Athletic Ice Bag Production Improvement Final Paper

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Abstract

Elizabethtown College's athletic department's current method of producing and securing ice bags to student-athletes for muscle recovery is flawed. Getting the air out of an ice bag and sealing it is an important yet difficult process. Air bubbles reduce the ice bag's coldness, making it less effective. Popping the ice bag is the method of getting air bubbles out after sealing the bag, causing cold water to leak out of the ice bag and the ice bag to slip out of the plastic wrap attaching it to the person's body. This plastic wrap is a single-use plastic in which Elizabethtown College's athletic department uses over 300 pounds annually.

The goal of this project is to improve the process of manufacturing and attaching ice bags to athletes more efficient, effective, and eco-friendly. An ice bag press squeezes air out of the ice bag and seals the bag. Ice bag sleeves will be used to attach ice bags to an athlete's sore areas without using plastic. These ice bag sleeves will be low cost and adjustable to any size athlete or any part of the body. These two devices will result in ice bags being made faster during less time, stop ice bags slipping, and prevent ice bags from leaking while reducing plastic waste.

1. Introduction and Background

1.1. Introduction

Athletes at Elizabethtown College use ice every day for their injuries. Producing an efficient ice bag is extremely difficult. Many details go into making an ice bag provide proper treatment like the ice needs to make contact with the athlete's skin. This problem may seem like a straightforward concept; however, it is complicated to attain by hand. Firstly, athletes fill a plastic bag with shredded ice. They then attempt to remove all the air out before tying it off. Any air left in the bag after tying will reduce its efficiency. Four-inch wide saran wrap attaches the ice bags onto the athletes, while creating, an air pocket in the ice bag is created and pressed against the skin. The skin area in contact with ice is minimal compared to the amount of ice in the bag. The current process to solve this dilemma is to pop the air pocket with a pen, allowing the air to escape. Popping the bag is a primitive technique which loosens the wrap, resulting in the bag moving out of place and leaking water. Overall, this inefficient process could be optimized and improved.

Our project was to fabricate a mechanical press to remove as much air out of a single ice bag as possible. We also created a substitute method to hold the bags in place on the athlete's body. On average, 11.4 grams of plastic is used per ice bag and wrap. With 6-12 ice bags used in a day, 68.4-136.8 grams are thrown away daily. This process is environmentally disastrous and unnecessary. A reusable, fabric wrap would eliminate this plastic waste. A return system would have to be set up and put into place so the training office can provide these reusable wraps daily. To keep things simple, we will use two buckets, one for dirty ice bag sleeve returns and one for clean ice bag wraps. Dirty ice bag sleeves will be placed into the regular athletic department laundry routine, which is washes on Monday, Wednesday, and Friday. After the ice bag sleeves are washed and dried they are placed into the clean ice bag wrap basket. This system is simple and easy for the athletic department to maintain.

Throughout the project, we had an open communication line between team members, mentors, and clients. We used a Google Drive folder throughout the semester to hold all research, documents, pictures, and anything relating to the project. This folder was shared with all the group members and will be shared with the client as the designs and prototypes are being developed.

1.2. Background

The current ice bagging process includes getting a plastic bag, waving it open, and adding ice to the bag with an ice scoop. After, the bag is pinched to remove as much air out as possible and then knotted. Then the ice bag is wrapped onto the specific area of the body with a plastic roll. This whole process to make an ice bag is approximately 1 minute and 30 seconds. There was a significant amount of athletes who needed one or more ice bags every day after a practice or game. Several other colleges and universities use plastic; however, there needs to be an eco-friendly alternative.

2. Market Analysis

2.1. Industry overview

Industry information was obtained from interviewing Elizabethtown college athletic trainer, Karl Palmer.

2.1.1. Ice per Bag. According to the Elizabethtown College athletic trainers the best size ice bag is approximately the size of a Chipotle burrito. This is roughly the same amount as both your fists together. This size, on average, provides plenty of coverage for the hurt area as well as not wasting ice [1].

2.1.2. Kind of Ice Used. Currently, at Elizabethtown College, the ice is shaped in thin rectangular prisms. This shape fits together, leaving less space between cubes, resulting in more efficient ice bags. Crushed ice forms to the body the greatest, but it melts too quickly [1].

2.1.3. Best Shape of the Ice Bag. A circle is the most efficient shape for the common injury which requires an ice bag since rectangular corners lower an ice bag's efficiency. On average, the source of pain is either a single point or a single circular area, with few exceptions. One exception is shin splints. People with shin splints have pain shooting up their shins which is a non-circular area [1].

2.1.4. Best Bag Material. An ice bag needs to be flexible and able to hold water. It also needs to be thin enough for the cold to radiate through it. The lightweight plastic currently used for bags meets these specifications; however, they are not environmentally friendly. Cloth bags are also an option. Refillable ones you would encounter at a hospital or ER are flexible and moderately hold water. When the ice melt builds up, they tend to become extremely moist and even drip everywhere. Getting the air out of these bags is easier, creating better contact with the user's skin. But, they are inadequate at allowing the cold to radiate through them and to the patient. They are much more healthy for the environment by reducing plastic bag use [1].

2.1.5. Attaching the Ice Bag to the Body. Saran Wrap is used to hold ice bags on the body. It's a roll about 6 inches wide. After wrapping the ice on a body part, the volume decreases. This creates an air pocket for the ice instead of being held directly on the body part. Currently, the solution to this is taking a pen and popping the bag as it's being wrapped. The hole is usually poked in a spot where water won't drip out. This method uses a lot of plastic and is not efficient. Reusable bags have strings on them to hold the bag in place. This is beneficial if the user is stationary, but athletes at Etown like to retrieve ice and move on with their day. Therefore the saran wrap is a better substitute if the air is pressed out of the bag [1].

2.2. Target market

The main target market of the project was Elizabethtown College since it was built around the athletic department's constraints. This project could also be applied to any athletic center which uses plastic ice bags or attaches cold items to the athlete's body for muscle recovery. So while the target market is Elizabethtown college, there is considerable room for growth.

2.2.1. Elizabethtown College. Currently, at Elizabethtown College, they use mostly cold recovery on their student-athletes. Though it is a small college, the athletic department makes roughly twenty ice bags a day, except for the off-season, where many of the sports seasons come to an end. For these twenty ice bags made a day, an ice bag sleeve needs to be available to match it [1].

To make these sleeves work, athletes need to return them to the athletic department to reuse. Since athletes go back home or to their dorm room after receiving their ice bag, it will not be until the next day when they could return the ice bag sleeve. These sleeves would also have to be washed by the athletic department before being reused on another athlete, which could delay some ice bag sleeves from being put back into rotation. To make sure the athletic department has enough ice bags for the athletes even with delays in ice bag sleeves returns, the ice bag sleeve stock should be enough for two full days. A full two days supply of ice bags is twenty small ice bag sleeves and twenty large ice bag sleeves.

3. Project Management

The Gantt Chart was used as a tool to manage the project. The team kept each other on task through frequent communication, especially during the weekly team meetings. Tasks were assigned based on the individual strengths of team members. One challenge faced concerning project management was the separation of the project into two parts: the sleeve and the press. Two group members having more knowledge about the press while the other two group members knew more about the sleeves, was a challenge. There was communication between group members about the two different parts of the project, but we could've increased the amount of detail we provided the other team members with. We communicated about the project both in person and over iMessage. We held each other accountable by asking in our iMessage group text whether a task was completed. The timeline and schedule we created were set up so the project gets completed in time for SCAD.

4. Budget

The budget allowed for the project was $200 per person in the team, which came to a total of $800 for our group. The team laid out an initial budget plan at the beginning of the project. This budget plan is shown in table 1 below. At the end of the project, the team spent a total of $569.29 out of the allotted $800 for the project. The team's expenses for the project are laid out in table 2 below.

Team Budget	
Item	Pre-tax Costs
Ice Bag Maker (1 prototype / final product)	Total: $337
Foam Budget (4 types of foam + replacement foam piece)	$50
Press Budget	$287
Ice Bag Holder Sleeve (3 different designs)	Total: $400
Fabric Budget	$150
Velcro Budget	$50
Sleeve Making Station Budget	$200
Organizational System + Posters	Total: $15
Poster Budget	$15
Organizational Budget	$0
Total Pre-tax Budget	$752

Table 1: Spending Plan for the Ice Bag System

Disclaimer: Pennsylvania has a 6% sales tax, so we took out 6% of our budget. This 6% of the budget amounted to $48.

Item	Qty	Cost	Remaining Budget	Link to Item
Foam samples	1	$15.75	$784.25	
Polyester Lycra/ Spandex Fabric (Grey)	2	$15.78	$768.47	Amazon Link for Polyester Fabric
Nylon Lycra Fabric (Black)	1	$7.37	$761.10	
Velcro	2	$25.98	$735.12	
2x8x2 Lumber	1	$1.37	$733.75	
Hinge Set	1	$5.35	$728.40	
8" Impulse Heat Poly Bag Closer Sealer	1	$20.08	$708.32	
Monel Standard Staples	1	$17.99	$690.33	Monel Standard Staples
Iron On Velcro	1	$11.93	$678.40	
Liquid stitch	2	$16.24	$662.16	
Starboard	1	$64.88	$597.28	Starboard (HDPE)
HD36- HQ foam	1	$27.99	$569.29	
	Total Cost Spent:	$230.71	**Remaining**	**$569.29**

Table 2: Actual Spending Plan for the Ice Bag System

5. Project Design Specifications (PDS)

The product design specifications were chosen based on research the team had gathered for previous reports. The PDS outlined the critical requirements and criteria desired for the project. The most important aspects of the PDS for our project were the performance, company constraints, maintenance, size, standards, product lifespan, and quality/reliability when considering the design of the product.

PDS about performance.

1. It is integral that the project has a long life span of at least five years.
2. The project should be easy to maintain by the athletic trainers
3. Every component of the project should be user-friendly and safe to use.
4. reduce the amount of air in the ice bags
5. allows the ice bag to conform to the human body
6. takes less than 45 seconds to make one ice bag
7. makes ice bags flatter than 2 inches
8. The ice bag press has to produce ice bags in rapid succession.
9. Precision needs to be better than one defective ice bag per a thousand ice bags made.

PDS about Trade-offs

1. Less air in the ice bag results in the ice not being able to move freely in the ice bag to conform to the body.
2. Using a heat seal makes the bag more durable and the ice bag makes the process faster, though it also makes the ice bag machine less safe to use.

PDS about company constraints.

1. The overall cost of the project is $800.
2. The final project must be finished and installed by May 2020.
3. Athletes must be comfortable using the ice bag press, or they will go back to the old way of making ice bags, and the ice bag press will be useless.

PDS about maintenance.

1. The ice bag mechanism must be easy to maintain for the athletic trainers and student helpers. The device will increase user-friendliness and encourage future use of this arrangement outside of our college, and potentially used by other athletic training rooms as well in different colleges or high schools.

PDS about size.

1. The product will be relatively small compared to the other equipment in the athletic center.
2. The product will fit into the measured constraints of the room.

PDS about standards.

1. This mechanism must be an appropriate size for an athletic training room.

PDS about product lifespan.

1. The product should have at least a five-year lifespan.

PDS about quality and reliability.

1. The product needs to be safe to use.
2. The product needs to be easily repaired by the athletic department if it breaks.
3. The team will write a manual describing how the product works and give a procedure to correct any failure which might occur with the product.

6. Design

6.1. Design Problem, Methodology, and Constraints

Three problems were plaguing the muscle recovery ice bags produced by Elizabethtown College's athletic department, they were inefficiency, ineffectiveness, and eco-unfriendliness. The longest part of the process was squeezing the air out of the ice bag, which is not effective. Any air in the ice bags diminishes the coldness of the ice bag, which reduces the ice bag's effectiveness in assisting with muscle recovery. Also, over 300 pounds of single-use plastic is expended every year by the athletic department via attaching the ice bags to the user with saran wrap [1].

There were three main types of design methodology used when creating our solution to the design problem: transitional design, design to value, and minimalism. The design problem is to modify the current method of producing and attaching ice bags, this required a traditional design methodology to be used. Learning about the current methods were required to better understand the needs and wants of the target customers. When it comes to designing to value, we chose this design since it would have value for others. Most of the design constraints were created after conducting market research and talking to the target customer. One of the design constraints discovered during market research was the need for minimalism in our design. The device will attach the ice bag to the user's body needs to be easily replaceable since it will be used by many people and therefore could become easily lost. To design something replaceable, the design has to be simple so people can easily and quickly produce the device with minimum tools and materials.

Minimalism is one of the constraints of the project. All of the project constraints were listed in the project design specifications. These specifications covered topics such as performance, project management, maintenance, size, standards, product lifespan, quality, and reliability.

6.2. Alternative Designs.

When designing to solve the problem the team went through various alternative designs. Originally, our idea was a fully automated uniform ice bag manufacturing system. This idea was scrapped since athletes need different sized ice bags to cover different body types and body parts, so our design changed to have a lever which controlled the amount of ice put inside the ice bags. Unfortunately, we realized this would be difficult to maintain, build, and physically fit in the small area given to us. Finally, a smaller simplified design was created, which requires the athletes to fill a bag full of ice and stick it in the ice bag machine to get the air out, flatten, and heat seal the bag.

After arriving at this idea for the final project the team started to think more about the eco-friendliness of the ice bags as a whole. Since each bag is attached to a student-athlete by being wrapped in plastic wrap, the amount of plastic wrap used in putting on an ice bag outweighs the amount of plastic which makes up an ice bag. So by creating a fabric ice bag holder to hold the ice bag to the athlete's body would reduce the majority of plastic used for ice bags for student-athletes.

Sadly, ice bag sleeves need to be collected from the athletes after they are done with them so they can be reused. These ice bag holders also have the problem of needing to be washed. So to solve these two problems, an organization system for the fabric ice bag holders should be put into place. The first idea we had was to assign every athlete a fabric ice bag holder and tell them to treat them as another piece of their uniform. The result is needing to make more than a hundred fabric ice bag makers; however, this would take a long time to finish and put us over the budget. Our final idea was to make a few ice bag holders and create an organization system, so they get returned. This is because not every athlete gets ice bags daily, so having twenty ice bag holders which get cleaned and replaced daily will cover a large percentage of people getting to use ice bags holders. There is a significant risk of people losing the feeling of accountability for ice bag holders and losing them. So to counteract this the ice bag sleeve will be open source and able to be easily and cheaply made.

While these larger design changes were done through research and discussions between the team, the smaller details of the project were decided using pugh decision matricities. Then after creating the design testing was used to decide on the smaller design decisions like fabric choice for the ice bag sleeve and the foam used for the ice bag press.

6.3. Pugh Decision Matricities

Pugh Chart for Type of Bag							
	Weight		Option 1	Option 2	Option 3	Option 4	Option 5
Criteria		Current plastic bag	Fabric	Chemical	Gel	Nylon/Vinyl/polyester ice filled	Nylon/Vinyl/polyester gel filled
Cost over time	4		1	-1	1	1	1
Time to make 1 IB	4		1	1	1	1	1
Lack of air pockets in IB	3	D	1	0	1	0	1
skin contact	2	A	0	1	1	0	1
Durability of IB	1	T	1	1	1	1	1
Ease of use	5	U	0	0	0	0	0
Safety	4	M	0	-1	-1	0	-1
Maintenance	3		0	0	0	0	0
Eco-friendly	2		1	-1	0	1	0
Movability of ice in bag	4		0	0	0	0	0
Waterproof	4		0	0	0	1	1
Coldness	5		-1	-1	0	0	0
Sum of -1			-5	-15	-4	0	-4
Sum of 1			14	7	14	15	18
Sums			9	-8	10	15	14

Pugh Chart for Air Removal Methods				
		Original	Option 1	Option 2
Criteria	Weight		Vacuum	Foam Press
Affordability	2	D	0	1
Speed	4	A	1	1
Lack of Air	5	T	1	0
Easy of Use	4	U	1	1
Maintenance	3	M	-1	1

Safety	5		0	0
Flatness of bag	2		1	1
Cleanliness	3		0	0
Total		Sum of 1	15	15
		Sum of -1	-3	0
		Total Sum	12	15

IB = ice bag	Pugh Chart on Sealing the Bag				
Sealing the Bag			Option 1	Option 2	Option 3
Criteria	Weight	Original	Heat seal and foam press	Plastic tie and foam press	Vacuum seal
Initial cost	3		0	0	-1
Cost per bag	4		1	-1	1
Time to make 1 IB	4	D	1	1	0
Lack of air pockets in IB	3	A	0	0	1
Flatness of IB	2	T	1	1	1
Durability of IB	1	U	1	-1	1
Ease of use	5	M	1	1	0
Safety	4		-1	1	-1
Maintenance	3		0	1	-1
Eco-friendly	2		0	-1	0
Movability of ice in bag	4		1	1	-1
		Sum of -1	-4	-3	-14
		Sum of 1	20	22	10
		Total Sum	16	15	-4

Pugh Chart on Attaching Ice to the Body					
			Option 1	Option 2	Option 3
Criteria	Weight	Original	Compression sleeve	Velcro/other wrap	Plastic
Amount of plastic used	4		1	1	-1
Amount of ice used	1		0	0	0
Time it takes to attach to body part	3	D	1	1	-1

Type of body part	4	A	0	0	0
Durability of attached ice bag	5	T	1	1	-1
Ease of movement after ice bag is attached	4	U	1	1	0
Comfortability of material used to attach ice	4	M	1	0	-1
Total cost	3		0	0	1
Reusability of method (eco-friendly)	2		1	1	-1
Sum of -1			0	0	-18
Sum of 1			22	18	3
Total Sum			22	18	-15

6.4. Prototype Component Testing Results and Analyses.

In order to produce the best product the project's components were tested to assure they were the most beneficial option for achieving the project's objectives. Prototype components tested for the ice bag press were the foam and heat sealer. Velcro adhesion methods were the ice bag sleeve prototype component tested.

6.4.1. Foam Selection Testing. When selecting the best foam for the ice bag press there were many factors to include in our decisions. Requirements of the foam wasit would last long and it would be effective at pressing the foam out of the bag. The ten foams will be tested against these requirements by completing testing for density, cleanliness of cut, drying time, absorbance amount, ease to clamp down on the ice bag, amount of air left into the ice bag, and deformation recovery.

The density of the sample foam is proportional to the durability and how long the foam will last. A foam with a high-density will last longer and durable.

The foam will be cut in order to form it into the shape needed for the ice bag press. So whether or not the foam will cleanly cut is important to know. If the foam does not cut well it could damage the foam. The team will need to keep this factor in mind when picking out the best ice bag press foam.

It is important to avoid mold in the foam, since moldy foam needs to be replaced and will lower the life cycle of the foam used in the ice bag press. Moisture is the leading cause of mold. So by having a fast-drying foam, it reduces the moisture amount in the foam and therefore decreases the chances of mold forming in the foam.

Absorbance is important since it is a measure of how much water the foam will hold. The more water the foam is storing the longer it will take to dry. Also a foam with a low absorbance would not have as much water that needs to be dried as a foam with a higher absorbance. So a foam with a low absorbance and a longer dry time could have the same risk of mold as a foam with a high absorbance and a short dry time.

The ice bag press should be easy to use. If the foam is too hard it won't be easy to press the air out using the foam and more force will be needed. So by measuring the force needed to clamp down the ice bag using a press will tell us in a quantifiable way which foam is the most difficult to use to oust the air out of the ice bag.

There is a balance of how much air needs to be in the ice bag. If there is too much air it will create air bubbles which will create a barrier between the athlete's skin and the coldness of the ice. When there is too little air, the bag is stiff so it will not wrap around the athlete's body well and will be uncomfortable to use. By creating a balance between these two extremes we can create a more comfortable and colder ice bag for an athlete. Finding this balance will be done by having an athlete try on each icing bag to sense for air bubbles and stiffness.

If the foam deforms under a continuous heavy force it is more likely to deform under regular use. So by placing a weight on the foam for a period of time we will determine whether or not the foam will deform.

The seven variables were tested using procedures that the project member's constructed to determine which of the ten foams fulfill the foam requirements the best.

Density test

1.) Measure the mass of each foam using a digital scale.

2.) Compute each foam's volume by measuring each foam's dimensions and multiply them together.

3.) Divide the mass by the volume to find the density of each piece of foam.

4.) List all the foam and their density in the order of the highest density to the lightest density.

Cleanliness of cut

1.) Draw a line halfway along the thinner side of each piece of each foam sample.

2.) Cut along the line drawn on each sample piece of foam.

3.) Write comments on the smoothness and ease of cut on the cut side of the foam.

Absorbance Amount

1.) Weigh the foam while it is dry on a digital scale.

2.) Pour water on the top side of the foam until it collects a puddle of water on top of the foam.

3.) Rub the water into the foam in circular motions until the foam will no longer be absorbed by the foam.

4.) Pour collected water on the top side of the foam into a bowl without squeezing water out of the foam.

5.) Weigh the foam on a digital scale after pouring the extra water off the foam.

6.) Complete this process with all the pieces of foam.

Drying Time

1.) Take the foam directly after the last measurement for the absorbance testing and place all the foam in a dry area where there is an even light and temperature distribution on all of the ten different samples of foam. The starting measurements for the dry time testing are the same from the absorbance amount testing. See the appendix for more information about the drying location.

2.) Check each foam piece every hour for the first ten-hours by measuring the mass of the foam pieces until all the pieces of foam are back to their previous dry mass.

3.) After the first ten hours, the foam will be measured every six hours until three days have passed.

4.) If any foam sample is not back to its original mass by the end of the three day period it will be labeled as "High Risk for Mold" and considered unsuitable for the ice bag press. The calculated amount of water left in the foam will be listed next to the foam labeled "High risk for Mold."

5.) Create two lists, one for foams they are high risk for mold and the other is for foams that are completely dried. Any foams labeled "High Risk for Mold" will be ranked by the least amount of water remaining in the foam to the most water remaining. Foams that are completely dried will be ranked by the fastest drying time to the slowest drying times.

Ease to clamp down/ amount of air remaining in the ice bag

1.) Create a simplified ice bag press made of wood. Specifications of the ice bag press and pictures of the final product will be in the appendix.

2.) Attach the two pieces of foam that makeup one foam sample to the ice bag press made of the foam.

3.) Place the bag of ice made with one cup of ice in the ice bag press.

4.) Use a force meter to pull the handle of the ice bag press down

5.) Record the largest amount of force needed to press down on the handle

6.) Tie the ice bag close

7.) Take the foam out of the ice bag press

8.) Attach the ice bag to a group member's arm and comment on the amount of air in the ice bag. Each ice bag is attached to a different part of the arm. This is so the group member's arm does not get used to the cold in the area the ice bags are getting attached to.

9.) Repeat the test again with each of the other foam samples

Deformation recovery

1.) Measure the dimensions of all of the pieces of foam.

2.) Put one piece of foam underneath the leg of each bedpost.

3.) Keep the weight on the foam pieces for 48 hours.
4.) After the 24 hours are over, take the weights off and re-measure the height of the foam pieces.
5.) If the foam doesn't quickly reform after the weights are taken off, measure the height of the foam every twenty-four hours until it returns to its original dimension. Then if it still does not return to its original height after three days label the foam as "deforms under pressure".
6.) Repeat the procedure until all the pieces of foam have been measured.

Foam Type	Height (in)	Width (in)	Length (in)	Mass (g)	Density (g/in^2)
Recycled	1.977	4.779	4.793	73.6	1.625
Memory	1.826	4.919	4.899	45.6	1.036
Super Luxury	2.047	4.789	4.727	34.5	0.745
Luxury	1.969	5.006	4.943	35.6	0.731
HD36	2.019	4.905	4.981	34.6	0.701
HD23	2.022	4.902	5.008	30.9	0.623
Dry Fast	1.929	4.936	5.08	24.9	0.515
Charcoal Egg Crate	1.477	4.945	4.958	17.1	0.472
Charcoal Firm	1.951	4.954	5.002	22.1	0.457
Poly	2.046	4.762	4.737	19.7	0.427

Table 3: Measurements for volume, mass, and density of the ten different foam samples before cutting listed by their densities in descending order.

Density has a positive correlation with the longevity of a foam. This means that the higher the density of foam, the longer the foam will last under regular use. This is seen by the packaging foam (Charcoal Firm and Charcoal Egg Crate) being two of the lowest density foams tested. Recycled foam that has a higher density is used in carpets and other long lasting products. The ranking of the best to worst foams for the ice bag press foam-based on the density testing results is done in table 3. From this round of testing the poly foam, charcoal foam, and charcoal egg crate foam were eliminated but testing would continue to be done on them.

Foam Type	Method	Notes
HD23	bandsaw	hard to cut off the end
HD36	bandsaw	bandsaw markings
Memory	bandsaw	bandsaw marking, hard to cut off the end
Poly	bandsaw	clean cut
Super Luxury	scissors	Cut easily, would of been adequate with the bandsaw
Luxury	bandsaw	minor bandsaw markings
Recycled	bandsaw	fell apart at the sides a little
Dry Fast	bandsaw	clean cut
Charcoal Firm	bandsaw	clean cut

Charcoal Egg Crate	bandsaw	n/a because of irregular shape

Table 4: The method and reaction of each piece of foam had when being cut in half.

All of the pieces of foam were cut on the bandsaw, with the exception of the super-luxury foam, which was cut with scissors. The reason one of the pieces of foam was cut differently was because the original plan was to cut all the pieces of foam with scissors. Though using scissors ended up being messy and not providing an even cut. So the scissors in the experiment were replaced by a bandsaw, which provided a much cleaner and even cut.

The charcoal egg crate was not included in the cleanliness of cut testing because it had an irregular shape which made it impossible to cut in half on the same side as the other foams and still be usable for the ice bag press test.

All of the foam was able to be cut. The recycled foam fell apart around the edges when being cut. This made the recycled foam undesirable because it is a high risk for falling apart when being used to create ice bags. Both memory foam and luxury foam had markings on them after being cut with the bandsaw, though these markings are not expected to cause problems for the ice bag press. Markings will not affect the foams' ranking for the best choice of ice bag press foam.

Foam Type	Water absorbed (g)
Charcoal Firm	6.9
Super Luxury	7.5
HD36	9.7
Recycled	12.1
Poly	13
HD23	13.5
Dry Fast	17.2
Luxury	22.1
Memory	36.8
Charcoal Egg Crate	65.8

Table 5: The amount of water absorbed in grams by each piece of foam listed in order of increasing absorbance amounts

All of the foam had the most amount of water absorbed into it that would happen through pouring water on top and rubbing it into the foam. Though one exception was made for the charcoal egg crate foam sample since it was made from the same material as the firm charcoal. So testing the charcoal egg crate sample that same way would be repetitive and it was testing differently, since the water collected on top of the foam was not poured off so it would hold more water. This choice was decided because the difference between the firm charcoal and the egg crate charcoal sample was that the egg crate charcoal was capable of holding water within the shaped divots on the surface of the foam. When comparing the different types of foam and their absorbance data for the egg crate charcoal foam will be ignored since it was tested differently and was made of the same material as the firm charcoal foam.

Based on the measurements the memory foam held a significantly larger amount of water than the other types of foam. The memory foam held 14.7 grams of water more than the luxury foam, which was the second most absorbent foam. This is a significant amount of water since the luxury foam absorbed 22.1 grams of water. Then the six least absorbance foams from our testing were under 14 grams of water. So based on this high absorbency the memory foam was deemed unsuitable for the project because of its high absorbency making it a high risk for developing mold, which will reduce the project's longevity.

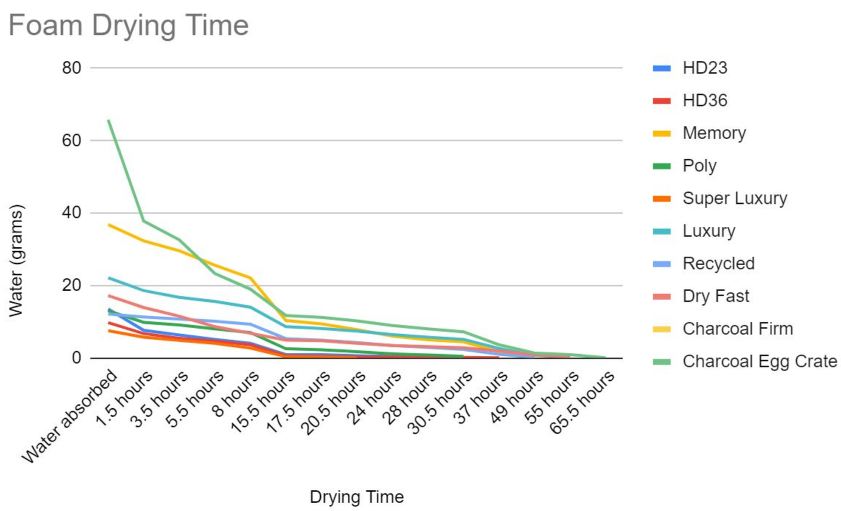


Figure 1: Chart shows the dry time of each foam sample

When saturating the foam in water, water was poured on one side of the foam sample and was rubbed into it until no more water would absorb. Then the water not absorbed into the foam sample was dumped off of the foam sample but the water was not in any way squeezed out of the foam sample. The charcoal egg crate foam was the one exception to this method, since it is the same material as the charcoal firm but is in a different shape. So when testing the charcoal egg crate we did not dump out the water that was collected in the divets of the foam.

For all the foams but the dry fast foam, the water did not immediately soak into the foam. Most of the water ran off of the foam then the remaining water took a few seconds to slowly soak into the foam. Though for the dry fast foam most of the water was immediately absorbed and then quickly exited through the bottom of the foam sample. After pouring water on top of the dry fast foam, 17.2 grams of water remained inside the foam.

Though while the dry fast foam was not the fastest drying foam, it was the most consistent on the amount of water drying over time. Most of the foam dried the fastest within the first hour and a half it spent drying. The charcoal foam was the first foam to completely dry, unfortunately, there was a seven and a half-hour time period that this final drying took place.

The time periods in between mass measurements are inconsistent because the person conducting the test had to schedule measurements around a busy schedule.

Foam Type	Max Force (N)	Mode Force (N)	User Notes
Memory	0.19	0.15	very little air, little force needed
Super Luxury	0.2	0.17	same air as hd36,
HD36	0.2	0.18	some air bubbles, not stiff
Luxury	0.21	0.16	more air then memory
Poly	0.23	0.2	soft, maxed out on softness, had air in it

Charcoal Firm	0.24	0.21	more air then memory, pushed the air away rather then press the air out
Dry Fast	0.24	0.21	Remove the air, didn't move the ice, foam is flaking off
Recycled	0.24	0.22	took a lot of force, had the most air, moved the ice out of the press
HD23	0.25	0.2	easy to push down and remove the air out, did not move around the ice
Charcoal Egg Crate	n/a	n/a	n/a

Table 6: The max and mode force needed to close the ice bag press with each type of foam sample attached to it

For the ease of clamping down the press testing Kyle Pienik was pressing down on the press while Isabella Panzica was recording the force measurements. The force measurement device was a Pasco force meter that was connected via BlueTooth on the SPARKvue app. Then the force meter recorded the force during the entire testing time. Of each foam sample's data set for force, the mode and the maximum force measurements and notes were recorded in a table. This table was then organized from the maximum force in descending order. Also, the charcoal egg crate was excluded from both these types of testing because it was not cut in half and therefore we couldn't attach it to the ice bag press.

Of all of the testing done on the foam samples, the ease of clamping down of the foam and the amount of air remaining in the ice bag is the most important in testing the usability of the foam. As a result, foams that performed poorly in this part of testing were eliminated from the list of sample foams considered for the final project. Based on having high maximum forces needed, high mode force needed, and negative user noted five foams were eliminated: poly, charcoal firm, dry fast, recycled, and charcoal egg crate. The HD23 foam had a high maximum force but had low mode forces and positive user feedback so it was not eliminated. Based on user comments on using the press the five best foams were HD23, HD36, charcoal firm, luxury, and super luxury.

Foam Type	Before Height (in)	After Height (in)	Recovery Time
Recycled	1	12/16	24 hours to recover
Memory	1	8/16	5 seconds to recover
Super Luxury	1	1	immediate recovery
Luxury	1	1	immediate recovery
HD36	1	1	immediate recovery
HD23	1	1	immediate recovery
Dry Fast	15/16	13/16	24 hours to recover
Charcoal Firm	15/16	12/16	24 hours to recover
Poly	1	14/16	24 hours to recover

Table 7: Volume measurements for before and after weights were applied to it for 24 hours.

Using volume dimensions the deformation of each of the foams was measured. Most of the foams recovered right away, while the others recovered within a day. This means that none of the foams were eliminated for not being able to recover. As a result of all the foams' quick recovery all the foams that did not immediately recover were eliminated. Foams eliminated using deformation recovery testing were poly, charcoal firm, dry fast, and recycled.

Using data from the different tests performed the best types of foams were foam. The best four foam types for the ice bag process improvement project is HD23, HD36, super luxury, and luxury. This is because none of the four top foams were eliminated in any of the foam tests. Observing the density data for the four foams the HD23 was significantly less dense and is therefore significantly less durable than the other foams. HD36, super luxury, and luxury are the top three foams for the ice bag process improvement project. Then using the notes from the ice bag press testing the top five rated foams are the two HD foams (tied), charcoal firm, luxury, and super luxury. So applying these notes to the three highest-rated foams the best foam is HD36. The final results of the foam testing are that the HD36 foam was used for the ice bag press.

6.4.2. Plastic Bag Sealing Testing. The reason for testing the heat sealing method is to investigate if the type of sealing meets the team's standards. The team standards are: the bag should not leak, be torn, or become hot enough to burn the student-athletes. Also, the seal should be strong enough not to come apart when pulled at. These standards are tested by creating a heat seal and testing it. Testing the seal is described in the procedure section. The two changing variables are the heat source and the ice bag bunching style.

Two uncommon terms the team used in the procedures are bunching style and bunched area. A bunching style is defined by the team as the way the ice bag was moved into place to prepare for the heat source. A bunched area defined by the team is part of the bunch style the heat source is applied to.

Plastic Bag Seal Testing Procedure

1.) Place water in the bag.
2.) Scrunch up the top (Variable to change)
3.) Apply heat on the bunched area.
4.) Apply a heat source (Variable to change)
5.) Cool for a few seconds.
6.) Tug at the seal with two hands on opposite sides of the seal. If the seal does not come apart it should be categorized as a strong seal.
7.) Tip bag to move all the water over the sealed area. If any water leaks out of the bag it should be recorded.
8.) Write comments about the seal's strength, leakage, damage of the bag, and heat of the seal.

The results of the testing is as follows:

Heat Source: Hair straightener
Bunch Style: bunch together in layers
Results: The bag leaked water, needed a few seconds to cool, minimal damage to the bag, strong seal

Heat Source: Hair straightener
Bunch Style: twisted together
Results: The bag leaked water, cleaner seal, needed a few seconds to cool down, strong seal

Heat Source: Heat sealer, level 3
Bunch Style: bunched together
Results: did not work because of air bubbles in the seal, no tearing, strong seal

Heat Source: heat sealer
Bunch style: Flat, one fold, level three
Results: no tearing, no leaking, strong seal

Heat Source: heat sealer
Bunch Style: twisted together, level 3
Results: did not work because of air bubbles in the seal, no tearing, strong seal

Heat Source: heat sealer
Bunch Style: twisted together, level 5
Results: did not work because of air bubbles in the seal, no tearing, strong seal

Heat Source: heat sealer
Bunch Style: bunched together, level 5
Results: held water, medium strength

Heat Source: heat sealer
Bunch Style: bunched together, level 7
Results: did not work because of air bubbles in the seal, no tearing, strong seal

Heat Source: none
Bunch style: basic knot
Results: strong seal, no leaking,

6.5. Results of the Design Analysis.

Based on pugh charts, multiple team discussions, and design testing both large and small design decisions were made. The topics of the pugh charts are type of ice bag, air from ice bag removal, sealing methods, and ice bag to body attachment methods. Following the pugh charts the team had discussions on the decisions when new information can to light about the constraints of the project or something did not work the way it was originally expected to work. Design testing also led to the team to learn new information that led us making design decisions. When it came to what type of foam to use for the ice bag press and what heat source the heat press should be made of, the team used testing in order to make these decisions.

6.5.1. Pugh Chart Decisions. The first decision made using the pugh chart was the most important decision, what type of ice bag should we use. Our options on the pugh chart were fabric bags, chemical cold bags, gel cold bags, nylon/vinyl/polyester ice filled bags, nylon/vinyl/polyester gel filled bags. After completing the pugh chart for deciding on the type of ice bag the team decided that nylon/vinyl/polyester ice filled bags would work best. This decision worked out well since the athletic department representatives were very against changing their current method of using polyester ice filled bags.

Using the pugh chart to decide the method that was going to be used to remove the air out of the ice bags we decided on using a heat sea;. The current method of removing air out of the ice bag is by pushing it out with your hands, which is ineffective and takes a while to do. Since the original ice bag air removal method is so inefficient we decided it would have to be replaced by either a vacuum or a press lined with foam. After testing and team discussions the team decided to continue with this design decision for the final product.

The current sealing method of the ice bags are by people tying the bag, which is slow and clumsy. New sealing methods debated by a pugh chart are heat seal with foam press, plastic ties with foam press, and vacuum seals. Of these new methods the heat seal paired with the foam press was chosen as the best design for the ice bag press and this design choice was carried out onto the final product.

Ice bag to body attachment methods was another important design choice we used the pugh chart to make a decision. The current method is to use plastic wrap to attach ice bags to the sore body part, which accumulates to 300lbs of plastic wrap that gets thrown out a year. Design options the team considered were compression sleeves, creating velcro wraps, and to continue using plastic. After completing the pugh chart it was decided compression sleeves were the best. Though after talking about how the athletic department would need to upkeep the system the team decided it would be in our best interest to create an open source design that the athletic department could make when they run out. This is because compression sleeves are expensive and having an open source design would be easier for the athletic department to uphold without straining their budget.

6.5.2. Design testing Decisions. The prototype component testing done to help make decisions was foam testing and plastic ice bag seal testing. Since there was more time available there was extensive testing done on ten different foam samples to find the best one for the ice bag press. This testing resulted in the team determining that HD36 foam was the best for the project, so we used this foam on the final design of theice bag press.Then test seal testing resulted in discovering the the heat sealer set at level three with the plastic bag bunched in layers at the seal created the strongest seal for the plastic ice bags.

6.6. Detailed Design of Specific Components

The ice bag sleeves are made of polyester lycra/spandex fabric. The fabric was chosen because of it's stretch ability. The fabric did not sketch too far so that it would be difficult to make tight around the leg. The non-sticky back hook and loop velcro are sewed to the fabric. Sewing the non-sticky back hook and loop velcro to the fabric is inexpensive and durable through laundry cycles.

Starboard is the material chosen for the body of the ice bag press. It is a High Density Polyethylene plastic that is designed for high moisture situations. This was an easy choice for our design. The press is used for ice which inevitably will melt. The placement of it within the Athletic Training room is near a sink, an ice machine, and two hot/cold baths. It is nearly guaranteed our product is going to be used in a moist environment if not be saturated for at times.

6.7. Calculations Involves and Results

There were no major calculations involved in our design process.

7. Social, Ethical, and Environmental Implications

The modified ice bag press and ice bag sleeve changed the current process of fabricating and attaching athletic ice bags to cool athlete's sore areas to be more effective, efficient, and eco friendly. Socially, ethically, and environmentally the project will benefit others in both the short and long term.

7.1. Ethical

Currently there are air bubbles in the ice bags when made with the college's current method. These air bubbles prevent the ice inside the ice bags from going against the side of the ice bag making contact with the student-athletes skin. This results in the surface of the ice bag not being as cold as it has the potential to be. So by pressing the ice out of the ice bag before sealing, the person making the ice bag will be eliminating the air bubbles that reduce the coldness of the ice bags. By increasing the coldness of the ice bags it will help sooth the athlete faster, which is one of the immediate goals of the project that increases the effectiveness of the ice bag press.

The way that the athletic department is trying to deal with the ice bag process is by securing the ice bag to the athlete and then popping the bubble if they detect a noticeably large one. This way of dealing with air bubbles gets rid of large bubbles and causes the ice bag to leak cold water onto the athlete. By letting the air and the leaked water out of the ice bag, it decreases the volume of the ice bag, which causes the ice bag to fall out of the wrap that was previously holding it in place while the athlete is walking around with the ice bag attached to them. So using the ice bag press would also help to solve the problem of the ice bag falling as well as the effectiveness of the bag.

7.2. Social

Another immediate implication of the project is that the athletic trainers can perform their job duties faster by allowing athletic trainers to fabricate ice bags and attach the ice bags to the athletes. In total, the amount of time saved is not large enough that it could threaten the trainer's job stability. The trainers are excited about this project and getting to finally use the ice bag press and ice bag sleeve. One of the trainers even requested to help manufacture the ice bag press so the ice bag press would be produced better. This excitement from the trainers is desirable since they are responsible for maintaining both the ice bag press and the ice bag sleeve in the future.

7.3. Environmental

Unfortunately, the bad part of the ice bag press will be that it has an electrical component, the heat seal. This heat seal will take up electricity, which is negative when concerning the project's ecological impact. While the heat seal is used in short bursts throughout a day but is likely to be plugged in while not in use. The total energy that the ice bag press will use in sealing the bags is 4.38 MJ. Electronics that are not in use but are still plugged in still use energy, this is called phantom power consumption. While there is no value for the phantom power consumption of the heat sealer, it can be compared to similar electronics that also run on 100 watts. One electronic that is close to the heat sealer is the multi-function laser device that has a phantom power consumption of 4.7 watts an hour, which adds up to 4.1172*10^-4 MJ a year when continuously plugged in. Totaling the phantom energy usage and the energy used when the heat seal is in use the total energy that the ice bag press will use within a year is 4.42 MJ. Thankfully this is offset by the amount of energy that will be saved by reducing the amount of plastic used by switching the athletic department to the fabric ice bag sleeve.

Method	Energy Use	Habitation destruction/ depleting nonrenewable resources
Plastic Wrap	6123.0 MJ	300 lbs
Ice bag Sleeve	1092.9 MJ	5.17lbs

Table 8: Environmental classification risk matrix for the two types of attaching ice bags to bodies

There are many different ways that a project can negatively affect the environment. Currently, the athletic ice bag process is negatively affecting the environment by destroying habitats, depleting nonrenewable resources, and producing CO2 that contributes to global warming. By switching to the new method of producing and attaching athletic ice bags we eliminate most of the habitation destruction impact that the current ice bags are causing and reduce the amount of CO2 produced because of the ice bags.

At Elizabethtown college the amount of plastic saved each year by this project will be around 90% of the plastic wrap used by the athletic department, this is estimated to be roughly 300 pounds of plastic a year. Producing this much polyethylene plastic takes 6123 MJ of energy a year, and all of the produced plastic is single-use and rarely recycled. To produce, wash, dry, and maintain a full stock of fabric ice bag sleeves it will take 1092.9 MJ per year, and 5.17lbs of a combination polyester fabric and velcro. These reductions of both waste and energy use are substantial. Energy use from material production will be reduced 82%, while waste will be reduced 98%.

7.3. Economical

The annual cost of buying plastic wrap for the athletic department to use for attaching athletic ice bags to people is roughly $600. By switching to the fabric ice bag sleeves it would eliminate the need to buy the plastic wrap, resulting in the athletic department saving money on their yearly budget.

Washing the ice bag sleeves will cost the school approximately $21.96 more on energy usage. Then annually restocking forty ice bag sleeves due to them getting lost or damaged will cost $308.40. The number of forty replacement fabric ice bag sleeves is also an inflated number, so the cost of maintaining the fabric ice bag sleeves will be less than the given price. Though even using these prices over $250 a year will be saved by the department annually.

7.4. Long Term Impact

Currently this project is in effect at Elizabethtown college, though other colleges could benefit with similar outcomes from this project. Since the plastic ice bag and ice bag wrap system this project is based on, is standard at many colleges and sports stadiums, by creating easy to follow work instructions, the group is allowing others to replicate our project. As a group we are giving the athletic trainers permission to share both the ice bag press and ice bag sleeve manufacturing plan to other trainers, colleges, and athletic stadiums. This will allow any person or organization that wants to use our project the ability to recreate it.

A negative long term effect is that the company the college buys the plastic wrap from will lose sales. Elizabethtown college's athletic department orders 330lbs of plastic wrap a year but this project could reduce that number to 30lbs a year. While this is not a large enough sale that could substantially hurt the company, if other colleges and sports stadiums decide to switch to our method it would negatively affect the plastic wrap industry.

8. Prototype Testing and Analysis

Unfortunately during the end of our project when testing on student athletes was about to take place the United States was hit by the corona virus pandemic. This caused Elizabethtown College to shut down for three weeks as an attempt to slow down the spread of the virus and to protect the elderly population surrounding the campus. As a result of the closure the testing on student athletes at Elizabethtown was cancelled and the only testing completed was on the team members and their close family members. The team realizes that the population tested on is not the project's target demographic and acknowledges that the data collected has this source of error due to uncontrollable external circumstances.

8.1. Time Study Testing

A time study is used to create an estimate of how long a task or a series of tasks will take to finish. Instead of using multiple data series to create an estimated task time, time studies use one set of data that is manipulated to create an estimated task time.

Time studies are a reliable tool used frequently by industrial engineers. Since time studies are reliable, quick, and easy to produce for tasks it was decided that they would be used to analyze the efficiency of the current and new methods for both making and attaching ice bags. After finishing these time studies it can be determined whether or not the new method for making and attaching ice bags is actually better than the currently used method.

8.1.2. Procedure and Results. To complete a time study task is observed by writing down and timing every component that composes the task. The unit of time used in time studies is seconds. After recording the data it is manipulated in a way that makes it more reliable. Data is manipulated by assigning every component of the task a level based on whether or not that task component is being done is slower or faster than usual. Level 1, means the task component is being done at a pace deemed regular. When a level is lower than 1, it means that the task component is being done slower than usual and is multiplied by its level number to speed up that data's task time. Then when a level is larger than 1, the task component is being performed faster than usual, the data is manipulated to become more accurate by multiplying the data by the task's level number. If more then one person was involved in a task component multiplied the time attached to the task component by the number of people involved.

After this is done for each task component all of the times are added together to create a total time for the task. This is the time it takes to complete the task one time. Though if the task is repeated multiple times, like when making ice bags for a team the total time needs to be multiplied by a fatigue rate to find what is called the real-time. A fatigue rate accounts for a person slowing down the longer they complete a task. The real-time is the final value of time it takes to complete the task the time study focused on.

The two tasks observed for the time study were making the ice bag and attaching the ice bag to a person. Afterward, the time for the two tasks taken from the time studies was added together to calculate the total time for the old ice bag process.

Task #	Element	Start Time (seconds)	End Time (seconds)	Level	Actual Time (seconds)
1	Get plastic bag	0	6	1	6
2	Open plastic bag	6	11	1	5
3	Open ice machine	11	13	1	2
4	Put ice in bag	13	18	1	5
5	Close ice machine	18	20	1	2
6	Press air out of the bag	20	29	0.66	5.94
7	Tie bag shut	29	33	0.66	2.64
8	Flatten bag	33	41	0.5	4
9	Walk to plastic wrap	41	51	0.75	7.5
				Total time	40.08
				Fatigue rate	1.25
				Real-Time	50.1

Table 9: Time study topic: Making an Ice Bag

Task#	Element	Start Time (seconds)	End Time (seconds)	People Involved	Level	Real-Time (seconds)
1	Place bag on the body part	59	62	2	1	6
2	Prep plastic wrap	62	66	2	0.66	5.28
3	Wrap plastic around body part	66	90	2	0.75	36
4	Pop air bubble in the ice bag	90	96	2	0.75	9
					Total Time	56.28
					Fatigue rate	1.25

	Real-Time	70.35

Table 10: Time study topic: Attaching an Ice Bag to a Leg

Element #	Element	Real Time (seconds)
1	Making a Ice Bag	50.1
2	Attaching an Ice bag to a leg	70.35
	Total Time	120.45

Table 11: Time study topic: Making and Attaching an Ice Bag

The current ice bag making and attachment method are quick, though there is still room for improvement. As seen in the time studies, it takes 50.1 seconds to fabricate an ice bag and then it takes 35.2 seconds to attach an ice bag to a person.

8.2. Ice Bag Press Testing

8.2.1. Introduction. The ice bag press is the part of the project that makes the ice bags more efficient and effective. Conducting this test required approval from the IRB since it uses students as test subjects. By testing the ice bag press it can be determined whether or not the project works or not. This procedure tests the efficiency of both the ice bag press and the heat seal. After testing is completed both the quantitative and qualitative data will be analyzed. The measured time results will be averaged together in order to determine the amount of time it takes to make the new ice bag making process. Time for the old ice bag making process will be taken from the time study. These two times will be compared to determine which ice bag process is faster. Qualitative data will be read through if a comment is repeated by multiple people the team will time it seriously. Though if the comment is an outlier, the group will write it down and discuss it later.

8.2.2. The Procedure. The ice bag press testing is done by making an ice bag using the heat-sealed ice bag that takes the air out of the bag before sealing. Before starting, prepare a stopwatch for timing the participant. Start the stopwatch right before getting a standard thin plastic bag provided by the athletic department and adding one to two scoops of ice into the bag. Then bring the ice bag to the wall-mounted ice bag press. Open the press by pulling the labeled pin on the right side of the press and pulling the handle away from the wall. Lower the ice bag into the newly open shaft with the opening of the bag should be facing the ceiling and stick out the top of the press. Avoid touching the side of the press attached to the wall. Confirm that everything but the ice bag is out of the press or near the hinge. Shut the press by pressing the handle towards the wall. Continue to push the handle until the press is fully closed. Wait for one second before pulling the labeled pin located on the right side of the press. Once the pin is removed open the press by pulling the handle away from the wall. Lift the ice bag up from the excess plastic that was sticking outside of the press. Be careful not to touch the inside of the press. When the ice bag is outside of the ice bag press stop the stopwatch. After making an ice bag using this method, participants will complete a short survey about their experience using the ice bag press

Ice Bag Press Survey:
1.) How long did it take you to make an ice bag using the new method? (Use the time from the stopwatch)
2.) How does the time it took to make a completed ice bag compared to the traditional method?
3.) How does the quality of the completed ice bag using the ice bag press compare to the traditional method?
4.) Do you feel that enough safety procedures were put in place to prevent people from getting hurt by the press? (Ex: pinching fingers, getting burnt, etc.)
5.) Would you use this device in the future?

8.2.3. Student Athlete Trials. All testing was cancelled due to the coronavirus pandemic of 2020. The fabrication lab the ice bag press ws being made in was shut down due to safety precautions before the ice bag press build was completed.

8.3. Ice Bag Sleeve Testing

8.3.1. Introduction. Testing the ice bag sleeves involved two methods. The first method determined the best option for attaching the velcro to the sleeve fabric. The second method involved testing the ice bag sleeve on current Elizabethtown student athletes. This method required approval of IRB forms in order to conduct a trial with the student athletes. Due to COVID-19 the original ice bag sleeve testing plan changed. The team decided sewing the hook and loop velcro to the fabric was the best attachment method. Sewing is less expensive and will last longer than staples or glue. Instead of testing the ice bag sleeves on Elizabethtown athletes, Annie Novy's sister and brother participated in the sleeve testing.

8.3.2. Procedure. Before being given the sleeve, the test instructor will demonstrate how to put on the ice bag sleeve. An ice bag sleeve will be given to the participant who will be asked to put the sleeve on with the ice bag inside based on what they saw. Then the participant will walk 50ft, turn around and walk another 50ft. They will repeat this process twice. After walking, the participant will fill out a survey. If the participant does not wish to walk around they can fill out the survey while skipping the questions about walking around.

Ice Bag Sleeve Survey:
1.) Did you notice the ice bag sleeve slide when you walked around? Did it stay in place well? Explain.
2.) How comfortable on a scale from 1 to 10 was the fabric? (10 being the most comfortable)
3.) How comfortable on a scale from 1 to 10 was the sleeve to wear overall? (10 being the most comfortable)
4.) Did you feel any water leaking from the ice bag?
5.) How easy was the sleeve to put on yourself? Did you need someone to help you (athletic trainer/staff)?
6.) How do you like the ice bag sleeve compared to the old method of the plastic wrap? Was this new method faster? Was this new method more efficient? Explain.
7.) Was the size a good fit? Explain and state what size you wore.
8.) How environmentally friendly do you think this new method is compared to the old method?

8.3.3. Student Athlete Trials. All student athlete testing was cancelled due to the coronavirus pandemic of 2020. The only testing done was on one of the team members and her family. Annie's siblings are twenty-two years old college students and were athletes previously. This allowed the team to test the sleeves on one male and one female who closely matched the original target demographic of Elizabethtown student athletes. The survey results of the survey are included below in figures 2 -5. An informal testing session held by group members to test if the ice bag sleeve can hold an ice bag without slipping. The results of this informal testing was that three strips of velcro were needed to hold against the athletes skin and prevent slipping. This was the only data taken from this informal testing session.

Ice Bag Sleeve Survey

1. Did you notice the ice bag sleeve slid when you walked around? Did it stay in place well? Explain.
   It stayed in place well, the ice bag did not slide.
2. Did at any time during the walking part of the testing did you have to readjust the ice bag sleeve?
   No
3. How comfortable on a scale from 1 to 10 was the fabric? (10 being the most comfortable)
   8
4. How comfortable on a scale from 1 to 10 was the sleeve to wear overall? (10 being the most comfortable)
   8
5. Did you feel any water leaking from the ice bag?
   No
6. How easy was the sleeve to put on yourself? Did you need someone to help you (athletic trainer/staff)?
   It was easy, I did not need help.
7. How do you like the ice bag sleeve compared to the old method of the plastic wrap? Was this new method faster? Was this new method more efficient? Explain.
   N/A
8. Was the size a good fit? Explain and include what size you wore.
   Yes, I was a large
9. How environmentally friendly do you think this new method is compared to the old method?
   Yes
10. How environmentally friendly do you think this new method is compared to the old method?
    Yes

Figure 2: Lauren Novy's First Ice Bag Sleeve Testing Survey

Ice Bag Sleeve Survey

1. Did you notice the ice bag sleeve slid when you walked around? Did it stay in place well? Explain.
   It stayed in place well, the ice bag did not slide.
2. Did at any time during the walking part of the testing did you have to readjust the ice bag sleeve?
   No
3. How comfortable on a scale from 1 to 10 was the fabric? (10 being the most comfortable)
   8
4. How comfortable on a scale from 1 to 10 was the sleeve to wear overall? (10 being the most comfortable)
   8
5. Did you feel any water leaking from the ice bag?
   No
6. How easy was the sleeve to put on yourself? Did you need someone to help you (athletic trainer/staff)?
   It was easy, I did not need help.
7. How do you like the ice bag sleeve compared to the old method of the plastic wrap? Was this new method faster? Was this new method more efficient? Explain.
   N/A
8. Was the size a good fit? Explain and include what size you wore.
   Yes, I was a large
9. How environmentally friendly do you think this new method is compared to the old method?
   Yes
10. How environmentally friendly do you think this new method is compared to the old method?
    Yes

Figure 3: Lauren Novy's Second Ice Bag Sleeve Testing Survey

Ice Bag Sleeve Survey

1. Did you notice the ice bag sleeve slid when you walked around? Did it stay in place well? Explain.
   I did not notice the ice bag sleeve slid when walked around. It stayed in place well.
2. Did at any time during the walking part of the testing did you have to readjust the ice bag sleeve?
   No
3. How comfortable on a scale from 1 to 10 was the fabric? (10 being the most comfortable)
   7
4. How comfortable on a scale from 1 to 10 was the sleeve to wear overall? (10 being the most comfortable)
   5
5. Did you feel any water leaking from the ice bag?
   No
6. How easy was the sleeve to put on yourself? Did you need someone to help you (athletic trainer/staff)?
   No
7. How do you like the ice bag sleeve compared to the old method of the plastic wrap? Was this new method faster? Was this new method more efficient? Explain.
   N/A
8. Was the size a good fit? Explain and include what size you wore.
   Yes, it was snug as a bug
9. How environmentally friendly do you think this new method is compared to the old method?
   It's more environmentally friendly
10. How environmentally friendly do you think this new method is compared to the old method?
    double

Figure 4: Preston Novy's First Ice Bag Sleeve Testing Survey

Ice Bag Sleeve Survey

1. Did you notice the ice bag sleeve slid when you walked around? Did it stay in place well? Explain.
   No
2. Did at any time during the walking part of the testing did you have to readjust the ice bag sleeve?
   No
3. How comfortable on a scale from 1 to 10 was the fabric? (10 being the most comfortable)
   7
4. How comfortable on a scale from 1 to 10 was the sleeve to wear overall? (10 being the most comfortable)
   4
5. Did you feel any water leaking from the ice bag?
   No
6. How easy was the sleeve to put on yourself? Did you need someone to help you (athletic trainer/staff)?
   Very easy
7. How do you like the ice bag sleeve compared to the old method of the plastic wrap? Was this new method faster? Was this new method more efficient? Explain.
   N/A
8. Was the size a good fit? Explain and include what size you wore.
   Yes
9. How environmentally friendly do you think this new method is compared to the old method?
   It's more environmentally friendly
10. How environmentally friendly do you think this new method is compared to the old method?
    Double

Figure 5: Preston Novy's Second Ice Bag Sleeve Testing Survey

9. Implementation/Fabrication Report

9.1 Ice Bag Sleeve Fabrication Report

There were no design modifications or adaptations throughout the fabrication of the ice bag sleeve with the exception of adding the third velcro strip. This change in design was made while we were at the end of designing the ice bag sleeve, so all our manufacturing instructions and pictures include the third velcro strip.

9.2 Ice Bag Press Fabrication Report

Ther design for the hinge changed slightly as we were working through manufacturing in the shop. We would no longer use a set screw to hold the hinge bolt in place. We were not confident of its ability. Screwing directly into the lid was decided as a better option. In turn, the already planned ¼ in. hole in the lid was then threaded and the clearance hole in the side was made larger to .6500 in. diameter. A ⅝ in. bolt is used as the hinge.

10. Ice Bag Press Manufacturing Plan

10.1. Ice Bag Press Manufacturing Applications

When it comes to the project one ice bag press will be made. If the athletic department decides they want another ice bag press they will be responsible for manufacturing it. This is true for other athletic departments or stadiums not related to Elizabethtown college that would like to also use their version of the ice bag press. Any group of people who decide they want to produce an ice bag press will use the ice bag press manufacturing plan to find the estimated cost of material, the amount of materials needed, tools required, and the work instructions for it.

10.2. Ice Bag Press Manufacturing Plan

Although the manufacturing process for this body of the press is very simple and seems short, it takes many hours to complete. It is a tedious process. Holes must be precise so that all the pieces fit together the way they are supposed to.

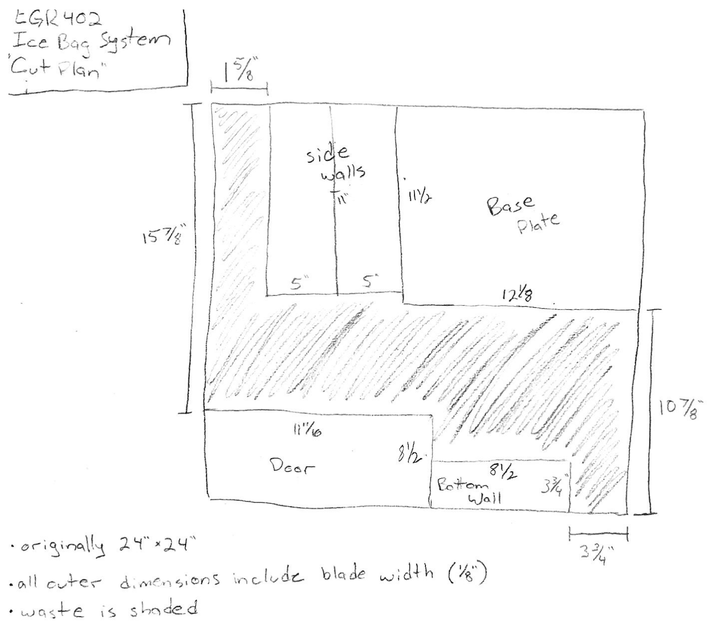
10.2.1. Materials and tools required.

A High Density Polyethylene (HPDE) called StarBoard, was used for the body of the press. It is a marine grade plastic that will withstand potential moisture accumulating on the outside of the press. It's also very strong. Withstanding the forces of compression were key in choosing this material. Screws of various lengths were used to hold the body of the press together. But, they are all size #10-32. HD-36 is a High Density foam that is in place to press the air out of the ice bags. This type of foam was chosen for its density properties. It is soft enough to compress over the ice without pushing the ice out of the foam area. For the heating element, we bought an 8" Plastic Heat Sealer and mounted it onto the base of the press body. This keeps the ice in and air out.

When machining the press, we used multiple different fabricating tools. Initially we used the table saw to cut out the different pieces of the press body. Then we used the milling machine to drill and tap all the holes in those pieces. We essentially used it as a drill press. Using the electronic measuring ability of the milling tool, we were able to quickly and accurately drill holes.

10.2.2. Work Instructions.

Step 1.
Use the Table saw to cut the different Block Pieces of the press body from the 24" x 24" x ½" Starboard material according to the dimensions in the cut diagram (below).



Step 2.
Cut each of the Block Pieces down to the exact dimensions according to the CAD Drawing of each respective Block Piece (CAD Drawings available in the Appendix). For this, a combination of scroll saw and band saw will be used, depending on the radius and sharp corners of each cut. Sharper radii should be cut with a scroll saw.

Step 3.
Use the Milling Machine to drill the holes in each of the press body pieces. Location and sizes of the holes are shown in the CAD Drawings available in the Appendix.

> Step 3a.
> Locate on the CAD Drawing which holes are taped and which are not. Clearances, through holes are not tapped. Only blind holes are tapped. Tap them according to the indicated size on the CAD drawings.

Step 4.
All the pieces of the press are now cut, drilled, tapped, and ready to be screwed together. All screws are flathead, size #10-32 screws of various lengths. Refer to the CAD drawings for locations of each size of screw. Screw until the flathead is flush with the body of press.

Step 5.
Attach the base of the heat press the to press body using four #6-28 screws. Clearance holes are drilled in the base of the press body for this step.

Step 6.
Attach the heat press arm to the lid of the press using the indicated screws on the CAD drawings.

11. Ice Bag Sleeve Manufacturing Plan

11.1. Ice Bag Sleeve Manufacturing Applications

When it comes for the ice bag sleeve it is planned that they will be produced by the Elizabethtown college athletic department on a need to supply basis. The Elizabethtown College athletic department will have to supply the ice bag sleeves if a sleeve gets lost, they receive a larger demand for ice bag sleeves, if an athlete wants to buy a personal ice bag sleeve, or the department wants to have a reserve of back up ice bag sleeves. Other athletic departments and stadiums that would like to adopt the ice bag sleeves systems may also produce ice bag sleeves. The estimated cost of material, the amount of materials needed, tools required, and the work instructions for the ice bag sleeves available in the ice bag sleeve manufacturing plan.

11.2. Ice Bag Sleeve Manufacturing Plan

The team decided to make two sizes for the ice bag sleeves, a small size and a large size. Both sleeves use the same material and have the same width. The dimensions of the small ice bag sleeve are shown in the table below.

Small Ice Bag Sleeve Dimensions		
	Length (inches)	Width (inches)
Polyester Lycra/ Spandex Fabric	20	11 1/2
Loop Velcro	4	11 1/2
Hook Velcro (3x)	14	2

Table 10: Small Ice Bag Sleeve Dimension

The dimensions of the large ice bag sleeve are shown in the table below.

Large Ice Bag Sleeve Dimensions		
	Length (inches)	Width (inches)
Polyester Lycra/ Spandex Fabric	24	11 1/2
Loop Velcro	4	11 1/2
Hook Velcro (3x)	18	2

Table 11: Large Ice Bag Sleeve Dimension

The manufacturing plan for the ice bag sleeves involves using fabric scissors to cut the polyester lycra/ spandex fabric to the specified dimensions shown in the tables above. The velcro should be cut with regular scissors to the dimensions specified above as well. The velcro is attached to the fabric using a sewing machine along the edges around each piece of velcro.

11.2.1. Materials and tools required.

The materials needed to make the ice bada sleeves include the polyester lycra/ spandex fabric, 4 inch wide sew on hook and loop velcro, and thread. The tools used to make the ice bag sleeves are a sewing machine, a measuring tool, marker/pen, and a pair of regular scissors, and fabric scissors.

11.2.2. Work Instructions.

Step 1.
Measure the polyester lycra/ spandex fabric following either the small or large sleeve dimensions with a measuring tool such as a ruler or a yard stick and mark the dimensions with a pen or marker.

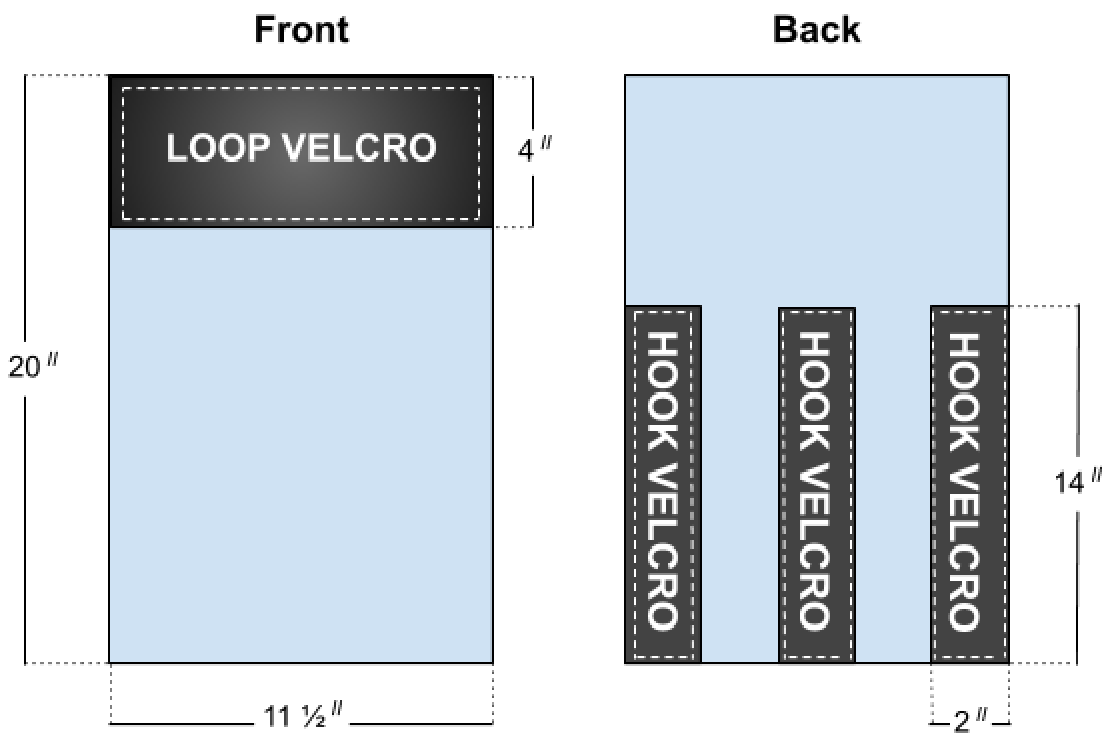
Step 2.

Cut the fabric following the marked dimensions using fabric scissors

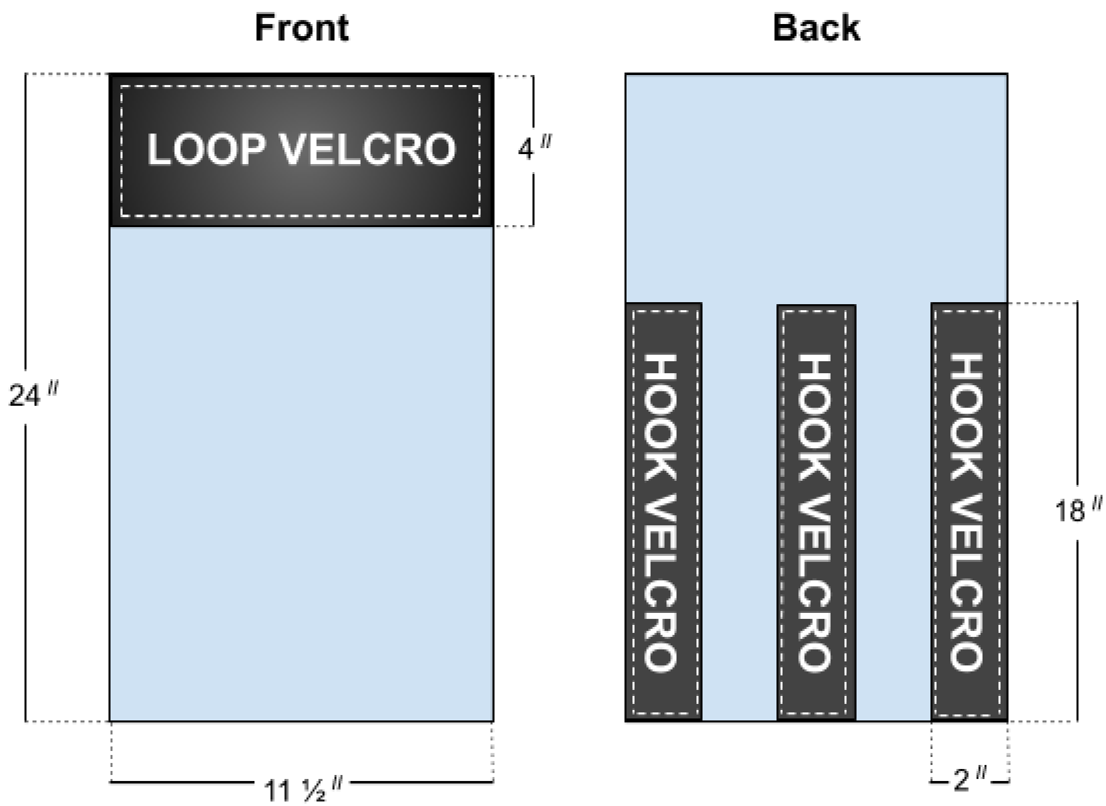
Step 3.
Measure and cut the hook and loop velcro with a pair of regular scissors. Follow the dimensions of the velcro according to either the small or large sized ice bag sleeve.

Step 4.
Use a sewing machine to sew each piece of velcro to the fabric. Follow the image below according to the desired size.

Small Ice Bag Sleeve:



Large Ice Bag Sleeve:



12. Final discussion and conclusions

12.1. Project Results

Our project was successful in all it's goals except it's implemented. Mathematically we were able to determine that the project would make the system more eco friendly, efficient, and even cheaper, which wasn't even an initial goal. Then we were able to determine that the reduction of air in the ice bags due to the ice bag press will increase the effectiveness of the ice bags.

One area of the project that failed was implementing the project for the ice bag sleeves.Our project was not implemented because of our project timeline being cut short due to unforeseen events. This also ruined all plans to test our project on student athletes.

Then the only other part of the project we failed at was creating an organizational system for the ice bag sleeves. While we discussed this part of the project in team meetings we never had more than a basic plan for it. This organization system we planned was going to be a drop off box and a pick up box for the sleeves, then each ice bag sleeve would have a number attached to it. So every time an ice bag sleeve is given to a student their ID number and name is put on a sign out sheet for the ice bag sleeve. Though since there was no testing done to see if this organization system would fail or succeed for the athletic department, we are labeling our system as a failure.

12.2. PDS summary

When reflecting on our projects project design specifications (refer to section 5) our project was successful in fulfilling most of them. When it comes to the PDS about performance we have accomplished six out of nine of these specifications. The three specifications that we did not accomplish because we did not finish the final product and could not test if our project was successful in those three design specifications. Though in our testing of our prototype ice bag press we can determine that the ice bag press would have also been successful in making the ice bag flat, fast, and getting the correct amount of air out of the ice bag.Other testing done using our prototype and testing our heat press we were able to also determine that we accomplished all our PDS about trade-offs. For our PDS about company constraints, we were successful about accomplishing our specification about staying within budget, but failed the two other specifications that relied on us finishing our project. Then we succeeded in accomplishing all the PDS for maintenance, size, standards, product lifespan, quality, and reliability. Since our failed PDS were mostly caused due to the project not being finished we decided not to alter the PDS or the problem statement.

12.3. Reflections and Future Plans

Since the coronavirus pandemic broke out during the building of our final product we were unable to put our project into practice at the Elizabethtown college athletic department, which was the end goal of our project. Our team was unable to finish the ice bag press or make our organizational system for the ice bag sleeves.

If we could do things differently we would have not applied for IRB testing. Instead our team would have given the athletic department our final products after quick tests on ourselves and started setting up the project in the athletic department. If this was done it would have saved our team about a week of time, which would have been enough time to finish the ice bag press and give it to the athletic department.

Even though our team has completed our part of the project, we believe that it can still be completed by a future group. There is enough work for a team to complete a sophomore project by continuing our project or for a college club to complete it. While we have reached out to campus clubs there have been no replies about any clubs interested in finishing our project. So our team's best possibility for someone finishing our project is for a sophomore team to pick our project up next year. Our pitch for other people to pick up our project is as follows.

Elizabethtown College’s athletic department’s current method of producing and securing ice bags to student-athletes for muscle recovery is flawed. Getting the air out of ice bags is an important yet difficult process. Air bubbles reduce the ice bag’s coldness, making it less effective. Also, 300lbs of single-use plastic is thrown out annually by the Elizabethtown College’s athletic department to make these plastic wraps used to attach ice bags to athletes..

Improving the process of manufacturing and attaching ice bags to athletes to be more efficient, effective, and eco-friendly is the goal of this project. A press will squeeze the air out of the ice bag and seal the bag. Then a reusable fabric ice bag sleeve will be used to attach ice bags to an athlete’s sore areas. What remains of the project is to complete the ice bag press, incorporate the new system into the athletic department, and create an organizational system for the ice bag sleeves. The press needs two hours to complete. Eight fabric ice bag sleeves have been manufactured, though more might need to be made in order to successfully implement the project.

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Appendix:
Foam Testing Details
Location for Foam Drying

Figure 1A: The location of the foam when drying in the dry time experiment.

The foam drying location is located on two planks of wood in an isolated dark location. More specifically it is underneath a raised bed in one of the group member's dorm rooms in Ober. There is enough room for all of the pieces of foam and they will remain undisturbed for the entire time of the experiment. While the experiment is happening all of the pieces of foam will not be touching so no water from one foam gets absorbed by another piece of foam.

Build for Simplified Ice Bag Press for Foam Testing

https://www.commonobjective.co/article/fibre-briefing-polyester

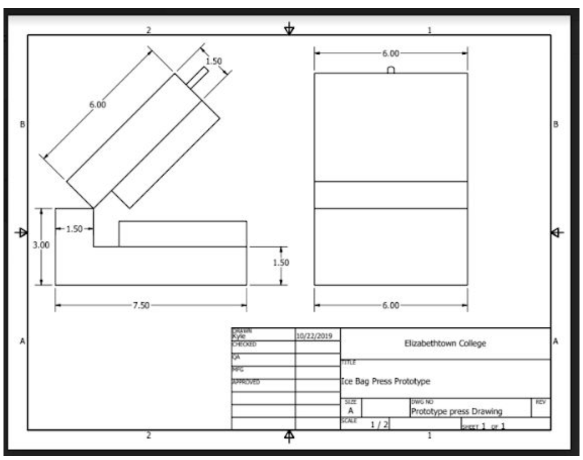


Figure 2A: Simplified ice bag press used in testing the ease to clamp down on the ice bag and the amount of air remaining in the ice bag

Materials Needed

Three 3" screw
- Hinge and screws for hinges (usually sold together)
- Velcro
- Three pieces of wood: 1.03 board feet
  - 6" X 6" X 1.5"
  - 7.5" X 6" X 1.5"
  - 3" X 6" X 1.5"

Figure 3A: Built the foam testing ice bag press without the velcro or foam attached

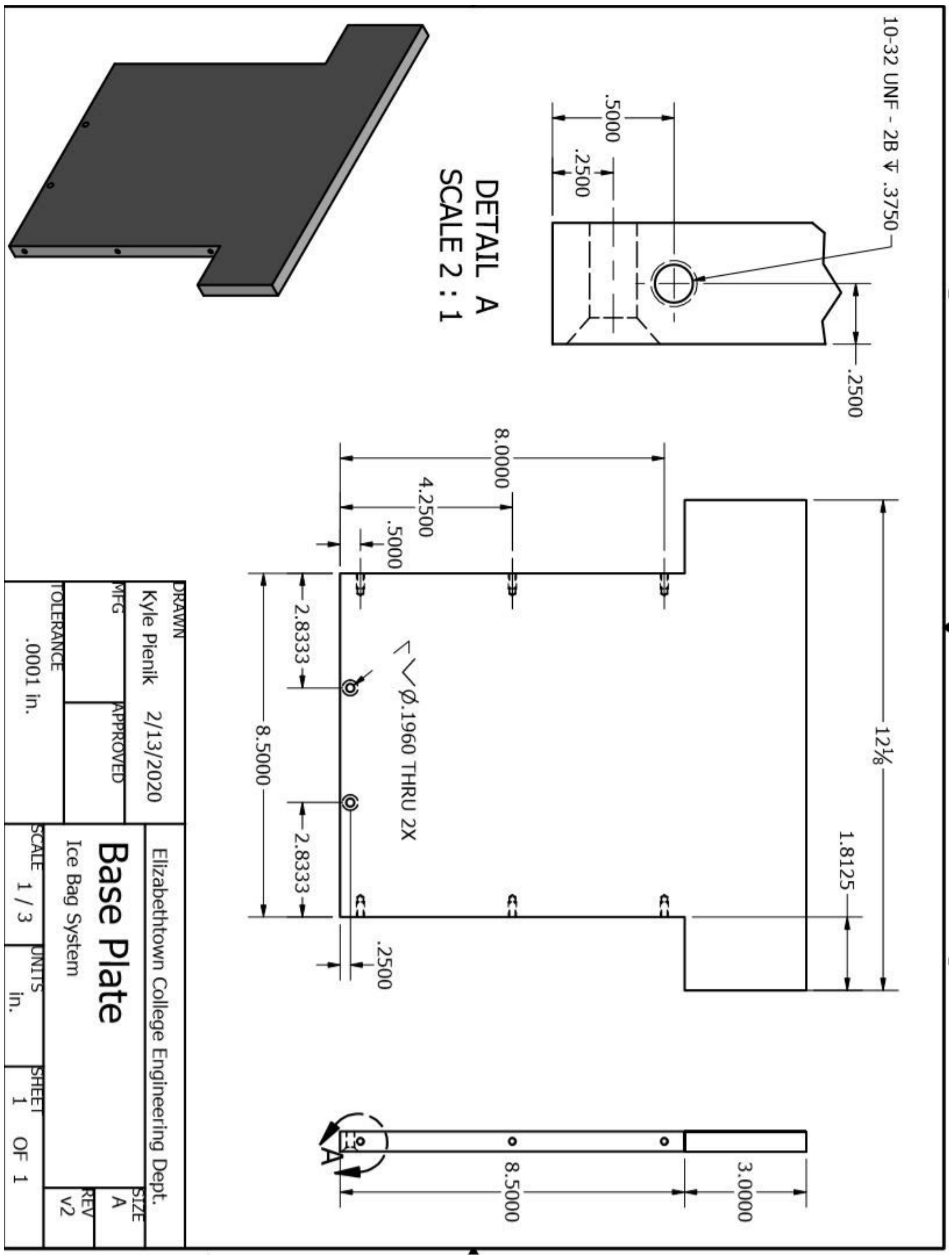
Changing out Foams

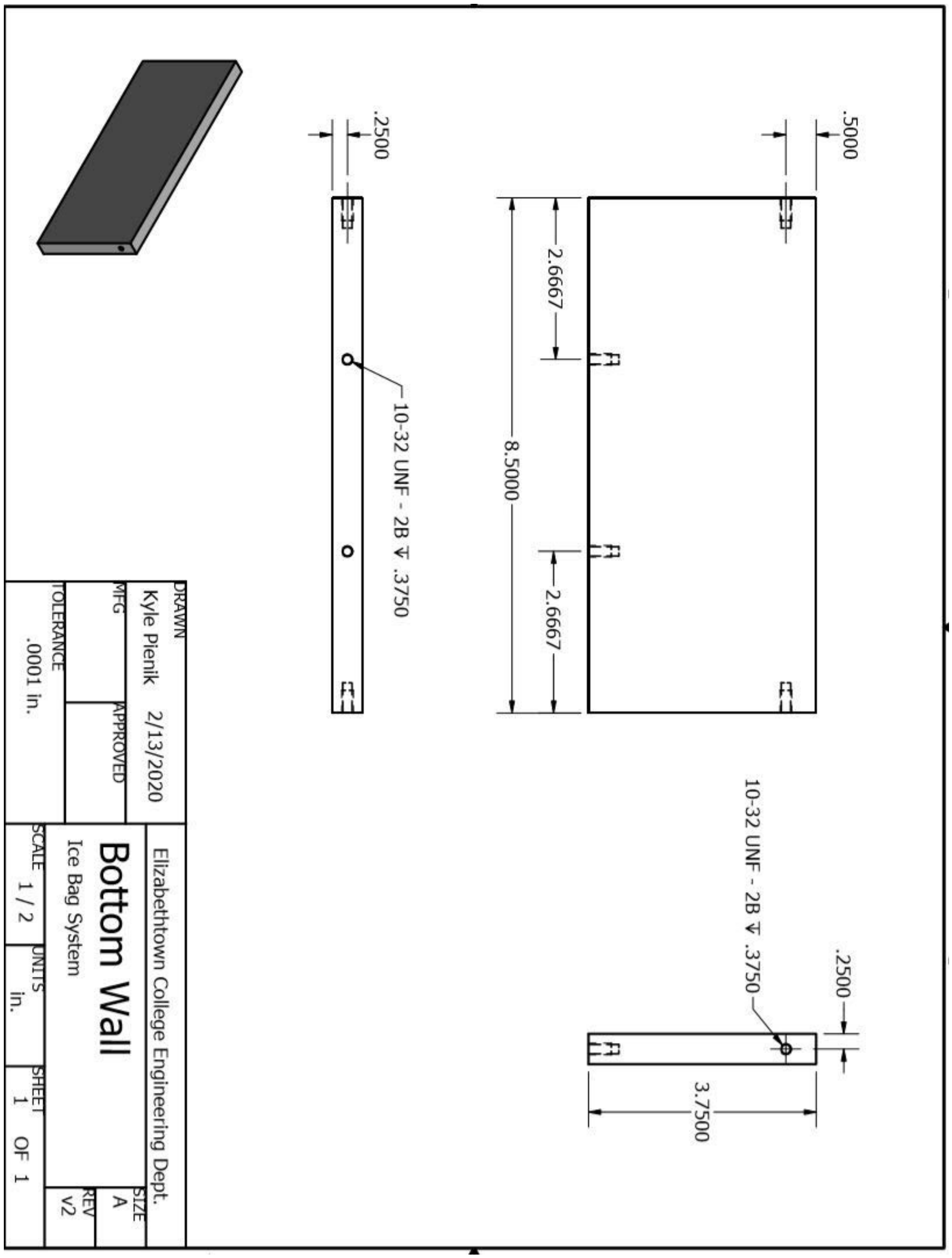
The foam will be attached to the ice bag press by velcro. The hook side of the velcro will be attached to the ice bag press with hot glue. Then each piece of the foam will have the loop side of the velcro attached to it with hot glue. This will allow for the foam samples to be easily interchanged while being attached to the ice bag press when being used to compress ice bags for testing.

Using the Forcemeter

The force meter will be hooked onto the nail stuck out of the top part of the ice bag press. Pull the top part of the ice bag downward by the force meter hooked to the nail so the top part of the ice bag press is pressed against the bottom part of the ice bag press. Then using the Sparkvue app and connecting it to the digital PASCO force meters via Bluetooth. This app will record the amount of force used to press down on the ice bag while at the same time graphing the data.

CAD Drawings

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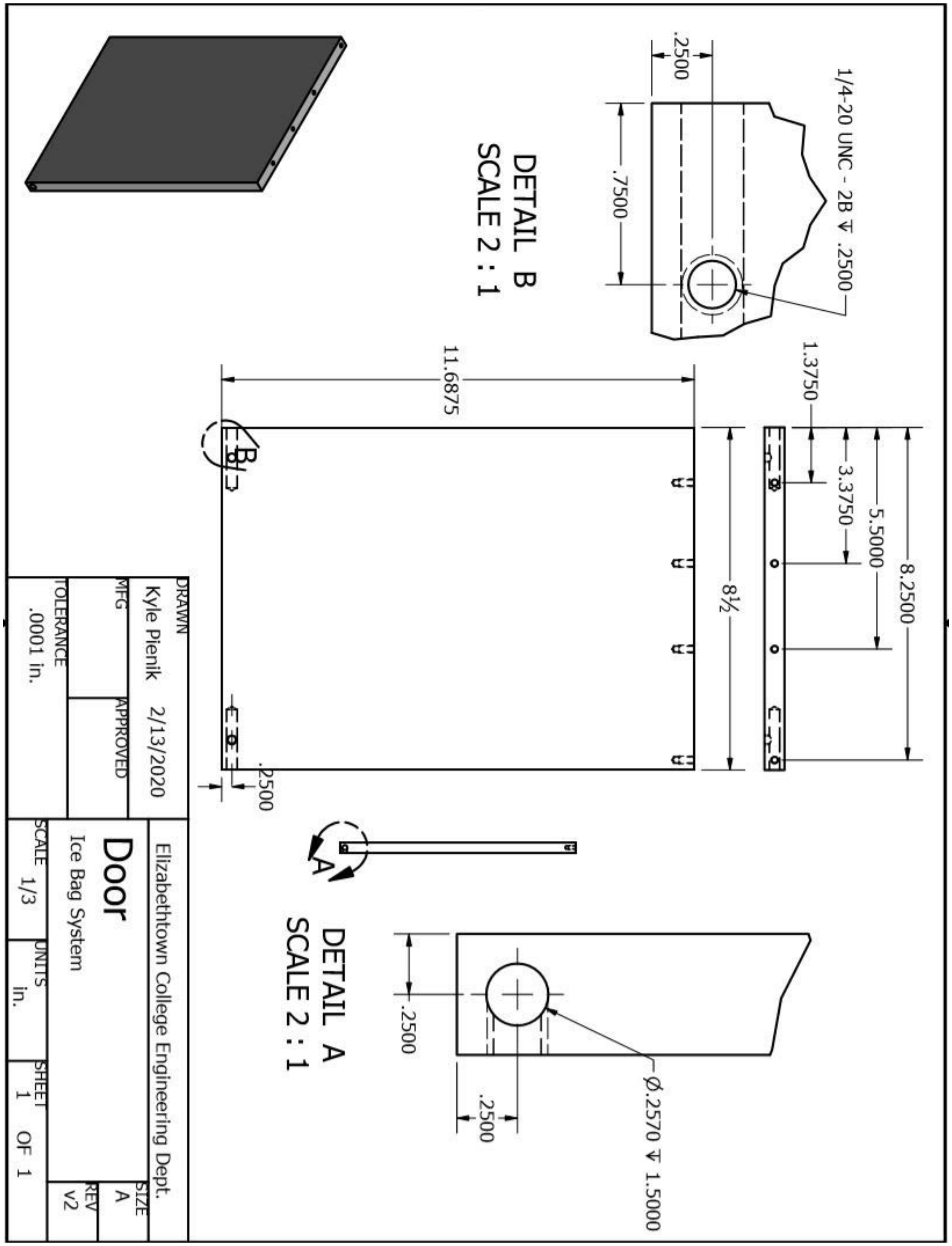
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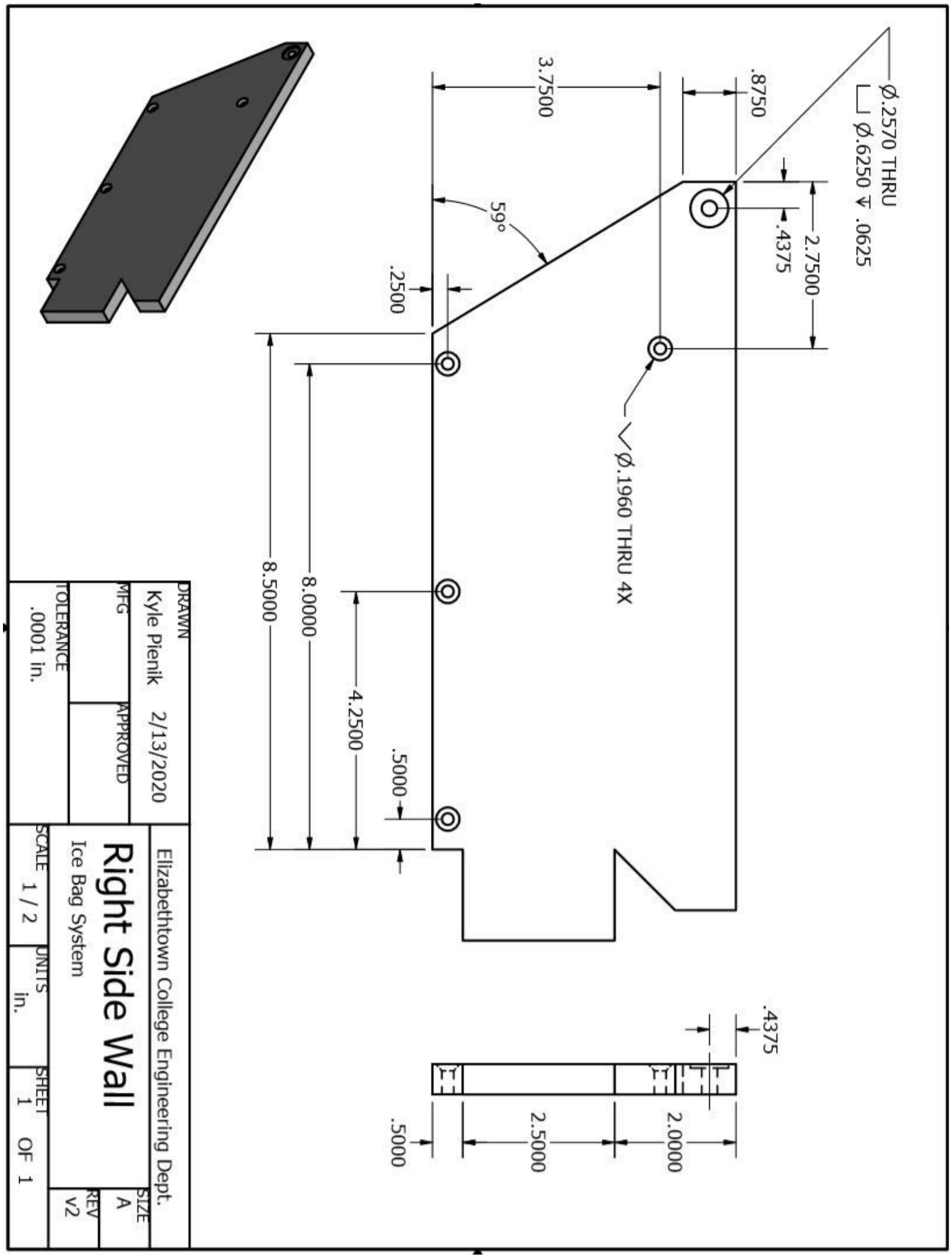
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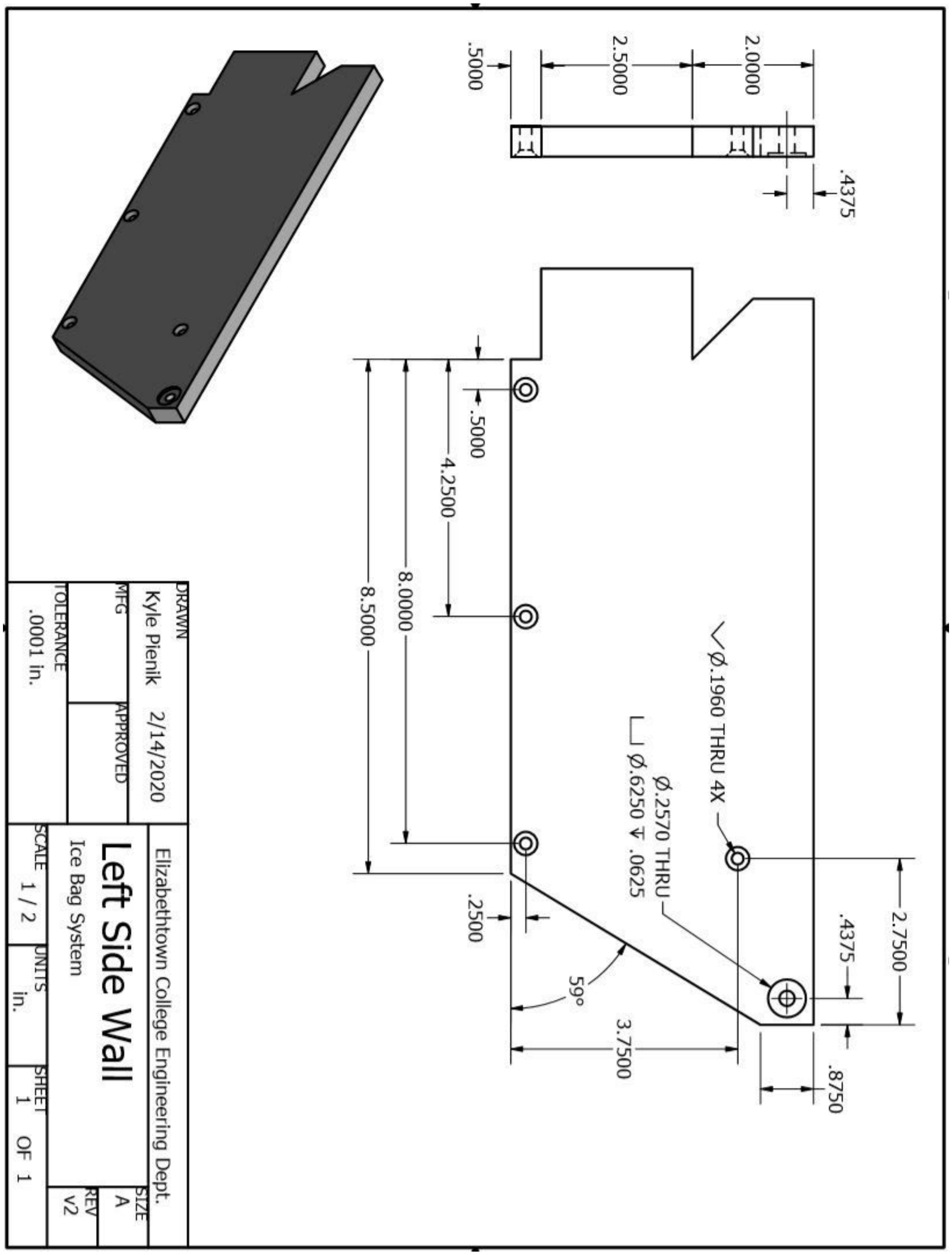
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IRB Forms

IRB Application Document

1. Title of the project.
The working title of this study is "Ice Bag Improvement Processes."

2. Name of principal investigator/association with the College/address/telephone/faculty sponsor and/or department chair.
The students completing this study are Olivia Beachley, Isabella Panzica, Annie Novy, Kyle Pienik (mailbox 2011, 215-421-2342). The faculty advisor is Dr. Kurt DeGoede, Director of the Biomechanics Research Lab and chair of the Physics and Engineering Department (717-361-1380).

3. Other project participants (individuals or institutions/agencies).
There are no current other project participants.

4. Subjects of the study (describe how they will be obtained).for
Subjects for the study will be athletic male and female young adults at Elizabethtown college. Please see attached subject inclusions and exclusions.

Subjects will be recruited from acquaintances who have expressed interest in the project. The research team will be working with the athletic trainers in recruiting student-athletes to participate. Please see the attached recruiting statement, which will be presented to subjects from both sources.

5. A summary of the research methods and procedures.
Please see the attached Protocol, Subject Information, and Instructions documents.

6. A discussion of how subjects will be debriefed, if needed.
No debriefing is needed beyond the attached Informed Consent Form. This form provides contact information for any follow-up concerns (sections 2.10 and 2.13).

7. A discussion of any and all risks and the procedures to minimize them.
Risks may include feeling cold or tripping while walking. The risk involved in this study is no greater than one would encounter in daily activities. Please see the attached Informed Consent document, section 2.6.

8. Benefits to participants and non-participants.
Although there are no direct benefits to the subjects in this study, the knowledge gained can improve the current athletic ice bagging process for Elizabethtown college students. Please see attached Informed Consent document, sections 2.8 and 2.9 for details.

9. The nature of the subjects' participation and an assurance letter signed by the principal investigator
Please see attached assurance letter.

10. Informed consent procedures
Please see attached Informed Consent document.

11. Waiver of Informed Consent.
Not applicable to this study.

Recruiting statement Document

The Engineering and Physics Department is looking for volunteers for a research project examining the efficiency and effectiveness of the ice bag press and holder for the athletic department. The goal of this project is to create a more efficient, effective, and eco-friendly way to make ice bags and attach them to the sore area of an athlete. Volunteers will make an ice bag using the press, have the ice bag attached to them, and walk a distance. While there is a risk for bruises if the subject trips while walking, participating in this study will not increase your chances of such an injury above incurred with normal daily activities. Volunteers must be healthy athletic males and females between the ages of 18 and 30 without any nerve injury. If you are interested in participating, please contact Isabella Panzica at panzicai@etown.edu.

Subject Inclusions Document

Males and females athletes who are between the ages of 18 and 30 years.

Subject Exclusions:

Factors present which may bias the sample:

a. Nervous system problems which affects feeling in the skin or muscles
b. Not having experience with the original ice bag system
c. Nerve injury
d. Muscle atrophy

Factors present which may increase the risk of injury:

a. Trouble walking
b. Nerve injury (any occurrence)

Subject Information Form Document

Please answer the following so we can determine your eligibility for participation in our experiment. Most of our experiments survey the comfort of using the ice bag press and holder. For example, they include using the ice bag press, putting on the ice bag sleeve, and walking around with the ice bag sleeve.

Name:
Phone Number: (   )
Email Address:
Birthdate: **Gender:** Male Female
Height: **Handedness:** R L
Weight: **Footedness:** R L Unknown

1. Have you ever had to use a ice bag from the Elizabethtown college athletic department?

Yes No Describe:

When?
With what frequency?
What areas have you used the ice bag on?

2. Are you a member of any Elizabethtown College sports team?

Yes No Describe:

When?
What team?
What position?

3. Do you have any condition that affects the feeling in your skin or muscles?

Yes No Describe:

4. Are you currently being affected by any type of muscle atrophy?

Yes No Describe:

5. Have you ever had problems with your limbs, joints or muscles (back pain, arthritis, sprains, fractures, joint dislocation, nerve injury, paralysis, etc…)?

Yes No Describe:

When?
Any residual effect?

6. Have you ever had any nerve injury?

Yes No Describe:

7. What is/are the language(s) that you spoke and wrote growing up and/or that you are the most comfortable with?

8. *Have there been any changes to the above answers since the above date*?____re-date

Comments (any other broken bones, any recent injuries, or any other existing medical condition):

For more information contact:

Kurt DeGoede, Ph.D.
164A Esbenshade
degoedek@etown.edu
(717) 361-1380

Signed______________________________

Please answer the following so we can assess your activity level:

Informed Consent Form Document

INFORMED CONSENT - PARTICIPANTS

1. GENERAL INFORMATION

1.1 This version of the consent document was prepared on: December 6th, 2019

1.2 This version of the consent document was approved by the IRB on: TBD

1.3 This project's approval by the IRB will expire on: TBD

1.5 Names of the investigator responsible for this project:

Kurt DeGoede, Ph.D.
Professor of Physics and Engineering
Director of the Biomechanics Lab at Elizabethtown College

1.6 The title of this research project is:

Improving the Process for the Athletic Ice Bag System

1.7 This research is funded by:

Elizabethtown College – SCARP (EPICS Scholarship/NSF S-STEM Scholarship Reporting Site for Award 1259474) program

2. INFORMATION ON THE RESEARCH STUDY

2.1 What is the purpose of this research study?
You are being asked to participate in this study investigating the reaction time of athletes from Elizabethtown college. The purpose of this research is to make the ice bags that the athletic department uses to treat athlete's sore body parts more efficient, effective, and eco-friendly. By receiving student feedback on the new ice bag process, this information can be used to make further improvements to the ice bag process.

2.2 Who can take part in this study?
Healthy males and females at Elizabethtown college and who do not have any nerve damage or muscle atmospy.

2.3 Why should I consider joining this study as a research subject?
There are many benefits of participating in the study: using a more effective ice bag for sore areas, reducing plastic use in the athletic ice bags, and using an ice bag holder that firmly holds the ice bag to the sore area.

2.4 Do I have to become a subject in this study? If I joined the study, can I change my mind and drop out before it ends?
Your becoming a subject in this study is entirely by your own free choice. You may drop out of the study at any time or for any reason by your free will, even after having agreed to be a subject. You may refuse to participate in the study or drop out of the study at any time without penalty or loss of any benefits that you may be entitled to.

The investigators of this study may have to end your taking part in this study as a subject if, for any reason, they estimate that there is an increased risk of injury to you.

2.5 What exactly will be done to me, and what kinds of treatments or procedures will I receive if I agree to be a research subject in this study?
This study has five parts made up of three tests and two surveys, which is separated into two different parts.

Please initial each section below that you are willing to consider doing after having your questions answered by the individual helping you with this form.

<u>Part I - Ice Bag Press and Survey</u>
Part one is the ice bag press testing and survey. The ice bag press testing is done by making an ice bag using the heat sealed ice bag that takes the air out of the bag before sealing. After making an ice bag using this method, participants will complete a short story about their experience using the ice bag press.

<u>Part II - Ice Bag Holder and Survey:</u>

Part two is the ice bag holder application, testing, and survey. An ice bag will be attached to the participant’s sore area via the ice bag holder. Then the participant will walk around with the ice bag holder and ice bag attached to them. After walking around with the ice bag holder and the ice bag the participant will fill out a survey. If the participant does not wish to walk around with the ice bag holder on they could also fill out a shorter survey that does not include questions about walking around.

2.6 What kinds of harm can I experience in this study, and what will the investigators do to reduce the chances of harm?
If you have a history of nerve injury or illness please inform us. You may not be permitted to participate in this study. The researchers believe that this study presents no more risk than performing everyday activities. The risks include tripping while walking, getting slightly wet, and feeling uncomfortable because of the coldness of the ice bag. The temperature of the ice bags will not reach or become near a temperature that will harm participants.

If you are already taking part in another study, please let us know, as participating in multiple studies may be harmful to you. Avoid taking part in multiple studies at the same time, unless you and the investigators agree that you are not likely to be harmed, and the outcome of the study will not be disturbed. This is particularly important if you are receiving in another research study any investigational or non-investigational drugs.

2.7 What will the investigators do to make sure that the information they will collect on me will not get into the wrong hands?
In any reports on this study, you will not be identified, and all records will be kept confidential to the extent provided by federal, state and local laws. Questionnaire responses, photographs, videotape, and other information obtained during your participation in the study will be used by medical and research personnel in the course of their analyses of your actions. Some photographs or video recordings may be presented in a classroom setting, to scientists visiting the College, or at scientific conferences. Results may be published in the form of an undergraduate paper or in a scientific journal.

We shall put the information collected about you during the study into a research record. We shall not enter in this record your name, registration number or anything else that might allow someone to find out that the information belongs to you. No one will be able to link the information on your research record to you.

2.8 What kinds of benefits can I expect personally from taking part in this study?
A personal benefit of the study is that a sore area will be soothed and numed to reduce pain. You will not derive any other personal benefit from participating in this study. If significant new knowledge is obtained during the course of this research, which may be a benefit to your participation, you will be so informed.

2.9 What kinds of benefit to others can come out of this study?
The study will help in increasing the quality and efficiency in making ice bags that are used to sooth sore areas of athletes. This study will also benefit the environment by reducing the amount of plastic waste is created by the athletic department by 323 pounds per year.

2.10 What will the investigators do, if I become injured in the study?
If you experience any discomfort or injury, which may be related to this study, you may contact Kyle Kopko, Ph.D., in the Office of Sponsored Research and Programs at kopkok@etown.edu or by phone at (717)-361-1990.
Should you experience physical injury as a result of research-related procedures, immediate first-aid treatment will be provided by Campus Security personnel and Penn State Hershey Medical Group, Elizabethtown, as needed. Additional medical treatment will be provided as necessary. However, the College does not provide compensation to a person injured while taking part as a subject in research.

2.11 Will I be paid for taking part in this study?
No.

2.12 Will I or my health insurance company be charged for any of the costs of this study?
No. Neither you nor your insurance company will be charged for any of the costs associated with this study.

2.13 Once I start in this study as a subject, what do I do if I want to find out more about the study, or to complain about the way I get treated?
To find out more about any aspect of this study, including your rights as a subject, you may contact the persons whose names, and telephone numbers appear below:
Kurt DeGoede, Ph.D., Department of Engineering and Physics (717) 361-1380
If you have any questions or concerns about your rights as a research subject, you may contact Kyle Kopko, Ph.D., in the Office of Sponsored Research and Programs at kopkok@etown.edu or by phone at (717)-361-1990..

2.14 If I decide not to become a subject in this study, what may happen to me, or what other choices do I have if I need treatment?
The older system of making ice bags and attaching them will still be available to use. This older method consists of putting ice in the bag and tying it into a knot. Then attaching the ice bag onto the athlete by wrapping plastic saran wrap around the ice bag and the sore area multiple times.

3. DOCUMENTATION OF CONSENT

3.1 Who gets to keep this document, once I sign it?
One copy of this document will be kept together with the investigators' research records on this study. An additional copy will be given to you to keep.

3.2 Research subject's statement of consent to participate in this study
I have read the information given above. I am 18 years of age or older. The investigators personally discussed with me and told me about the study, and answered my questions. I understand the meaning of this information. I am aware that, like in any research, the investigators cannot always predict what may happen or possibly go wrong. I have been given sufficient time to consider if I should join this study. I hereby consent by my own free choice to take part in the study as a research subject.

3.3 Research subject's identity, and the identity and dated signatures of the subject and/or legal representative of the subject, affirming that consent was given:

Name: Birth Date:

Address:

(full, including ZIP code)

Social Security Number: Telephone: ( ) -
(*for payment purposes only*)

Consenting Signature: Date:

3.4 Investigators' confirming statement:
I have given this research subject information on the study, which in my opinion is accurate and sufficient for the subject to understand fully the nature, risks and benefits of the study, and the rights of a research subject. There has been no coercion or undue influence. I have witnessed the signing of this document by the subject.

Investigator's Name:

Investigator's Signature: Date:

Patient Information:

Our projects are sometimes funded by the Federal Government, which asks that we supply the following information about our subjects. This is not required for your participation in our testing. If you are willing, we would appreciate your selecting the items below that best describe your nationality, ethnic/racial status, and any disability. Your name is not connected in any way, after this consent, with the information. Thank you.

Gender:	Male	Female	
Citizenship:	U.S. Citizen	Permanent U.S. Resident	Other (non-U.S. Citizen)
Ethnic/Racial status:	American Indian or Alaskan Native Pacific Islander Asian Black (not of Hispanic Origin) Hispanic White (non-Hispanic)		

Do you have a disability, which limits a major life activity? Yes No

Protocol IRB Document

Subjects:

The subjects for this experiment will be Elizabethtown college students in the athletic department. All subjects will be volunteers without any fractures in the last 10 years. Young adult subjects must be between 18 and 30 years old. Young adult subjects will be recruited from acquaintances and athletic trainers. The subjects will be provided information about the experiment before they give their informed consent and will complete a brief medical questionnaire and history form.

Experimental Procedures:

The ice bag testing is separated into two sections: the ice bag press and Survey and then the Ice Bag Sleeve and Survey.

The first section: Ice Bag Press and Survey will be done by either the subject or the test proctor depending on whether or not the subject declines to participate in the ice bag press and survey. If the participant is completing the Ice bag Press and survey they will go through the procedure, if not then the test proctor will go through the Ice Bag Press protocol to produce an ice bag.

After the ice bag was made using the ice bag press protocol part two of the testing will be able to start. If the participant does not want to continue the ice bag sleeve testing, the ice bag produced from their previous testing can be used as a regular ice bag and given to anyone in need of one. Though if the participant does want to continue testing they will use the ice bag produced using the ice bag protocol in the ice bag sleeve testing.

<u>Part I - Ice Bag Press and Survey</u>

The ice bag press testing is done by making an ice bag using the heat-sealed ice bag that takes the air out of the bag before sealing. Before starting, get a stopwatch ready. Start the stopwatch right before getting a standard thin plastic bag provided by the athletic department and adding one to two scoops of ice into the bag. Then bring the ice bag to the wall-mounted ice bag press. Open the press by pulling the labeled pin on the right side of the press and pulling the handle away from the wall. Lower the ice bag into the newly open shaft with the opening of the bag facing the ceiling and stick out the top of the press. Avoid touching the side of the press attached to the wall. Make sure everything but the ice bag is out of the press or near the hinge. Shut the press by pressing the handle towards the wall. Continue to push the handle until the press is fully closed. Wait for one second before pulling the labeled pin located on the right side of the press. Once the pin is removed open the press by pulling the handle away from the wall. Lift the ice bag up from the excess plastic that was sticking outside of the press. Be careful not to touch the inside of the press. When the ice bag is outside of the ice bag press stop the stopwatch. After making an ice bag using this method, participants will complete a short survey about their experience using the ice bag press

Part II - Ice Bag Sleeve and Survey:

Part two is the ice bag sleeve application, testing, and survey. Before being given the sleeve, the test instructor will demonstrate how to put on the ice bag sleeve. An ice bag sleeve will be given to the participant who will be asked to put the sleeve on with the ice bag inside based on what they saw. Then the participant will walk 50ft, turn around and walk another 50ft. They will repeat this process 3 times. After walking, the participant will fill out a survey. If the participant does not wish to walk around they can fill out the survey while skipping the questions about walking around.

Appendix:

Ice Bag Press Survey

1. How long did it take you to make an ice bag using the new method? (Use the time from the stopwatch)
2. How does the time it took to make a completed ice bag compare to the traditional method?
3. How does the quality of the completed ice bag using the ice bag press compare to the traditional method?
4. Do you feel that enough safety procedures were put in place to prevent people from getting hurt by the press? (Ex: pinching fingers, getting burnt, etc.)
5. Would you use this device in the future?

Ice Bag Sleeve Survey

1. Did you notice the ice bag sleeve slid when you walked around? Did it stay in place well? Explain.
2. Did at any time during the walking part of the testing did you have to readjust the ice bag sleeve?
3. How comfortable on a scale from 1 to 10 was the fabric? (10 being the most comfortable)
4. How comfortable on a scale from 1 to 10 was the sleeve to wear overall? (10 being the most comfortable)
5. Did you feel any water leaking from the ice bag?
6. How easy was the sleeve to put on yourself? Did you need someone to help you (athletic trainer/staff)?
7. How do you like the ice bag sleeve compared to the old method of the plastic wrap? Was this new method faster? Was this new method more efficient? Explain.

8. Was the size a good fit? Explain and include what size you wore.

9. How environmentally friendly do you think this new method is compared to the old method?

10. How environmentally friendly do you think this new method is compared to the old method?

Instructions Documents

Part I - Ice Bag Press and Survey

Part one is the ice bag press testing and survey. The ice bag press testing is done by making an ice bag using the heat-sealed ice bag that takes the air out of the bag before sealing. This is done by getting a standard thin plastic bag provided by the athletic department and adding one to two scoops of ice into the bag. Then bring the ice bag to the wall-mounted ice bag press. Open the press by pulling the labeled pin on the right side of the press and pulling the handle away from the wall. Lower the ice bag into the newly open shaft with the opening of the bag should be facing the ceiling and stick out the top of the press. Avoid touching the side of the press attached to the wall. Make sure that everything but the ice bag is out of the press or near the hinge. Shut the press by pressing the handle towards the wall. Continue to push the handle until the press is fully closed. Wait for one second before pulling the labeled pin located on the right side of the press. Once the pin is removed open the press by pulling the handle away from the wall. Lift the ice bag up from the excess plastic that was sticking outside of the press. Be careful not to touch the inside of the press. After making an ice bag using this method, participants will complete a short survey about their experience using the ice bag press located in the appendix of the document.

Part II - Ice Bag Sleeve and Survey:

Part two is the ice bag sleeve application, testing, and survey. Before being given the sleeve, the test instructor will demonstrate how to put on the ice bag sleeve. An ice bag sleeve will be given to the participant who will be asked to put the sleeve on with the ice bag inside based on what they saw. Then the participant will walk 50ft, turn around and walk another 50ft. The participant’s pace should be at a steady pace. If at any point the participant wants to adjust the ice bag sleeve, they are free to do so. Though in the survey the participant should write whether or not they adjusted the ice bag sleeve and why. They will repeat this walking process 3 times. After walking, the participant will fill out a survey. If the participant does not wish to walk around they can fill out the survey while skipping the questions about walking around.

Style Guide For the Athletic Ice Bag Production Improvement Final Paper

Tense and Tone

The final paper should be written in past tense. The tone of the paper should be formal and not reveal any bias. First-person terms use is allowed in the paper. Also, the repetition of words should be avoided.

Writing Pattern Unification

After analyzing all of the group member’s writing styles and comparing them, a list was made on writing style rules that would be put in place to unify the groups writing style.

Writing style rules

1.) Limit the use of the word “with” two times per paragraph

2,) The words “this” and “the” is used too much

3.) The words like “get”, “bad”, good”, and “very” should never be used in the final paper

4.) Two sentences or more in a row should not share the same first word.

5.) Avoid using the same first word in a sentence more than once within a paragraph.

Do not worry about the use of the words “the”, “of” and “and”, since these three words are normal words to use frequently. Dictionary.com, states that “The word “the” is used about 5% of the time, which means that in every text of 100 words, 5 of those words are “the.” Similarly, the word “of” is used about 3% of the time, and the word “and” is used about 2.5% of the time” [2].

Reinforcing the use of active and assertive voice

An active voice is defined by the subject acts on the verb. A verb’s actions acting on a subject creates a passive voice. Then an assertive voice is done by getting rid of uncertainties in our wording. Soft verbs such as “feel, believe, think, kinda, guess, and might” should be avoided in our paper. Vague or boring verbs should also be replaced by more descriptive verbs. For example, instead of using the word find, words like discover, detect, recognize, or uncover should be used. Weak adjectives like good and bad should be avoided and replaced by a more descriptive adjective [3].

Abbreviations

The athletic ice bag was referred to as an ice bag. The fabric wrap holds the ice bag in place was called the ice bag sleeve. Then the device that squeezed the air out of the ice bag was called the ice bad press. When referring to the Institutional Review Board the IRB was used. Other than these four terms no other abbreviations were used.

IEEE Formatting basics

Normal text is written using single spacing and 10 point font. The beginning of each paragraph is indented [4].

1. First Headers are bold 12 point fonts.

There should be an empty space above and below the first headers [4].

1.1. Second headers are bold 11 point fonts.

There should be an empty space above and below the second headers [4].

1.1. Third headers are bold 10 point fonts. There should be a blank line above the third header. The normal text underneath the third header starts on the same line as the header [4].

For in-text citations, the required notations are the sources assigned numbers within brackets. Assigned numbers of sources are assigned by the order of the sources being used within the paper. For example, the third source in the paper should be notated as [3] within the paper. Then the bibliography needs to list the sources in the order they appeared in the bibliography. If a source is used in multiple places in the paper the source is assigned to the first instance it was used within the paper.

Life Cycle Impact Assessment Report of Ice Bag Sleeve Methods

Classification and Characterizations

There are many different ways a project can negatively affect the environment. Currently, the athletic ice bag process uses 300lbs of single-use plastic per year, negatively affects the environment by destroying habitats, depleting nonrenewable resources, and producing CO2 contributes to global warming. By switching to the new method of producing and attaching athletic ice bags we eliminate most of the habitation destruction impact the current ice bags are causing and reduce the amount of CO2 produced because of the ice bags. Citations for the variable data of the following calculations are located within the calculations.

Method	Global Warming	Habitation destruction	Depleting nonrenewable resources
Plastic Ice Bag Wrap	yes	yes	yes
Fabric Ice bag Wrap	yes	n/a	n/a

Table 1: Environmental classification risk matrix for the two types of ice bag wraps.

Valuation For Production

At Elizabethtown college the amount of plastic saved each year by this project will be around 90% of the plastic wrap used by the athletic department, this is estimated to be roughly 300 pounds of plastic a year. Polyethylene plastic takes 4.5 x 10^7 J/kg to produce [5]. Using this production energy rate it can be calculated that eliminating 300lbs of plastic will eliminate the need for 6123 MJ of energy a year.

Though this reduction of plastic wrap is exciting, the amount of fabric and velcro use should not be forgotten. Production of one kilogram of polyester fabric takes 125 MJ of energy [6]. Using a fabric density of 0.98 g/cm^3 and the large ice bag sleeve dimensions, the energy needed to produce the fabric for one ice bag sleeve can be found [7]. For one large sleeve, it takes 4.817 MJ to produce. In the manufacturing of velcro, it uses polyester like the fabric used in the ice bag sleeve, so the carbon production caused by manufacturing velcro is very similar to manufacturing polyester [8]. Since there are four large strips of velcro per a large ice bag sleeve, the needed velcro produces 2.328725 MJ per a large ice bag. By adding the energy needed to produce both the fabric and plastic wrap together the total energy needed to produce one large ice bag is 7.146285 MJ. To produce the fabric for a full stock of forty-five ice bag sleeves it will take 321.582825 MJ, which is still substantially smaller than the energy it takes to produce the 300 pounds of plastic.

Ideally, the fabric ice bags will last for a few years, though in order to factor in fabric ice bags getting lost and to keep the calculations liberal it will be assumed that the full stock of fabric ice bags will be replaced one a year. The amount of fabric used per fabric ice bag wrap is 32.12 grams, while the velcro used is 6.45 grams. This makes the total weight of one fabric ice bag wrap 38.57. A full stock of 45 ice bag wraps will take up 3.825lbs. In comparison 3.825lbs of fabric and velcro waste is minuscule to 300 pounds of plastic that would have been thrown out using the plastic ice bag wrap.

Figure 1: Chart showing the amount of waste produced throughout the years by the different ice bag wrap methods.

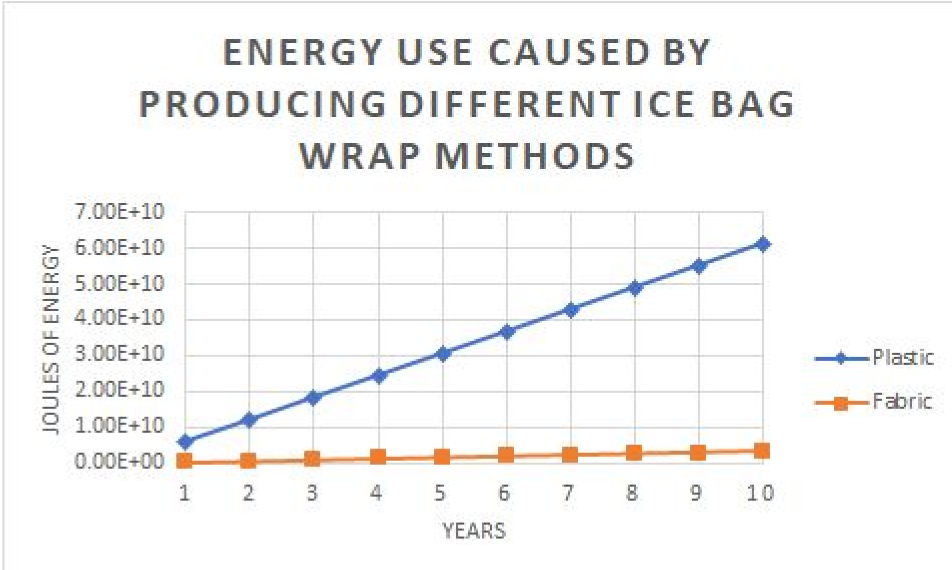


Figure 2: Chart showing the amount of energy used to produce materials throughout the years by the different ice bag wrap methods.

Validation After Production

After the production of the fabric ice bags there are two more factors which need to be considered in this method of ice bag wrapping; replacing lost wraps and the energy needed to wash the ice bag wraps. Another factor that needs to be reflected in the energy calculation for the fabric ice bag wrap is the energy used to regularly wash them since these wraps will be directly placed on an athlete after they finish their workout, causing the fabric ice bag wrap to smell like body odor. To avoid this odor it is recommended to wash the fabric ice bag wrap after every use, especially when sharing the same fabric ice bag wrap with multiple people. Preferably, the fabric ice bag wraps will be air-dried but it can also be put in a dryer. Because the calculations for electricity consumed by the fabric ice bag wrap is liberal, the energy consumed by the dryer for the ice bag wraps will also be added to the final energy calculation for the fabric ice bag wraps. The fabric ice bag wrap is small and will not need its own load of laundry, resulting in only a small portion of the energy used to run the laundry machine and the drying machine will be contributed to the fabric ice bag wrap calculation. A typical laundry machine can wash 7-8 pounds of clothing per load, an ice bag sleeve takes up 0.012 of the laundry machine's capacitance. Since the same amount of laundry that goes through a laundry machine also goes through the dryer, the same laud capacitance ratio will be used on the laundry machine as the dryer machine [9]. Because a maximum of twenty fabric ice bag wraps is used daily this means a total of 140 fabric ice bags will be washed per week. This makes up 1.7 loads of laundry in total per week. Since the athletic department rarely uses ice bags for four months out of the year it is converted to three months of not washing the fabric ice bag wraps. This helps make the total loads of laundry for the fabric ice bag wrap be 65.03 loads a year. This amount of laundry loads calculates to 11.7 MJ per year spent on washing and drying fabric ice bag wraps [10]. So in total, it will take 333.28 MJ per year to produce and maintain a full stock of fabric ice bag wraps.

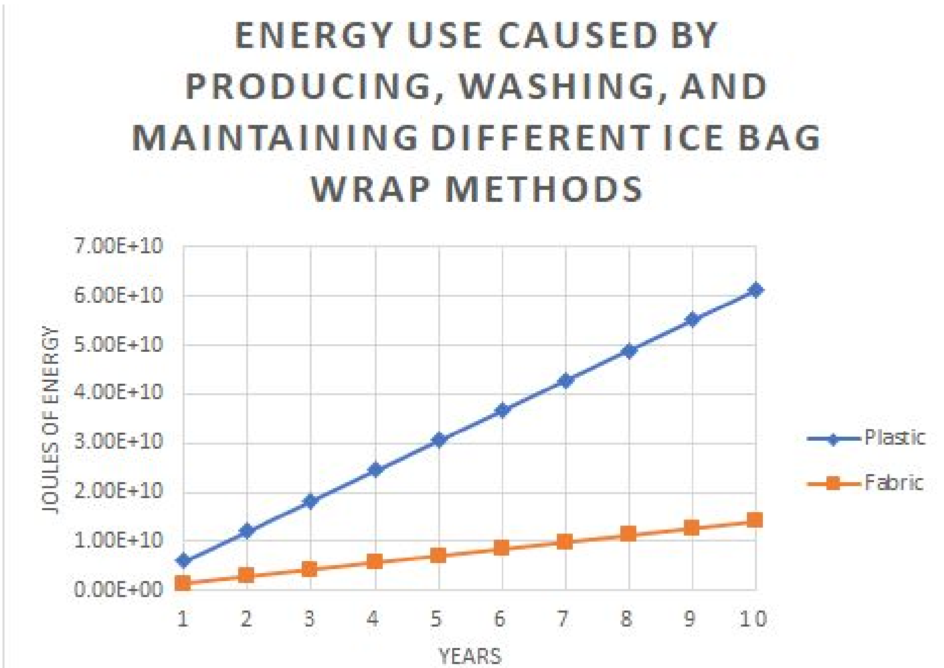


Figure 3: Chart showing the amount of energy used to produce and maintain materials throughout the years by the different ice bag wrap methods.

Conclusion

As seen in figure1 and figure 3, by switching from the plastic ice bag wrap to the fabric ice bag wrap a large amount of waste will never reach landfills and a large amount of energy use will be avoided. Every year 296lbs of single-use plastic could avoid use and 5789.72 MJ of energy could be saved. These reductions of both waste and energy use are substantial. Energy use from material production will be reduced 82%, while waste will be reduced 98%. Citations for the variable data of the calculations will be found within the calculations.

Life Cycle Impact Assessment Calculations

Mass and Energy Used to Produce the Fabric for One Fabric Ice Bag Sleeve				
width (inches)	length (inches)	thickness (inches)	Area (inches)^3	Area (cm)^3
11.5	24	0.01	2.76	45.228396
0.98	density of fabric (grams/cm)			
44.32382808	grams of fabric		Citation	
1250000	Energy used to produce a gram of fabric		Fabric/Fibre?," Better Meets Reality, 01-Apr-2020. [Online]. Available: https://www.bettermeetsreality.com/is-polyester-sustainable-eco-friendly-as-a-fabric-fibre/. [Accessed: 10-Mar-2020].	
55404785.1	Joules to produce the fabric for a fabric ice bag sleeve			
55.4047851	MJ to produce the fabric for a fabric ice bag sleeve			

Energy Used to Produce 300lbs of Plastic			
300	lbs of plastic		Citation
136.0776	kg of plastic		
45000000	(J) energy used to produce plastic		R. N. Walters, S. M. Hackett, and R. E. Lyo
6123492000	(J) energy used to produce 300lbs of plastic		

Mass and Energy Used to Produce the Velcro for One Fabric Ice Bag Sleeve					
width (inches)	length (inches)			Total Length (incl	77
2	18		15ftX2inch velcro roll is (ounces)		0.64
2	18		180inchesX2inch velcro roll is (ounces)		0.64
2	18		2.337662338	times the total length can fit in 15 ft	
4	11.5		0.2737777778	total ounces of velcro	
			7.761463111	total grams of velcro	
			0.0171110768	Total pounds of velcro per a fabric ice bag sleeve	
1250000	Energy used to produce a gram of velcro		Citation		
9701828.889	Joules to produce the velcro for a fabric ice bag sleeve		N. Gilani, "Facts on Velcro," Sciencing, 02-Mar-2019. [Online]. Available: https://sciencing.com/velcro-6470547.html. [Accessed: 10-Mar-2020].		
9.701828889	MJ to produce the velcro for a fabric ice bag sleeve				

Total Weight of a Fabric Ice Bag Sleeve		
Weight of fabric	44.32382808	grams
Weight of Velcro	7.761463111	grams
Total Weight	52.08529119	grams
	0.1148282747	lbs

Total Weight of a Fabric Ice Bag Sleeve		
Power for fabric	55.4047851	MJ
Power for Velcro	9.701828889	MJ
Total Power	65.10661399	MJ

Laundy Loads per a Year		
140	used wraps per week	**Citation**
16.07595845	lbs of laundry per week	S. Aguirre, "What Is a Proper Full Load of Laundry?," The Spruce, 02-Oct-2019. [Online]. Available: https://www.thespruce.com/laundry-full-load-1900682. [Accessed: 10-Mar-2020].
2.296565493	loads of laundry per week	
87.84363012	Loads of laundry per year	

Energy Use for a Laundry Machine Per a Year		
500	watts used per laundry load	**Citation**
1800	seconds per load	"Electricity usage of a Clothes Washer," Energy Use Calculator. [Online]. Available: http://energyusecalculator.com/electricity_clotheswasher.htm. [Accessed: 10-Mar-2020].
900000	energy for a laundry machine load	
79059267.11	yearly energy used for laundry machines	

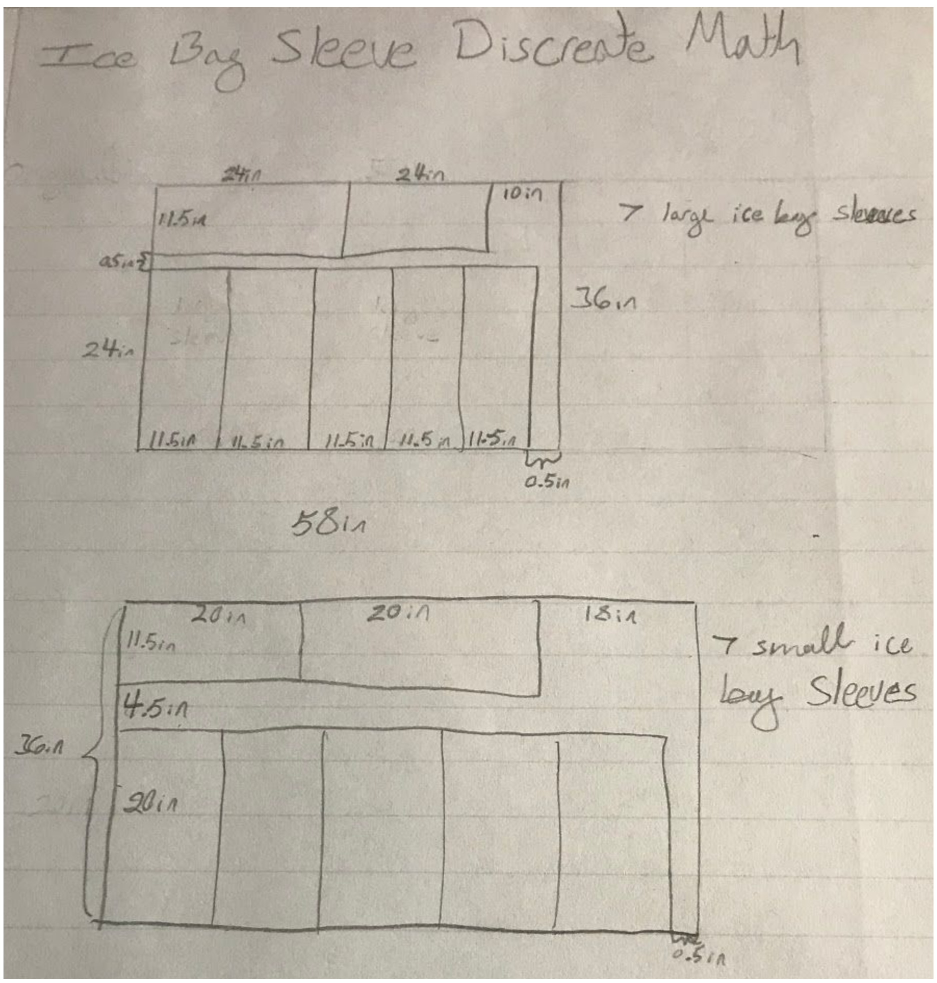
Energy Use for a Drying Machine Per a Year		
3000	watts used per dryer load	**Citation**
3600	seconds per load	"Electricity usage of a Clothes Washer," Energy Use Calculator. [Online]. Available: http://energyusecalculator.com/electricity_clotheswasher.htm. [Accessed: 10-Mar-2020].
10800000	energy for a drying machine load	
948711205.3	yearly energy used for drying macl	

Yearly Energy Use Caused by Washing the Fabric Ice Bag Sleeves	
1027770472	total yearly energy for washing and drying
1027.770472	MJ of yearly energy

Total Energy used to Produce, Wash, and Maintain the Fabric Ice Bag Sleeves	
1027.770472	MJ of yearly energy spent washing
65.10661399	MJ of yearly energy spent producing ice bag sleeves
1092.877086	Total MJ of energy used the Produce, Wash, and Maintain the Fabric Ice Bag Sleeves

Total Weight of a Full Stock of Fabric Ice Bag Sleeves	
0.1148282747	pounds for one Ice Bag Sleves
5.16727236	pounds of Ice Bag Sleves the makes up a Full Stock

Cost Calculations



Velcro: Three horizontal velcro strips and one vertical velcro strip to make an ice bag sleeve
Width: 2in

Small Sleeve Length: 14in
Large Sleeve Length: 18in
Vertical Strip: 4in x 11.5in

Total Length of Large Ice Bag Sleeve: 11.5+((18*3)/2)= 38.5 inches
Total Length of Small Ice Bag Sleeve: 11.5+((14*3)/2)= 32.5 inches

Velcro Price: $12.99
Width: 4 in
Length: 79.2in
One roll of velcro can make either 2 large ice bag sleeves or 2 small ice bag sleeves
Large Ice Bag Sleeve Velcro Cost: $6.49
Small Ice Bag Sleeve Velcro Cost: $6.49

Fabric: less than 11.5 in wide
Small sleeve: 20in
Large sleeve: 24in

Fabric Price: $8.45
Width: 58 in
Length: 36 in

Can fit either 7 large ice bag sleeves or 7 small ice bag sleeves per piece of fabric making one ice bag sleeve cost $1.21 in fabric.

Ignoring the cost of the adhesion method for the ice bag sleeves the ice bag sleeve cost are below:

Large Ice Bag Sleeve Cost: $7.71
Small Ice Bag Sleeve Cost: $7.71

Cost of 20 small ice bag sleeves and 20 large ice bag sleeves= $308.40
Cost of added laundry loads
Time per load: 30minutes / 60= 0.5 hour
Added Loads of Laundry: 87.84
Total time of the added loads of Laundry: 0.5 hour *87.84 loads = 43.92 hours
A washing machine used “500 Watts for 0.25 hours a day at $0.10 per kWh”, using these values in the energy use calculator we found the cost of the added loads of laundry to be $21.96 [13].

One case of plastic bags is around $100 and the athletic department buys six to eight cases a year. This means at the cheapest the plastic ice bags cost $600 a year. Spending less than $600 a year on the new ice bag system would result in the athletic department saving money.

Manual

Extra CAD Drawing :

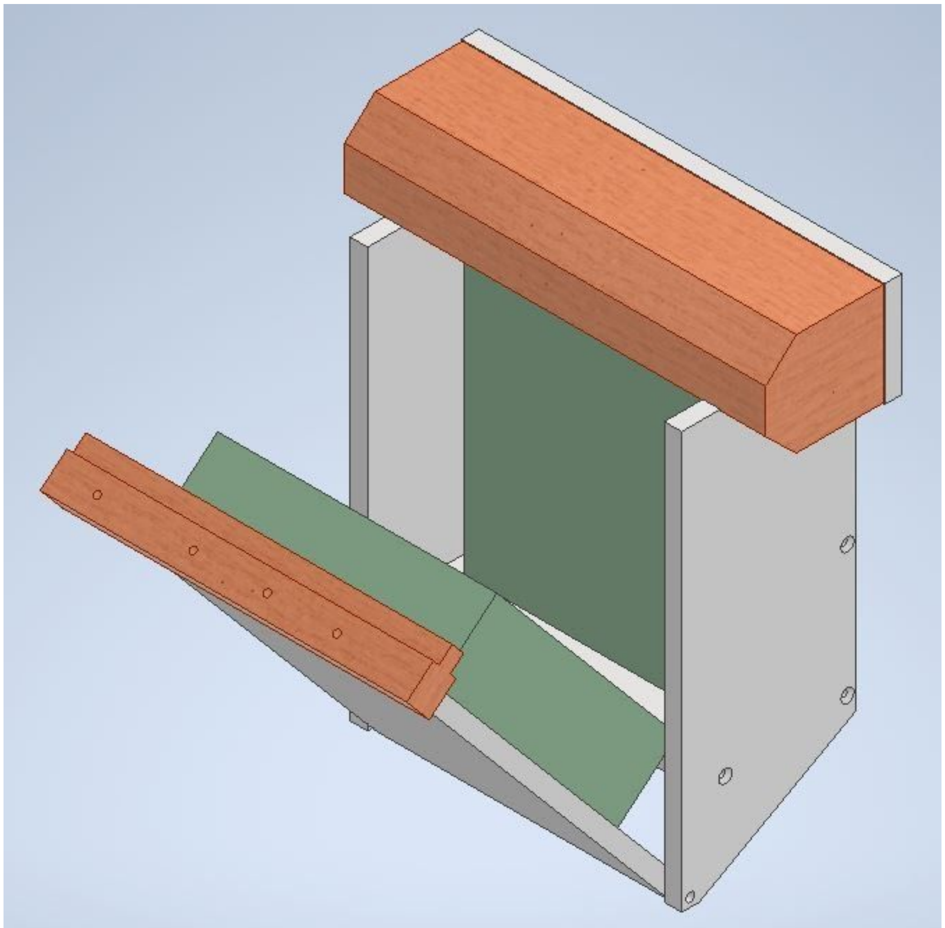


Figure 3: *CAD Drawing of Ice Bag Press*

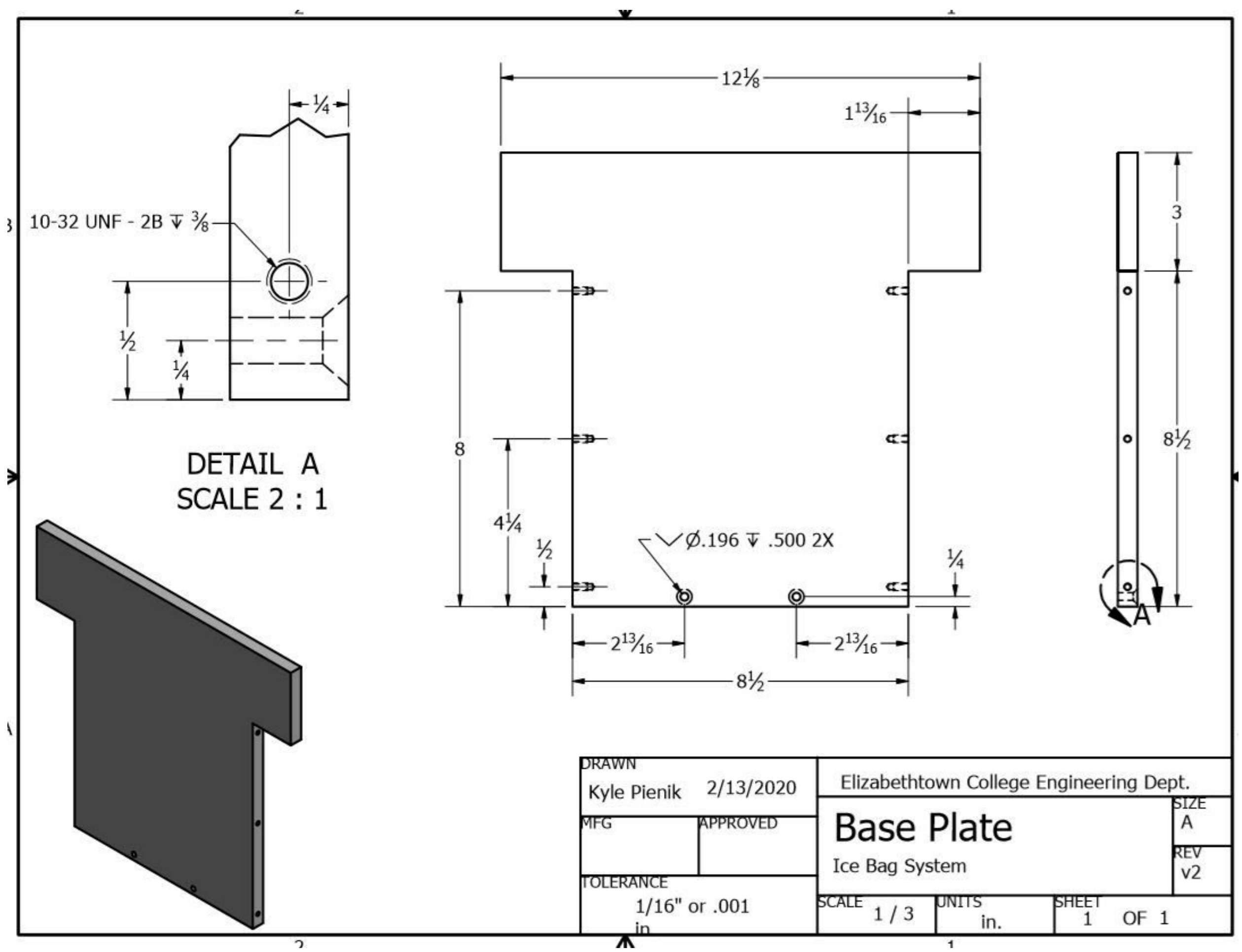


Figure 4: *Drawing of Ice Bag Press Base Plate*

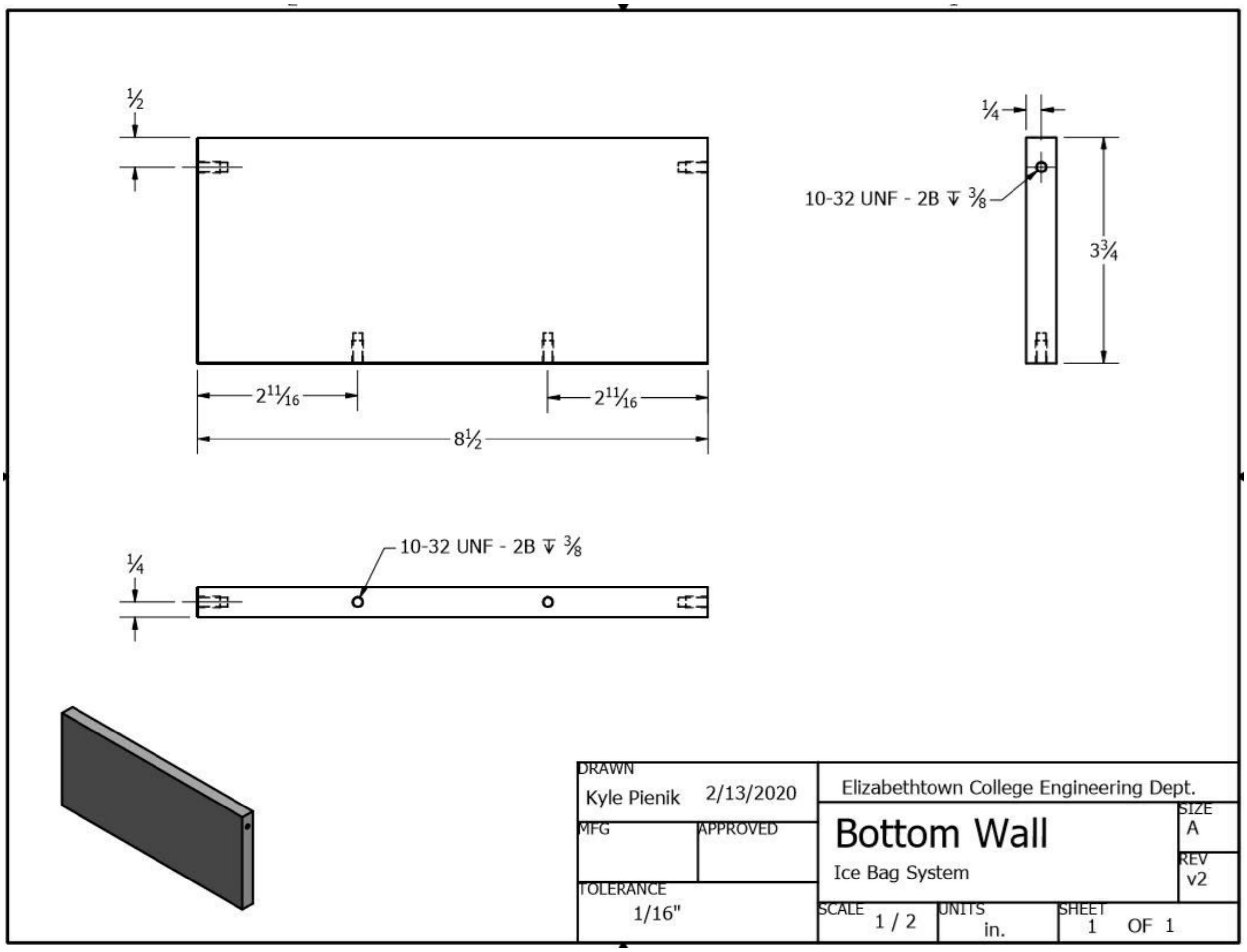
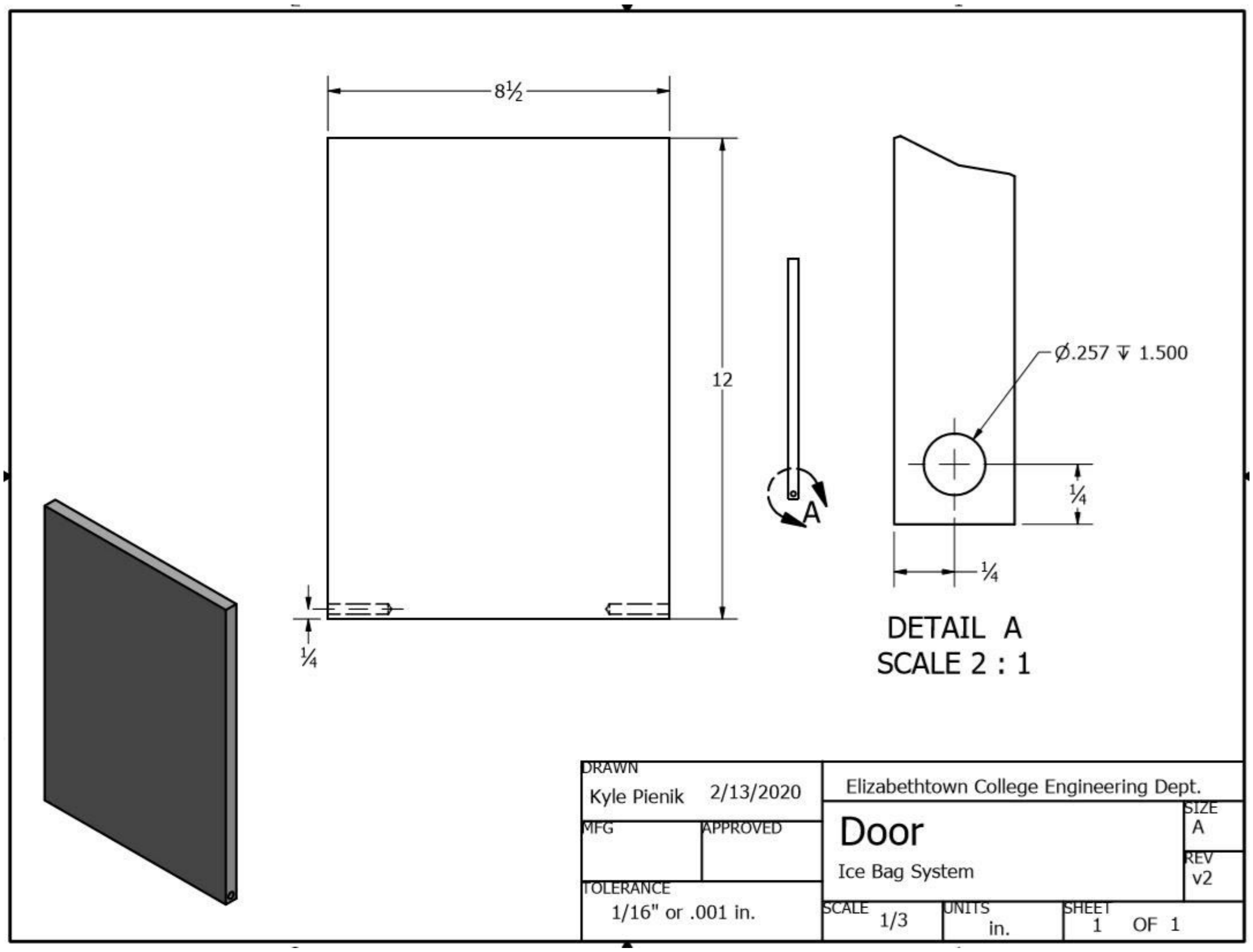


Figure 5: *Drawing of Ice Bag Press Bottom Wall*

Figure 6: *Drawing of Ice Bag Press Door*



8½
12
¼
Ø.257 ↧ 1.500
¼
¼
A
DETAIL A
SCALE 2 : 1
DRAWN
Kyle Pienik 2/13/2020
MFG
APPROVED
TOLERANCE
1/16" or .001 in.
Elizabethtown College Engineering Dept.
Door
Ice Bag System
SIZE
A
REV
v2
SCALE
1/3
UNITS
in.
SHEET
1 OF 1

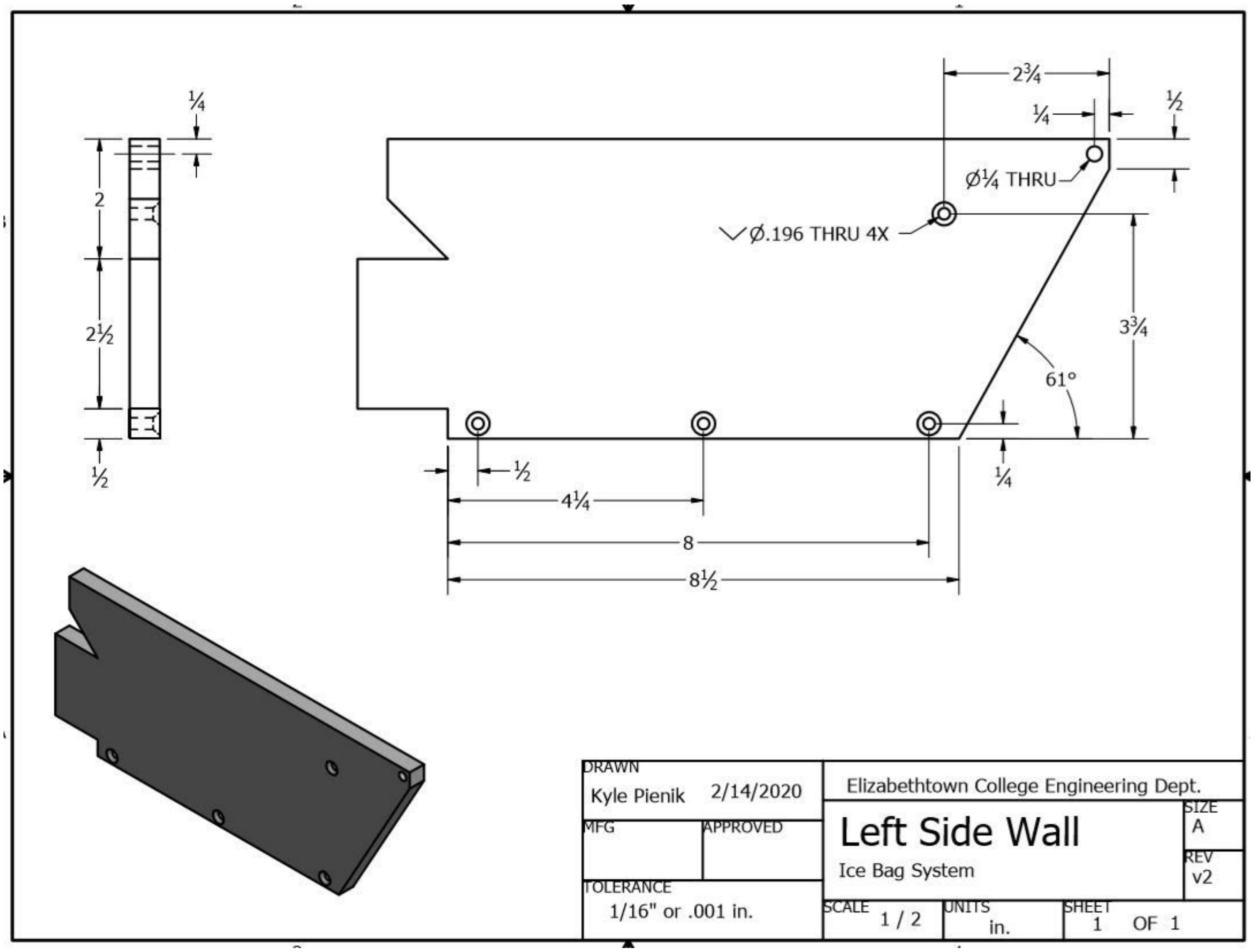


Figure 7: *Drawing of Ice Bag Press Left Side Wall*

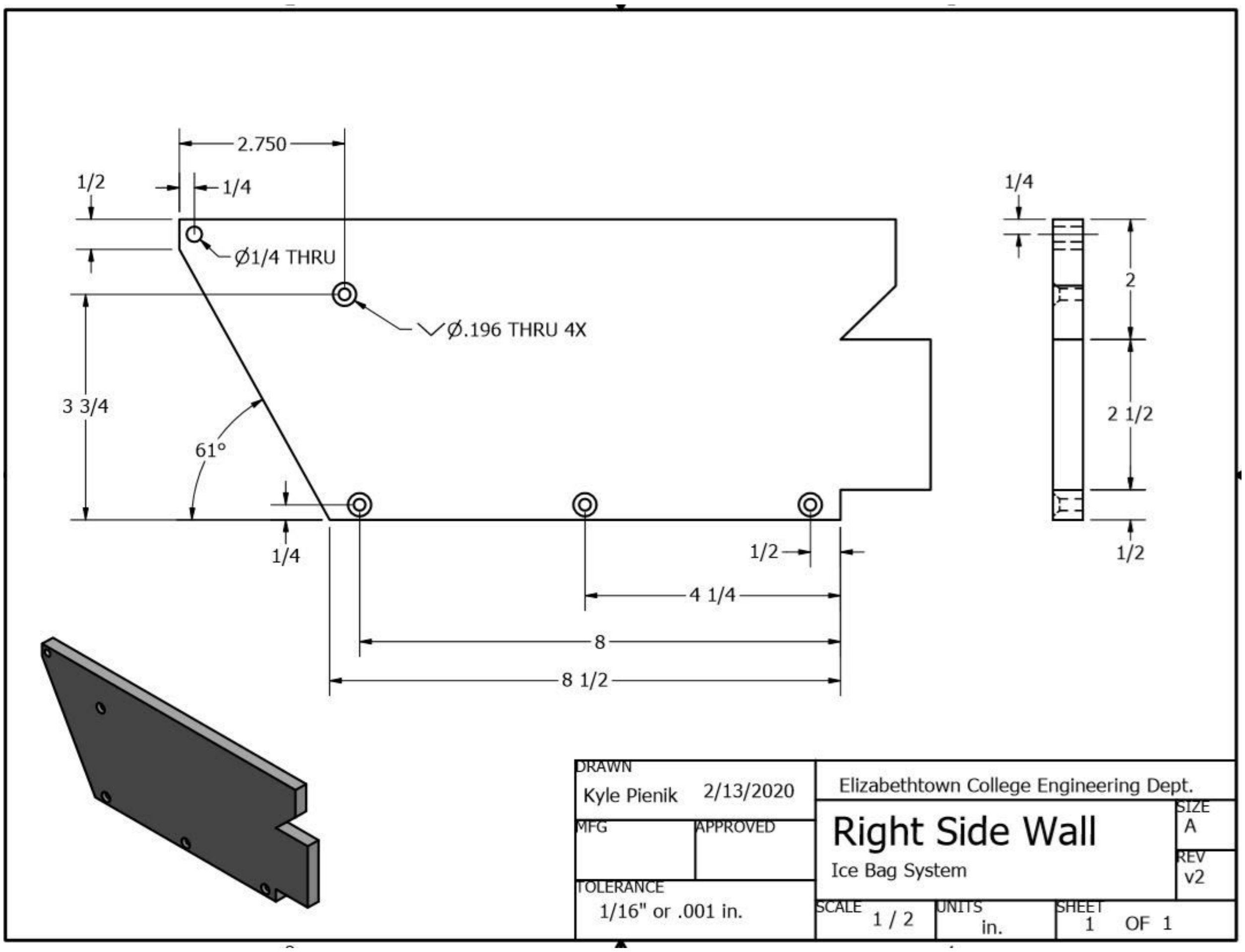


Figure 8: *Drawing of Ice Bag Press Right Side Wall*