SkillsUSA 2024
District Additive Manufacturing Challenge

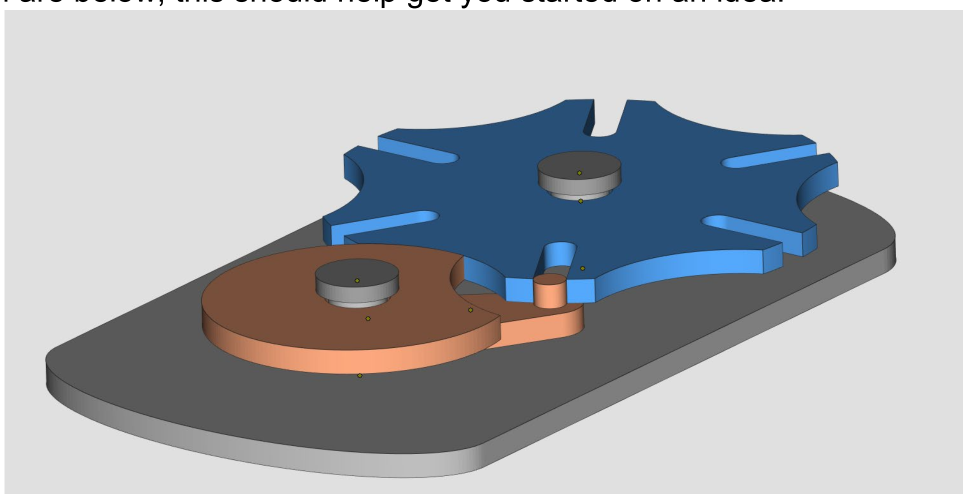
Kinematic Assembly Models

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 if 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 contestants.
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 part's 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** have final prints ready to deliver to judges 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-7I9rl05lBHHlTarl

District Competition Procedure

Before or on contest day:
1. Students submit Engineering Notebook (Engineering notebook guidelines below)
2. Students submit print files in both CAD (.step, .iges, .sldprt, etc.) and mesh (STL, 3MF, OBJ, etc) format on USB drive that may not be returned.
3. Students submit physical parts
4. Students submit final assembly if applicable
5. Students submit their Presentation

District 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.

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.