UNIVERSITY of GUELPH

School of Engineering
ENGG*2100
Reverse Engineering Project – Winter 2021

Instructor: Dr. J. Runciman
Submission Method: Courselink Dropbox
Total Course Weight: 18% of final grade
Late Penalties and Grading Policies: See course outline
Deliverables:

- Note: Each deliverable is due during the week indicated below, at 11:59 PM (Eastern Time) on your **second** scheduled lab day (Thursday for Sections 01 & 04, Friday for Sections 02 & 03)

Item	Due Date *(unless otherwise posted on CourseLink)*	Course Weight (% of final grade)
Group Formation	**Week 1** (week of January 11, 2021)	1%
Part A – Machine Selection • 1 submission per group • See page 2	**Week 3** (week of January 25, 2021)	1%
Part B – Engineering Drawings • 1 submission per individual • See page 3	**Week 6** (week of February 22, 2021)	2%
Part C – Assembly and Animation • 1 submission per group • See page 4	**Week 7** (week of March 1, 2021)	13%
Peer Evaluation	**Week 7** (week of March 1, 2021)	1%

Project Overview: You must work as a team to reverse engineer a complex machine. Specifically, you will create a virtual 3D CAD model of each component of your chosen machine, generate engineering drawings for a few of these components, then assemble all of the components (in CAD software) to create a virtual copy of your machine. Finally, you will generate a short animation video to illustrate how your machine is assembled, and how its mechanical components move.

Winter 2021 Theme: LEGO®. You will reverse-engineer a LEGO® toy based on freely-available assembly instructions (https://www.lego.com/en-us/service/buildinginstructions). Your group can choose any LEGO® Technic machine or any LEGO® set of sufficient complexity. Your chosen toy must contain >70 components and multiple moving parts (e.g. gear trains, chains, pistons, etc.). Machines with greater complexity will be rewarded, although incomplete submissions will be penalized. Refer to the **Assembly and Animation Rubric** (later in this document) for more information.

START EARLY! There is no reason why you can't select your machine and get to work in Week 1.
DON'T PROCRASTINATE! It can take a long time (i.e. hours) to render and upload your video.

Part A – Machine Selection (Group)

Instructions: Using the internet as a resource, work as a team to select a machine (toy) that you wish to model (e.g. visit https://en.wikipedia.org/wiki/Lego_Technic), then submit your toy's Building Instructions (https://www.lego.com/en-us/service/buildinginstructions) for graduate teaching assistant (GTA) approval. If your toy is overly complex, you may opt (in writing) to omit certain components. Any such modifications to the scope of modeling must be submitted at the time of machine selection.

What to submit?

- A .pdf file containing "Building Instructions" for your toy. Where applicable, please crop the file to contain ONLY the specific toy configuration that you intend to model.
- (OPTIONAL) A document or annotated instructions describing any modifications your team will make to the toy (i.e. components added or omitted).

Grading Scheme (1% Course Weight)

- 1 = submitted Building Instructions for a LEGO® toy as a .pdf, downloaded from www.lego.com.
- 0 = did not submit, or submitted in an incorrect format

F.A.Q.

i. **Can we select a toy that we already own (or purchase)?** We have no way to control whether or not groups obtain a physical toy. Thus, it is allowed. However, there is no reason why you need to purchase a physical toy. Instructions, images, and many videos are available on the internet.

ii. **Can we select a toy that is available on a CAD repository (e.g. GrabCAD™)?** Yes, but please avoid doing so. Note that you will need to submit all of your model files, and we have methods to detect academic dishonesty.

iii. **Can we select the same toy as another group?** Yes, but you cannot share any files. Don't cheat.

iv. **How can we model a toy if we don't know how big it is?** Teamwork. You'll need to agree on some basic dimensions, refer to Building Instructions, and work together to fit your components into an assembly. You will not be graded on the dimensional accuracy, only model quality.

v. **Can we talk to our GTA about the complexity of our toy?** Absolutely. Please use the scheduled lab periods to consult with your GTAs as you choose, model, assemble, and animate your toy.

vi. **What if our chosen toy is not approved by the GTA/Instructor?** You will still receive 1 point (1% course grade) for submitting your building instructions on-time, in the correct format. Subsequently, we'll work with you to approve a different (or modified) toy.

Figure 1: Example LEGO® Technic toys. Left: Mobile Crane #42009, 2606 components (image: Wikimedia Commons). Right: Go-Kart #8256, 144 components (image: Bricklink.com). The crane example is more complex than required; with GTA approval, you could opt to simplify the assembly.

Part B – Engineering Drawings (Individual)

Instructions: Select two (2) different components from your machine. The components you select must interact (i.e. fit together, either statically or dynamically), and they must not be submitted by anyone else in your group (except by written GTA permission). You will model each component in CAD, then generate:

- a 4-view (i.e. front, top, side, and isometric views) Engineering Drawing for each component
- (optional) additional pages and drawing views if required to fully define your components

What to submit?

- A single .pdf file containing your drawings
- A .zip file containing your solidworks files (.sldprt)
- *NOTE: Your submission must include all required files (listed above), or else it will be considered late until all required files are received.*

Grading Scheme (2% Course Weight)

See CourseLink for complete rubric

Criterion	Outstanding	Points
Model: Complexity	Complex features including many of: chamfers, fillets, sweeps, cuts, extrusions	4
Model: Detail	Model proportions and features look realistic	4
Drawing: View Layout	Excellent choice of scale, use of space, page orientation Excellent choice of primary views Views are well-aligned	4
Drawing: Dimension Layout	Dimensions are well-spaced and clear Each dimension is placed on the most-appropriate model view No dimensions on isometric views No intersecting leaders	4
Drawing: Choice of Dimensions	All critical features (e.g. interacting features) are dimensioned No redundant dimensions Appropriate choice of dimensions (e.g. Radius vs Diameter) Minimization of dimensions: uses replication (e.g. 5x) where applicable	4
Drawing: Tolerances	Critical features (e.g. hole/shaft sizing for mating parts) have tight tolerances Non-critical features (e.g. aesthetic features) have loose tolerances Appropriate use of chain versus ordinal dimensioning	4
Drawing: Title Block	Professional-looking title block. No empty/incomplete fields. Good use of space. Includes all of: part name, author, date, units, general tolerances, "Do Not Scale Drawing", material, finishing, and notes	4
	Total	28

Part C – Assembly and Animation (Group)

Instructions: Create a short (e.g. 1-5min) animation video showing your machine in the following states:

a. Completely assembled
b. Exploded view(s)
c. Being assembled (i.e. animating the assembly of components and fasteners)
d. Moving (e.g. gears turning, pistons reciprocating, wheels steering and rotating, etc.)

What to submit?

- A .mp4 video file
- A .zip containing all SolidWorks parts and assembly files
- A .pdf of your Building Instructions (which may have been modified with GTA approval)
- A .jpg or .png screenshot of your model and Solidworks assembly "tree". Add annotations to indicate i) the total number of parts and ii) the total number of unique parts
- *NOTE: Your submission must include all required files (listed above), or else it will be considered late until all required files are received.*

Grading Scheme (13% Course Weight)

See CourseLink for complete rubric

Criterion	Outstanding	Points
Model: Complexity	>200 components Many unique components Many complex shapes (curved, toothed, etc)	4
Model: Completion	No obvious missing components or features; All independent components modeled separately	4
Model: Appearance and Detail	Impressive. Photo-realistic. Includes all obvious features. Components fit seamlessly. Excellent use of chamfers, fillets, colours, materials etc.	4
Animation: Overall Viewing Distance	Fills the screen The camera is set at an appropriate distance for the video	4
Animation: Detail Views	All parts appropriately sized and easily visible, including details. Intuitive use of section views and/or transparency	4
Animation: Flow	Very smooth transitions. Logical sequence of assembly operations Video seems to anticipate where your eyes want to look next	4
Assembly: Camera Speed	The speed at which the camera moves allows the viewer to clearly see what is happening	4
Assembly: Moving Parts	Very high motion complexity (e.g. chains, gear trains) All components that should move, do move Good motion speed (easy to see)	4
Overall Impression	Outstanding in all categories of modeling, assembly, and video. High attention to detail. Professional video.	4
	Total	36