Deliverable E

Project Schedule and Cost

GNG 1103

Group 20

Abstract

This document contains our first prototype design floor plan, bill of materials required for developing the prototype and its presentation, critical risk analysis and contingency planning, and prototype testing plan.

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1. Objective:

Develop project tasks with a schedule view to ensure that your team can complete all three project prototypes from now until the end of the semester and provide an estimation of the costs and the components that will be required for your project. Devise a test plan for your first prototype.

Instructions:

1. First, you need to include a clear and detailed design drawing that summarizes your chosen concept, having refined your ideas into a single idea based on your work in deliverable D. All parts should be included in the detailed design, including fasteners, adhesives, wires, power supplies, libraries or APIs, depending on your project.
   See https://en.wiki.makerepo.com/wiki/Professional_development/Design_thinking/Detailed_designs.
2. To spend your budget, you must have the cost of your materials and components approved by your TA. A product/project cost spreadsheet greatly simplifies this approval and you need to include links to specific products in this spreadsheet or Bill of Materials (BOM). This should include an estimate of the cost for all components and materials (even if they are 0$) which you will need for the different prototyping deliverables described below. Use your detailed design to make sure no items are missing from the BOM.
   See https://en.wiki.makerepo.com/wiki/Professional_development/Project_management/Purchasing_Guide.
3. A list of equipment (software or hardware) needed to build each prototype should also be included. It can contain temporary materials that are only needed for initial prototyping but are not part of the final design (a breadboard for example or a design software like Onshape).
4. Teams must outline a list of the significant project risks and your associated contingency plans to mitigate the critical risks that are reasonably likely, in addition to the task plan update.
5. Teams will outline a prototyping test plan based on the template provided in "Lecture 11 – Prototyping Test Plan" to prepare to build the first prototype in the next deliverable.
   1. Typical objectives include: communicating and getting feedback for ideas, verifying feasibility, analysing critical subsystems or system integration or reducing risk and uncertainty.
   2. You must also define a stopping criteria which will allow you to end the test once you are satisfied that you have achieved your testing objectives.
   3. Be very clear about what you are trying to measure and define an acceptable fidelity based on the objectives of your prototype.
      See https://en.wiki.makerepo.com/wiki/Professional_development/Design_thinking/Design_for_manufacturing.

Three prototyping deliverables will be due from now until the end of the semester (see due dates in BrightSpace). The first prototype will be a basic proof of concept and should be made using materials and components that cost very little (e.g. things found around the house, scraps, etc.). A simple analysis of critical components or systems should also be included, based on your current knowledge of engineering science or other material. If the project is completely software-based, make sure that you include the cost of any special tools or software services that you will need for a functional prototype. Ideally, free software tools should be used only. The second prototype should be of a (or maybe *the* most) critical subsystem, to ensure that your design will work. An analytical, numerical or experimental model should also be included. Finally, the third prototype should be a fully functional version of your solution (i.e. a comprehensive prototype). Many successful groups do *more* than three prototypes, based on their specific project risks, but at least three are required.

For the project, each team will be allocated $100 or $50 (depending on the project). You can take the opportunity to concentrate your purchases on one subsystem and collaborate with other teams to share resources. You will purchase materials and components yourselves and you will bring your TA the original receipts for a reimbursement. It is easier if only one person on your team makes all the purchases, but you must provide the receipts.

In the lab following the submission of this deliverable your group will meet with your PM/TA and you will present your detailed design and your BOM to get feedback about the quality of your design and the manufacturing feasibility, this is called a design review.

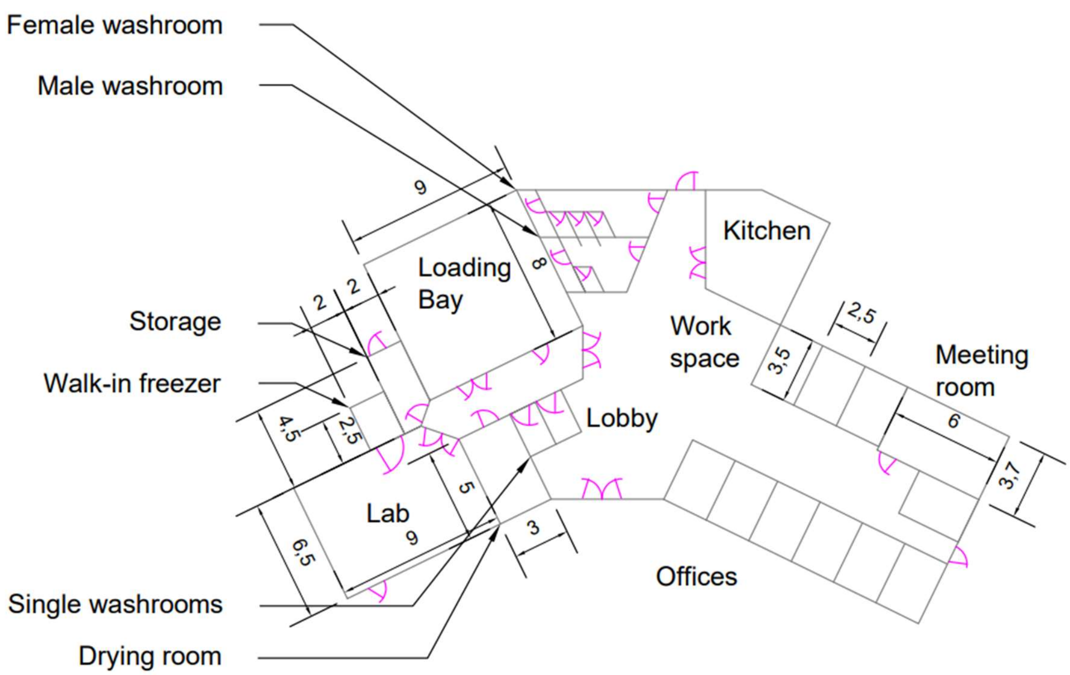
Task Plan Update:

1. Update your Wrike task boards to include any changes in estimated task duration, missing tasks, task responsibilities, milestones, or dependencies, based on your better understanding of the project or based on feedback that you have received from your PM/TA.
2. Include more detailed sub-tasks for the tasks that will need to be completed over the next few weeks.
    - *Important note*: It should be possible for ONE person to complete each identified task or sub-task in the allotted time. The allotted time should also be *reasonable*, based on the task owner's availability. Everyone should be doing their fair share of the work.
3. Verify and update the task start dates and end dates for each task, based on your project progress.
4. Ensure that you have taken into account each team member's *actual* availability over the next two weeks, as well as significant events, such as particularly high course loads, exams or travel, which might be going to limit actual project work progress.
5. For *each* person in your group, it should be possible to determine:
    - What was completed last week (i.e. "**Completed**" tasks),
    - What will be done next (i.e. "**In Progress**" tasks)
    - If tasks are going to be put "**On Hold**" or "**Cancelled**" altogether
6. Any and all group "Issues" should be discussed and dealt with, ideally with the assistance of your Project Manager (PM). This should happen during **each** of your

lab sessions or can happen earlier, using your defined communication methods. As already explained, it is essential to keep your PM/TA "*in the loop*" throughout the term. It is usually *not* a good idea to ignore conflicts between team members. Instead, you should deal with them in a constructive way.

2. Design summary:

2.1. Floor plan:



2.2. Likely iterations:

- Expand drying room width to 4 meters so the door opens inwards.
- Expansion of large washrooms by decreasing angle made between wall with doors and hallway. Also add an extra bend at entrance for privacy.
- Extra layer of doors at main entrance for better insulation from external environment.
- Expand storage width to 3 meters.

3. Bill of materials (BOM):

Required tools	Purpose	Cost ($ CAD)
AutoCAD	2D designs including floor plans.	0
Tinker cad	3D designs for digital visualization and prototyping.	0
RS means	Building cost planning.	0 (free trial)
3D printer	Primary material for creating 3D representations of building exterior and interior subsystems.	0
Laser cutter	Secondary material for creating 3D prototypes. Might omit if not needed.	0
Cardboard + paper	Presentation aids for design day.	0
Either building stress simulation or manual calculation	Calculating stress load on the building.	Unknown

4. Critical risks and contingency planning:

Risk	Probability of occurrence (%)	Impact (least (1) – most (5))	Contingency plan
Final design exceeds cost requirement	90	2	Reduce size of building, or cut out functionalities, or reduce aesthetical elements.
Final design misses more than 1 client needs	90	2	Iterate on design or cut out the unconsidered requirement.
Design planning exceeds time limit	70	4	Cut out functionalities or spend more time working on project.
Prototype fails to withstand required load	80	5	Must increase the structural integrity by improving material or structure.
Prototype fails to consider emergency situations	70	5	Consider the emergency and iterate prototype to accommodate.
Prototype fails to accommodate capacity requirements	70	4	Reconsider capacity and its distribution and increase the size of subsystem to accommodate.
Unable to complete prototype testing in time	90	4	Make assumptions and focus on testing necessary aspects.
Unable to use makerspace due to high human density	90	3	Put more visuals in design day presentation.
Unable to obtain cardboard	60	3	Improvise on ways to display information.

5. Prototype testing plan:

5.1. Aspects to be tested:

1. Loads withstand able by subsections of the building. Subsections will be defined by homogeneous structure, where it can be generalized more easily into a single expression.
2. Occupant capacity.
3. Wheelchair accessibility.
4. Fire emergency evacuation and controlling of fire.
5. Accessibility of building in high snow accumulation.

5.2. Testing methods:

Test 1.a: Since much of the building would likely be constructed with wood and steel framing, we can use miniature models of components with the same material and test for maximum load, then multiply the results to estimate the maximum load of the actual sized component. Note that size and load withstand able is not a direct relationship, this is meant for estimations to obtain a reasonable size for components.

The equation to represent the change in size of a material on its strength is: $f/f_0 = (W_0/W)$^w X (H_0/H)^h X (L_0/L)^l ~= (V_0/V)^v, where f is the strength of a specimen with width W, height H, and length L. f_0 is the strength at a reference point, with corresponding width, height, and length. Each term has an exponent which is the size effect parameter, a constant exponent for specific materials shaped as a rectangular prism. V, V_0, and v is a simplified expression. The size effect parameters w, h, and l, as well as v, can all be assumed to 0.09. Note that this information may not be accurate and should be tested for accuracy. Also, not all materials will fit this relationship.

Test 1.b: Use an online simulation platform to estimate the maximum load. Note that most applications with appropriate features require several hundred $CAD to access.

Tests 1 a and b should collect information on maximum load, which would be used to obtain minimum structural strength for components, which will be used to determine materials to use and size of component.

Stop when a safe measurement and specification for all critical components are acquired.

Test 2.a: Estimate with 1 m^2 squares in logical placements to simulate human traffic. Could be conducted using online platforms such as Tinkercad.

The simulation is used to get an idea of how crowded the subsystems are and produce a list of crowded rooms. If there is limited space between squares, the room can be expected to be crowded.

Stop when the maximum anticipated traffic is subjectively considered acceptable.

Test 3.a: Search the entire building for non-wheelchair friendly areas. This includes inaccessible rooms, pathways, or subsystems.

This should produce a list of inaccessible regions of the building.

Stop when all critical subsystems and exits are accessible to wheelchair users.

Test 4.a: Generate a fire evacuation plan as well as placements of emergency functions. Then estimate capacity based on evacuees per exit, longest distance to closest exit, longest distance to closest emergency functions, etc.

This should produce a fire safety plan and evacuation map.

Stop when a feasible fire safety plan with regards to Ontario Provincial standards in acquired.

Test 5.a: Estimate the requirements for components such as doors, windows, and ventilation at highest snow accumulation in Ontario.

This should produce a list of risked components with a certain height of accumulated snow, as well as the minimum requirement or design of the component to accommodate.

Stop when all critical components are usable at maximum anticipated snow height.