

MAE 1351 Introduction to Engineering Design
Dr. Raul Fernandez – Fall 2020

Final Design Project

UT Arlington Honor Code

By submitting this homework, I represent that I understand and am in full compliance with the academic integrity policy as explained in the course syllabus. This declaration applies to all team members.

This is a team project; all team members receive the same grade, and fair contribution and collaboration from all members is expected. Teams are not allowed, however, to work in collusion with other teams or copy their solutions.

This assignment permits the use and adaptation of information and reference designs available online, but you must properly credit your references, and there must be a non-trivial contribution by the team towards the solution offered.

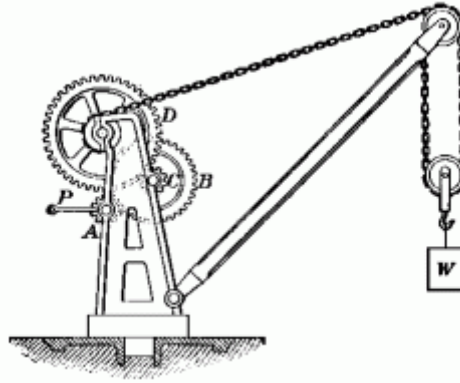
Further explanation regarding Honor Code statement: here's what's **NOT OK**—

1. **Copying:** this means essential content in your submission has been taken from someone else in this course, whether in this semester or in prior ones.
2. **Collusion:** this arises when two or more teams collaborate towards a single design, and then turn in essentially the same solution—with or without "whitewashing" (isolated changes to give the appearance of original work).
3. **Failing to credit your sources:** this means you are representing work as your own that isn't—whether explicitly or by failing to acknowledge its provenance. For example, if you downloaded a gear design "X," or if your solution is largely based on "Y," you must state what X and Y are, where they come from, and what non-trivial modifications you have contributed.
4. **Outsourcing fabrication:** this means you had third parties do substantial amounts of fabrication work (machining, assembly, etc.—beyond reasonable equipment guidance and support) for components that you then turn in and represent as having built yourselves.

THE ABOVE ARE HONOR CODE VIOLATIONS THAT CARRY SIGNIFICANT CONSEQUENCES.
IF IN DOUBT, ASK DR. FERNANDEZ.

MAE 1351 FALL 2020

FINAL DESIGN PROJECT



1. Project brief

Your team will design and document a mechanical device (“product,” or “assembly”) of your choice. The product may be self-standing, or it may be an addition or enhancement to an existing item, for example:

- a deployable camera housing (the product) carried in the underbelly of a skateboard or drone
- an auditory or visual signaling device (the product) that triggers upon contact with a bicycle wheel

The class will divide into teams, each of which will work on a product of their creation. Teams may be a single individual (“team of one”), or may comprise two, three or four individuals.

2. Minimum design requirements

2.1. Original content: the final product may contain any number of parts sourced from anywhere, except for TWO which must be the team’s original design. These two parts must be substantially different from each other, of non-trivial complexity, essential to the operation of the assembly, and:

- 2.1.1. conceived entirely from the ground up, or
- 2.1.2. reverse-engineered from an existing part (i.e., no 3D models or prints are available), or
- 2.1.3. a non-trivial modification of a COTS component for which 3D models or prints are available

2.2. Moving parts: at least one of the two original-design parts in 2.1 must experience motion relative to other assembly components during normal operation of the product.

2.3. Off-the-shelf components: the product must include at least one unmodified COTS component. It is acceptable to use or scavenge COTS components from hardware that is already available to you, but an actual part number from a commercial source for said component, to be assembled into your product as *supplied* (unmodified), must be documented.

3. Engineering data package

You must submit an engineering data package documenting your product per the items below. The submission is done through Canvas, where you are provided with placeholders to insert text, pictures and internet links that satisfy the requested content. Your submissions are expected to be professional in appearance and content.

3.1. Title page and introduction

- title of the project
- course name / number / professor / date
- bulleted list of all team members including full, proper first & last name, student ID, and section
- individual pictures of all team members with how they like to be called under each picture

3.2. Introduction (5% of grade)

- brief introductory paragraph describing the overall design and its main features
- credit to any reference designs you may have used, and how you have made them uniquely your own through non-trivial modifications.
- full datasheet & purchasing information for the COTS component you have utilized
- high-quality CAD rendering(s) of the parts or assembly, using PhotoView 360 or similar

3.3. Engineering analysis / simulation (50% of grade)

- at least one paragraph describing a simulation and how it informed a design decision; this would involve the use of SolidWorks Motion, or SolidWorks Simulation (e.g., structural, thermal, fluid).
- at least two screen captures of the above; examples: (a) for SolidWorks Motion, two frames showing how the device moves, (b) for SolidWorks Simulation, displacement and FOS plots. Screen captures must be of the *entire, maximized SolidWorks window, with the product geometry well centered in the screen and minimal dead space around it.*

3.4. Assembly drawing (5% of grade)

- at least one assembly drawing (exploded, layout or equivalent) associated BOM of your product; ref. Figures 18.20-22 in the textbook.

3.5. Engineering working drawings (40% of grade)

- 2D drawing or MBD packet for each of the two original-design parts
- Expectations:
 - “packet” to be interpreted as one or more screen captures depicting the sheet(s) associated with a 2D part drawing, or the view(s) associated with an MBD representation of said part
 - adherence to Y14.5 dimensioning standards; high complexity features (e.g., intersecting fillets and other organic or intricate shapes) may be left undimensioned
 - use of sectional / auxiliary / detailed views where appropriate
 - tolerancing: at least two GD&T callouts (control frames) per part; judicious use of decimal places in dimensions that default to block tolerancing
 - *You must upload your original SolidWorks part and assembly files as a single ZIP file using the “pack-and-go” feature.*

3.6 Extra requirement for teams with two or more people

- Under 3.3, you must additionally include two videos of your simulation—e.g., two views or closeups of the device in motion, or a video made from a progression of still frames showing displacement under different loads or FOS thresholds. You can obtain good results from free video editors like Microsoft Photos (a built-in Windows 10 app).
- Said videos must be edited to 10-15 seconds each. They need not be studio quality (no need for introduction, narration, subtitles, special effects, soundtrack, etc.), but they should be of enough quality to appreciate and judge your work. Footage that is shaky, out-of-focus, too light or too dark, off-center, idle, repetitive, needlessly long, irrelevant... in other words, difficult to watch and/or wasting the viewer's time, will endure grade penalties.
- You must upload your videos to Canvas Studio, where you can also edit them. Helpful tutorials: uploading media to Studio: <https://community.canvaslms.com/docs/DOC-9671-50736467901>; submitting Studio media: <https://community.canvaslms.com/docs/DOC-9659-50736656933>
- NOTE: hand-held smartphone video of the screen is specifically disallowed and will receive no credit. Use the SolidWorks-provided simulation video capture or similar video editing tools.

4. General Disclaimers

4.1. The above rules may be modified if necessary for clarification or if unforeseen circumstances arise. In such an event, students will be promptly notified through Canvas.

4.2. This narrative uses terms like “substantial,” “non-trivial,” “significant,” etc., for which there is a range of interpretation. This is to allow for creativity in your designs while providing a fair grading process—i.e., rejecting transparent attempts at getting by with little or no effort. In general, something is regarded as “trivial” if the geometry is so simple that it can be reproduced in, say, less than half hour by someone with the skills taught in this course. If in doubt about any of the rules or what is or isn't permissible, don't guess: simply bring the matter to the TA's or Dr. Fernandez's attention—he loves to talk about this stuff—but please! come prepared with pictures, sketches, concepts, web pages, a partial prototype, some initial mock-up made out of cardboard, whatever... specific and visual so that we can have an effective conversation.

4.3. Safety, reasonableness and intended use: although there is no prototype fabrication involved or required, Dr. Fernandez reserves the right to reject designs whose content can be perceived as untoward or offensive. Therefore, I both commit to answer any questions and reserve the right to disqualify submissions that, as professor of this course, feel do not serve its educational objectives.

4.4. Due to social distancing concerns this semester, there is no requirement to build a physical prototype. Though some might choose to build a prototype of their project—and Dr. F would love to hear about it—unfortunately no extra credit will be granted (this is done in order to remove any such incentives). There are a few references to physical prototyping in this document; these have been left only for context and should otherwise be disregarded.

5. Team structure & scoring

5.1. Students may work in teams of one, two, three or four individuals. All team members are expected to contribute fairly in a spirit of cooperation and professionalism, and all students in the team receive the same grade. Team members can be from different sections of the course. The team will choose a single individual responsible for submitting the proposal and final report in Canvas on behalf of all members (even across multiple sections); we will credit every team member identified in the submission.

5.2. Grades will be assigned reflecting the following considerations, presented in order of importance:

5.2.1. Failure to meet the minimum requirements outlined in section 2 will result in the heaviest penalties; this said, getting a good grade requires proper design documentation (section 4).

5.2.2. We will carefully assess the design complexity and quality of the required original-content components (2.1); this is where you should concentrate your design efforts. Team size will be considered in grading—more is expected of larger teams.

5.2.3. We will reward creative applications of your mechanisms over simple instantiations of well-known designs (geneva wheels, spur gear sets, four-bar linkages, IC engines, etc.)

5.2.4. We will credit artistic effects to the extent they are connected to CAD effort.

Project ideas

You are free to design something you're passionate about, that catches your attention, or that could be useful in your own life. The product need not have practical use, however—it could be decorative or entertaining. Instead of an actual functioning device, demonstration mock-ups or look-alikes (e.g., a single-cylinder engine) are acceptable so long as they comply with the foregoing rubric. If you are not sure what to do, consider the ideas below, or google "simple mechanisms."

If you choose a mechanism that doesn't seem to have enough parts to meet the minimum original-content requirements of 2.1, think of a way of augmenting its capability so that it would need some additional parts of reasonable design complexity.

Beyond the requirements in 2.1, be careful not to make your project too expensive or complicated (unless you absolutely want to). Be careful with large parts which will take a long time to print or may need to be glued; consider scaled-down models.

- Geartrain or transmission
- Internal combustion engine
- Geneva wheel or other cam-driven mechanism
- Four-bar linkage (e.g., pantograph)
- Catapult (light load! please refer to 4.3)
- Remote-controlled or autonomous vehicle
- Hand or electric mixer, governor, pump, motor, etc.

