SOLIDWORKS

DESIGN PROJECTS

STUDENT GUIDE

3DEXPERIENCE



KINETIC SCULPTURE

DASSAULT SYSTEMES

DESCRIPTION

Welcome to the Design Projects Student Guide for Kinetic Sculptures! The focus of this project is to combine engineering skills and artistic vision to create a hand-cranked piece that comes to life with motion. These sculptures use cams and linkages to transform creative ideas into captivating kinetic designs.

This guide contains information regarding Design Intent, DFAM (Design for Additive Manufacturing) and Design Tips to keep in mind for each part.

You will use CAD to design each part, print the parts on a 3D printer and assemble them to complete the sculpture.

For a video demonstrating the design approach, detailed dimensions and step by step instructions, see the links in the **Additional Resources** section below.

PROJECT TASKS

Depending on the goals of the class, at a minimum students should be able to accomplish the following tasks.

- Model the following sculpture components in CAD:
    - Butterfly Wings
    - Butterfly Head and Tail
    - Flower
    - Stem Base
    - Cam
    - Link and Yoke
    - Pin, Stopper, and Axle
    - Crank
- Create a working, moving assembly of the sculpture in CAD.
- Print the physical components on a 3D printer.
- Assemble the sculpture.

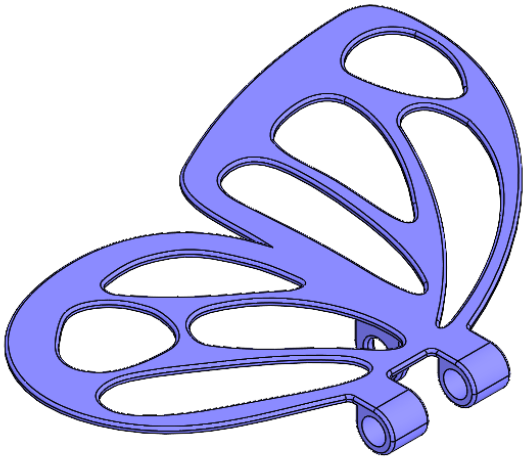
ADDITIONAL RESOURCES

LINK TO DOCUMENTS

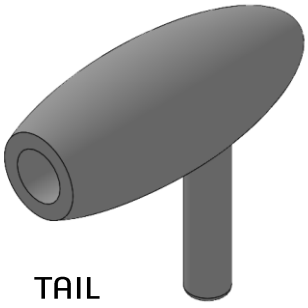
LINK TO YOUTUBE

LINK TO STEP-BY-STEP

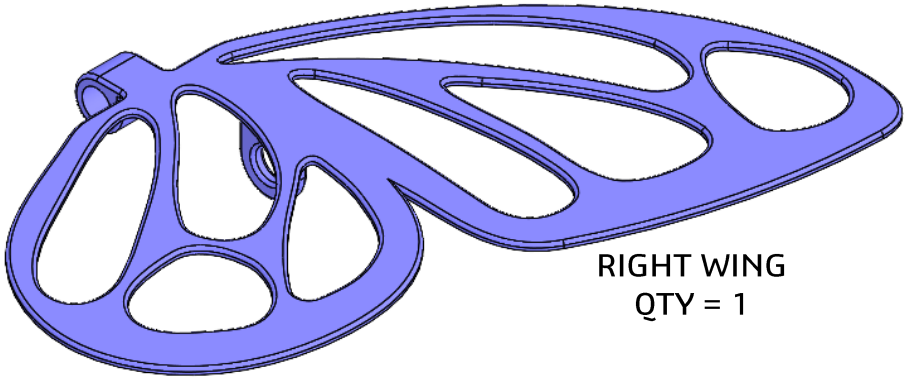
KINETIC SCULPTURE COMPONENTS



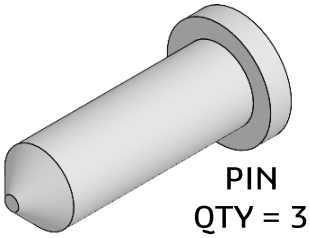
LEFT WING
QTY = 1



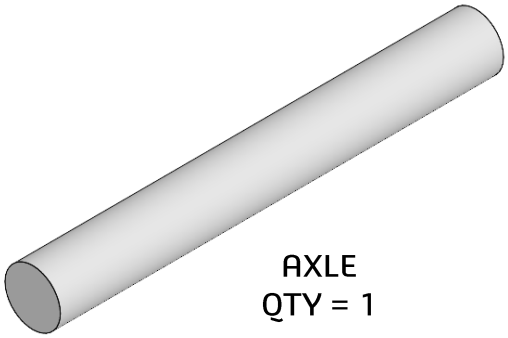
TAIL
QTY = 1



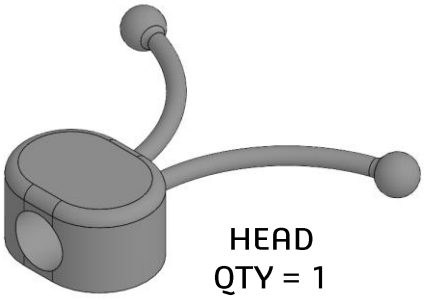
RIGHT WING
QTY = 1



PIN
QTY = 3

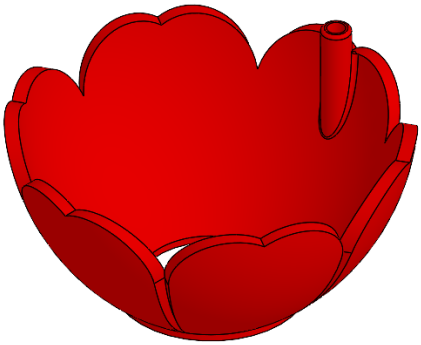


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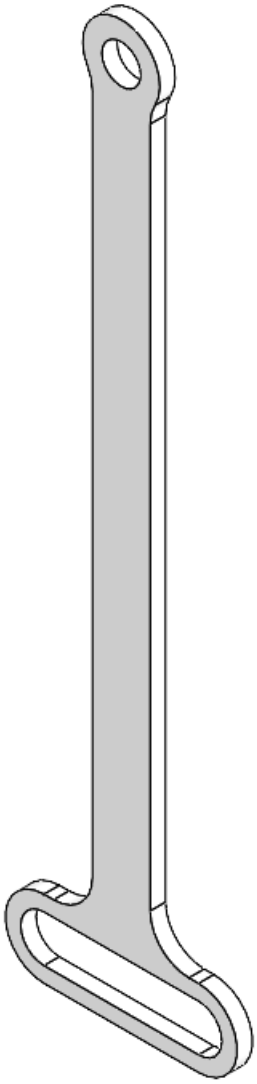


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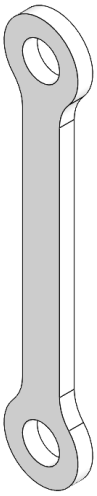
KINETIC SCULPTURE COMPONENTS



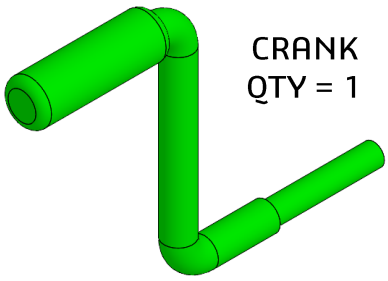
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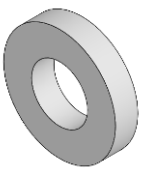
YOKE
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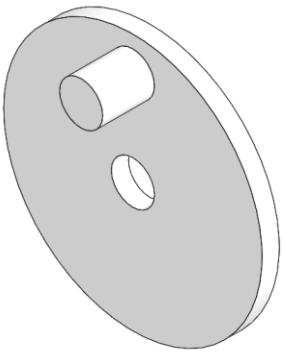
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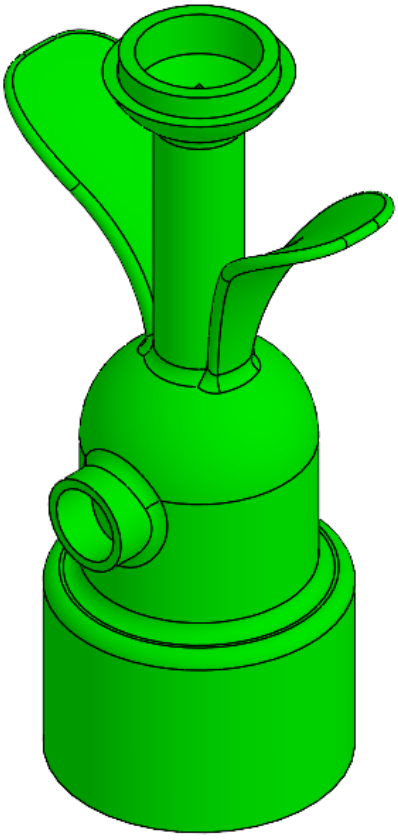
CRANK
QTY = 1



STOPPER
QTY = 5



CAM
QTY = 1



STEM
QTY = 1

RIGHT BUTTERFLY WING

DESIGN INTENT

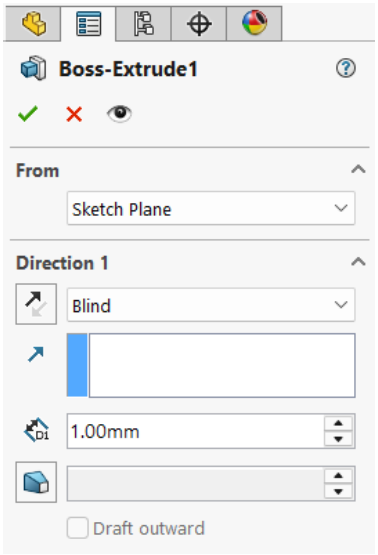
- The Right and Left Wing are symmetrical until the center connection is split.
- A link tab (small tab with hole) connects the Wing to a linkage.
- An Axle mount (cylindrical feature with hole) connects to the Axle allowing the wing to rotate.

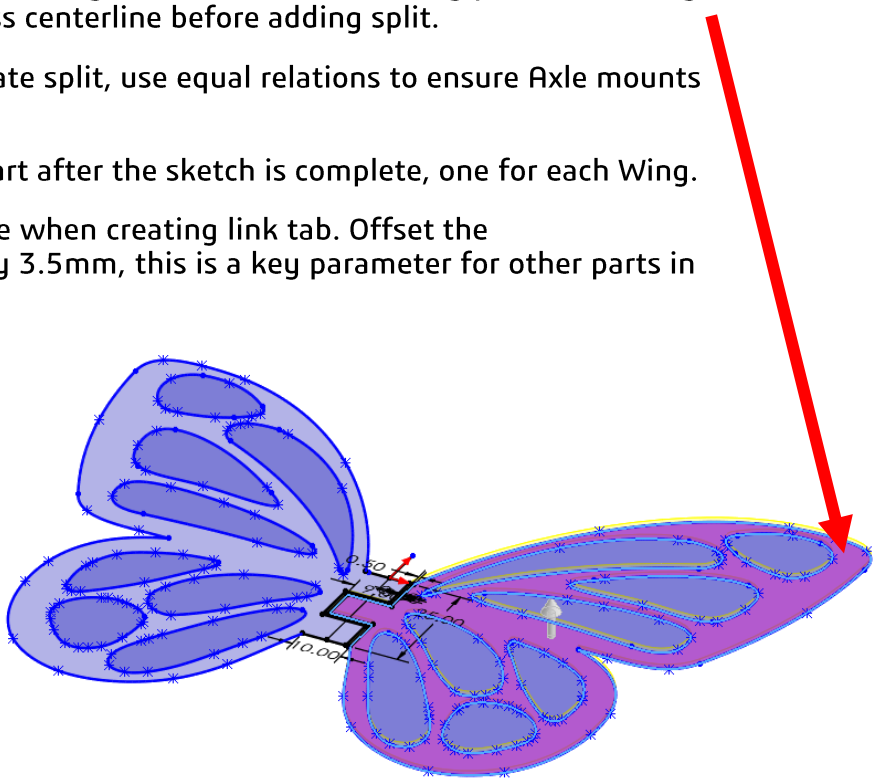
DFAM

- Minimal support is needed, link tab and Axle mount require small amounts due to their overhangs.
- Orient so that the top flat face is on the build plate. Can be nested to print several at one time with proper orientation.

DESIGN TIPS:

- Using the reference image as a guide, sketch half the wing profile including cutouts then mirror across centerline before adding split.
- Use offset entities to create split, use equal relations to ensure Axle mounts are same lengths.
- Save two copies of the part after the sketch is complete, one for each Wing.
- Sketch on the Front Plane when creating link tab. Offset the extrude start condition by 3.5mm, this is a key parameter for other parts in the design.





LEFT BUTTERFLY WING

DESIGN INTENT

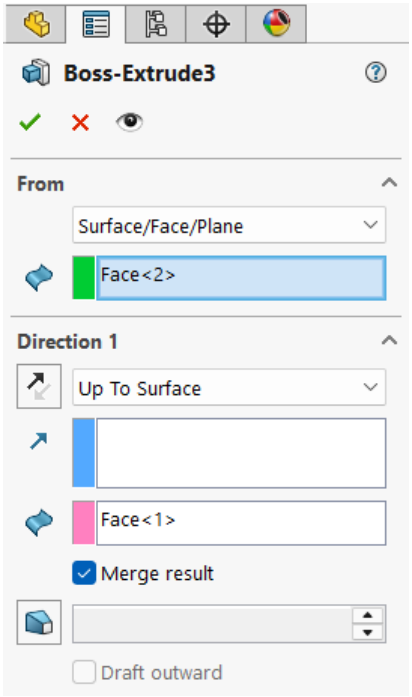
- The Left and Right Wings are symmetrical until the center connection is split.
- A link tab (small tab with hole) connects the Wing to a linkage.
- The Left Wing features two Axle mounts spaced to hold the Right Wing's single mount between them, allowing both Wings to rotate around a shared pivot.

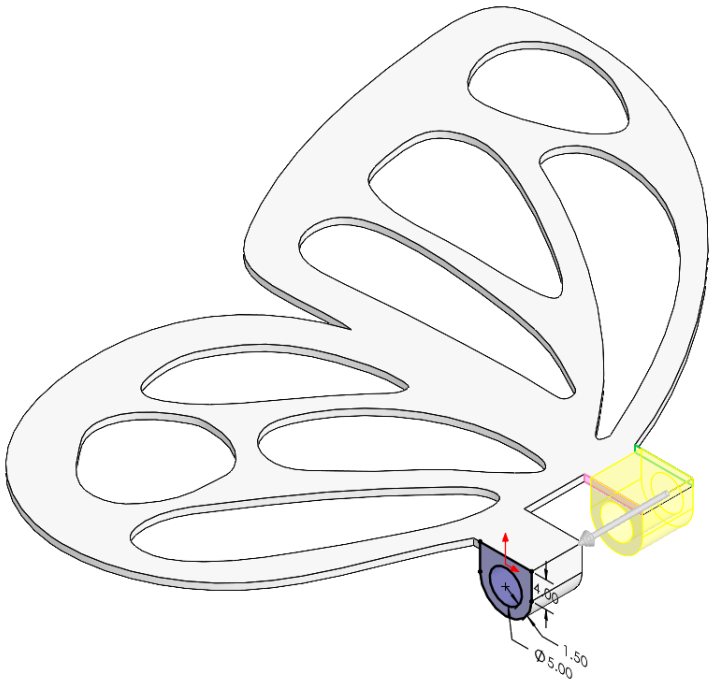
DFAM

- Minimal support is needed, link tab and Axle mount require small amounts due to their overhangs.
- Orient so that the top flat face is on the build plate. Can be nested to print several at one time with proper orientation.

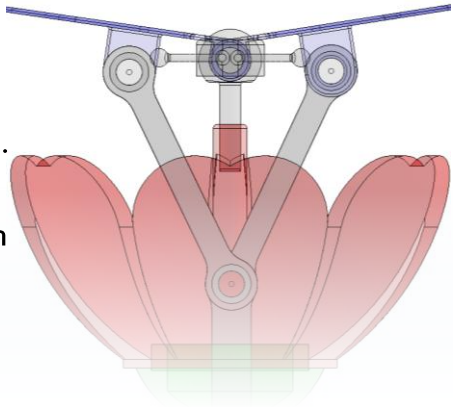
DESIGN TIPS:

- Re-use the same base sketch from the Right Wing for the Left Wing.
- Use two separate extrude features to create the Axle mounts.
- For the second axle mount, change the From condition to "Surface/Face/Place" and select one of the second tab's faces. Select the opposing tab face as the direction 1 end condition.





LINK



DESIGN INTENT

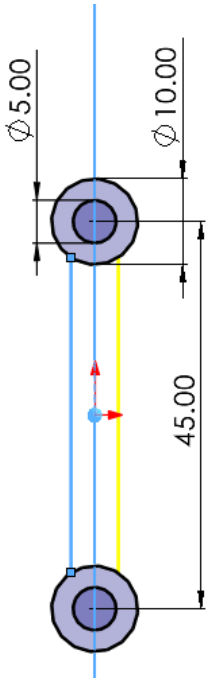
- Connects wings to yoke, allowing them to move up and down simultaneously when the yoke is actuated.
- Add enough length to push wings above horizontal position, while preventing contact with the flower on the downward motion.
- Keep thin to reduce weight of mechanism.

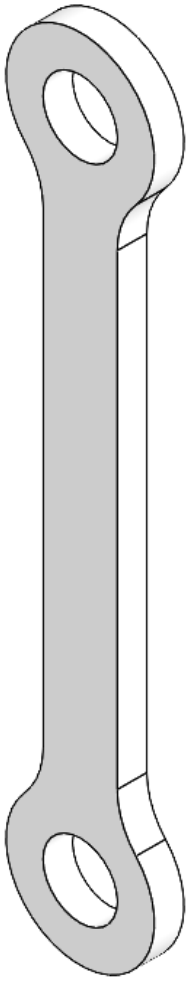
DFAM

- Uses flat-pack Design, no support materials necessary.
- Component can be nested to print several at one time.

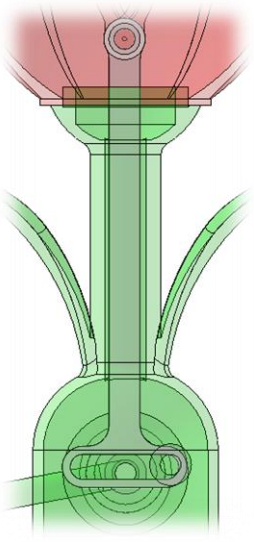
DESIGN TIPS:

- Dimension distance between center of holes to be 45mm, this is a key parameter for other parts in the design.
- Symmetrical about Top and Right Planes. Draw circles so their centers align vertically with origin, then mirror across Top Plane.





YOKE



DESIGN INTENT

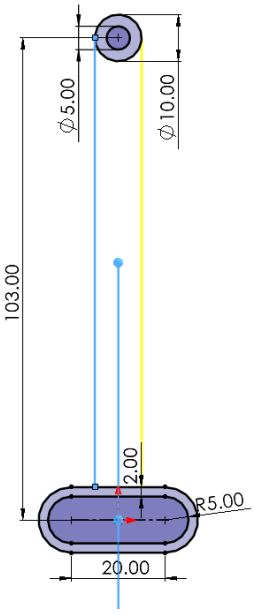
- Attaches two links to the driving mechanism.
- Slot allows the pin to slide along its length as it follows a circular path causing the entire yoke to slide up and down in a linear path.
- Keep thin to reduce weight of mechanism.

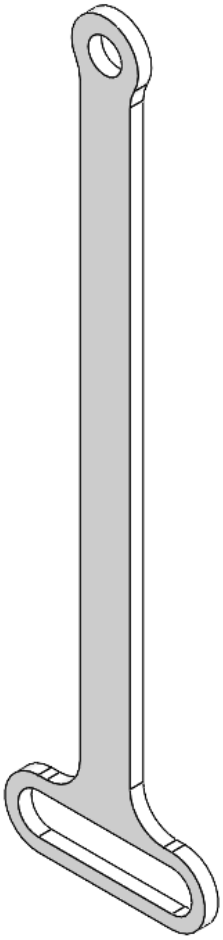
DFAM

- Uses Flat pack Design, no support materials necessary.
- Component can be nested to print several at one time.

DESIGN TIPS:

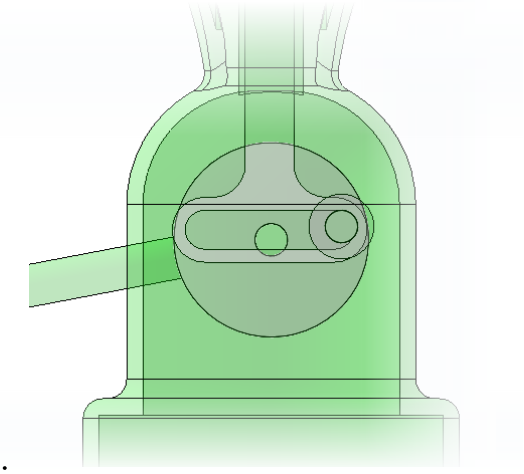
- Symmetrical across Right Plane. Draw centerline slots at origin, center circles vertically with origin. Mirror connecting lines across Right Plane.
- Dimension distance between the centers of the circle and slot to be 103mm. This is a key parameter for the other parts in the design.





CAM

DESIGN INTENT



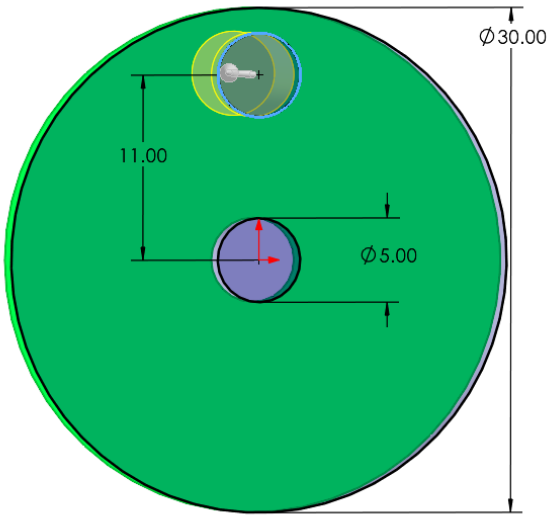
- Circular base with center hole for crank attachment.
- Offset pin rotates in a circular path, driving yoke's vertical motion.
- Keep thin to reduce weight of mechanism.
  Add fillets to reduce material.

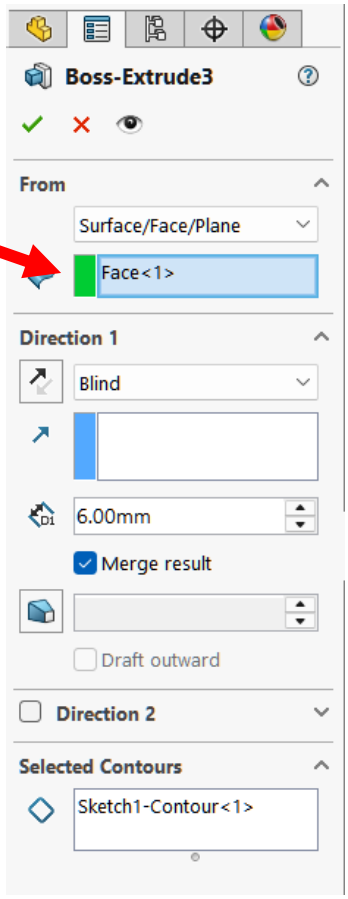
DFAM

- Component is not flat-pack due to its 3D geometry, but with proper orientation supports are not needed.
- Component can be nested to print several at one time.

DESIGN TIPS:

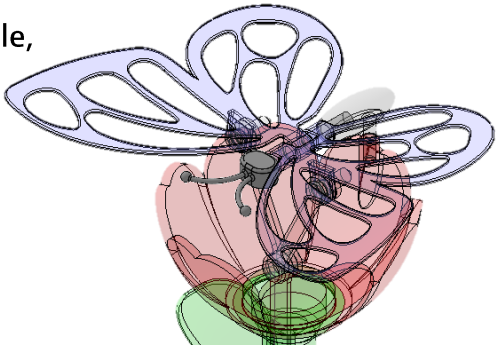
- Set second extrudes start condition to "From Surface/Face/Plane" and select the front face. This ensures pin is correct length and starts flush with base.





BUTTERFLY HEAD

DESIGN INTENT

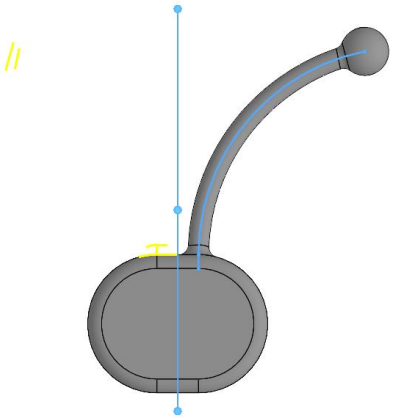


- Decorative and functional. Caps the end of the axle, meant to keep wings from slipping off when in motion.
- Sized not to interfere with wings when moving.
- Fillets to prevent snapping on thin small printed pieces.

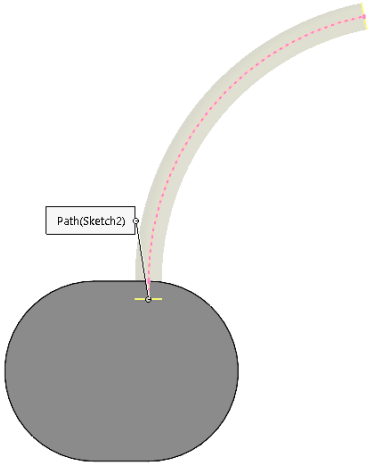
DFAM

- Minimal support material is needed, antennas and hole require small amounts due to their overhangs.
- Component is not flat-pack due to their 3D geometry, but can still be nested to print several at one time with proper orientation.

DESIGN TIPS:

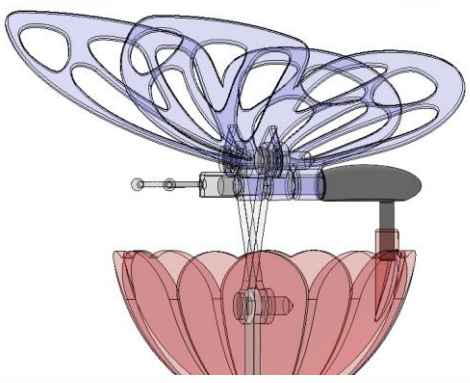


- Set the direction of the first extrude to midplane.
- After creating sweep path, use circular profile to complete sweep.
- Revolve half circle to create sphere on end.
- Mirror the sweep, revolve, and fillets to create second antenna on the opposite side.



BUTTERFLY TAIL

DESIGN INTENT

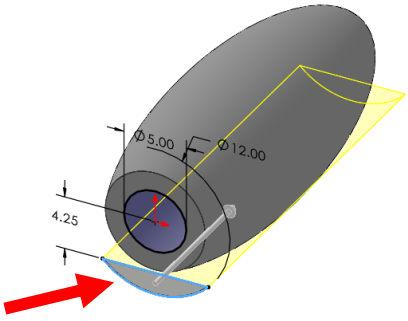


- Decorative and functional. Attaches to flower with mounting rod, secures Axle in position while wings are in motion.
- Fillets to prevent snapping on thin small printed pieces.

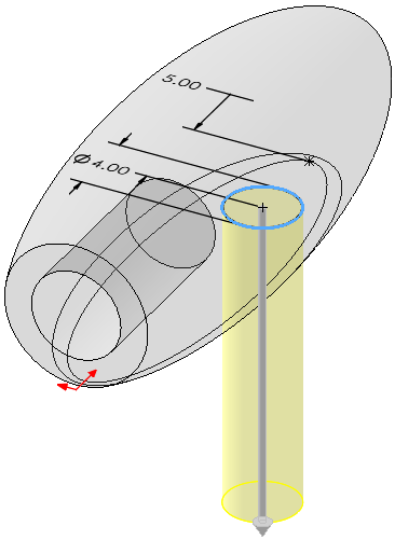
DFAM

- Minimal support material is needed, extended rod requires small amounts due to overhangs.
- Component is not flat-pack due to its 3D geometry, but can still be nested to print several at one time with proper orientation.

DESIGN TIPS:



- For extruded cut make diameter of arc the same as the widest part of the revolve.
- Add fillet to flat bottom before making profile for extended rod, use outer edge as reference.
- Extrude mounting rod by 17mm. This is a key parameter for other parts in the design.



FLOWER

DESIGN INTENT

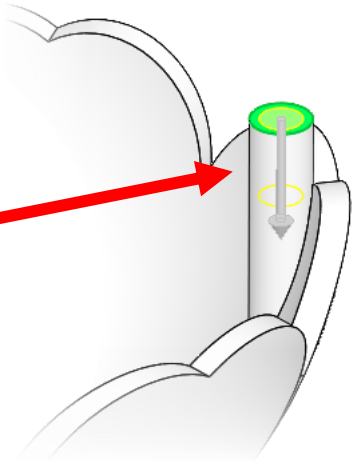
- Decorative and functional. Mounting post secures tail post to support wings at correct height.
- Petal shapes are designed to avoid interference with flapping wings.
- Press-fits securely onto the top of the stem base while allowing for easy removal and interchangeability.

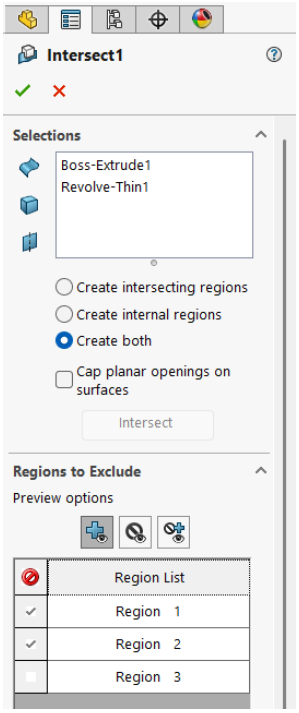
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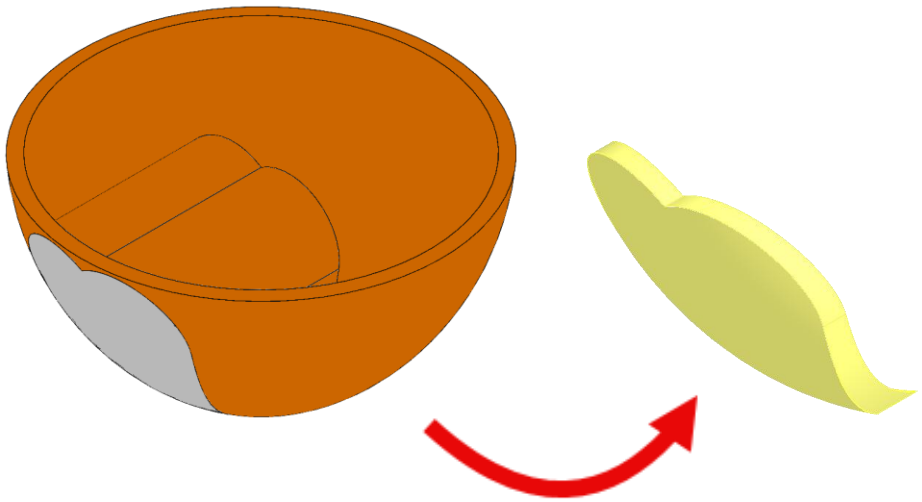
- Component is not flat-pack due to its 3D geometry, but curved faces are designed to not need any supports.

DESIGN TIPS:

- Create one petal using a revolve, extrude, and the intersect tool.
- Use extruded cut to create hole for the mounting sleeve, cut a distance of 9 mm. This is a key parameter for other parts in the design.
- Use the circular pattern tool to duplicate the petal.







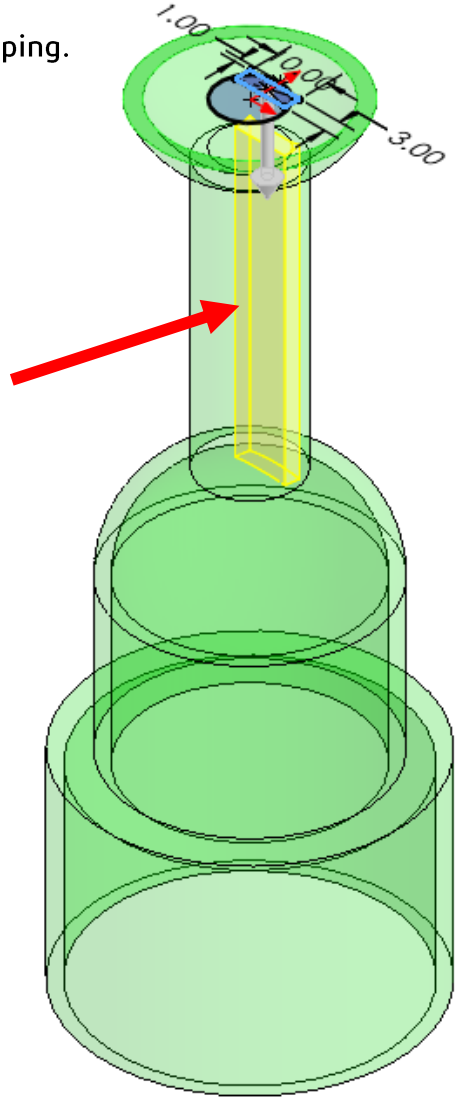
STEM

DESIGN INTENT

- Decorative and functional. Rectangular cut through body serves as a linear motion guide for the yoke, preventing rotation with the cam.
- Side mounted hole and shaft holder supports crank; extruded outward to stabilize its weight.
- Wide-base for stability when force is applied.
- Fillets added around leaves to reduce the risk of snapping.

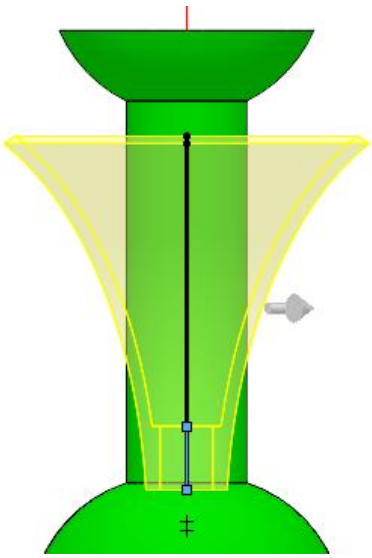
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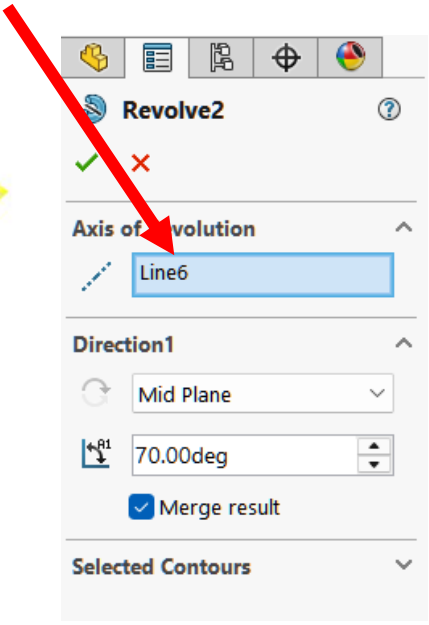
- Support material is needed, design features multiple overhangs. Use organic supports to minimize material usage and ease removal.



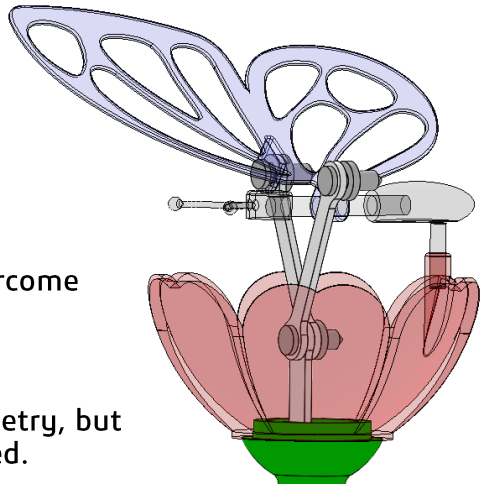
DESIGN TIPS:

- Use revolve to create the symmetrical main body from a single sketch.
- The rectangular cut is not centered on the base, positioned with intent for assembly
- Create leaves by revolving the contour 70 deg about the midplane.





PIN



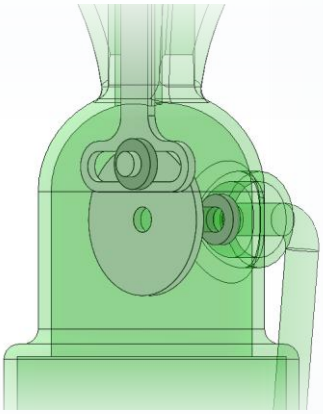
DESIGN INTENT

- Designed to securely connect wings to links, and links to yoke.
- Wide head stops pin from passing completely through holes.
- Chamfer makes assembly easier and helps overcome minor 3D printing defects or misalignments.

DFAM

- Component is not flat-pack due to its 3D geometry, but with proper orientation supports are not needed.
- Component can be nested to print several at one time.

STOPPER



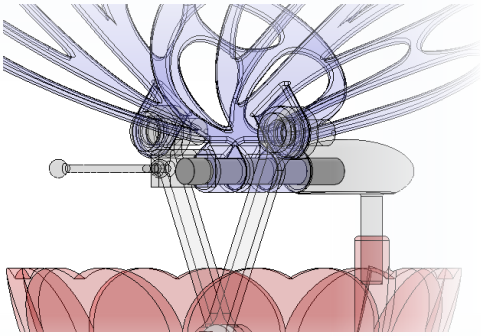
DESIGN INTENT

- Snap-fits onto pins to prevent slipping off during rotation.
- Used on crank, link pins, and cam pin.

DFAM

- Uses Flat pack Design, no support materials necessary.
- Component can be nested to print several at one time.

Axle



DESIGN INTENT

- Same diameter as the holes in the tail and the head.
- Long enough to hold together the tails, wings, and head.

DFAM

- No support materials necessary.
- Component can be nested to print several at one time.

CRANK

DESIGN INTENT

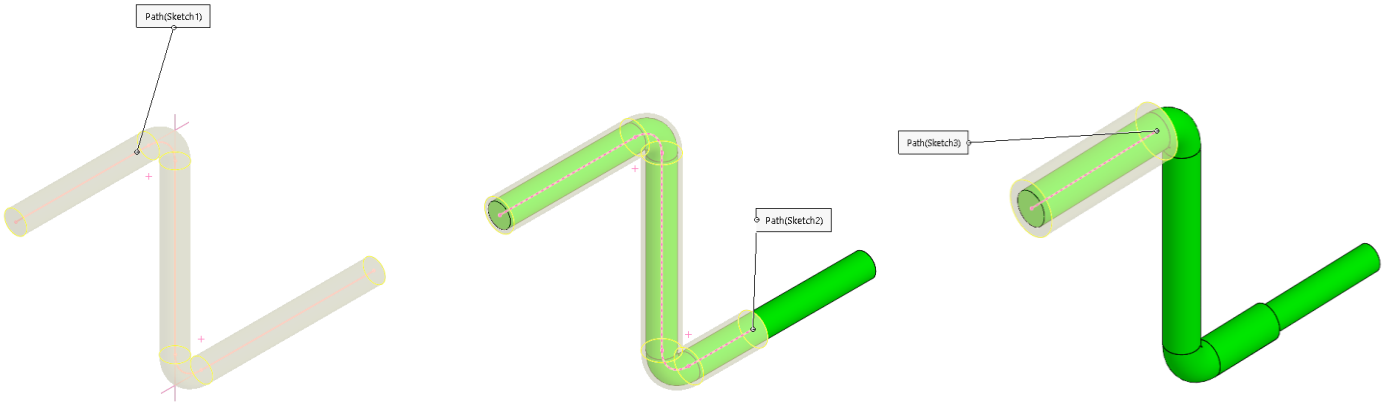
- Connects to cam and is manually rotated by the user to drive the mechanism.
- Crank shape increases torque and improves leverage for easier rotation.
- Snap-fits into cam, allowing them to rotate together.

DFAM

- Minimal support material is needed, small amounts required due to overhangs caused by rounded shape.
- Component is not flat-pack due to it's 3D geometry, but can still be nested to print several at one time with orientation adjustments.

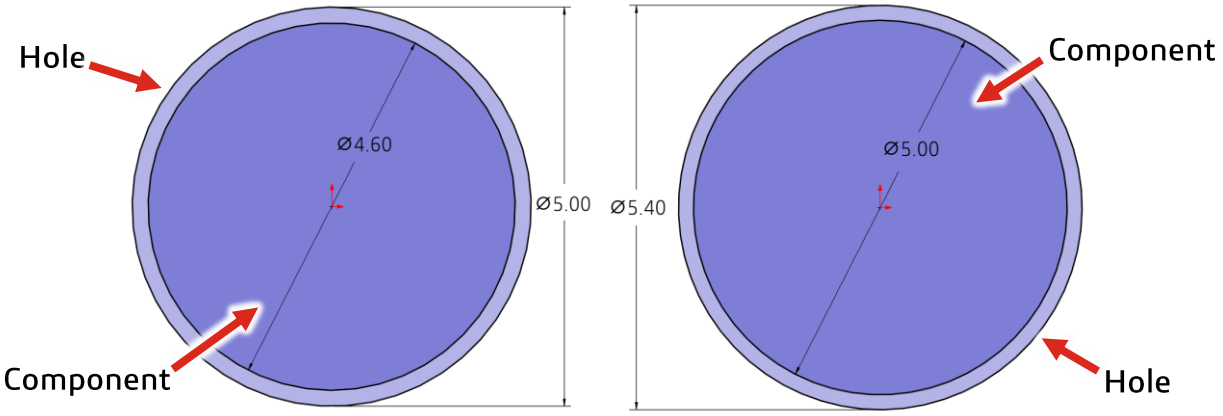
DESIGN TIPS:

- Create the crank using three sweep features. Use circular profiles of different diameters for the main body, handle, and connection point. Use the sketch of first path as a reference for the others.



3D PRINTING - TOLERANCING

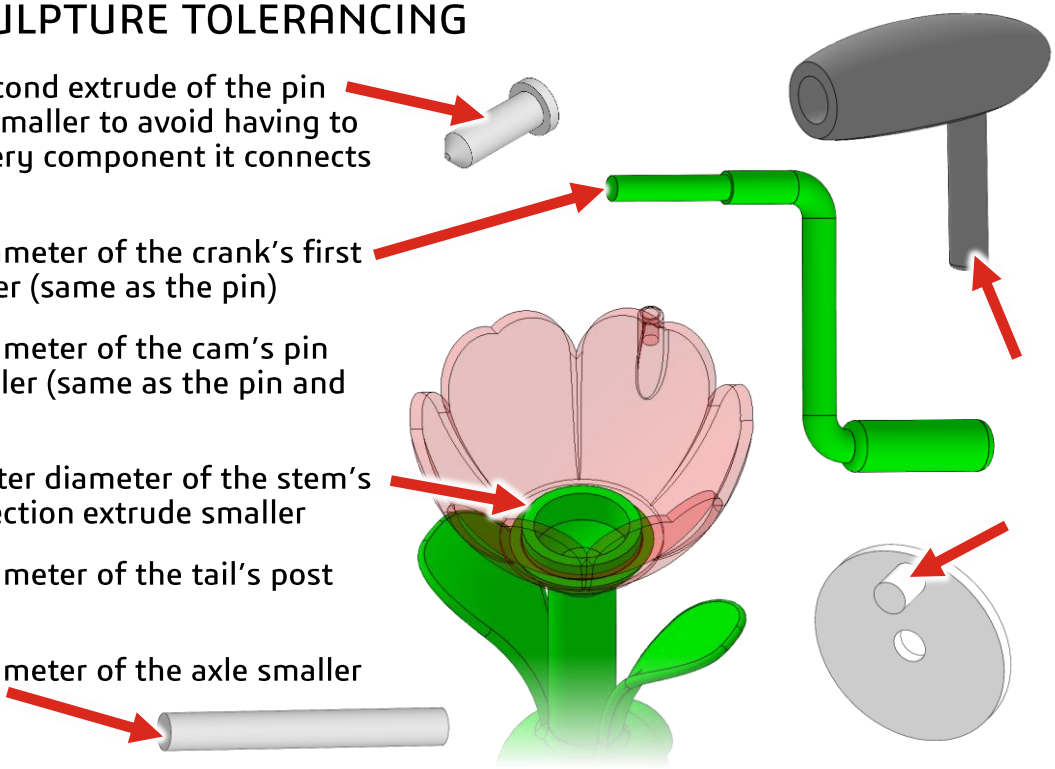
- Designs with perfect fits in CAD do not always fit together perfectly when 3D printing because every printer has a different resolution.
- Any component interacting with each other will likely need to be adjusted slightly – this process is called tolerancing.



*The numbers displayed are just for demonstration. Tolerancing required for every printer varies.

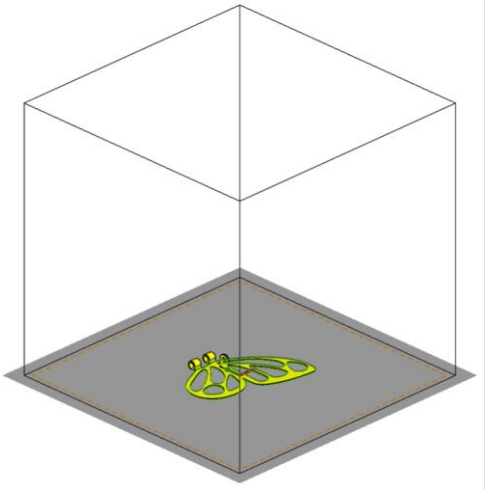
KINETIC SCULPTURE TOLERANCING

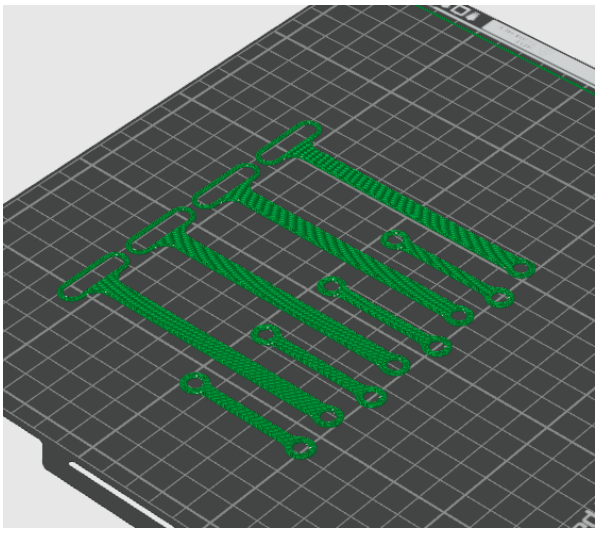
- Make the second extrude of the pin component smaller to avoid having to tolerance every component it connects to
- Make the diameter of the crank's first sweep smaller (same as the pin)
- Make the diameter of the cam's pin extrude smaller (same as the pin and crank)
- Make the outer diameter of the stem's flower connection extrude smaller
- Make the diameter of the tail's post smaller
- Make the diameter of the axle smaller



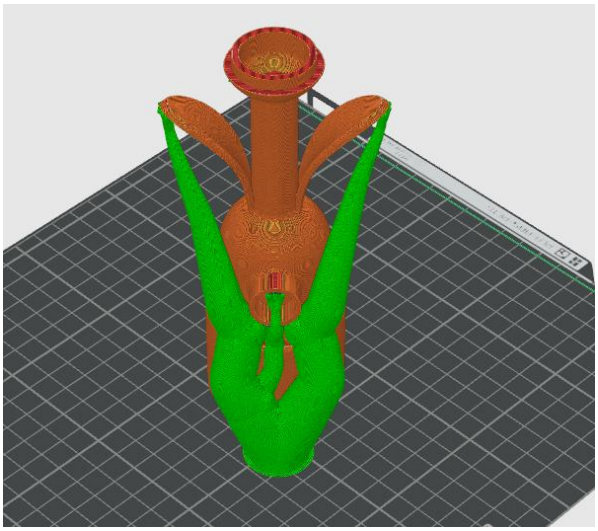
3D PRINTING

- Save your files as STL files.
- Nest your parts to print many at one time.
- Orient the parts to minimize the use of support material, (see images below).





NESTING



ORGANIC/TREE
SUPPORT STRUCTUTRES