear pieces.



Step 2. Attach the acrylic plate (E) using the mounting screw (F).

Step 3. Rotate the shafts a few times.
Additionally, rotate the crank that was created in 2.3b a few times

How does each gear train feel?

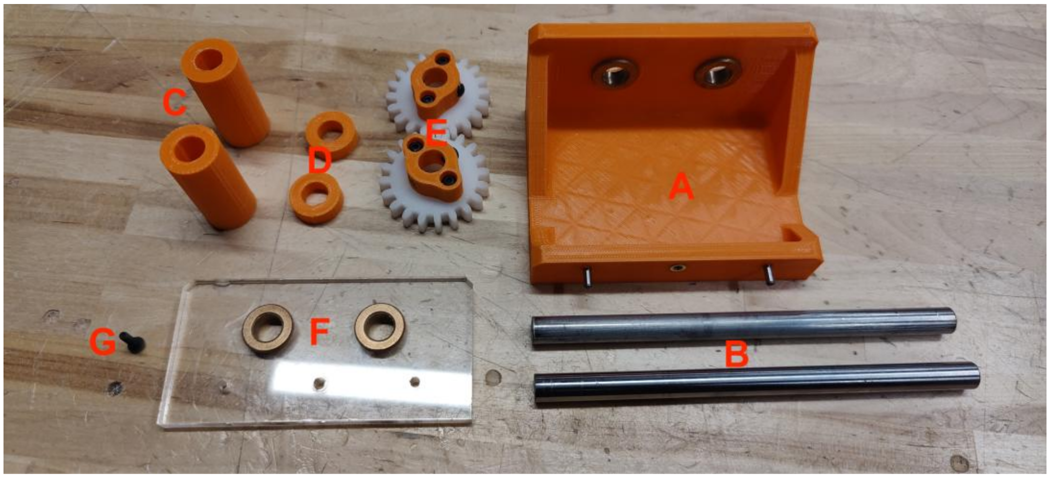
What are the primary differences between 2.3a and 2.3b?

How do these differences impact the performance of the gear train?

Step 4: Disassemble everything for the next group

Section 2.3b: Gear Train

At this station, will assemble 2 different gear mechanisms. 2 people should follow the directions listed here in section 2.3b, while 2 people should follow the directions listed in section 2.3a.

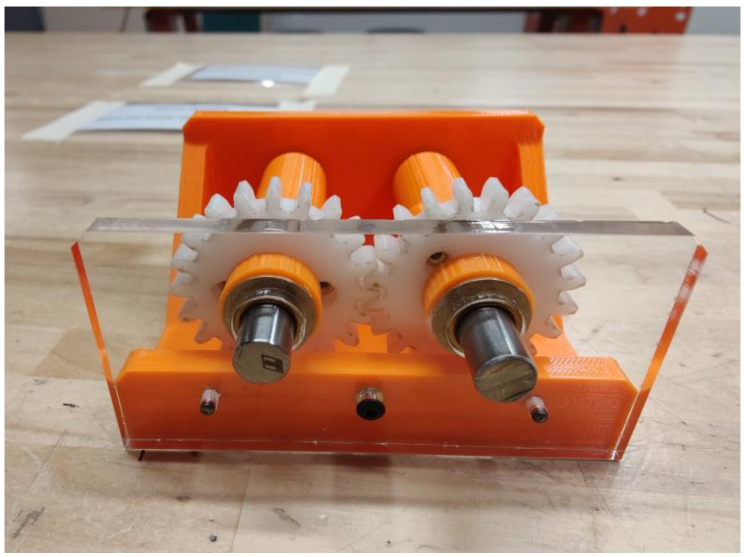


Components:

A: Frame
B: Axles (2)
C: Long spacers (2)
D: Short spacers (2)
E: Gears (2)
F: Acrylic plate
G: Mounting screw

Step 1. Slide the two axles through the bushings on the orange frame. Then, on each shaft, insert the long spacer, followed by the gear, followed by the short spacer. Fasten the set screws on the gear pieces.

Step 2. Attach the acrylic plate (F) using the mounting screw (G).



Step 3. Rotate the shafts a few times.
Additionally, rotate the crank that was created in 2.3b a few times

How does each gear train feel?

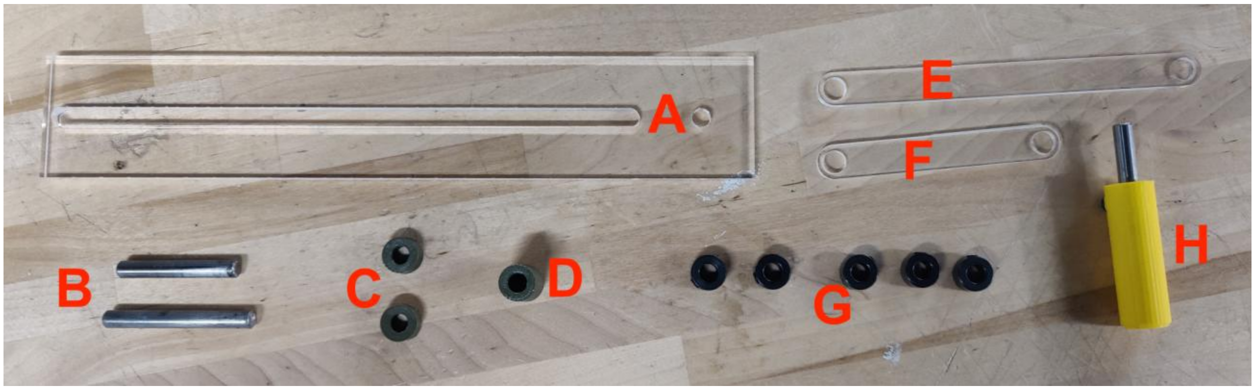
What are the primary differences between 2.3a and 2.3b?

How do these differences impact the performance of the gear train?

Step 4: Disassemble everything for the next group

Section 2.4a: Crank-Slider

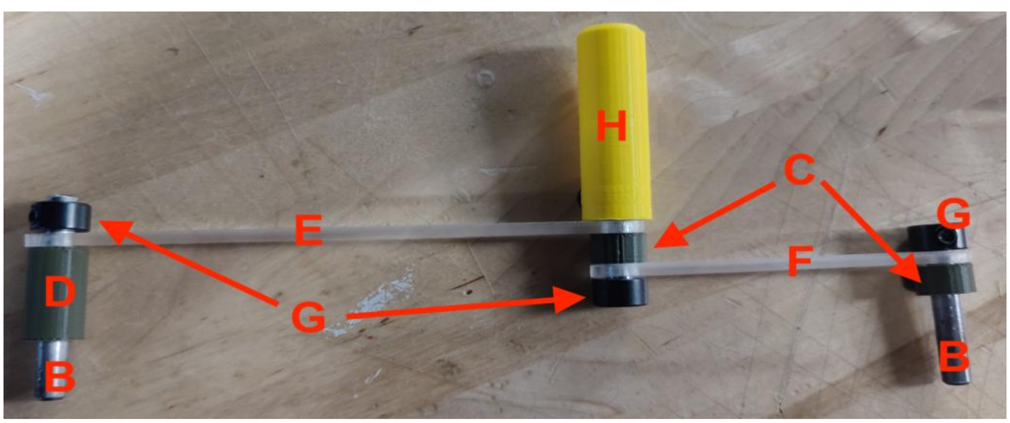
At this station, will assemble 2 different crank-slider mechanisms. 2 people should follow the directions listed here in section 2.4a, while 2 people should follow the directions listed in section 2.4b.



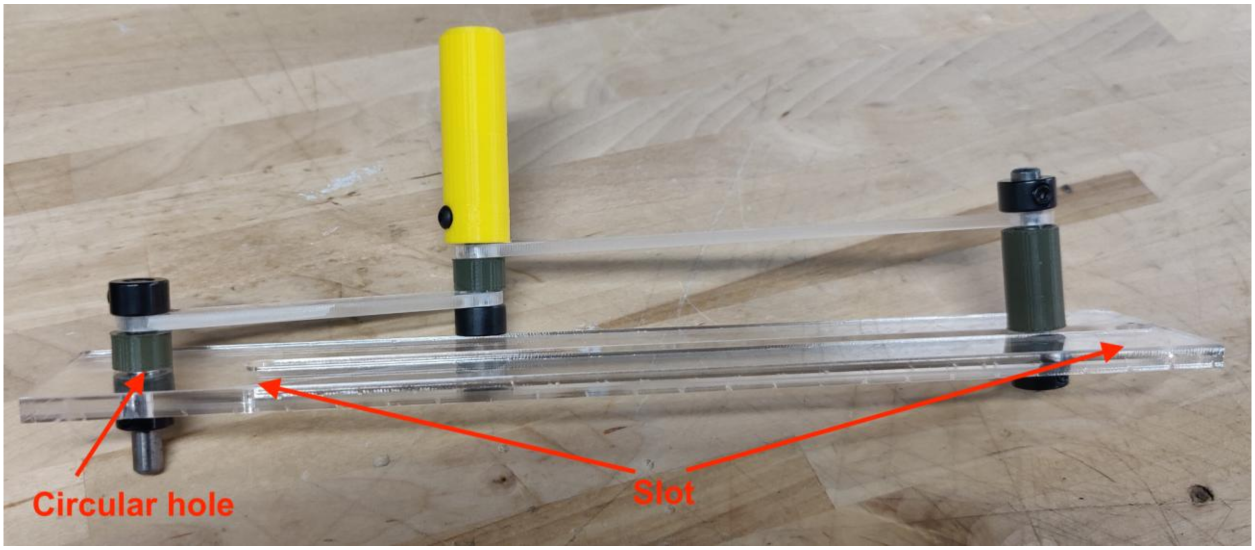
Components:

A: Frame
B: Axles (3)
C: Short spacers (2)
D: Long spacer
E: Short link
F: Long link
G: Shaft collars (5)
H: Crank handle

Step 1. Assemble the linkage as shown:



Step 2. Mount the linkage to the frame as shown.



Step 3. Rotate the crank a few times.
Additionally, rotate the crank that was created in 2.4b a few times

How does each gear slider feel?

What are the primary differences between 2.4a and 2.4b?

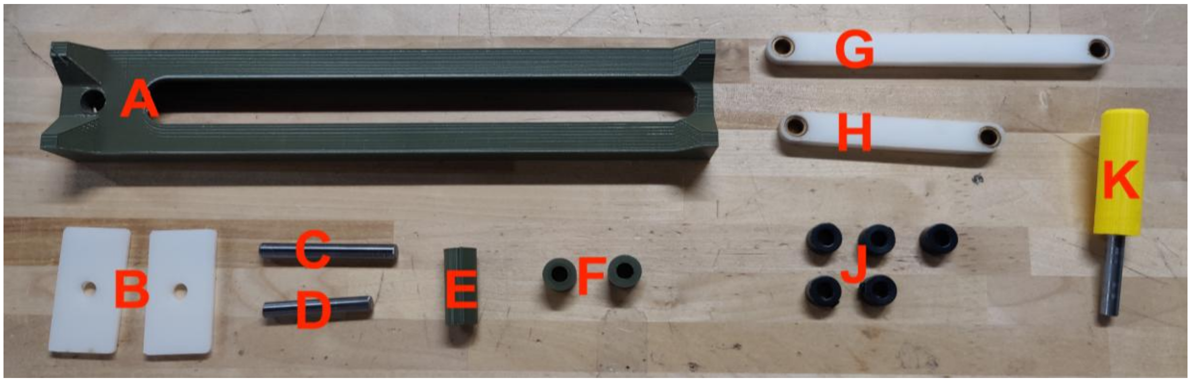
How do these differences impact the performance of the slider?

Delrin, the white plastic, is known for being a low friction material. What might this be useful for?

Step 4: Disassemble everything for the next group

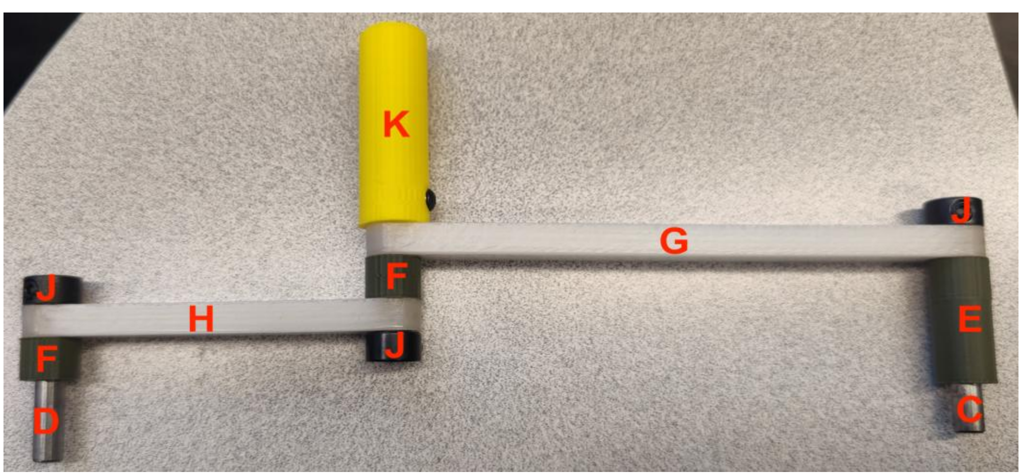
Section 2.4b: Crank-Slider

At this station, will assemble 2 different crank-slider mechanisms. 2 people should follow the directions listed here in section 2.4b, while 2 people should follow the directions listed in section 2.4a.



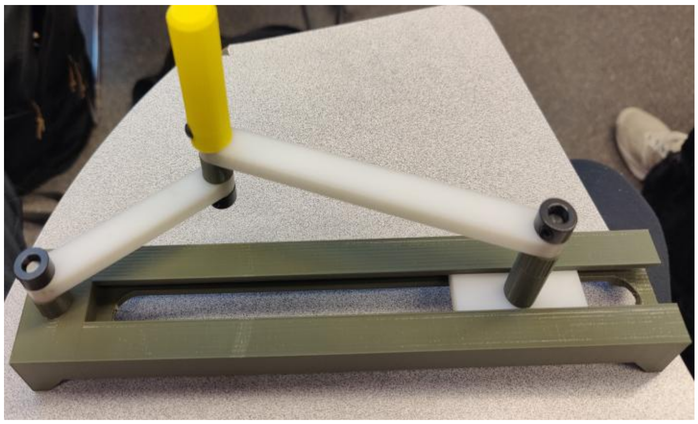
A: Frame
B: Slider Block (2)
C: Short Axle
D: Long Axle
E: Short spacers (2)
F: Long spacer
G: Long link
H: Short link
J: Shaft collars (5)
K: Crank handle

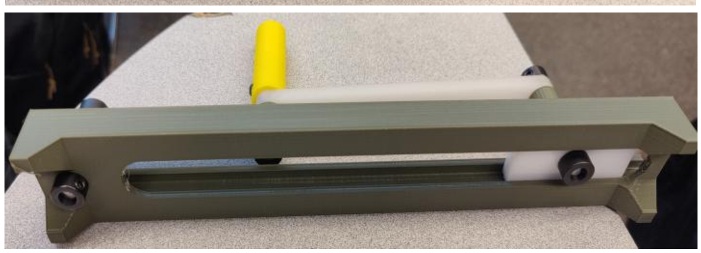
Step 1. Assemble the linkage as shown:



Step 2. Stack the two slider blocks and slide them into the frame as one piece.

Step 3. Mount the linkage to the frame as shown.





Step 3. Rotate the crank a few times.
Additionally, rotate the crank that was created in 2.4b a few times

How does each gear slider feel?

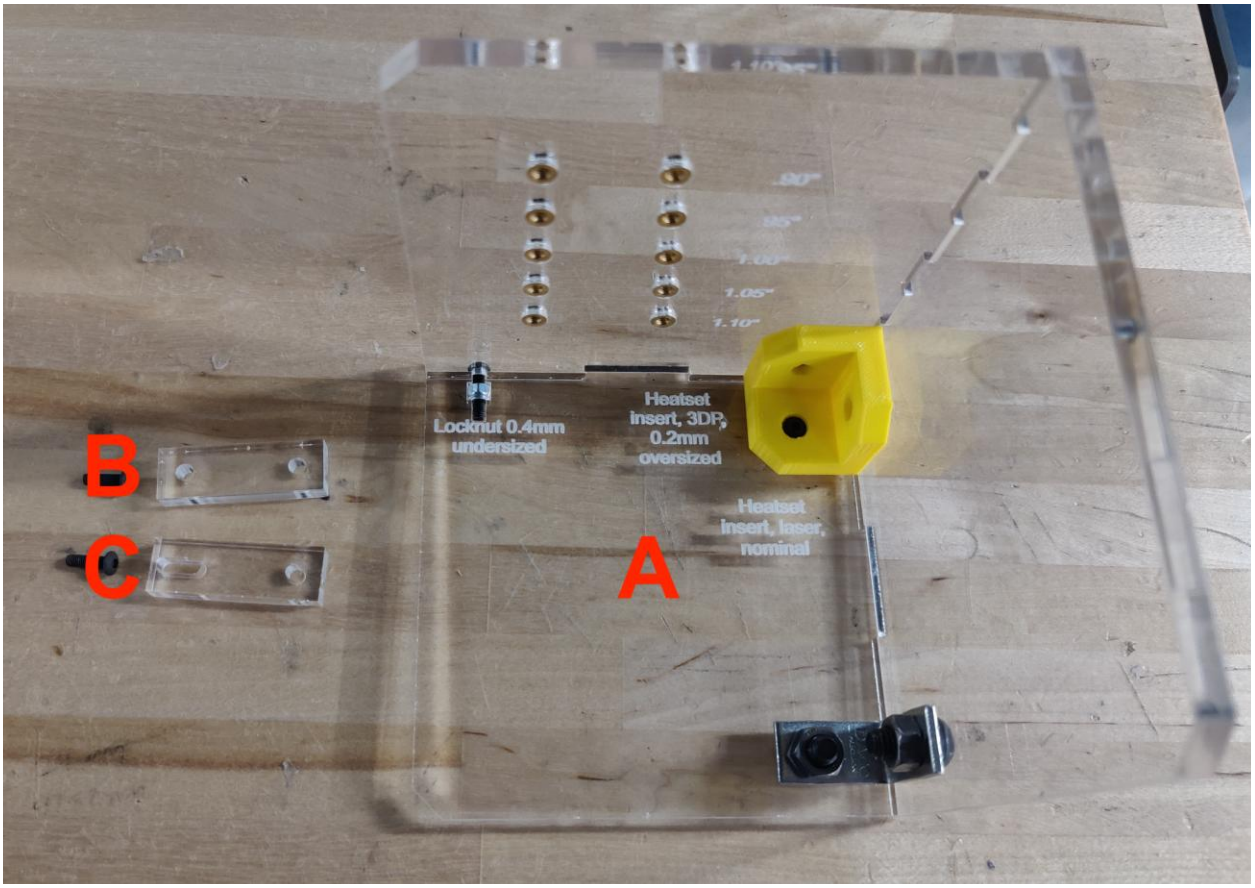
What are the primary differences between 2.4a and 2.4b?

How do these differences impact the performance of the slider?

Delrin, the white plastic, is known for being a low friction material. What might this be useful for?

Step 4: Disassemble everything for the next group

Section 2.5: Boxes and Joinery



Components:

A: Frame
B: Link with two circular holes
C: Link with one circular hole and a slot

Step 1: Locate the link with two holes (B). Find the appropriate set of threaded holes based on the distance between the two holes.

How many degrees of freedom are there in this system?

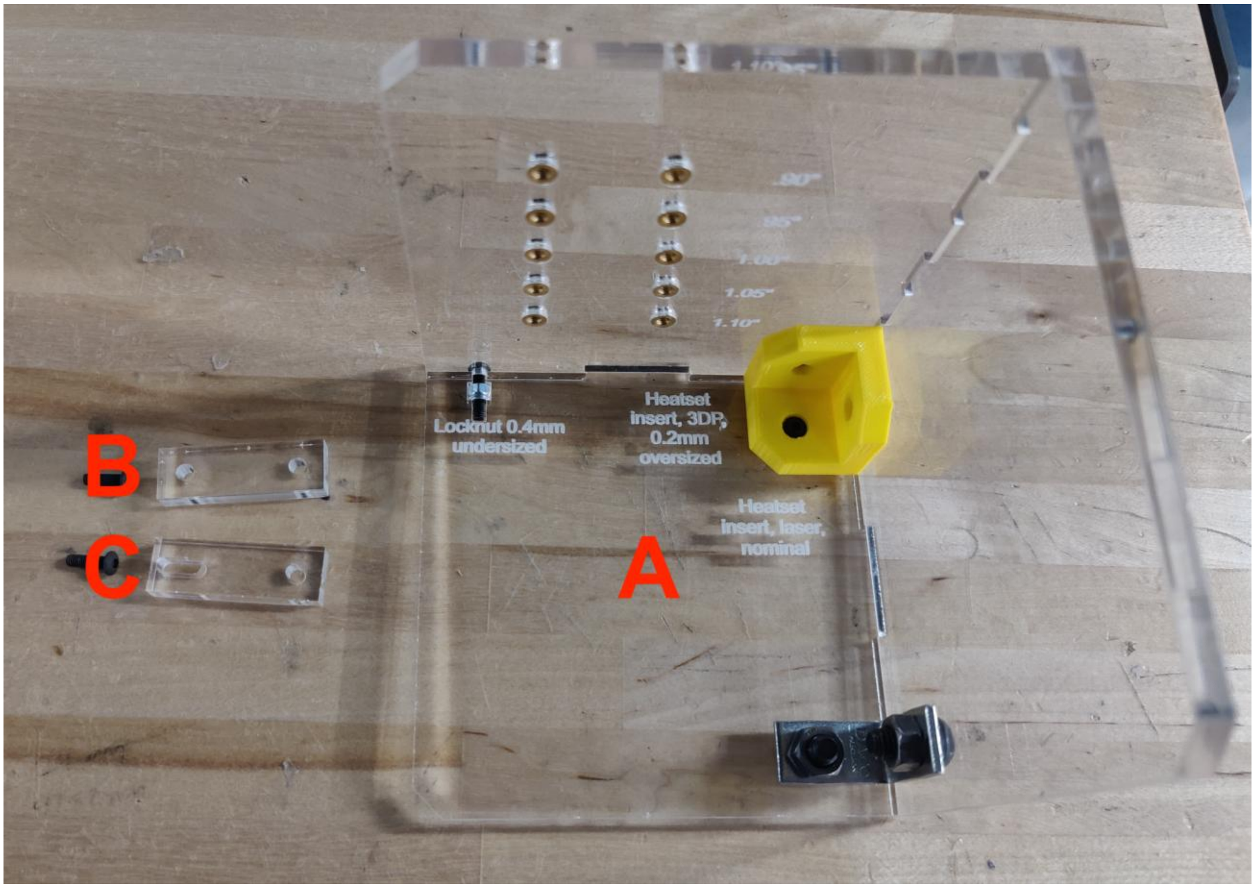
Step 2: Locate the link with a hole and a slot (C).

How many sets of holes can accommodate this link?

Does it wobble around or sit securely?

How many degrees of freedom does this system have?

In what scenarios might this type of fitting be useful?



Step 3: identify the different methods that the pieces of the box are jointed together

List an advantage and disadvantage for each method.

Step 4: remove (B) and (C) from (A)

Set of all postlab questions (For reference)

Section 1: Design tips presentation

Are there any themes that a lot of good designs have in common?

Section 2.1: Cam

Step 4.

Do you notice anything different about how the two followers move and react to the cams?

Step 5.

Do you notice any key differences?

How do you think such design choices may affect the operation?

Section 2.2: Crank Rocker

How does each crank feel?

What are the primary differences between 2.2a and 2.2b?

How do these differences impact the performance of the crank?

Section 2.3: Gear Train

How does each gear train feel?

What are the primary differences between 2.3a and 2.3b?

How do these differences impact the performance of the gear train?

Section 2.4: Crank-Slider

How does each gear slider feel?

What are the primary differences between 2.4a and 2.4b?

How do these differences impact the performance of the slider?

Delrin, the white plastic, is known for being a low friction material. What might this be useful for?

Section 2.5: Boxes and Joinery

Step 1:

How many degrees of freedom are there in this system?

Step 2:

How many sets of holes can accommodate this link?

Does it wobble around or sit securely?

How many degrees of freedom does this system have?

In what scenarios might this type of fitting be useful?

Step 3:

List an advantage and disadvantage for each method.