Engineer 1C03: Winter 2015
Engineering Design and Graphics

McMaster Engineering 1
Cornerstone Project Course Competition

Instructor: Dr. McDonald
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ENG 1C03 – Cornerstone Project Course Competition

1. Overview

Working in design teams, you are tasked with the responsibility of retro-fitting a CD-ROM drive with a custom designed gear train. Your custom gear train must meet the dimensional constraints of the CD-ROM chassis and, when assembled, must fit inside an existing CD-ROM drive. To demonstrate this, you will need to produce a solid model assembly of your design constrained to the CD-ROM (a solid model assembly of the CD-ROM will be provided). Functionality of your design must also be demonstrated through system modelling and rapid prototyping. Your team must also submit a technical report with simulation results and a complete set of engineering drawings that are in accordance with ANSI Standards. Your completed project (including prototype and all project files) is to be submitted following an individual and team oral assessment (held during the Week 12 lab). Your technical report will be due at the end of the term.

2. Team Formation

Teams will be **formed during your week 3 lab** and are restricted to a **maximum of 3 members**. Students who do not enroll in a team during their lab will be assigned a team by the IAI. All members are also required to register as a member of their team on Avenue to submit project components and receive grades/feedback.

Teams are strongly advised to consider a Gantt chart very seriously and (at minimum) to schedule a weekly team meeting (at a minimum once per week). You will be submitting a summary of meetings and attendance in the technical report.

Any team problems must be addressed to Dr. McDonald by **February 9, 2015**.

3. Your Project – The Re-Design of a CD-ROM Drive

The product your team has been assigned to modify is the mechanism used to control the read-head of a computer CD-ROM drive. The read-head slides back-and-forth along a track as the disc spins, and a laser retrieves data by "reading" the pattern of pits on the disc surface. The translational motion of the read-head is controlled by a motor, which spins at a high rotational speed and connects to the read-head by a series of gears. Due to the original motor not being available, your team is provided with a new motor that is placed in a different location and equipped with different drive characteristics (i.e., spinning at a different rotational speed). Consequently, **a new gearing configuration must be designed**.

For your project, it is required that your team **design a gearing mechanism that will incorporate the input position and drive characteristics of the new motor to produce the original output read-head movement and speed**. Note that your retro-fit gear-train must use the provided CD-ROM case geometry and fit the design within the space limitations.

4. Drive Characteristics & Dimensional Constraints

The read-head of the CD-ROM is responsible for retrieving data from the disc by sliding back-and-forth along a track. For the CD-ROM you will be retro-fitting, the total distance the read head can move (known as a full stroke) is 60 mm. The typical average seek time of your CD-ROM drive is 100 ms (Note: the seek time refers to the amount of time it takes to move the read-head to a specific part of the disk). Therefore, if the read-head rests at the center of full stroke and average stroke distance is half of the full stroke (i.e., 30mm), we can derive an **ideal read-head linear target speed of 0.30m/s** (i.e., average stroke distance / seek time = 30mm / 100ms).

Movement of the read-head is controlled by a motor, which has been repositioned for this project. Based on your group number, **each team will be assigned a unique motor rotational speed (RPM)**:

- Group numbers between 1 - 9: multiply your group number by 8,500
- Group numbers between 10 - 49: multiply your group number by 965
- Group numbers between 50 - 99: multiply your group number by 365
- Group numbers between 100 - 200: multiply your group number by 105

Your gearing mechanism must connect to the motor at the input (rotating at a speed that is a function of your Group number – see above), and to the read-head at the output (translating at 0.30m/s). The motor must be placed inside the chassis as follows:

- The base of the motor must be flush with the floor of the chassis
- The back of the motor must be flush with the back wall of the chassis
- **The motor's base can be positioned up to 5mm from the right wall of the chassis** in order to accommodate various designs and gearing ratios

The CD-ROM chassis will be posted on Avenue. If you refer to the Inventor assembly file in the Project Files zip folder ("ASM – CDROM.iam"), you will notice that the top of the CD-ROM drive has been removed, but your design is still limited to the chassis height. **Ensure your assembly is fully constrained to the CD-ROM chassis**.

5. Custom-Designed Mounting Bracket

Your gearing mechanism design must fit within the chassis without modification to the chassis, and **must include a custom-designed mounting bracket** for mounting all gearing components (e.g., shafts, collars, etc.). When designing your mechanism to meet the dimensional constraints of the CD-ROM chassis, be sure to account for the dimensions of this mounting bracket.

Your mounting bracket is a requirement of the solid modeling and rapid prototyping portions of your project, but not the system modeling portion. Rapid prototyping will involve use of the 3D printers in the EPIC lab. However, you may use rods and screws (that are not printed) to secure components together). As with all printed components, **your team will be evaluated based on the appropriateness and utility of your design**. There are only 8 3D printers available at any given time to service over 150 teams, and overloading the printers with long and overly-complicated prints may result in unexpected printer failure. Therefore, the use of the 3D printers requires that your team design your parts using as little printing material as possible. **Designing components that result in excessively long print times may result in you being denied access to the EPIC lab until your components are re-designed**.

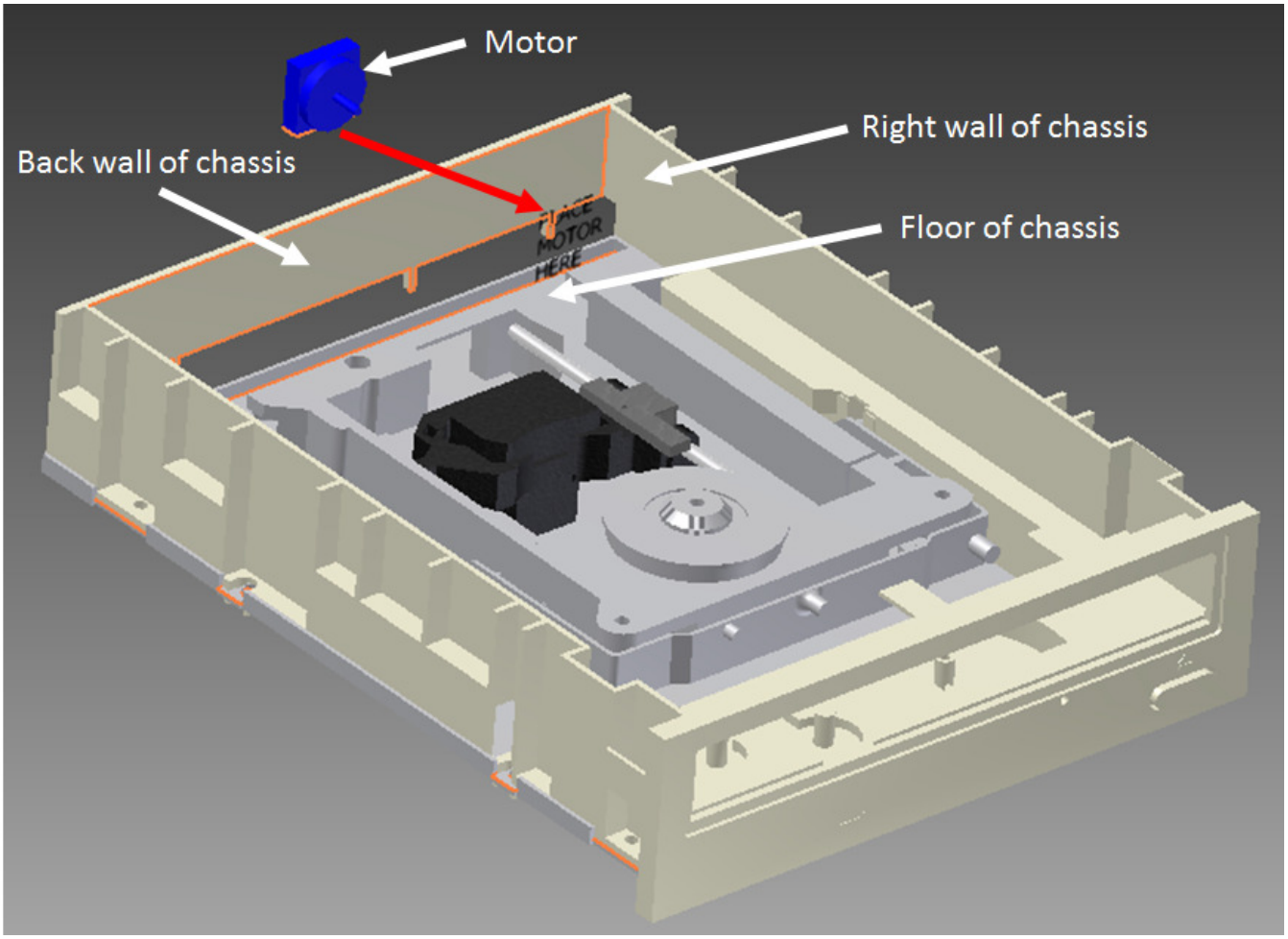

Figure 1: Chassis CD-ROM and Motor.

6. Submission Requirements

Completion of the project requires that you submit the following:

- A **solid model of your gear train** (using Inventor) designed to the scale of the CD-ROM and fully constrained to its chassis (refer to the CD-ROM assembly – "ASM – CDROM.iam")
- A **system model** (using MapleSim) demonstrating correct operation of the gear train
  - i.e., the input and output speeds match the design requirements
- A **working prototype** scaled up by a factor of 1.5X (using the 3D printers in the EPIC lab)
- A **technical report**, submitted as both a (printed) hard-copy and soft-copy (PDF)
- A **complete set of engineering drawings** that complies with ANSI standards and conventions
  - The engineering drawings must be submitted with your technical report

7. Submission Deadlines

Please adhere to the following due dates. In addition to the project deliverables due during your oral assessment and at the end of the term, this project requires the completion and submission of TWO milestones prior to project completion. Instructions will be provided in separate documents.

- Milestone 1: uploaded to Avenue by **Friday February 13, 2015 at 6:00pm**
- Milestone 2: uploaded to Avenue by **Saturday March 7, 2015 at 6:00pm**
- Project Interview: an individual and team oral assessment will be held during your **Week 12 lab**
    - Your Inventor and MapleSim files should be loaded on the EPIC lab computer or a laptop prior to your interview in order to demonstrate your work
- Project Files: all Inventor and MapleSim files combined in a compressed .zip folder and uploaded to Avenue **no later than 60 minutes after the Project Interview**
- Technical Report: a hard (printed) copy handed in to the instructor (ETB-114) and an electronic copy (PDF) uploaded to Avenue by **Wednesday April 8th at 4:00pm**

8. Evaluation

Your work will be evaluated based on a completed and clearly documented design and simulation, structured and professional presentation, clearly written technical report, and the success and functionality of your prototype. The overall grade is 100% and a full marking scheme will be posted to Avenue. Working as a team, each member is expected to participate equally in all areas of this project and each member will be examined on the overall project. Any student unable to explain the work for which they are assuming credit may be assigned a 0 for the project.

8.1 Peer Evaluation

In addition to your TA/IAI's evaluation, each team member must complete an online form evaluating themselves and the other members of their team. This peer evaluation will factor into each individual member's final mark. Members who clearly did not contribute equally to the project may have their project grade reduced at the instructor's discretion. Failure to submit a peer evaluation will result in a **5% penalty** to the overall project grade.

8.2 Bonus 5%

A team wishing to submit an alternate/innovative/unique design may do so as a bonus to the project. Each submission will be evaluated on its technical merit and must be accompanied by both an Inventor model and MapleSim simulation (a prototype is not required). Note that the bonus is only considered for teams that complete all of the primary objectives of the project.

9. Course Competition

The top student teams based on TA evaluation of individual / team assessments will be invited to compete in early April 2015 (date to be confirmed). The selected teams will then present their designs in a 10 minute PowerPoint-style presentation to a judging panel. A two percent bonus to the final project grade will be awarded to teams participating and an additional two percent will be awarded to the top team.