

# SkillsUSA 2023 Additive Manufacturing State Challenge

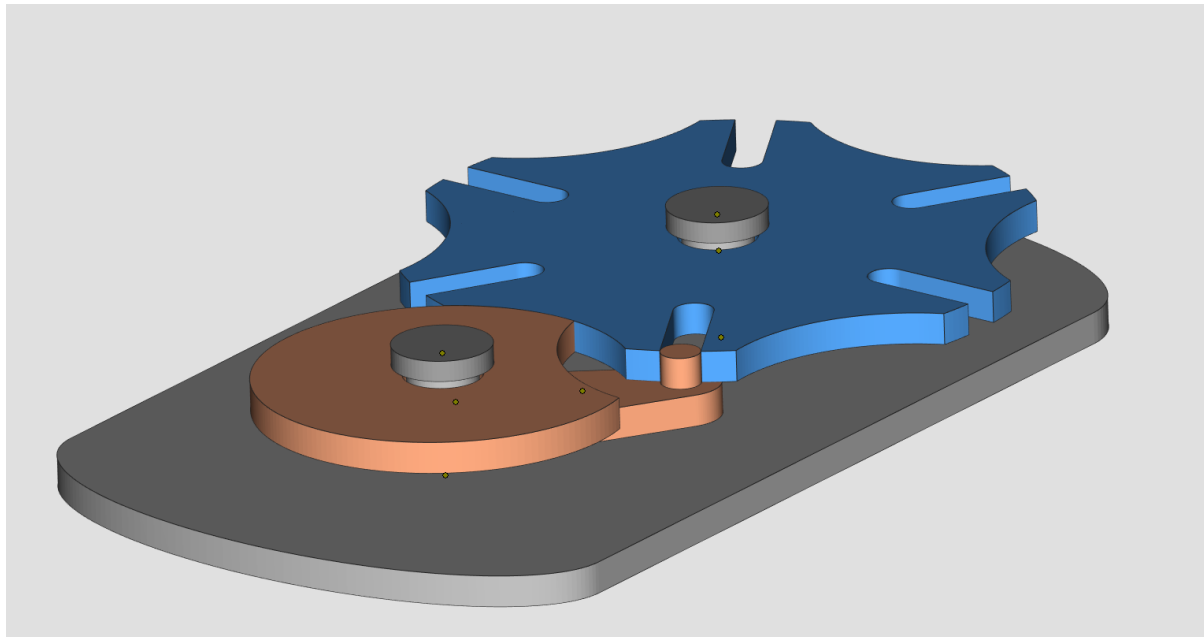
## Kinematic Assembly Models

Welcome to the “Kinematic Assembly Models” challenge!

The task at hand is to design a functional/movable assembly, also known as a gear system, or kinematic model.

Examples of this type of system are below, this should help get you started on an idea:

- Peristaltic Pump
- Geneva Gear
- Rack and Pinion
- Differential
- Planetary Gear
- Bearing



Example of a functional assembly for reference only

## **Competition Requirements**

1. The design **must** contain at least 3 individual bodies to be printed assembled or to be assembled after printing.
2. Printed parts **must** be able to mate and stay together during operation by design or additional hardware provided by contestant.
3. The design **must** contain at least two printed moving parts in the assembly.
4. One printed part's motion **must** be directly driven by another printed parts motion.
5. The printed parts **must** be able to mate together as an assembly, as designed, without major post-processing.
6. The design **must** be able to rotate/move as designed and should not have excessive backlash.
7. The design **can** contain up to 6 additional store-bought hardware to aid in the final assembly; If used, these shall be provided by the contestant and brought to judging.
8. 3D Printed Design - Students **must** create a design that:
  - Is original and designed by contestant
  - Prints all parts in less than **8** hours
  - Uses less than **5** cubic inches of model and/or support combined for all parts
9. Students **must** submit files to be printed via State designated file share site no later than 10:00AM on April 27. Final prints will be delivered the day of the contest so that students can test, assemble/modify and be evaluated.

## **Tips for Competitors**

Here are some tips to maximize the points awarded to you:

- Be sure to design using the correct tolerance between printed parts to allow motion of assembly.
- Be creative by incorporating an end-use for the design.
- Additional moving parts may add to your score but can produce more points of failure on the final assembly.
- Try to leverage design for 3D technology to reduce the amount of additional hardware needed for final assembly.

- Use online resources (YouTube, GrabCAD Tutorials, Cornell's Kinematic Models for Design)
- Whenever intellectual property (IP) deters you from a project, try using approximate geometries to communicate the design intent
- Solve a problem that impacts multiple people
- Optional design for additive manufacturing learning resources:
  - Stratasys Think Additively™ Masterclass:
    - <https://youtube.com/playlist?list=PLUYaY5EIPtNBdU-s-7I9rI05IBHHITarI>

### **State Competition Procedure**

Before contest day:

1. Teams submit print files in both CAD (.step, .iges, .sldprt, etc.) and mesh (STL, 3MF, OBJ, etc) format to [State Designated File Share Site]

On contest day:

2. Teams collaborate on redesign
3. Teams submit Engineering Notebook (Engineering notebook guidelines below)
4. Teams submit final assembly if applicable
5. Teams submit their Presentation

### **State Competition Judging Criteria**

1. The Engineering Notebook should contain robust content, including at a minimum the following:
  - 1.1. Be clearly labeled with contestant name(s), date and page # on each page
  - 1.2. Begin with a problem statement
  - 1.3. Include discovery and documentation of approach to solve problem
  - 1.4. Include sketched design concepts with critical features labeled
  - 1.5. Critical dimensions clearly labeled in design sketch
  - 1.6. Considerations for designing for additive manufacturing distinctly addressed (i.e. part strength, part orientation) especially including any expected risks during printing
  - 1.7. Screenshots of the print time and material usage for all printed parts
  - 1.8. Design decisions and alternatives are documented and evaluated thoughtfully
2. The design must adhere to the Competition Requirements stated in the prior page.

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3. Quality of final assembly
    - 3.1. Does it perform the function in the manner it was designed to do?
    - 3.2. Does it meet all requirements in contest guidelines?
    - 3.3. Do inserted components or multiple printed parts mate together properly?
    - 3.4. Did the students design the part with additive manufacturing in mind?
    - 3.5. Is there sufficient tolerance between parts for movement?
  
  4. The design must illustrate best practices for “design for additive manufacturing (DFAM)”. Below are some *potential* DFAM metrics to optimize for.
    - 4.1. Build Time
    - 4.2. Post-Processing/Support Removal Time
    - 4.3. Functionality Optimization (gear ratio, pliability, strength, etc.)
    - 4.4. Monetary Savings
    - 4.5. Material Consumption
    - 4.6. Energy Usage
    - 4.7. Component Consolidation (lack of store-bought hardware)
    - 4.8. Lightweighting for Ergonomics
  
  5. Presentation Criteria
    - 5.1. The team clearly describes their understanding of the problem to be solved.
    - 5.2. Design Process: good design logic is used for key design choices. Intentional and well-communicated
    - 5.3. The presentation is professional and well-rehearsed
    - 5.4. The presentation emphasizes quantitative improvements (measured and estimated) of the time, quality, or cost of the improvement as well as any DFAM tactics employed.
    - 5.5. Practical evaluation: team demonstrates visually (videos, photos, drawings, animation, etc) the task they improved, both before and after.