

Project Deliverable [B]: Needs Identification and Problem Statement

GNG1103[F]: Engineering Design

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Introduction:

In this briefing, Team 5 will identify, interpret, analyze, and prioritize client, Jonathan Rausseo's, needs in order to begin the process of developing a design for a heated sidewalk. After empathizing with the client, these criteria were recorded by the team during a 'Q and A session', during Client Meet 1 on January 27, 2021. Once the client's needs are identified, interpreted, and ranked, Team 5 will perform user benchmarking to explore similar products currently on the market, along with their challenges. These products include glycol/water and electric-powered snow melting technologies for sidewalks. This research will be reflected against the client's needs, to help determine additional needs and challenges faced when designing the heated sidewalks. Additionally, the analysis performed through user benchmarking will help further identify needs and refine questions for the client, during the upcoming Client Meet 2. Lastly, a problem statement will be defined to summarize the client's essential needs; this will help guide the team when brainstorming solutions in upcoming Deliverables.

Problem Statement:

A solution is needed to quickly and effectively melt snow off of the sidewalks, high traffic areas and emergency exits at the University of Ottawa without compromising safety. The environment must be protected while still allowing this solution to be modular and scalable.

Interpreting client needs:

Following Client Meeting 1, we were able to interpret the needs of the client as well as establish the importance of each need on a scale from one to five, with five being the most important, and one being least important. These results are shown in Tables 1 and 2 below. Through this process, we found that needs related to the safety of the sidewalk were the most important to the client, as shown in Table 2 below. We also found that the product should be easy to assemble, deconstruct, and maintain.

Table 1: Interpreting Client's Needs from Client Meeting 1

Question	Customer Statement	Interpreted Need
<i>Typical Uses</i>	<ul style="list-style-type: none">· There needs to be a place for the water to drain· Need a sidewalk that allows students with physical disabilities to get around campus· The sidewalk has to be removed in the summer· Has to be modular· Needs to be scalable to deploy across all of campus· The sidewalk has to be easy to maintain and clean· Needs to be capable of melting snow right away· Has to provide traction to prevent slipping· Will be used in high traffic areas	<ul style="list-style-type: none">· Drainage system· Clear snow and ice quickly· Ability to be deconstructed· The sidewalk is easy to assemble· The sidewalk is easy to assemble· Easy to maintain· Clear snow and ice quickly· Safe to walk on· Durable
<i>Likes (current method)</i>	<ul style="list-style-type: none">· The cost of salt is cheap· No initial investment· Simple to maintain· Removes the snow and ice	<ul style="list-style-type: none">· Low cost· Low cost· Easy to maintain· Clear snow and ice quickly

<i>Dislikes (current method)</i>	<ul style="list-style-type: none"> · Salt causes damage to infrastructure and wildlife on campus · Salt and sand can travel on shoes to indoor spaces · There is a cost to apply the salt every time it is needed 	<ul style="list-style-type: none"> · Safe for the environment · Ability to keep salt and sand off the surface · Low cost
<i>Suggested Improvements</i>	<ul style="list-style-type: none"> · It would be preferable to have a more environmentally friendly product · on/off switch to put the heating system to sleep when not needed · A compact solution is also preferable 	<ul style="list-style-type: none"> · Safe for the environment · Energy efficient · Storable

Table 2: Ranking the Customers Needs by Importance

<i>Number</i>	Need	Importance
<i>1</i>	Drainage system	5
<i>2</i>	Clear snow/ice off quickly	5
<i>3</i>	Ability to be deconstructed	4
<i>4</i>	Easy to assemble	4
<i>5</i>	Easy to maintain	4
<i>6</i>	Safe to walk on	5
<i>7</i>	Low cost	2
<i>8</i>	Safe for the environment	4
<i>9</i>	Ability to keep salt and sand off the surface	3
<i>10</i>	Energy efficient	2
<i>11</i>	Storable	2
<i>12</i>	Durable	4

User Benchmarking:

User Benchmarking was used throughout this Deliverable. There are two main designs for Heated Sidewalks: Glycol/Water Mixture and Electric. The ranking system takes into account the client's requirements, weighted by importance and compares the research found for each design. The benchmarking tables are colour coded based on the quality of the design. See Appendices A, B, C, D, and E.

Glycol/Water Mixture Benchmarking :

One method of removing ice and snow in high traffic areas without the use of salt is a glycol/water mixture system. This system consists of a glycol/water mixture at a very high temperature, which is run through a series of tubes that line the area required to be maintained. The installation of the tubing differs depending on the type of system implemented. The client specified that the system should be modular and removable at the end of the winter season. Based on the research provided (See Appendix A, Table 3), most of the outdoor and durable glycol/water systems are permanent/long term options. There was only one option that was installed in panels. The panel system allows for easier maintenance; if tubing breaks, the individual panel can be removed. In the other system designs, concrete is poured over the tubing. If the tubing breaks, the entire system must be replaced. The concrete option is better for the environment, as if the tubing is broken, the mixture is trapped between multiple layers of concrete and would not be exposed to the surrounding environment. Compared to the panel option, the concrete solution would be in direct contact to people, animals, and the ecosystem. A draining system for the melted snow and ice to drain off the mat was only included in two models, but would not be difficult to incorporate into the design. In terms of melting the snow and ice, all of the designs are comparable in the amount of heat provided. The system with the highest ranking, taking into consideration the client's needs and requirements, was the panel system with a score of 101 (See Appendix B, Table. 4). However, the aforementioned designs do not fully satisfy some of the client's most important requirements, such as removability and storage capability of the heated sidewalk, as these designs are fixed, long-term and permanent solutions.

Electric User Benchmarking:

Electrically powered snow melting technologies have taken on the market in the recent years. As the risks associated with slipping and falling on used pathways and snowy walkways remains a large concern, such devices are an effective technology to decrease the chances of injury due to such weather. Through research, it was determined that electrically powered snow-melting devices are by far the most popular. There are many different applications and installations possible for such devices; yet our research was focused on user-friendly, storable devices which would mostly be situated at essential emergency exits and low pedestrian traffic sidewalks.

The client, Jonathan Rausseo, identified that this project is a passion-project for him as he is very involved in preserving and protecting the natural environment and all its inhabitants. The electric model is ecologically safe as it does not require the application of any bio-hazardous chemicals or materials. Due to the modularity of most electrically-powered designs, it can be installed then disassembled and stored as one pleases. All models are portable and user friendly making the devices easy to maintain and user-friendly allowing for simple application and decreasing any risk factors associated with misuse and installation errors (Appendix C; Table 5).

Financially, this design is more costly when compared to a hydraulic design as it accounts for the electrically usage as well. Price is important as the transition between the depends on a cheap substance, such as salt, is highly elevated. The price of this technology will be worth it in the long run as it is durable and energy efficient depending on the electrical input source.

Overall, the electrical models present with an average of 92.67 when compared to the hydraulic systems which scored an average of 83.43 (Appendix B; Table 4 and Appendix d; Table 6) therefore demonstrating that even though none of the models account for all of the client needs and specifications, the electric model would serve as a good basis for further research and development.

Conclusion:

In this report, the client, Jonathan Rausseo's, needs were identified, ranked, and discussed, resulting in the formulation of a problem statement. The client essentially requires an effective, environmentally-friendly, modular, and scalable solution to melt snow off of sidewalks which carry a large volume of pedestrian traffic at the University of Ottawa. User Benchmarking was then performed to analyze the challenges of existing products, which have the potential to provide a solution to the problem. These products were compared against the client's needs to help identify further challenges Team 5 may face when designing the heated sidewalk for the client. After this analysis, the Team will further develop questions for the client to identify more specific, additional needs, during Client Meet 2. This will be discussed at length in future Deliverables.

Appendices:

Appendix A: User Benchmarking Glycol/Water Mixture Heated Sidewalks

Table 3. User Benchmarking Glycol/Water Mixture Heated Sidewalks

Specifications	Glycol/Water Mixture Heated Sidewalks						
Company/Name	Hydronics.com	Therma-Hexx	Hydronic Snowmelt System	SIM Systems	Metrolinx: Glycol Solution Snow Melting System	Lee's Hydronics'	Watts Heatway
Drainage system	Not Listed	Yes	Not Listed	Yes	Not Listed	Not Listed	Not Listed
Clear snow/ice off quickly	Moderately - glycol mixture below the concrete	Moderately - glycol mixture below panel sections	Moderately - glycol mixture below the concrete	Moderately - glycol mixture below the concrete	Yes - Operating Conditions: -50°C to 95°C (-58°F to 203°F) at 87 PSIG	Moderately - glycol mixture below the concrete	Moderately - glycol mixture below the concrete
Ability to be deconstructed	No - Concrete/Asphalt	Yes - Panel Sections	No - Mixture of asphalt, concrete and sand bed	No - Mixture of asphalt, concrete	No - Mixture of asphalt, concrete	No - Concrete/Asphalt	No - Concrete/Asphalt
Easy to assemble	No - concrete mixture poured over the system	Yes - Individual panels	No - concrete mixture poured over the system	No - concrete mixture poured over the system	No - concrete mixture poured over the system	No - concrete mixture poured over the system	No - concrete mixture poured over the system

Easy to maintain	No - if tubing breaks, the entire system will have to be replaced	Yes - Individual Panel can be replaced	No - if tubing breaks, the entire system will have to be replaced	No - if tubing breaks, the entire system will have to be replaced	No - if tubing breaks, the entire system will have to be replaced	No - if tubing breaks, the entire system will have to be replaced	No - if tubing breaks, the entire system will have to be replaced
Safe to walk on	Yes - flat surface with texture (concrete surface)	Yes	Yes - flat surface with texture (concrete surface)	Yes - flat surface with texture (concrete surface)	Yes - flat surface with texture (concrete surface)	Yes - flat surface with texture (concrete surface)	Yes - flat surface with texture (concrete surface)
Safe for the environment	Yes - Tubing embedded below the surface	Moderately - if tubing breaks it can be exposed to surface (glycol mixture is poisonous to the environment)	Yes - Tubing embedded below the surface	Yes - Tubing embedded below the surface	Yes - Tubing embedded below the surface	Yes - Tubing embedded below the surface	Yes - Tubing embedded below the surface
Ability to keep salt and sand off the surface	No - Sand/Salt will eat away at the surface	No - Sand/Salt will eat away at the surface	No - Sand/Salt will eat away at the surface	No - Sand/Salt will eat away at the surface	No - Sand/Salt will eat away at the surface	No - Sand/Salt will eat away at the surface	No - Sand/Salt will eat away at the surface
Energy Efficient	Moderately - 150,000 BTU/h	Not listed	Moderately - 200 and 220 BTUs per sq. ft. per hour - Requirements for busy streets and emergency exits	Moderately - 150,000 Btu/h	Not listed	Moderately - 100 to 150 Btu per square foot of slab surface required	Moderately - 100 to 150 Btu per square foot of slab surface required
Low Cost	Moderately - roughly \$40/8hr	Not listed	Not listed	Not listed	Not listed	Moderately - \$5-10 per square foot to install	Yes - 12-25 cents per square foot

Storage	No - permanent solution	No - permanent solution	No - permanent solution	No - permanent solution	No - permanent solution	No - permanent solution	No - permanent solution
Durable	Yes - Long term Solution	Moderately - Installed in pieces	Yes - Long term Solution	Yes - Long term Solution	Yes - Long term Solution	Yes - Long term Solution	Yes - Long term Solution

Appendix B: User Benchmarking Glycol/Water Mixture Heated Sidewalks Ranking by Importance

Table 4. User Benchmarking Glycol/Water Mixture Heated Sidewalks Ranking by Importance

Specifications	Importance	Glycol/Water Mixture Heated Sidewalks						
Company or Name	N/A	Hydronics.com	Therma-Hexx	Hydronic Snowmelt System	SIM Systems	Metrolinx : Glycol Solution Snow Melting System	Lee's Hydronics	Watts Heatway
Drainage system	5	1	3	1	3	1	1	1
Clear snow/ice off quickly	5	2	2	2	2	3	2	2
Ability to be deconstructed	4	1	3	1	1	1	1	1
Easy to assemble	4	1	3	1	1	1	1	1
Easy to maintain	4	1	3	1	1	1	1	1
Safe to walk on	5	3	3	3	3	3	3	3
Safe for the environment	4	3	2	3	3	3	3	3
Ability to keep salt and sand off the surface	3	1	1	1	1	1	1	1
Energy Efficient	2	2	1	2	2	1	2	2
Low Cost	2	2	1	1	1	1	2	3
Storage	2	1	1	1	1	1	1	1
Durable	4	3	2	3	3	3	3	3

Total	-	79	101	77	87	80	79	81
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Appendix C: User Benchmarking Electric Heated Sidewalks

Table 5. User Benchmarking Electric Heated Sidewalks[illegible]

Ability to keep salt and sand off the surface	Not listed	Not listed	Not listed	Not listed	Not listed	Not listed
Energy Efficient	540 Watts, 120 Volt, (~11.3 Amps for the 2'ft x 5'ft mat)	180 Watts, 120 Volts, 1.5 Amps	240 Watts, 110 Volts, 2.18 Amps	100 Watts, 120 Volts, 1.3 Amps	350 Watts, 120 Volts, 15 Amps	120 Volts
Low Cost	Size dependant (average: \$23.85/ft²)	\$48.33/ft²	\$27.87/ft²	\$9.58/ft²	\$39.29/ft²	\$23.19/ft²
Storage	Not listed	Not listed	Not listed	Not listed	Not listed	Not listed
Durable	Weight will damage heating element (wheelchair is fine)	1-year warranty	6-month warranty	2-year warranty	2-year warranty	Not listed

Appendix D: User Benchmarking Electric Heated Sidewalks Ranking by Importance

Table 6. User Benchmarking Electric Heated Sidewalks Ranking by Importance

Specifications	Importance	Electric Heated Sidewalks					
Company or Name	N/A	Roof Heating Systems: RHS Snow Melting Mat/System	Power Blanket: Summer step Home DM24x36C-RES Residential Snow Melting Heated Door Mat	Cozy Products ICE-SNOW Ice-Away Heated Snow Melting Mat	HeatTrak HR20-60	HOTflake Outdoor Heated Snow Melting Walkway Mat	SEAL Snow Melting Mat
Drainage system	5	1	1	1	1	1	1
Clear snow/ice off quickly	5	3	3	1	3	3	3
Ability to be deconstructed	4	3	3	3	3	3	3
Easy to assemble	4	3	3	3	3	3	3
Easy to maintain	4	2	2	2	2	2	2
Safe to walk on	5	3	3	3	3	3	3
Safe for the environment	4	2	2	2	2	2	2
Ability to keep salt and sand off the surface	3	1	1	1	1	1	1
Energy Efficient	2	1	3	2	3	1	2
Low Cost	2	2	1	2	3	1	2
Storage	2	1	1	1	1	1	1
Durable	4	1	2	2	2	2	1
Total		90	96	86	100	92	92

Appendix E: Colour Legend for Ranking Scale

Table 7. Colour Legend for Ranking Scale

Good = 3
Average = 2
Bad = 1