

Progress report:

**Reduction of Snow and Ice Accumulation
on Stairs Through Heated Paneling**

Group 4

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Introduction:

During the original proposal, a tentative timeline was set to manage the work required for designing the Solar Step. The goals set for the past few weeks included deciding on materials, meeting with Paul to discuss his thoughts and concerns, creating sketches to show what the product will look like, completing the analysis on the amount of sunlight needed and power output, and finalizing the cost analysis. Although some are not yet completed, most of these goals were met.

As work was being done, it was decided that the cost analysis should be completed later in the design process. Along with this, the calculations for amount of sunlight, energy created, and power output have proven to be difficult, but the group has been making progress. In the original timeline (Fig 1.1), there was extra time left at the end to compensate for anytime lost to unexpected setbacks or challenges.

Goals Completed:

Material Selection

The first goal was to decide on the type of materials needed to create a durable and efficient product. During the last report many options were discussed. With further research and evaluation, the materials were chosen.

The glass portion of the Solar Step will be made from tempered glass. By using tempered glass, the Solar Step will be able to withstand the weight and stress of having hundreds of people walk on it every day. A problem brought to attention during the last presentation was the fact that the glass could become extremely slippery when wet. With some research it was found that the Solar Roadways Project also used tempered glass for their roads. To combat the lack of traction, the surface was texturized. Solar Roadways were able to create a texture that even when wet, was able to safely stop a car going 80mph (SolarRoadways.com).

Originally the Solar Step was expected to use an industrial type heating element that could reach temperatures over 500°C. Although this would meet the project's goal to melt any snow or ice, it is quite excessive for the scale of this project, whose goal is to only melt about 2-3 inches of snow at a time. For this reason, the project shifted from industrial type heating to a self-regulating medium heating cable. These cables have been implemented mainly on rooftops thus far and have proven to be successful in melting the desired amount of snow (Omega Engineering). The Chromalox SRM/E Self-regulating heating cable is also an energy efficient design, using less energy when less heat is required. Further is that because these cables are self-regulating, overtemperature conditions are virtually impossible meaning that the heating cable never exceeds the desired temperature, saving energy for a period that more energy will be required (Omega Engineering). For these reasons, the Chromalox heating cables were chosen as the heat source in the Solar-Step.

For the project to be successful a well thought out battery choice is essential. Specific standards needed to be met including being able to withstand cold temperatures, being compact, having a

relatively high-power output, having a long-life span and most importantly, being safe to use. By researching common batteries, it was found that lithium batteries would best fit the specified needs for the Solar Step. The next decision was to choose what type of lithium ion battery would be most appropriate. There are four different types of ions that pair with lithium batteries, Lithium-Cobalt oxide, Lithium-Titanite, Lithium Iron Phosphate, and Lithium-Nickle Manganese.

All compounds of lithium ion batteries have their pros and cons. Our most critical attribute for the Solar-Step is energy performance in low temperatures. Companies currently offer Lithium-Titanite batteries which can charge and output at temperatures as low as -60 Celsius with a limited effect on efficiency (Haroon, 2016). However, with this performance comes more upfront cost and temperatures do not necessarily drop to this extent in this specific climate. A more cost-effective alternative is the lithium iron phosphate battery (LiFePO₄). It can operate in temperatures from 0 to -20 however when temperatures approach the -20 range there is an effect on the battery's efficiency (Haroon, 2016). According to the government of Nova Scotia, it is predicted that in 2020 there will only be approximately 4 days in the year where temperatures go below -10 when not including windchill (Scotia, 2014). This battery type also fits our size requirements as they come in a range of sizes. With some quick searching of products, it was found that LiFePO₄ batteries range from 3.2V-96V (Haroon, 2016). In order to determine the optimal battery voltage, further calculations are needed on the watts needed to heat the cable to an effective temperature to melt snow at a rate of 4 cm/hr.

Sketches

A simple 3-D model of the Solar Step has been created using Inventor (Fig 1.2), as well as an exploded view showing the layering of the materials (Fig 1.3). As the design process continues, these drawings may require small changes, but the drawings included show what the Solar Step is currently planned to look like.

Analysis of sunlight, energy, power

Through research it was found that over the months of December 2018 – March 2019 there was a total of 453.5 hours of sun (Antigonish Monthly Climate). The number of hours of sun will change from year to year, but this number helps give an estimate on what to expect. From this value, it can be calculated how much energy the solar panels will be able to create. This will be a low ranged estimate as solar panels continue to produce energy even on cloudy days as well. The analysis will continue over the following weeks to find the amount of energy being created and the amount needed to power the heating coils.

Goals for next report:

The goals for the upcoming weeks include creating more detailed AutoCAD and Inventor drawings, completing the analysis of required power output, looking at the cost of the product and completing the website. The updated timeline shows the remaining weeks and what is planned to be accomplished (Fig 1.4).

Diagrams:

Fig 1.1 Original Proposed Timeline

Week	Presentation	Written report	Assignment/goal
1 (Feb. 3-10)	Completed	Proposal due Feb. 7 th	<ul style="list-style-type: none"> • Finish proposal • Rough sketch of design
2 (Feb. 10-17)			<ul style="list-style-type: none"> • Decide on materials to be used • Meet with Paul
3 (Feb. 17-24)			<ul style="list-style-type: none"> • Drawings of stairs (include solar panels, coils, glass and rubber on bottom of mat) • Engineering analysis of amount of sunlight and power output
4 (Feb. 24-Mar. 2)			<ul style="list-style-type: none"> • Cost analysis (of materials, energy) • Prepare for progress report
5 (Mar. 2 – Mar 9)	Progress report on 3 rd	Progress report on 6 th	<ul style="list-style-type: none"> • Start solving obstacles that were outlined in first proposal
6 (Mar. 9-16)			<ul style="list-style-type: none"> • Prepare for project update
7 (Mar. 16-23)	Project update on 17 th	WEB SUBMISSION	<ul style="list-style-type: none"> • Complete website
8 (Mar. 23-30)	Final report on 24 th	Final report on 27 th	

Fig 1.2 Simple Inventor Drawing

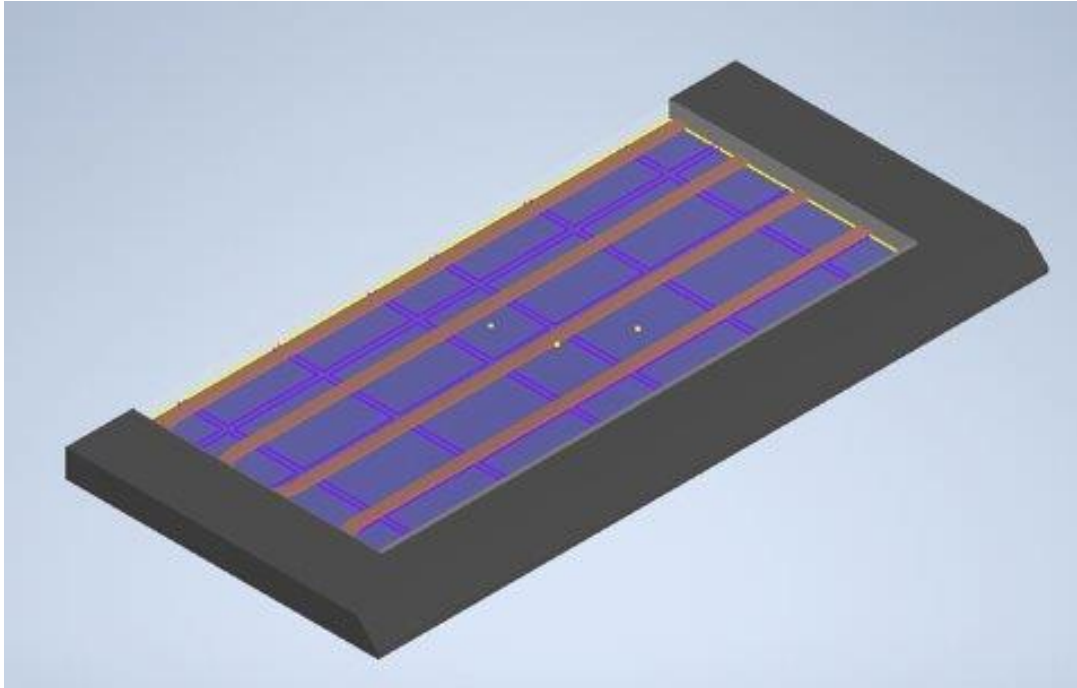


Fig 1.3 Exploded View Inventor Drawing

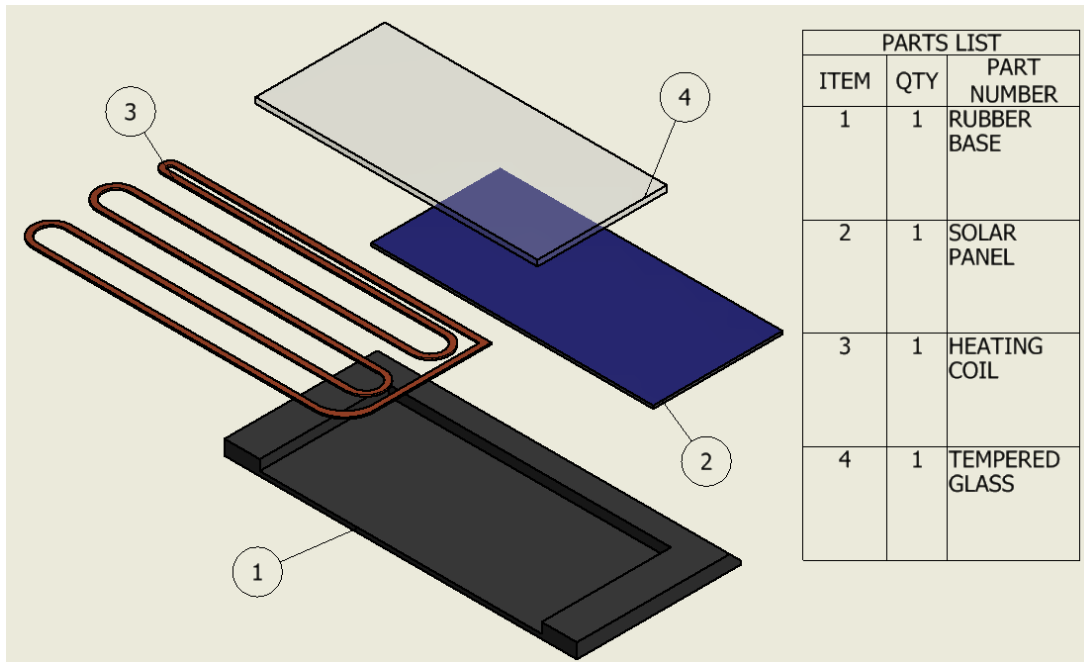


Fig 1.4 Updated Timeline

Week	Presentation	Written report	Assignment/goal
1 (Feb. 3-10)	Completed	Proposal due Feb. 7 th	<ul style="list-style-type: none"> • Finish proposal • Rough sketch of design
2 (Feb. 10-17)			<ul style="list-style-type: none"> • Decide on materials to be used • Meet with Paul
3 (Feb. 17-24)			<ul style="list-style-type: none"> • Sketches of design • Start engineering analysis of amount of sunlight and power output
4 (Feb. 24-Mar. 2)			<ul style="list-style-type: none"> • Prepare for progress report
5 (Mar. 2 – Mar 9)	Progress report on 3 rd	Progress report on 6 th	<ul style="list-style-type: none"> • Start solving obstacles that were outlined in first proposal • Continue analysis of amount of sunlight and power output*
6 (Mar. 9-16)			<ul style="list-style-type: none"> • Prepare for project update • Complete more detailed drawings on AutoCAD and Inventor (include solar panels, coils, glass and rubber on bottom of mat) *
7 (Mar. 16-23)	Project update on 17 th	WEB SUBMISSION	<ul style="list-style-type: none"> • Complete website • Cost analysis (of materials, energy) *
8 (Mar. 23-30)	Final report on 24 th	Final report on 27 th	

*changes made to timeline

References:

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