GNG 1103

Design Project User and Product Manual

Ultimat

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BOM	Bill of Materials

Table 2. Glossary

Term	Acronym	Definition
Ultimat		The final prototype

1 Introduction

First, it will explain the materials used in the device and how the prototype was developed and designed. The mechanical tutorial covers the process of making heating mats for this equipment. This heating mat can be laid on the sidewalk. It looks simple but can melt snow and protect the surface of the sidewalk. Finally, a tutorial is provided so that users can easily understand how to use and maintain the equipment and the required materials. This document ensures that users can thoroughly understand how the device works, allowing them to use it effectively for years to come.

Ottawa is a city with a long winter cycle. There is usually a lot of snow on the sidewalks to allow people to go through. Cleaning departments often use chemical salts to create chemical reactions that melt snow, but these chemicals often leave stains on crosswalks and pedestrian shoes after cleaning. Although this is a very good way to help pedestrians pass on the crosswalk normally, it is not a small problem to clean the surface of the crosswalk and shoes. Normal cleaning cannot remove the stains on the crosswalk. However, cleaners don't put chemical salts on the roads all the time to help melt the snow, so the snow doesn't melt on time and pedestrians can't walk on the sidewalks.

2 Overview

The people most affected by the snow are students and staff at schools. They needed a controlled heating mat that could melt snow by using an internal heater to raise the surface temperature of the mat. The device is very easy to disassemble and contains a Bluetooth sensor and a temperature sensor inside, so that users can control the heating pad remotely, giving full play to its function and saving electricity.

The most effective way to solve a problem is usually to be inspired by something that works. The proposed device is designed to be a very common cushion but capable of heating and melting snow in its harsh environment and has a streamlined surface. This design makes it easy to discharge the melted snow water effectively. The most important thing is that our design is very convenient and convenient and can melt the snow. Our internal heating device is based on the design of car heating seats. The internal heating wire is a cheap but durable material. If the budget allows, the Bluetooth APP designed by us can remotely control the heating pad. These designs prevent snow accumulation on the crosswalk and prevent chemical salts from damaging the crosswalk surface.

The proposed equipment is reasonably priced, light in weight, compact in result and easy to disassemble and install; An internal heating device provides heat to the surface of the heating pad to create the effect of melting snow. Because the heating equipment inside the heating pad is composed of wires, the possibility of preventing electricity leakage is taken into account, and the safety of pedestrians is protected through the insulation of the heating pad. The device communicates with a smartphone app via Bluetooth, which can learn the exact temperature of the heating pad from the phone using the pad's temperature sensor, and turn off the power if necessary. The equipment is used outdoors for long periods of time and can be easily cleaned so that it is ready and ready for use at any time required.

When using snow melt heating pads, users need to follow the appropriate conditions and use them in the appropriate environment. The whole equipment is based on the internal heating equipment

as the core, so as to heat the work. The heating device controls the device by using a heating switch and then passes the instructions to the heating wires. When the heating wire receives the heating instruction, the surface heats up and transfers the heat to the surface of the heating pad. If the budget allows, the internal structure will use the Arduino device and add a temperature sensor and Bluetooth sensor to connect the Bluetooth APP created for mobile phones. There are four buttons on the homepage of the app: Scan, Stop Scan, Connect and Disconnect. Users search and Connect Bluetooth devices using Scan and Stop Scan, and select and Disconnect connections using Connect and Disconnect. APP basically has two functions. One is to connect Bluetooth for matching, and the other is to display the internal temperature of the heating pad. The user decides whether to turn off the heating device by looking at the temperature data in the app. In terms of external design, the overall design takes into account the footstep area required by the user and the friction force of the heating pad, thus forming a segmented design.

Figure 1 : Final Prototype

2.1 Conventions

Conventions	Description
Chemical salt	Salt chemical substance refers to a metal ion, or ammonium ion (NH4 +) combined with acid radical ion or non-metal ion compound, such as calcium sulfate, copper chloride, sodium acetate, salt is usually the product of metathesis reaction, such as the production of sulfuric acid With sodium hydroxide, sodium sulfate and water, there are other reactions that can form salts, such as displacement reactions.

Chemical reaction	A chemical reaction is a process in which one or more substances (also called reactants) are transformed into products different from the reactants through chemical changes.
Rubber material	Rubber is a material that can stretch and shrink. It is a polymer. It can be produced from natural resources (such as natural rubber), or it can be synthesized on an industrial scale. Many things are made of rubber, such as gloves, tires, plugs and masks.
Aluminium wire	Compared with copper wire, aluminum wire has good electrical and mechanical properties and price advantages, and is an alternative conductive material.
Arduino	Arduino is an open source electronic platform or circuit board and software for programming.
Temperature sensor	A temperature sensor is an electronic device that measures the ambient temperature and converts the input data into electronic data to record, monitor or signal temperature changes.
Bluetooth sensor	Bluetooth Sensor is a mobile device connected to a blue device via Arduino.
Scan	Scan is the switch on the main interface of the app that connects the mobile device.
Stop scan	Stop scan is the switch on the main interface of the app that is responsible for unconnecting the mobile device.
Connect	Connect is the button that connects the connected device once it has been selected.
Disconnect	Disconnect is the button that shuts down the

	connected device.
Short circuit	A resistance circuit is a circuit with lower resistance than a normal circuit, especially a circuit caused by accidental contact of components and accidental transfer of current.

2.2 Cautions & Warnings

It is important to note before use that the device is connected to a circuit for heating purposes. In the process of heating pad work, do not open the surface of the heating pad without the right to make the internal heating device exposed to harsh environment, resulting in heating equipment to form a short circuit; In severe cases it can cause fires and damage equipment

3 Getting started

To begin with this section, a brief summary of the setup and removal process will be provided. More information and images can be found below in sections 3.1 – 3.5.

To set up Ultimat, all that needs to be done for a single iteration of Ultimat is to plug it in to a 120V outlet with the provided orange cord. This will start the sensor within Ultimat and automatically heat the sidewalk to maintain ~10°C. If multiple tiles are desired, a few things should be noted. Firstly, power is supplied to each tile individually rather than plugging one mat into another. Second, connectors are easier installed before the tile is placed. By placing 3 connectors to the underside of Ultimat before laying down the mat, it will provide a location for a second mat to be placed directly on top of the previous connectors, attaching tiles to one another.

Removing Ultimat is a simple process, requiring that you only have to unplug the power cord to stop supplying power and lift up the mat to remove connectors.

3.1 Set-up Considerations

Equipment: (Figure 2)

- Heating Wire (attached to surface)
- Support structure (attached to surface)
- Nitrile surface
- Connector x3

Figure 2 - Complete List of Equipment

Four components of the sidewalk are listed above, though 3 of the four are attached to one another. When working with Ultimat, it is important to note that each tile of sidewalk will be working with only the surface and 3-6 connectors. Other components are listed above in case parts are damaged or removed.

Ultimat is designed to be simple and easy to set up since it only has one electrical input to be powered by a 120V outlet. Since it requires no special conditions other than a standard power input, other attachments like a switch can be added to the same plug. Multiple iterations of Ultimat run parallel to one another, so they will be powered by separate outlets rather than plug into one another (though power bars or other power splitters can be used to make this more feasible). Since the temperature sensor is built-in to the wire, no other considerations need to be made in terms of power.

If connectors between multiple iterations of Ultimat are desired, it is easier to attach them before laying down the tile. On the underside of the tile, 6 grooves matching the extrusions on the connectors can be found. Placing 3 connectors in the grooves on one side (see Figure [][]) before laying down the mat will set up a position to place the next mat since the next mat can follow the same procedure and be placed directly on the previous tile's connection (see Figure [][]).

Figure 3 - Connectors Installed to Surface

Figure 4 - Sidewalk Prepared for Extra Connection

3.2 User Access Considerations

Many different users can use the sidewalk with ease with very few limitations. Since the width of the water channels is modelled after a water drain found on roads (see Figure 5), 1.5-inch gaps between walking surfaces should allow ease of traveling overtop for people to walk or pass over on a wheelchair. However, the channels are approximately ⅛ inches deep with rigid corners on the walking surfaces, so people using a white cane may have the cane caught occasionally. No testing was done with this, but it may be something to consider.

Figure 5 - Surface Element with Tape

Since the mats are made of a soft, flexible rubber, attaching no connector pieces on an end of the sidewalk will cause it to naturally flop, creating a ramp-like surface to make it easier to get on for those who may struggle with initially getting on top (see Figure [][]).

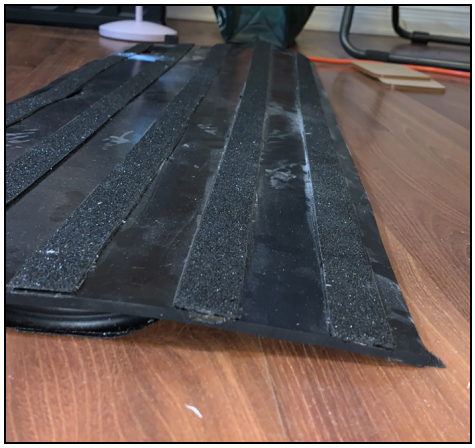

Figure 6 - Natural Slant on Exits

3.3 Accessing the System

No access is specifically required in terms of ID or passwords. Since the temperature sensor heats up the wire automatically once it is receiving power, all that needs to be done to turn on or install Ultimat is to plug it in. Any power bar or external manual override may have their own precautions that may need to be followed separately before attaching Ultimat.

3.4 System Organization & Navigation

Surface (Topside)

On the top face of the surface, water channels and non-slip strips can be seen. These strips are 1.5 inches wide with 1.5 inches between them, and lifted off the surface with layered weatherproof adhesive tape to create channels with a depth of ⅛ inches. These strips run parallel to the long face of the surface, spanning 3 feet to cover the entire width of a standard sidewalk.

Figure 5 - Surface Element with Tape

Underneath the surface can be found 7 main support structures and 1 heating cable with an attached temperature sensor. In Figure [][] it can be seen that these main support structures contain 3 that support the center of the structure and 4 that are placed between connectors (2 supports on either side). These are coated with a weatherproof adhesive to strengthen the supports as well as proved some grip to surfaces the sidewalk is laying on. These supports are put in place to level the sidewalk more effectively with the addition of connectors, but are not fully necessary without connectors. However, the connectors may improve the lifespan of the functionality of the heating wire, which can be seen to be laid out between the support structures and connecting pieces. The heating wire nearly makes one complete lap around the tile, ending the wire on that same side that it begins. The temperature sensor can be seen in orange on the far end of Figure [][], making direct contact to the sidewalk and is placed at the beginning of the circuit. In the case of this image, it can be seen that Ultimat would be plugged into an outlet on the far side of the mat since that is where the circuit begins and ends.

Figure 7 - Bottom of Surface Element

Figure 8 - Wire Pattern on Bottom of Surface

The underside also features grooves or holes that are positioned along either long side of the sidewalk tile. On each side, one is placed in the middle, and the other two are placed closer to the edges, 12 inches apart from the center.

Connector

6 connecting pieces are modelled all alike, so they can be attached to any hole in the underside. Each connector has 2 extrusions (as seen sealed with black weatherproof tape in Figure [][]), each of which will be connected to a different tile. Each sidewalk will contain 6 points at which a connector can be attached by fitting the extrusion on the connector to a hole on the underside of the sidewalk.

Figure 9 - Final Connector Element

3.5 Exiting the System

To turn off the mat or to remove it properly, all that needs to be done is to simply unplug it and it will power down on its own. Unless an external manual override is attached, no further actions need to be made to disassemble or put away equipment. Since the sidewalk can be used with external attachments such as manual override, specific precautions must still be made to remove those or turn those off in addition to just unplugging Ultimat.

Removing connectors from Ultimat requires only that the sidewalk is lifted, and connectors can be removed from the grooves underneath.

4 Using the System

4.1 Connector

A connector has 3 thin rectangular at each side, and they can fit into the rectangular holes at the edge of the each Ultimat unit, In order to connect 2 Ultimat units, plug the connector into the surface, so the thin cylinders on the connector can fulfill the surface of the Ultimat. To have a better connecting strength and avoid the slippery, at least 3 connectors are required to connect 2 pieces of Ultimat. If the product is installed on the stair, no connector is required. Refer to Figure4.

4.2 Heating Element

The heating component is inserted into the bottom of the surface, and it is covered and protected by the rubber surface. The heating element can be simply turned on by inserting the power plug and keeping the switch on. If you need the Ultimat to stop working, firstly turn the switch off and disconnect to the power. Refer to Figure# in the Equipment list.

When the Ultimat is stored and not used, make sure that there is no water left over on the surface, then keep it in a dry and cool place.

4.3 Temperature sensor in wire

The wire of the heating element contains a temperature sensor that could detect the temperature if the temperature is not within the safe range. If the temperature is too high, the heating element would give warning to the user and stop heating if necessary. Refer to Figure# in the Equipment list/

5 Troubleshooting & Support

Occasionally, heating elements are accidentally crushed or drilled or cut. Don't worry if this happens to you. Ultimat can be repaired easily even if it has already been placed. If a heating

element is damaged please contact your supplier to arrange for a repair kit and easy to follow instructions to be sent to you.

If your mat isn't working, first check to see if your mat is plugged in, then unplug it and plug it back in. Next, fold and unfold your mat to make sure it's flat. Then heat it up covered on the maximum temperature for 25 minutes and make sure the app works properly. If the app isn't working, there are things you can try. Unplug it from the mat and the wall, then plug it in again. Try using a different outlet, and use a singular outlet rather than a surge protector. Make sure you plug the controller all the way in on both ends. If you're still having issues, please contact us.

5.1 Error Messages or Behaviors

- **If the cable was damaged during installation and needs to be repaired**

  If the location of the damage is known, you need a Heating Cable Repair Kit and the proper tools to complete the repair.

  If the location of the damage is not known, we have tools that can help you find the damage, contact us for details.

- **If the ohm value does not match range shown on ID tag**

  Your Ohmmeter may be on the wrong scale, for instance, the 200k ohms scale measures up to 200,000 ohms, or 200k Ω.

  The meter should typically be set on the 200 ohms scale (200 Ω) for testing cables with an ohm value less than 200 ohms.

- **If the system is not responding to snow sensor, not automatically turning on**

  Is your snow sensor located where it is exposed to the weather and has been covered with winter precipitation?

  If not, consider alternative locations for the sensor so it will be more likely to receive unobstructed precipitation. When the air temperature outside is too cold, some Ultimat systems may just take longer to melt the precipitation.

5.2 Special Considerations

If there is internal overheating, contact us. Ultimat is sensitive against bending. Do not fold from the middle, this may cause wires detached from the surface. Never cut the heating cable. A heating cable will not work if it has been cut. If the heating cable is too long, call us to consult with a technician who will guide you in utilizing the additional length of cable.

5.3 Maintenance

Damages that may occur over time must be controlled. Make sure the cable and the heating element are not damaged. Connecting elements must be attached to the Ultimat, before the mat plugged in. Keep the mat in a dry and ventilated place. Your mat will last longer the less you fold or bend it.

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5.4 Support

We can put you in contact with a technician for your product who can troubleshoot the unit with you and replace it if necessary.

If you wish to email us directly please use the following addresses:

Technical enquiries - apled085@uottawa.ca

Training enquiries - csay028@uottawa.ca

Call us on +1-613-413-0777 option 1 for Technical Support

Our online chat is available between the hours of 8.30AM - 5.30PM, please email us for a reservation. Address: 111 Cooper street, Ottawa, ON, K2P2E3

6 Product Documentation

The final prototype is made up of three subsystems; the surface element, the connector element and the heating element. Each subsystem was constructed separately and put together at the end.

6.1 Surface Element of Prototype

The surface element is a 3ft wide by 1ft long piece of rubber nitrile that has five rows of elevated grip tape to increase traction and the safety of the mat. The initial conceptual design of the surface element was a rubber mat with vertical lines to increase the traction and can be seen in figure ().

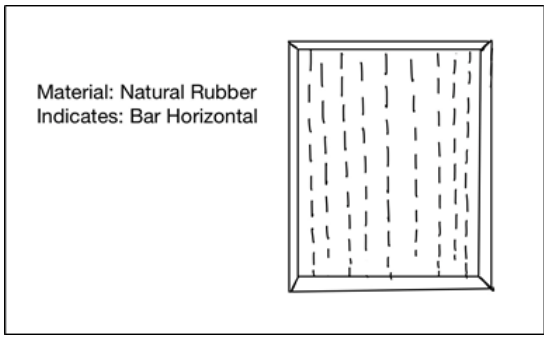

Figure 10 - Conceptual Surface Element Design

The final prototype is made from rubber nitrile but could be replaced with any other available durable rubber material that is rigid although new materials have not been tested. The nitrile could also be replaced with a pre-existing outdoor mat and in that case, the grip tape would not need to be purchased. The bottom of the mat has pieces of acrylic that are wrapped in weather resistant gorilla tape and are used as supports. The laser cut acrylic pieces could be replaced with hard plastic or stainless steel, as long as the material is strong and lightweight, it can be used under the mat as a support.

6.1.1 BOM (Bill of Materials)

Based on the conceptual design, a list of required materials was made. As a group, we decided to use rubber nitrile as the material for the surface. Originally, we were going to purchase a mat that already had grip on the surface, but due to our limited budget, the rubber nitrile was the most cost effective. With cuts in our budget in the heating element subsystem, our budget allowed for extra safety features to be added to the surface element. The grip tape was added to the bill of materials

along with weather resistant gorilla tape. While working on our prototype at the makerspace, large pieces of acrylic were found in the waste bin and we used them for free in our prototype as supports.

Table 3 - Bill Of Materials for Surface Element

Component	**Name**	**Unit Cost**	**Amount**	**Shipping**	**Total Cost**
Surface	Nitrile	$26.87	1	$0	$26.87
Surface	Grip Tape	$9.97	1	N/A	$11.25
Surface	Gorilla Tape	$14.97	1	N/A	$16.90
Surface	Scrap Acrylic	$0	1 piece	N/A	$0
Total					**$55.02**

6.1.2 Equipment list

The construction of the surface element was done by using some equipment at the makerspace along with standard handheld tools.

Table 4 - List of Equipment and Tools Used for Surface Element

#	**Tools and Equipment**	**Use**
1	Laser Cutter	Cutting out the acrylic supports
2	Exacto Knife	Cutting the rectangles for the connector
3	Scissors	Cutting the tape used
4	Tape Measure	Measuring the tape and rectangular holes

6.1.3 Instructions

To start the construction of the surface element, the piece of rubber nitrile was measured and was found to be 3 feet wide by 1 foot long. We started by measuring ½” away from the beginning and marking the spot with a silver marker. Then measured 1” away from the previously measured spot and then from that spot 1.5”. This was repeated until the end of the mat was reached alternating measuring 1 inch and 1.5 inches. Once all of the lines were marked out, long strips of gorilla tape were cut in half lengthwise and placed along the measured 1 inch apart lines. Four layers of the gorilla tape were placed on each row and then the grip tape was measured and placed on top of the layered gorilla tape creating channels.

Figure 5 - Surface Element With Tape

Once the tape was applied on the surface, we had to focus on the bottom supports of the surface element. Inkscape was used to create the shapes that were then going to be cut out of the scrape piece of acrylic with the laser cutter.

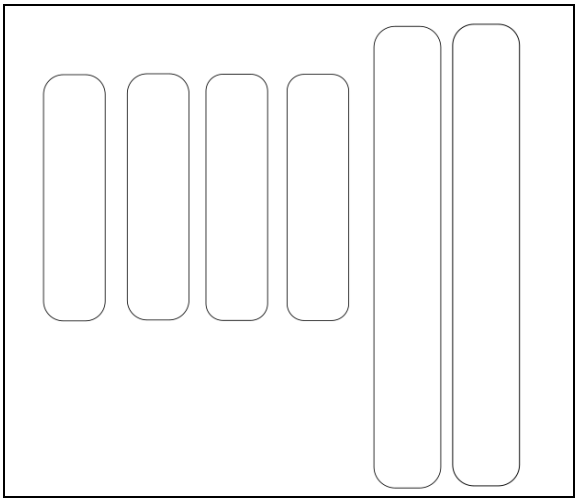

Figure 11 - Inkscape Design for Bottom of Surface

The inkscape design above is meant to have 0.01 inch thick lines since we used the laser cutter to vector cut the piece of acrylic but for the purpose of showing the design, the line thickness was increased. These pieces were cut out using the laser cutter and then wrapped in weather resistant tape. The tape ensures the acrylic pieces do not get damaged by rubbing on the ground as well as cover ant sharper edges. The taped pieces were then arranged on the bottom of the mat to add support.

Figure 7 - Bottom of Surface Element

When looking at the figure above, you can see the black taped acrylic pieces arranged on the bottom. The space that does not have any supports is for the wire, the supports are meant to protect the wire as well as support the weight of pedestrians. After the supports were taped down on the bottom of the surface, three rectangular holes were cut out on the edge of the mat for the connector pieces. On either side of the mat, 2 inches was measured and marked, then at that mark a 1.5” by 1” rectangles was marked out on either side. Then from each already drawn rectangle, 12 inches was measured and another rectangle of the same size was marked out. Using the exacto knife, the rectangles were cut out making sure not to cut or interfere with the grip tape on the other side.

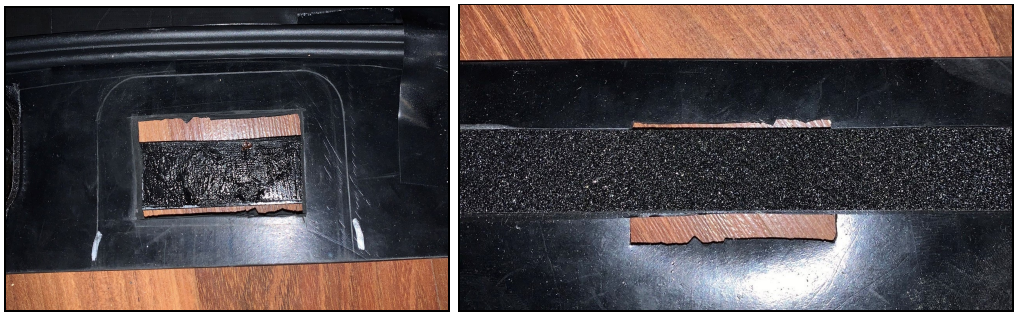

Figure 12 - Top and Bottom of the Rectangle Holes

Once the holes on the mat are cut out, the construction of the surface element is complete.

6.2 Connector Element of Prototype

The connector element is 3.5” wide, 6” long and ¼” thick made from laser cut acrylic. On each side of the acrylic, a 1.5” by 2.5” laser cut acrylic rectangle is taped down with weather resistant tape. The initial conceptual design used one piece to connect the mats but was then modified to use three pieces which would make it easier to replace if damaged and also lighter and more compact.

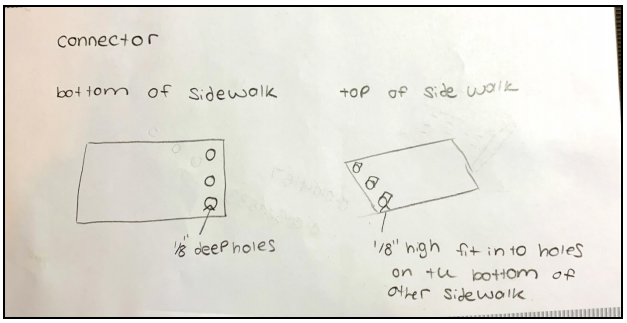

Figure 13 - Initial Conceptual Design of Connector Element

The connectors are made out of scrap acrylic but could be replaced with stainless steel or any strong, lightweight, non corrosive material although new materials have not been tested. The rectangles of the connector are taped down with weather resistant gorilla tape and the tape could be replaced with any strong adhesive although new materials have not been tested.

6.2.1 BOM (Bill of Material)

Once the design was determined, all of the materials required for the construction were gathered.

Table 5 - Bill of Materials for Connector Element

Component	**Name**	**Unit Cost**	**Amount**	**Shipping**	**Total Cost**
Connector	Scrap Acrylic	$0	1 piece	N/A	$0
Connector	Gorilla Tape	$14.97	1	N/A	$16.90
Total					**$16.90**

6.2.1 Equipment List

Table 6 - List of Equipment and Tools Used for Connector Element

#	**Tools and Equipment**	**Use**
1	Laser Cutter	Cutting out the acrylic
2	Scissors	Cutting the tape used
3	Tape Measure	Measuring the connector pieces

6.2.1 Instructions

To start the construction of the connector element, Inkscape was used to design six 3.5” by 6” rounded rectangular pieces along with six 2.5” by 1.5” rectangular pieces.

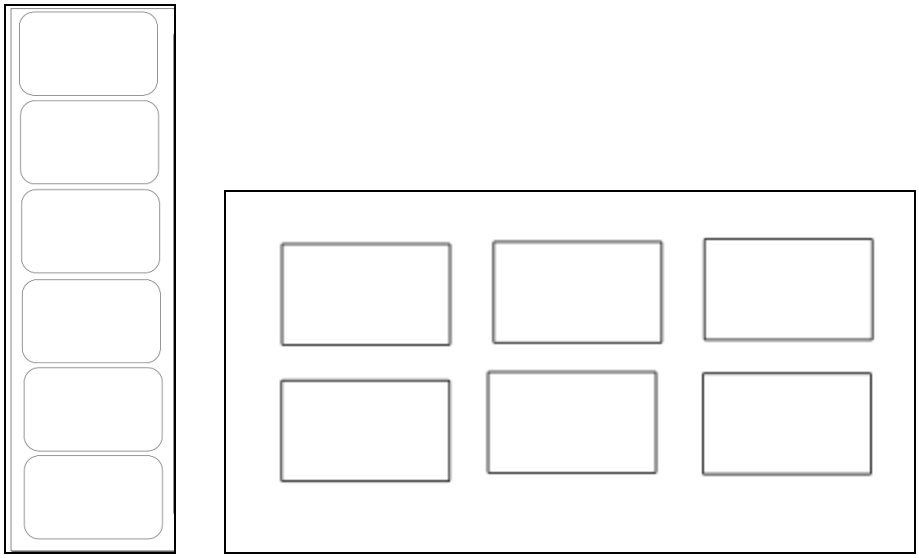

Figure 14 - Inkscape Design for Connector Element

Once the design on inkscape was made and finished, the laser cutter was programmed to vector cut a piece of acrylic and then cut the acrylic as planned. Once the pieces were cut, each piece was measured and the halfway point was marked. Then the middle of each half was measured and marked for the smaller rectangle pieces.

Figure 15 - Measured Connector Element

Once the base piece of the connector was measured, a piece of weather resistant gorilla tape was used to attach the smaller rectangle in the marked out spot.

Figure 9 - Final Connector Element

Once the smaller rectangles were taped down, the construction of the connector element was complete.

6.3 Heating Element of Prototype

The heating element of the prototype is an EasyHeat self regulating pipe wire with a built in temperature sensor. Originally, we were planning on using a heating wire that would attach to an arduino control and then the arduino would use a bluetooth sensor which then could connect to a website and app. Due to shipping delays with the wire, we were forced to change our plan quickly and use the self regulating wire with the built in temperature sensor.

With the final prototype using the EasyHeat wire, this could be replaced with any self regulating wire that has a temperature sensor and has to be at least 6 feet long. Ideally, the wire could be replaced with an arduino control and heating wire.

6.3.1 BOM (Bill of Materials)

To build the heating element, the wire, and weather resistant tape were used.

Table 7 - Bill of Materials for the Heating Element

Component	Name	Unit Cost	Amount	Shipping	Total Cost
Heating Element	EasyHeat Wire	$34.99	1	N/A	$39.55

Heating Element	Gorilla Tape	$14.97	1	N/A	$16.90
Total					**$56.45**

6.3.2 Equipment List

The construction of the heating element was done using basic handheld tools.

Table 8 - List of Equipment and Tools Used for Heating Element

#	**Tools and Equipment**	**Use**
1	Scissors	Cutting the tape
2	Exacto Knife	Cutting the surface to embed temperature sensor

6.3.3 Instructions

To start the construction of the heating element, a path on the bottom of the surface element needed to be mapped out. We choose to make a U like shape with the wire on the bottom of the mat to ensure all parts of the mat have heat.

Figure 8 - Wire Pattern on the Bottom of Surface

Once the pattern for the wire was determined, the weather resistant gorilla tape was used to tape down the wire up until the orange temperature sensor. At the temperature sensor, a small hole was

cut using the exacto knife in the rubber nitrile so that the sensor could be embedded on the surface and get as close to the surface as possible.

Figure 16 - Embedding of Temperature Sensor

Once the hole was made, the temperature was taped down with weather resistant tape and the construction of the heating element was complete.

Figure 17 - Final Heating Element

6.4 Tests and Validation

The final prototype was tested and adequate results were obtained. Due to the late delivery of the original wire and the change to the new pipe wire, only one test was done with the full prototype. Once the final prototype was fully constructed, there was only one day where the temperature went below 0 before design day. The fully constructed prototype was set up in a shaded area

where the temperature was -3°C and felt like -11°C and crushed ice was placed on top to simulate a snow fall.

Figure 18 - Results of the Prototype Melting Snow

When looking at the figure above, it is seen that the prototype melted the smaller pieces of snow within 45 minutes. The orange temperature sensor increased the height of the mat on one side causing the water to want to flow away from where the plug it. The slant could be increased slightly in future work to ensure water will not pool on the surface.

7 Conclusions and Recommendations for Future Work

The document reports all the information about Ultimat from the beginning of the design process to the final prototype. It also provides simple instructions to guide the users of Ultimat and some tips to maintain the product. Ultimat had been tested to equip with desired functionality and meet the safety standard, all the information given is true and trustworthy.

The design of Ultimat is an iterative process and each single procedure is remarkable. Since a prototype was scrapped fairly late into the semester, some of the extra features of our design had to be removed to save some budget for the necessity. With more budget and time, more possibilities and developpements could be made. The implement of the arduino control as well as the function of Bluetooth could be added to the system, Besides The acrylic material for the connector now is supported by the waterproof tapes, but with more budget and equipment, stainless steel which is also waterproof can be a better alternative to support it with welding. By carving out the surface element, the wire could be placed closer to the surface and it would increase efficiency.

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APPENDICES

9 APPENDIX I: Design Files

Table 9. Referenced Documents

Document Name	Document Location and/or URL	Issuance Date
Team contract and project management	https://uottawa.brightspace.com/d2l/common/viewFile.d2lfile/Database/MzEyNDY0Mw/GNG1103-Team%20Contract(Deliverable%20A)-5.pdf?ou=209771	January 24, 2021
Needs identification and problem statement	https://docs.google.com/document/d/19XT0lnoHlPFH2kHQsF7iqOqnFSMhfM6catByP9RHEbc/edit?usp=sharing	January 31, 2021
Design criteria	https://docs.google.com/document/d/1Yp_2q8o7ZIghMRWwFJkdN4bHVZpE_fQZViooIvsDE4g/edit?usp=sharing	February 7, 2021
Conceptual design	https://docs.google.com/document/d/1xw69X9v7LJ0T545NjrQqUPnzDDVX0gzeQmlAAMqczJ4/edit?usp=sharing	February 21, 2021
Project plan and cost estimate	https://docs.google.com/document/d/15JA_hS99Vj5Xh458h1lTF7HDSiwKJVD6Leuha_9hjU4/edit?usp=sharing	February 28, 2021

Prototype I and customer feedback	https://docs.google.com/document/d/1h8hKRe6tOq225l4-E9o5sgs60ESDT7I4Hu0b_8D9sfQ/edit?usp=sharing	March 7, 2021
Prototype II and customer feedback	https://docs.google.com/document/d/1PGykoXwcc3uK5MQaPH-uiwyWjHviIQ_gtBXrnFSkrHU/edit?usp=sharing	March 14, 2021
Prototype III and customer feedback	https://docs.google.com/document/d/1NCI_R45PjTDVlnzfFjdeEly5kbNlICIdeIwHjhd1GUk/edit?usp=sharing	March 28, 2021
Design showcase presentation	https://docs.google.com/presentation/d/1O05YVwCicyzFWmtUcIYassHMFwHl_Y3QwpeqL9CvtmM/edit?usp=sharing	April 6, 2021
Project presentation	https://docs.google.com/presentation/d/1hK-Tf9K0p3XFXssytmaxARyAIA0RVKxYL4sxfN4_3fM/edit?usp=sharing	April 6, 2021
MakerRepo	https://makerepo.com/Aidanpledge/868.ultimat	N/A