EML2322L – Design Report Template

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(for this report template, not for your submitted design reports)

NOTE: All instructions in red (including hyperlinks) should be deleted from this template ***after reading*** and prior to submitting each report via Canvas.

EML2322L – Design and Manufacturing Laboratory

Design Report 1, 2, 2R, 3, 3R, or 4
(denote appropriately for each submission; R = resubmission)

Team Number (e.g. Team 1A)

Team Member Name (1) (e.g. Alberta Gator (1))
Team Member Name (2)
Team Member Name (3)
Team Member Name (4)
Team Member Name (5)
(List in alphabetic order by last name and retain number in parenthesis)

Instructor: Mike Braddock
TA: TA Name (assigned 3rd week of semester, so don't worry about this for DR1)

Semester

Date

NOTE: please do not change formatting (i.e. page margins, font type or size, etc.) on this page or in any part of the template

Introduction / Problem Statement

Print the Design Project Description and Design Project Schedule and neatly highlight the following (you can also use electronic .pdf highlighting tools, such as those in Adobe Acrobat Reader DC):

1. project design specifications (i.e. ALL objectives and constraints) in yellow (including important dimensions in the description body **and on the accompanying drawings**)
2. evaluation criteria in blue
3. project deliverable dates in orange or red
4. underline in red ink any other information that may be important for the project's success

NOTE: Each group submits one *Introduction / Problem Statement*.

Background Research

To assist in this important phase of the project, relevant research has been assembled on the topics listed below. **This is a reading comprehension assignment. As you read each section please complete the Background Research Quiz which is due the second week of the semester at the start of your formal lab period.** As noted on the quiz, you are randomly assigned to work with ONE other student. You only need to submit one copy of the quiz containing both of your names in the provided locations. If the assigned student does not respond within 48 hours to your request to collaborate, please complete the quiz individually and write DNR (did not respond) in the location for their name. If you are not assigned a partner due to an odd number of students in each section, you can choose any course student as a partner.

This is the only chance you will have to do background research, so please take the exercise seriously and use the course website and the Internet to perform information and image searches on relevant topics to develop your understanding of how each may influence your design choices.

0. Before you begin researching
1. Brief Intro to Robotics (video)
2. Electric DC motors
3. Robot controllers
4. Mobile robotic platforms
5. Center of gravity
6. Steering mechanisms
7. Wheels and tires
8. Friction coefficients
9. Bucket and ball lifting mechanisms / manipulators
10. Ball hoppers
11. Ball sorting mechanisms / strategies
12. Ball dispensing mechanisms / strategies
13. Gears / gearing
14. Materials / material selection
15. Material properties
16. Tennis & golf balls
17. EML2322L Design Flowchart

Conceptual Design Generation (Team Member Name (1))

After completing the background research, brainstorm ideas to solve the problem. Good sketches are essential for explaining concepts. Each group member must submit one set of neatly drawn hand sketches (**i.e. do not use any electronic aids; only pencils/pens, straightedges/rulers, and paper**) which clearly illustrate a complete design solution and contain the following (in the noted sequence):

- **Typed written description** referencing each sketch by figure number to explain the concepts and material selections for each part of the design. Include the maximum robot velocity for the selected motor speed and wheel size using this reference chart (these components can be changed in the future after performing calculations to decide which combination will work best for your conceptual design)
- **Three orthographic views** (front, side, top) of the entire conceptual design (sketch on the lighter side of standard green engineering paper)
- **One isometric view** of the entire conceptual design (sketch on lighter side of provided iso template)
- **Separate detailed sketches** of each mechanism / subunit (e.g. bucket / ball manipulator, hopper, dispenser/release, etc.) including two orthographic views and an isometric view of each.
- **Explicit dimensions** showing overall size of robot, frame, control box, motors, wheels, hubs, object manipulator(s), hopper, release mechanism(s), and attachment brackets *(note: some designs will not have all of these components and may include others);* here is a course CAD library for reference

Draw each required sketch on its own page, as large as possible, with unique and sequential figure numbers (e.g. 1A, 1B, etc. for team member 1). Draw all parts true scale. Use leaders to clearly label all components and materials. Ensure design satisfies all project constraints. Place your name on each sketch and in the concept selection report section header, as shown above**.**

Key points about this assignment:

- **This is NOT a rough draft,** but rather a detailed presentation of the best and most complete solution you can come up with based on your research
- **This is the only opportunity you will have individually to generate a real solution to the design problem**, so please take this assignment seriously, as it sets the stage for the rest of the project
- Do not submit stick drawings lacking detail that show you invested no serious effort synthesizing a real solution, but rather **sketch real components that will be used on the project**
- If your conceptual design incorporates components not stocked in lab, you must provide a **data sheet or catalog page** to validate specifications and cost
- **The first two weeks of the semester are the time to research and compare different ideas; this assignment presents the idea you conclude is best after doing so**
- Design Report Examples can be found on the course webpage. Do NOT copy the examples. The instructions in this template are the final authority for design reports.

After taking EML2023 you know what proper sketches looks like, so invest time to create them. **Unclear, messy, small, incomplete, and improperly scaled sketches lacking significant detail will be harshly graded.** Hand drawn sketches are an important communication skill that only improves through practice, so leverage this opportunity to improve your drawing ability. **Hand sketches take a significant amount of time, so plan to spend 12-15 hours on this assignment.** It helps to begin drawing using light line weights that are easy to erase or ignore, and after the sketch contains all desired components, darken line segments as appropriate to show depth, detail, and contrast.

At the conclusion of this report, each group should have as many possible solutions as it has members, giving the team a variety of ideas to evaluate when selecting the final design to refine and prototype during the remainder of the course. The checklist on the following page details everything required for each student's Conceptual Design Generation submitted in Design Report 1.

Please read the Conceptual Design General Checklist on the following two pages before beginning the assignment, so you know how your work will be graded.

Conceptual Design Generation Checklist

CONCEPT QUESTIONS (ANSWER IN THE BRAINSTORMING PHASE):

1. **Does the design satisfy all constraints noted in the project description?**
2. **Have realistic materials been selected for each part of the design and justified using the background research?** *This is the stage at which you investigate material choices; if you haven't done so, you haven't finished your research.*
3. **Can all mechanisms and components used in the proposed design be purchased for the allowable budget or manufactured using laboratory resources?** *If not, you need to do more research and speak with course TAs or the instructor prior to D.R.1 submission.*

ORTHOGRAPHIC & ISOMETRIC VIEWS:

1. **Are sketches drawn on the proper side of the proper paper and in the correct orientation?** Ortho views should be drawn on standard green engineer paper and iso views should be drawn on the provided iso template. All sketches should be drawn on the lighter side of the page so the provided graph lines do not obscure your sketch lines. In other words, printed grid lines should be on the back side of the page.
2. **Are front, side, top, and iso views of entire design neatly drawn as large as possible and on separate pages?** If more space is needed than an 8.5x11″ sheet provides, use multiple pages or an 11x17″ sheet folded to fit inside the 3-ring binder. Use unique & sequential figure numbers and place the drawer's name on each sketch and in each report section, as shown in this template.
3. **Does each view show clear and substantial detail of the entire design,** including the frame, control box, motors, wheels, hubs, mechanism(s), attachment methods/brackets, and each object being manipulated?
4. **Are all parts drawn to scale and clearly dimensioned?** Include **explicit** dimensions showing overall size of robot, frame, control box, motors, wheels, hubs, mechanism(s), attachment brackets, and any objects which must be manipulated.
5. **Are leaders included to clearly label components and material selections** which are discussed in the written description? Do not include lengthy explanations on drawings; those explanations should be in the written description.

DETAILED VIEWS OF OTHER MECHANISMS (MANIPULATORS, HOPPERS, DISPENSERS, ETC.):

1. **Is each mechanism neatly drawn as large as possible and on separate pages?** If more space is needed than an 8.5x11″ sheet provides, use multiple pages or an 11x17″ sheet folded to fit inside the 3-ring binder. Use unique & sequential figure numbers and place the drawer's name on each sketch and in each report section, as shown in this template.
2. **Does each view show clear and substantial detail,** including attachment method / bracket(s)? Include at least two orthographic views and an isometric view of each mechanism and include details of any objects being manipulated.
3. **Are all parts drawn to scale and clearly dimensioned?**
4. **Are leaders included to clearly label components and material selections** which are discussed in the written description?

WRITTEN DESCRIPTION:

1. **Is the description typed and placed at the beginning of your *Conceptual Design Generation* report section?** Use the format in this template.
2. **Does the description clearly explain how each part of the design works while referencing each sketch by figure number?** If you have nothing meaningful to say about a sketch, do not include it in the report.
3. **Does the description clearly justify each design choice made in your conceptual design drawings based on the background research or physical testing?** For example, why was a certain type of mobile platform or steering mechanism selected, from what material is each part of your design made and why was each material selected? If you are unsure about the reasons for any of your choices, return to the background research and speak with course TAs or the instructor. **Statements lacking logical justifications are conjecture and should be omitted.**
4. **Does the description include the maximum robot velocity estimation for your selected drive wheels and motors?** Pay attention to the units noted on the robot velocity chart and make sure your wheel and motor combination offer an appropriate balance of controllability and speed by paying attention to the labeled regions on the robot velocity chart.
5. **Is the description well written?** Does each sentence flow logically with the next? Are paragraphs used to clearly organize thoughts? Is the description clear and concise, like all good technical writing? No one is going to give your ideas the consideration they deserve if you can't explain them effectively. If your opening paragraph is difficult to read or full of errors, can you blame us if we don't want to read the rest? You are obviously quite bright to be at UF and in this course, so please use your intellect to submit a well written design description.

Design Report 1 Submission Instructions

Please submit the first design report via Canvas as one cohesive group document (pdf). Begin each report section on a new page. Separate report sections with consistently printed section dividers (i.e. pages containing the section headings) for easier document navigation; you can use the Appendix template towards the end of this document as a section divider template.

ORDER REPORT SECTIONS IN THE FOLLOWING SEQUENCE:

1. **Cover Page** (one per group as the first page in your report)
2. **Introduction** (one per group)
3. **Conceptual Design Generation** (Team Member Name (1))
4. **Conceptual Design Generation** (Team Member Name (2))
5. Etcetera

Final Notes Regarding D.R.1 Submission:

1. The appearance of your work is a reflection of the effort invested. Before submitting your report, ask yourself if the content is something you would be proud showing in an interview or submitting to a boss. Incomplete or poor-quality work on D.R.1 is an indication you are unable or unwilling to commit the necessary time to the course and you should consider dropping and taking the class a different semester. ***Consequently, students who receive lower than 60% on D.R.1 may be dropped from their assigned group and issued an E for the course due to their inability to meet the ABET objectives listed in the syllabus and the burden they will subsequently place on rest of their teammates moving into D.R.2 and D.R.3 project assignments.***

TLDR: DO NOT PROCRASTINATE ON D.R.1, AS IT TAKES A LOT OF EFFORT TO RESEARCH AND COMMUNICATE A COMPLETE DESIGN THAT CAN ACTUALLY SOLVE THE PROBLEM; THIS IS NOT AN ASSIGNMENT YOU COMPLETE IN A FEW DAYS FOR PARTIAL CREDIT.

2. ***Keep high quality scans of your final conceptual sketches to share with your group members while D.R.1 is being graded.***

3. ***Assemble the report WELL BEFORE it's due.*** *If any member's content is not in the design report for prompt submission before the start of lab, write "LATE" next to the member's name on the cover page before submission. Failure to do so will result in the entire group receiving a late penalty.* ***From this point onward, this option will not exist: the entire team will be penalized for work not submitted on time, so work well as a team and prepare your design reports for submission well in advance of each deadline.***

4. If any teammate does not communicate with your group or fails to equally contribute in preparing the report, ***write "DNC"*** *(did not contribute)* ***next to his/her name on the cover page before submission in lab.*** *If you don't flag this behavior now, it will only get worse moving into the more demanding D.R.2 and D.R.3 project assignments.*

[**This is the end of D.R.1;**
please review the Common Report Errors and Weaknesses section of this Design Report Template before submitting]

Selection of Design Concept

Please read the ENTIRE section before starting work.

The goal is to select the combination of ideas that best meet the objectives and weighting factors each group decides are best. After creating the decision matrices, your group must choose the design from each matrix that achieves the highest value or the matrices will not serve their intended purpose of unbiasedly identifying the best ideas. Combine the winning concept from each decision matrix to form the final hybrid design that best meets the predetermined objectives.

If the winning concepts do not appear compatible, brainstorm modifications to the concepts that allow them to work together. If after investing significant effort (and discussion with your assigned TA) a solution cannot be found, explain why in the report body and select the second-best idea for the incompatible matrix.

Only one submission of this section is required for each group and it must be completed as a **collaborative effort,** not as individual pieces placed in one submission.

1. **Divide your designs into logical subsystems** (e.g. mobile platform, object manipulator, hopper, release mechanism, etcetera) so each can be evaluated separately to select the best overall solution.

2. **Create a decision matrix for each subsystem** to unbiasedly select the best concept.
    a. **Begin with the mobile platform matrix.** Thoroughly read the provided mobile platform decision matrix example and provide the same level of clarity and assessment justification using the provided decision matrix template.
    b. **Explain in detail why each objective is chosen and how the weighting factors are assigned.** Clearly define each objective; do not assume the objective name explains what you're evaluating. **If an objective can be quantified, effort must be invested to do so** (e.g. cost, manufacturing time, and speed should always be quantitative objectives, never qualitative). Read the tips for selecting good decision matrix objectives for assistance with this important step.

       Evaluation criteria must include objectives which are pertinent to the project description. In the mobile platform example above, material cost, manufacturing time, and size (modularity) are evaluated since there is a project budget, limited manufacturing time, and multiple size constraints. Based on the current semester's project, decide what design considerations are important for each subsystem and use those criteria (minimum of five) for each matrix.
    c. **Repeat step b for each remaining subsystem / matrix.**

3. **Compare new or revised design concepts.** It is beneficial and common for groups to introduce and evaluate new concepts or modifications to existing concepts. Adding a new concept to one matrix does **not** require you to add a new concept to the others. This is the last chance to improve your conceptual designs. Follow the instructions below to add new or revised concepts to your decision matrices.
    a. **If a concept cannot be tested** due to motor, wheel, or other mechanism limitations (resulting in a score of zero), modification(s) to the concept must be made so it can function and be compared to the other concepts. Include sketches of the modified concept along with a written description that clearly illustrate and explain the modifications made to the original concept. These sketches do not require DR1-level detail but must be clear enough for any TA or teammate to understand. The updated concept **replaces** the original concept under evaluation in the decision matrix.

b. **If introducing a new concept or a modified version of an existing concept** (such as combining designs, changing dimensions, adding/removing components), include sketches of the new concept along with a written description that clearly illustrate and explain the new idea(s). These sketches do not require DR1-level detail, but they must be clear enough for any TA or teammate to understand. The new or significantly modified concept is then **added to** its respective decision matrix as a new design (e.g. Design 5) and compared to the other DR1 concepts in the decision matrix.

4. **Build representative models to evaluate the validity or capability of your ball manipulators, ball hoppers, and ball release mechanisms.**
    a. During a normal semester, each teammate builds and tests representative models for each of their subsystems during lab office hours; because of the COVID-19 restrictions, we want each teammate to **build representative models of your ball manipulator, ball hopper, and ball release mechanism concepts** at home.
    b. **This is just a representative model, so use any materials that are readily available and affordable, and representative of the materials you would use on the actual design.** Materials from your garage, the local hardware or Dollar store, an erector set, etc. The model does not have to be fancy, but it does need to be meaningful in what it allows you to evaluate. Common materials used for this type of testing include cardboard and painter's tape; various shapes and types of wood (rectangular strips for building structures, round rods for pivots and bars, balsa, etc.); PVC pipe and fittings (from 3/4" diameter and larger); a myriad of plastics; etc. Mike and the TAs are happy to help provide ideas for suitable testing materials.
    c. **Include (1) a written explanation** of the testing and results, **(2) reference to sketches** illustrating the relevant features being tested, and **(3) photos of testing in Appendix A**.
    d. **Include these results in your various decision matrices** (e.g. include an objective like effectiveness in the ball manipulator matrix and use the results of your teammates' testing to score each design regarding that objective).

5. **Include detailed justifications explaining how magnitudes and scores are assigned for each concept in each matrix.**
    a. **Quantitative objectives must be supported by clear calculations (including units)** organized in tabular format in Appendix A with results summarized and discussed in the report body. Remember, **if an objective can be quantified, effort must be invested to do so** (e.g. cost, manufacturing time, and speed should always be quantitative objectives, never qualitative). When comparing each concept, explain why it scores higher or lower than each of the others.
    b. **Qualitative objectives must be supported with (1) written explanations** justifying the score assignments, **(2) comparisons** to other matrix concepts, **(3) reference to sketches** illustrating the relevant features being tested, and **(4) evidence (e.g. photo) of testing**. When comparing each concept, explain why it scores higher or lower than each of the others.
    c. Use the provided material price list and cost template to **create accurate cost summaries,** and use the understanding obtained from the laboratory demonstration videos and the time estimation guides and templates to create **estimated manufacturing time summaries.** TAs will provide assistance in this area due to the challenges on this semester's online format.
    d. When organizing the report body, **compare all concepts with respect to each objective** as illustrated in the mobile platform matrix example.

6. **Present analyses and calculations in report appendices**.
   a. Analyses should include calculations of motor torques (amount required to drive the robot and operate each mechanism on the final design) & robot speed and estimated task completion times (object manipulation, sorting, aiming, release times, etc.) for each concept under consideration.

      When estimating task completion times it is necessary to include a top view of the arena showing the dimensioned path each conceptual design will follow when navigating the course**.** Use arrows and different line types to show the robot's planned path through the arena; label and explain each path segment's distance and estimated velocity based on example mobile platform testing; and include a summary table showing the estimated total driving distance.
   b. Show a clear sample calculation with units for each computed value using the format shown in the provided calculations template, and present a summary table containing similar calculations for other concepts under comparison. In other words, use the provided template for the drive wheel motor torque calculations and modify the provided template for other calculations submitted in DR2.
   c. When creating the summary calculation tables, report a reasonable number of decimal places for each parameter based on the level of precision accompanying your computations or estimations. For example, if computing *estimated* robot velocity, consider the precision of your computed values and use the appropriate number of decimals (e.g. 2.3 ft/sec vs. 2.3456 ft/sec; the latter boasts much higher precision than an estimate could reasonably possess).

[section length is typically 30-40 pages including appendices]

Peer Evaluation for Design Report 2, 2R, 3, 3R, or 4 (OPTIONAL)

Group Number: _____ **TA: ____________________**

The design reports are the hardest part of this course, requiring by far the largest amount of effort. **If any member(s) in your group does NOT do an equal amount of work on any of the design reports, this is your opportunity to inform me so the proper corrective action can be taken.** Examples include students who repeatedly fail to complete their weekly project assignments, don't show up for scheduled team meetings (or aren't prepared when they do), repeatedly make excuses why (s)he can't do their work, don't have the proper software installed on their computer, claim they aren't good at CAD (or writing, or calculations, or …), submit work that is subpar and requires other members to redo it, wait until last minute to submit their work to the rest of team for feedback and editing, etcetera. Realize everyone occasionally has a bad week, so I'm not asking to hear about the one time someone doesn't show up prepared or doesn't complete an assignment; but rather I'm asking to hear about the member(s) who offer more excuses than results while working on this challenging project.

Please be specific in explaining why you feel the following member(s) did not contribute their part to one (or more) of the design reports. Attach additional pages as necessary, as well as your **group meeting summaries** I asked all groups to use. **I will assume any group not submitting peer evaluation sheets was completely satisfied with their teammates' performance on the design reports. Submission of this evaluation is NOT a requirement for any of design reports.**

Example: Michael did not perform an equal amount of work on the second or third design reports. He rarely attended our group's design meetings and when he did, he always arrived late, would only stay for about 30 minutes and rarely contributed anything helpful. He refused to work on CAD drawings because he claimed he wasn't good at SolidWorks and his computer couldn't run the current version without crashing, that he learned AutoCAD at the last school he attended and that he would do more of the group's manufacturing during that phase of the project (which was not helpful for this part of the project and only an empty excuse, since logically one person can only do the work of one person once manufacturing commences).

The work Michael did on the decision matrices showed little effort, did not follow the guidelines or formatting in the design report template and had to be redone by the rest of the group. Specifically, objectives were not clearly defined, magnitudes were computed incorrectly, and magnitude justifications were poorly explained, if at all and did not use the provided cost or time estimation templates.

Michael repeatedly failed to submit his assignments to the rest of the team in time for proofreading, and consequently those sections show low effort and will now reflect poorly on the rest of our team. Michael was asked to complete the illustration of the robot's trajectory but claimed he didn't know how to make it the day before it was due. Michael was also asked to create the team's budget but failed to use the provided template for material costs, didn't include all necessary items, and once again did not complete it in time for anyone to proof it, so it had to be done by another team member.

As a group we feel Michael only contributed about 20% of what he should have as an equal member of this group. Each week he was assigned clear tasks, but acted helpless, offered excuse after excuse, and refused to attend the TA hours for assistance on his assignments, despite our attempts at talking to him about these issues multiple times. Nothing stated in this evaluation should come as a surprise to Michael.

To explain how the work was divided for the second report we are including a breakdown of what tasks were performed by which team members:

Selection of Matrix Objectives: Josh 40%, Sam 30%, Robert 30%, Michael 0%
Definition of Matrix Objectives: Sam 60%, Robert 40%, Michael 0%
Weighting Factor Justifications: Josh 80%, Michael 20%
Magnitude Assignments / Justifications: Josh 30%, Sam 30%, Robert 30%, Michael 10%
Robot Speed Calculations: Josh 50%, Robert 50%
Robot Path Illustration: Sam 80%, Michael 20%
Wheel & Lifting Motor Torque Calculations: Josh 50%, Robert 50%
Detailed Written Description: Sam 10%, Robert 90%

CAD Models (Custom Designed Parts): Josh 20%, Sam 60%, Robert 20%, Michael 0%
Main Assembly Model: Josh 20%, Sam 60%, Robert 20%, Michael 0%
Subassembly Models: Josh 20%, Sam 60%, Robert 20%, Michael 0%

Detail Drawings (Off the Shelf Parts): Josh 20%, Sam 20%, Robert 60%, Michael 0%
Detail Drawings (Custom Designed Parts): Josh 20%, Sam 20%, Robert 60%, Michael 0%
Assembly Drawings: Josh 20%, Sam 20%, Robert 60%, Michael 0%
Subassembly Drawings: Josh 20%, Sam 20%, Robert 60%, Michael 0%
Bill of Materials: Sam 75%, Josh 25%

Project Schedule: Josh 80%, Michael 20%
Project Budget: Robert 80%, Michael 20%

Final Report Assembly & Printing: Josh 20%, Sam 60%, Robert 20%

NOTE: estimations accurate to approx. ± 10%

All the members who sign below agree to these statements and hope you can have a talk with Michael so he will be more helpful during the prototyping phase of this project.

Josh X	**Samantha Y**	**Robert Z**
Josh X	Samantha Y	Robert Z

Please e-mail peer evaluations directly to your TA and the course instructor.

Design Report 2 First Submission Instructions

Please submit the second design report via Canvas as one cohesive group document (pdf). Begin each report section on a new page. Separate report sections with consistently printed section dividers (i.e. pages containing the section headings) for easier document navigation; you can use the Appendix template towards the end of this document as a section divider template. Meeting minutes will be individually submitted via a separate Canvas assignment in the form of a pdf.

ORDER REPORT SECTIONS IN THE FOLLOWING SEQUENCE:

1. **New Cover Page** (with updated report number and date)
2. **Selection of Design Concept**
   a. **Concept Selection Checklist** **accurately** completed by team (as it pertains to the first two decision matrices); if your group did not take time to fill it out accurately, do not submit it at all, as submitting an inaccurately completed checklist is worse than not submitting one at all
   b. decision matrices (in landscape orientation like the template)
   c. objective definitions, weighting factor justifications, and detailed magnitude and score assignment explanations (for first two decision matrices)
   d. objective definitions and weighting factor justifications (for remaining decision matrices)
3. **Appendix A: Decision Matrix Calculations & Justification Data** (including table of contents)
4. **Appendix B: Robot Path Illustration, Speed & Time Calculations**
5. **Appendix C: Wheel and Lifting Motor Torque Calculations**

INDIVIDUAL MEETING MINUTES (SUBMIT AS SEPARATE ASSIGNMENTS ON CANVAS):

1. **Meeting Minutes Cover Page** (with member name, report number, and date)
2. **Meeting Minutes Chronologically Ordered** (starting with the oldest at the top (i.e. the most recently completed document will be the last page of the submission))

Refer to Appendices section of DRT for details about the report appendices.

[**This is the end of D.R.2 First Submission;** please review the Common Report Errors and Weaknesses section of this Design Report Template before submitting]

Design Report 2 Resubmission Instructions

Please resubmit the second design report via Canvas as one cohesive group document (pdf). Begin each report section on a new page. Separate report sections with consistently printed section dividers (i.e. pages containing the section headings) for easier document navigation; you can use the Appendix template towards the end of this document as a section divider template. Meeting minutes will be individually submitted via a separate Canvas assignment in the form of a pdf.

ORDER REPORT SECTIONS IN THE FOLLOWING SEQUENCE:

1. **New Cover Page** (with updated report number and date)
2. **Concept Selection Checklist** (original copy completed by TA for first two evaluation matrices)
3. **Final Selection of Design Concept** (with TA feedback implemented)
   a. Concept Selection Checklist **accurately** completed by team; if your group did not take time to fill it out accurately, do not submit it at all, as submitting an inaccurately completed checklist is worse than not submitting one at all
   b. decision matrices (in landscape orientation like the template)
   c. objective definitions, weighting factor justifications, and detailed magnitude and score assignment explanations
4. **Appendix A: Decision Matrix Calculations & Justification Data** (with updated TOC)
5. **Appendix B: Robot Path Illustration, Speed & Time Calculations** (updated with corrections)
6. **Appendix C: Wheel and Lifting Motor Torque Calculations** (updated with corrections)

INDIVIDUAL MEETING MINUTES (SUBMIT AS SEPARATE ASSIGNMENTS ON CANVAS):

1. **Meeting Minutes Cover Page** (with member name, report number, and date)
2. **Meeting Minutes Chronologically Ordered** (starting with the oldest at the top (i.e. the most recently completed document will be the last page of the submission))

   NOTE: Each submission from this point on should include all the meeting minutes in the previous submission. (i.e. each submission will be a compilation of all meeting minutes from the beginning with an updated cover page)

Refer to Appendices section of DRT for details about the report appendices.

[**This is the end of D.R.2 Resubmission;** please review the Common Report Errors and Weaknesses section of this Design Report Template before submitting]

Detailed Design

Only one submission of this section is required for each group; however, all work should be distributed equally among team members and computer-generated.

1. **Provide a detailed written description of how the final design accomplishes the project goals.**
    a. Explain the function and selection of each subsystem based on research, analysis, and testing.
    b. Explain the material selection for each part of the design.

2. **Present complete CAD generated part and assembly drawings.**
    a. **Use required drawing templates for all drawings.**
    b. **Include detail drawings of all components used on the project (manufactured and OTS).** The only exception to this requirement is fasteners, which are specified completely in the BOM.
    c. **Include dimensions, tolerances, units, material specifications, surface finish specifications, appropriate hole & thread notes, part quantities, unique part names & numbers, designer and drawer names, and part deburring notes.**
    d. **Use the provided detail drawings for OTS parts (e.g. motors, wheels, and 80/20 accessories).**
    e. **Assembly drawings must contain a BOM clearly labeling all parts of the assembly with sequential and uniquely numbered leaders and balloons; this typically requires multiple views/pages for clarity.** If a part is present in multiple assemblies, it maintains the same balloon number; therefore, each BOM containing a subsequent appearance of this part will have a jump in the number sequence. When finished, include a complete BOM of the entire design as well.
    f. **Include subassembly drawings of each subsystem/mechanism that show necessary assembly dimensions (in the proper orthographic views) and follow the Assembly Drawing Organization and Dimensioning document.** For clarity and organization, it is often necessary to break a subsystem into multiple subassembly drawings.

3. **Provide a project schedule showing intermediate deadlines and responsibilities.**
    a. **Schedule parts manufacturing, assembly of each subsystem, preliminary testing, design changes, final testing, and competition.** Assume you have 5 lab periods worth of time.
    b. **Assign group member responsibilities and completion deadlines for each task** based on the time estimates compiled for the concept selection matrices (update times if necessary).
    c. **Do not pair up group members on tasks**; this is not an efficient use of resources. Everyone receives the same training and should be capable of performing the same manufacturing tasks. If anyone needs additional help, that group member should seek additional training in office hours.

4. **Provide a project budget showing the costs for all materials and components used on the project.**
    a. **Budget should include all items in the final BOM.**
    b. Purchased items must not exceed the project budget.
    c. Items provided free of charge (e.g. wheels, motors, and fasteners) must be noted as such.

5. **Include your team number on BOTH sides of the robot using characters which are at least 3 inches high.** Color, font, and background shade is at the team's discretion, but ensure the team number can be easily seen for identification purposes.

[section length is typically 35-50 pages depending on the complexity of the design]

Design Report 3 Submission Instructions

Please submit the third design report via Canvas as one cohesive group document (pdf). Begin each report section on a new page. Separate report sections with consistently printed section dividers (i.e. pages containing the section headings) for easier document navigation; you can use the Appendix template towards the end of this document as a section divider template. Meeting minutes will be individually submitted via a separate Canvas assignment in the form of a pdf.

ORDER REPORT SECTIONS IN THE FOLLOWING SEQUENCE:

1. **New Cover Page** (with updated report number and date)
2. **Detailed Design** (assemble in the following sequence)
   a. Final Design Checklist (original copy completed by TA or instructor)
   b. Detailed Design Checklist **accurately** completed by team; if your group did not take time to fill it out accurately, do not submit it at all, as submitting an inaccurately completed checklist is worse than not submitting one at all
   c. written description
   d. project schedule
   e. complete BOM table containing every item / balloon number used on the entire project
   f. assembly drawings of entire robot with BOM containing smaller subassemblies
   g. assembly drawings and BOM of subassembly 1
   h. detail drawings of all parts in subassembly 1
   i. assembly drawings and BOM of subassembly 2
   j. detail drawings of all parts in subassembly 2
   k. repeat for remaining subassemblies

3. **Appendix D: Estimated Project Budget**

INDIVIDUAL MEETING MINUTES (SUBMIT AS SEPARATE ASSIGNMENTS ON CANVAS):

1. **Meeting Minutes Cover Page** (with member name, report number, and date)
2. **Meeting Minutes Chronologically Ordered** (starting with the oldest at the top (i.e. the most recently completed document will be the last page of the submission))

   NOTE: Each submission from this point on should include all the meeting minutes in the previous submission. (i.e. each submission will be a compilation of all meeting minutes from the beginning with an updated cover page)

Refer to Appendices section of template for details about the report appendices.

[**This is the end of D.R.3;**
please review the Common Report Errors and Weaknesses section of this Design Report Template before submitting]

Design Review Instructions

The purpose of the formal graded design review is to allow the TAs to provide valuable feedback on each group's final design, engineering drawings, and other project details. Each group will receive a grade using the Detailed Design Checklist. Since a copy of the checklist is provided to each group, the expectation is that each team comes to the design review with all YES marks on the checklist. Inaccurate completion of the checklist will hurt your group's chance for success, so please be honest as you fill it out.

TIPS FOR GOOD DESIGN REVIEWS:

1. **Arrive to lab prepared with a complete D.R.3** your group is proud of; the alternative wastes everyone's time and hampers the TA's ability to provide valuable feedback.

2. **Write down all TA feedback** so your group can review the comments outside lab and the TA can examine and critique more of the report. Your TA is not your team's note-taker.

3. **Ask your TA to explain anything you don't understand, but don't argue with her/him.** Every TA is invested in their group's success and the feedback offered is done so with three goals in mind: (1) to improve designs, (2) to make designs easier to manufacture, and (3) to improve your D.R.3 grade. Encourage your TA to point out anything (s)he feels may be a potential problem with the design, and then later discuss and decide as a group whether you want to follow their advice. But don't be argumentative during the design review, as that only reduces the amount of assistance your TA can provide during the relatively brief window in which they can do so. If you have an obstinate or arrogant teammate who fallaciously believes challenging every correction and suggestion offered by the TA makes them look good, instruct that person to be quiet or leave the design review, as their behavior just decreases the amount of helpful feedback your TA can provide during the limited time available for the design review. Additional questions for clarification can always be asked after the design review is over.

4. During the design review the TA will likely catch several weaknesses and mistakes, since (s)he is knowledgeable about the requirements for each assignment. **The feedback provided during the formal design review can typically improve a group's performance and grade 10-15%,** if heeded.

5. Understand **the purpose of the design review is not for the TA to proof every drawing or report section;** that is the role of your team. The TA will bring mistakes or omissions (s)he notices to your attention while performing the design review; however, (s)he is more concerned with critically evaluating the function and manufacturability of your designs. Mistakes not found during the design review will still be penalized during the subsequent second grading of your DR3 resubmission.

6. The design review is the last chance for a TA to help improve your team's design; **if your group brings poor or incomplete work, you will not receive a second opportunity for a detailed design review,** which can seriously impact your group's chance for success on the project.

POST-DESIGN REVIEW:

Mistakes and weaknesses noted on the Detailed Design Checklist / Grade Sheet which are not corrected will be doubly penalized when the D.R.3 resubmission is graded. **All drawings updated after the design review must possess updated revision letters** (e.g. update *Rev. A* to *Rev. B,* or *Rev B* to *Rev. C*).

Design Report 3 Resubmission Instructions

Please submit the third design report resubmission via Canvas as one cohesive group document (pdf). Begin each report section on a new page. Separate report sections with consistently printed section dividers (i.e. pages containing the section headings) for easier document navigation; you can use the Appendix template towards the end of this document as a section divider template. Meeting minutes will be individually submitted via a separate Canvas assignment in the form of a pdf.

ORDER REPORT SECTIONS IN THE FOLLOWING SEQUENCE:

1. **New Cover Page** (with updated report number and date)
2. Detailed Design Checklist / Grade Sheet (original copies completed by TA or instructor)
3. Detailed Design Checklist **accurately** completed by team; if your group did not take time to fill it out accurately, do not submit it at all, as submitting an inaccurately completed checklist is worse than not submitting one at all
4. **Detailed Design Resubmission** (revised)
5. **Appendix D: Estimated Project Budget** (revised)

INDIVIDUAL MEETING MINUTES (SUBMIT AS SEPARATE ASSIGNMENTS ON CANVAS):

1. **Meeting Minutes Cover Page** (with member name, report number, and date)
2. **Meeting Minutes Chronologically Ordered** (starting with the oldest at the top (i.e. the most recently completed document will be the last page of the submission))

   NOTE: This submission should include all the meeting minutes in the previous submission.

[**This is the end of D.R.3 Resubmission;** please review the Common Report Errors and Weaknesses section of this Design Report Template before submitting]

Design Project / Design Review Discussion (Team Member Name (1))

NOTE: Each group member must individually complete and submit this assignment.

1. **Individually submit a brief paper (2 - 3 pages) summarizing at least three things you learned leading up to or during the design review process with your TA**, as that really is the main focus of the course, and probably the most valuable exercise in which you participated (since it's identical to what you will experience in industry).

2. **Optionally, I would also like you to include a short section describing how the COVID-19 outbreak has affected your lifestyle and your family--both positively and negatively.** If you don't feel like writing about this topic, no worries, as this section is completely optional.

For this assignment, please use the standard formatting (font, margins, line spacing, etc.) in the DRT Written Description Section.

Also, for this assignment, please focus on the topics outlined above. You will have a chance to provide feedback on the course and write about general things you learned (such as communication skills or manufacturing tools/procedures) in the final course/instructor/TA/teammate evaluation I will ask each of you to fill out the final week of the semester.

[section length is typically 2-4 pages]

Design Report 4 Submission Instructions

Individually submit each DR4 assignment. This is not a group submission.

DO NOT INCLUDE PRIOR DESIGN REPORT CONTENT IN SUBMISSION.

EML2322L – Design and Manufacturing Laboratory

Team Member Name (e.g. Alberta Gator) Meeting Minutes

Team Number (e.g. Team 1A)

Instructor: Mike Braddock

TA: TA Name (assigned 3rd week of semester, so don't worry about this for DR1)

Semester

Date

NOTE: please do not change formatting (i.e. page margins, font type or size, etc.) on this page or in any part of the template

Appendices

Appendices organize your reports by placing related material in one centralized location. Group required items in the sequential appendices listed below:

Appendix A: Decision Matrix Calculations & Justification Data

Appendix B: Robot Path Illustration, Speed & Time Calculations

Appendix C: Wheel and Lifting Motor Torque Calculations

Appendix D: Estimated Project Budget

~~**Appendix E: Final Budget & Purchase Orders**~~

~~**Appendix F: Engineering Change Notice Forms**~~

~~**Appendix G: Robot Wiring Schematic**~~

~~**Appendix H: Final Assembly Drawings & BOM**~~

~~**Appendix I: Meeting Minutes**~~

NOTES ABOUT APPENDICES:

1. **Place appendices at the back of the report.** Each appendix should have its own cover page using the template included on the following page. Separate each appendix with a labeled section divider.

2. **Explain analyses and calculations documented in appendices A, B, and C.** Include all notes, calculations, and units necessary to reproduce the logic behind the decisions made during the project. Present notes and calculations in a neat and logical manner and use proper grammar and complete sentences. For example, “The torque on the lifting arm motor was calculated by ...”.

3. **Appendix A must contain a table of contents (with page numbers) directly after the title page** so the large quantity of material contained therein can be easily navigated.

Appendix A: Decision Matrix Calculations & Justification Data

LEAVE THE REST OF EACH APPENDIX COVER PAGE BLANK

Common Report Errors & Weaknesses

1. **Background research assignment not taken seriously.** If you can't take the time to thoroughly research each topic presented on the course website until you possess a strong understanding of the material, you aren't ready to take this course.

2. **Poorly presented and explained conceptual designs.** You're training to become an engineer, not a cartoonist. Don't present sketches lacking clear detail of real parts or sketches of ideas that haven't been thought through. For example, if you don't know how a component is commonly attached, conduct more research and ask more questions until you do. In addition, do not present an idea without clearly explaining how it works and the materials you would use for each part of it after conducting research.

3. **Weak conceptual design selection criteria.** Present good, unbiased reasons how your group selected its best concept. Explain why you chose each objective for the various evaluation matrices, how you selected their weighting factors, and how you calculated and assigned the scores. *Every single magnitude assignment in your group's evaluation matrices must be justified using logical data.*

4. **Poorly thought out design.** Is the design realizable? Can the design be assembled? How will specific parts be manufactured and attached to one another? If you don't know how a part will be produced, you haven't done enough manufacturing research. Have part tolerances been reviewed to find a balance between part function and manufacturing time? Are the required part tolerances obtainable using processes available in the lab? Have costs been considered? If you don't know the answers to these questions, you need to do more work. Engage the laboratory staff with questions as you continue conducting research in pursuit of answering these questions.

5. **Poorly detailed parts.** Obey the rules summarized in the Dimensioning Rules document and the Detailed Design Checklist. Engage the lab staff with questions about your drawings, part tolerances, material choices, and surface finish specifications. You passed a CAD course, so you are expected to demonstrate that proficiency on each drawing-related assignment.

6. **Figures / tables not labeled properly or not referred to in the report body.** All figures and tables must be labeled with captions. Figure captions should be placed below figures; table captions should be placed above tables. Reference each figure and table in the text by number. Do not capitalize references to figures and tables, such as fig. 1A and table 2 unless they are the first word of a sentence. Number figures sequentially according to each member's group number and capitalize figure and table captions (e.g. Fig. 1A, Fig. 1B for team member 1; and Table 1, Table 2).

7. **Formatting.** Although every person in the group contributes their own work to the design report, formatting should be consistent throughout; therefore all reports must use this template. Do not change the formatting within (e.g. page margins, font style/size/color, line spacing, etc.). Use provided subheadings to separate material in major sections. Do not assemble reports last minute. If you invest serious effort into the project, the reports should show it. Consistent formatting is easy with the provided templates, but it takes time. Use the proper formatting from the start of each assignment, versus spending more time at the end trying to reformat everything to the correct format.

8. **Calculation Reporting Errors.** Use appropriate decimal places relative to the precision of the measured or computed value. For example, do not report estimated manufacturing times as 4.751hr because they are only estimates, so 4.8hr would be more appropriate. The common exception to this rule is US currency, which is traditionally reported as $XX.YY. Since reporting an estimated cost to the nearest cent is unreasonable, it makes sense to report currency to the nearest half or quarter dollar with a note in the table footer saying *costs reported to the nearest quarter or half dollar*.

9. **Organization.** Take time to clearly organize your thoughts. Sections should be well written so the content of each sentence flows logically with the next. Don't throw disconnected sentences together. Write to the point, using as few words as necessary. Use paragraphs to separate your thoughts or points. You've received a lot of education to get to this point and you are expected to use it in this course. If your writing isn't easy to read, please don't complain about the low grade you receive on it, because clear communication is an essential skill for success wherever our life journeys take us.

10. **Grammar / Style.** Your writing, spelling, and grammar will be evaluated to ensure they are at a collegiate level. Every sentence in the design reports should apply to this particular project, as opposed to just being a generality. Write in third person without exception (e.g. avoid the pronouns "I", "we", and "you" in favor of "it", "they", and "(s)he"). Insert two spaces between sentences and a blank line between paragraphs to reduce eye fatigue. Final drafts should be well proofed because writing mistakes will be harshly penalized. If we can't write well, few people are going to take our ideas seriously.

11. **Examples of Common Grammar Problems**. Never use trite words or phrases such as: *usage, utilize, in order to, or very*. Check homonyms. Ensure subject / verb agreement. Understand what a proper noun is and isn't. Understand the difference between commas, colons, and semicolons, and use each appropriately. Review the difference between apostrophes used to make nouns possessive and to form contractions. Do you know the difference between affect (a verb) and effect (a noun)? What about farther and further? Watch out for comma splices, run-on sentences and dangling participles. Always include a referent with "this", such as "this type of steering"; with no referent, "this" only confuses the reader. The same applies for "it", so use it sparingly. Very is an unspecific determinate. If you ask ten people how big very large is, you would get nine different answers. As engineers, we must do a better job quantifying something than by using very. Finally, never end a sentence with a preposition.

These points might seem overly picky; however, covering the basics will greatly improve your ability to communicate effectively, which is a key element of a good engineer. Solid grammar and spelling skills will also keep us from quickly losing credibility with a co-worker or customer who might not be capable of understanding what we do technically, but who can understand our inability to write at an eighth-grade level.