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DESIGNING AN EMS BICYCLE MOUNTED BACKPACK SYSTEM

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ABSTRACT

The use of bicycles for the delivery of emergency medicine services (EMS) is a relatively novel idea. Originally pioneered in the United States during the middle of 1980s, the idea has since spread throughout the world. In 2015, there are more than 200 bicycle EMS teams working in major cities in the United States and a growing presence in cities worldwide. The technology behind this recent phenomenon continues to evolve rapidly so as to address the needs of these bicycle riding medics. One of the greatest needs is for an ergonomic solution that allows medics to efficiently carry their medical equipment and supplies. Current designs are constrained by weight, maneuverability, weight distribution, ease of access, ease of transport, visibility, identification, resistance to weather, resistant to bio-hazardous substances, portability, and durability. Of the many current bags designed for EMS bike teams, a detachable rear pannier bag has been found to be the most appropriate. The rear pannier design sits on the rear rack of the bike and has deep pockets extending down to the axis of the rear wheel. This project addresses these constraints by designing a bag that can withstand vibration, protect consumables against contaminant and waste, and improve workspace of EMS bike teams. The proposed solution utilizes pannier design, incorporating a quick release mechanism that could be operated with one hand and two shoulder straps allowing the bag to be carried over difficult terrain. The final design contains a combination of prepackaged equipment and individual material storage.

The pannier design gives the bag a low center of gravity. The low center of gravity helps maintain the maneuverability by evenly distributing the weight. The fabric of the bag is made of a strong Gortex material. This material is resistant to tears. The frame of the bag is made of polypropylene block co-polymer. This polymer is both light weight and resilient. The materials

for the frame and fabric makes the bag both durable and portable. The bag is protected from bio-hazardous substances through the water resistant properties of the fabric. The straps on the bag also help in portability by allowing the bag to be worn on the user's back, freeing both hands for other tasks. The bag is colored a bright neon green with a reflective blue chevron pattern for high visibility at night. The colors and logos also helps with identification. Solid works was used to create a 3D model and drawings of the bag. Additionally, an unlaunched marketing website was created for the bag and to showcase the design to potential buyers. In the future, the bag can be fabricated to allow for field testing and more research.

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CHAPTER 1: BICYCLES IN EMS OVERVIEW

1.1 INTRODUCTION

The introduction of bicycles to emergency medicine has initiated research and development into bicycles and their associated equipment. Before this, bikes first became a tool of emergency responders with their advent into police department. Only a few years later did medical responders adopt this system, however with very limited use. As the use of bicycles spread into more departments, it began to be implemented in other roles. The modern day EMS bike teams have a range of assignments that included in this list are 24/7 area patrol, providing medical coverage to large events, and acting as the first responding agency at large public buildings such as airport or malls.

The London Ambulance Service (LAS) is the first credited EMS agency to implement 24 hour bike medical coverage to certain high traffic parts of London. The success of bike medics is due to their improvement of patient care. Bicycle medics have improved many areas of EMS. Bike medics have a lower response time to arrive at the patient which is critical in some emergencies such as cardiac arrest and traumatic hemorrhaging. Bicycles produce no air or noise pollution which improves the cities environment as compared to a diesel ambulance. Many EMS agencies struggle with small budgets and bike medics offer large savings on fuel and non-dispatch costs. Furthermore, bicycles can travel through traffic or narrow alleys to reach patients as well as inside buildings. Another benefit is the public contact bike medics receive. This can boost the image of department as well as save on advertising costs for hospitals because instead of paying for ad space, bike medics are already mingling and educating the public.

Equipment must be carefully chosen to efficiently use space. Many EMS bicycle units select their equipment for the purpose of correcting a cardiac arrest and diabetic diagnostic and treatment supplies. They also tend to carry medical supplies for trauma cases. This combination of supplies allows for a rapid solution to a hypoglycemic patient and control bleeding. The goal of this project is to design a system that maximizes space for equipment, detaches from a bike, and maintains rider's safety. By developing a design similar to current pannier bags the bag will be compartmentalized without losing space. To save as much time as possible, a light weight quick release system was also developed. The quick release system is composed of a sliding rail and a track. Both components are made of aluminum.

This system saves time by allowing the user to remove the bag with two steps. The bag was designed to have a low center of gravity while mounted on the bike. This helps prevent weight shifts that may unbalance the rider or otherwise limit the bikes maneuverability. To further enhance safety, the bag is made of polypropylene block co-polymer (PPC). PPC is a light weight polymer that offers flexibility without permanent deformation or structural failure. The surface of the bag is covered in a Gortex fabric. This fabric is resistant to tears and rips, and can also be made water resistant. Gortex helps improve the durability of the bag and protects the bag from dirt and potential bio-hazardous materials.

Chapter two describes current bike systems and how they are utilized around the world. Chapter two will also touch on standards for EMS bike use. Chapter three has a more in depth description of the solution and design process. In chapter three each iteration of the bag design can be found as well as how the solution was chosen. This chapter also contains the layout and development of the website that describes the project. Chapter four is a recap of the design process and future development of the bag system.

CHAPTER 2: EMS BICYCLE SYSTEMS

2 INTRODUCTION

Emergency Medical Services (EMS) is a type of service dedicated to treating and transporting patients with acute medical emergencies. The most basic form of emergency medical services provide only transport to the nearest available medical treatment facility. These types of services are mostly found in developing countries. However most developed countries have a government funded service that is either its own service or is attached to another emergency service such as the fire or police departments. Some emergency medical services are provided by private companies operating under a contract with the government or by non-profit organizations. Also, many colleges and universities operate emergency medical services ranging from first responder to Advanced Life Support (ALS) transport. These services are overseen by the National Collegiate Emergency Medical Services Foundation.

Most EMS systems provide care and transport using an ambulance specialized for either Basic Life Support (BLS) or Advanced Life Support (ALS) care. Ambulances are equipped with the necessary tools, materials, and medications to provide care at the appropriate level. In the United States, there is no mandated response time to emergency calls, however most municipalities have enacted standards of a less than eight minutes , 90% of the time for ALS providers (Ludwig, 2004). Contrary to this, most EMS systems operate under the notion that faster is always better (maintaining the highest level of safety) and any means to reach a patient quicker should be undertaken. For example, during cardiac arrest, often times blood is no longer circulated properly to the brain which needs oxygen constantly to survive, and in as little as four to six minutes, brain cells begin to die if CPR is not started. For every minute that CPR and defibrillation are not done, the patients chances of survival diminish 7-10%. Even the very short eight minute response time

is not fast enough to provide complete care to a patient in cardiac arrest (CPR Facts and Statistics, n/a.). In most of the test you have used reference citation as for example (Dunivin, 2010)

The main mode of transportation of EMS personnel to a patient is the ambulance. However, there are many situations and locations that ambulances either cannot respond to or are severely limited in their response times. Such situations could be large indoor area, high traffic arenas such as airports or large shopping venues, areas of large pedestrian traffic such as city centers, or large outdoor events. In response to these limitations, many EMS systems have adopted bicycle mounted EMTs. The history of EMS bike responders is short but the use of EMS bikes is growing rapidly. The first documented record of bicycles being purchased for EMS use was by the Indianapolis Fire Department in 1984 (Dunivin, 2010). First utilized as an integral part of an ambulance service by the London ambulance service in 2000, the trial was successful in that it reduced response time to highly pedestrianized areas and was able to provide sufficient medical care. Since the initial pilot program, EMS bike teams have become commonplace in hundreds of cities across the globe. There are many benefits to operating an EMS cycle response unit as opposed to ambulances in certain situations. In areas of high pedestrian traffic, such as city centers, a medic on a bicycle can respond much faster than an ambulance. Unlike ambulances, medics on bicycles can navigate elevators, curbs, and stairs that even smaller emergency vehicles cannot navigate such as gators, Segway's, or golf carts. Also, in larger public buildings such as airports or large shopping centers, response time by cycle medics is often considerably faster than traditional methods. For example, the Los Angeles International Airport conducted a study that found that, during the holidays, the response times for emergencies in the airport were one to two minutes for bicycle mounted medics, half of the time for response units on foot and considerably less than the fifteen minutes it took an

ambulance to arrive due to heavy traffic. In addition to quicker response times, cycle medics also save ambulance companies money (Dunivin, 2010).

2.1 LONDON AMBULANCE SERVICE

The London ambulance service has been utilizing bicycles for emergency response since 2000. During the first ten years of the program, it was estimated that the cycle teams have treated 50,000 patients and currently average 16,000 calls per year, fifty percent of which are resolved on scene (Cycle Responder, n.d.). Figure 1 shows emergency calls and Patient journeys in the UK.

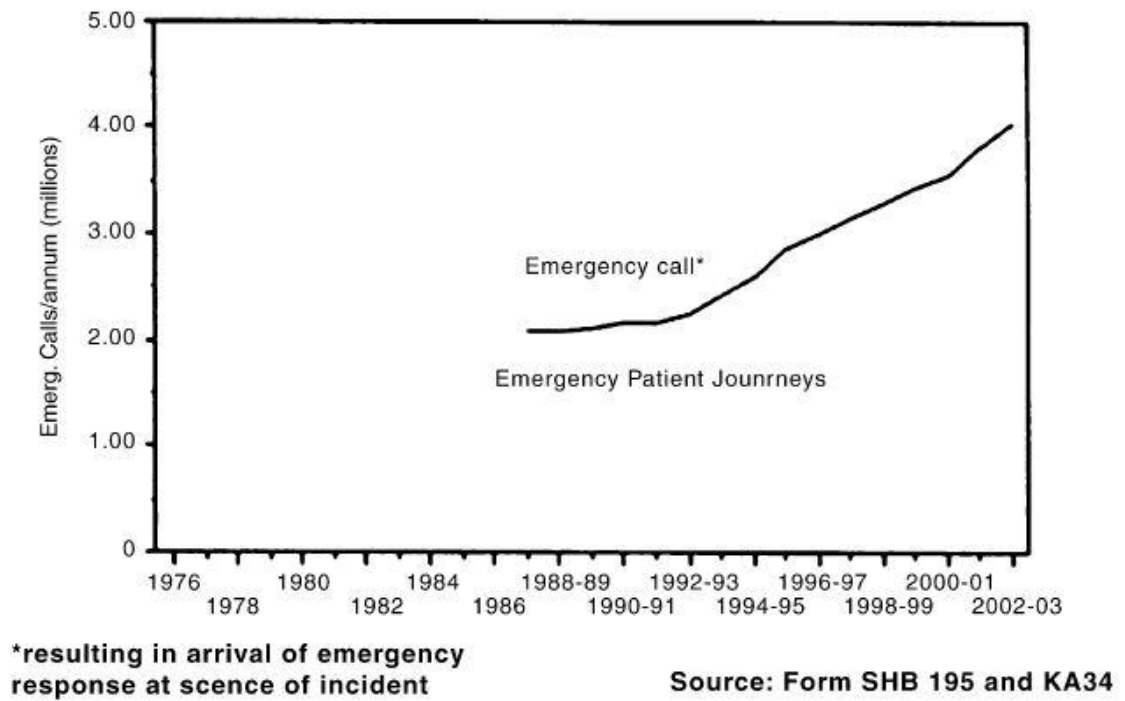


Figure 1: UK Emergency calls and Patient Journeys (International EMS)

That is the equivalent of 5,000 ambulance hours per year or the same as adding an additional two fully staffed paramedic ambulances to the department. Funds for EMS services are generated exclusively through taxation. This accounts for 5.5% of the UK GDP. (International EMS) The contribution of EMS to the UK GDP over time is shown in figure 2. Figure 3 shows health care expenditures in other G7 countries as a percentage of GDP. The benefits are really

starting to show as well. The London Ambulance Company has saved an estimated 300,000 pounds in fuel saving alone as well as providing more rapid care to critically ill or injured patients.

There are almost sixty cycle responder working in London as of 2014 (Goodchild, 2010).

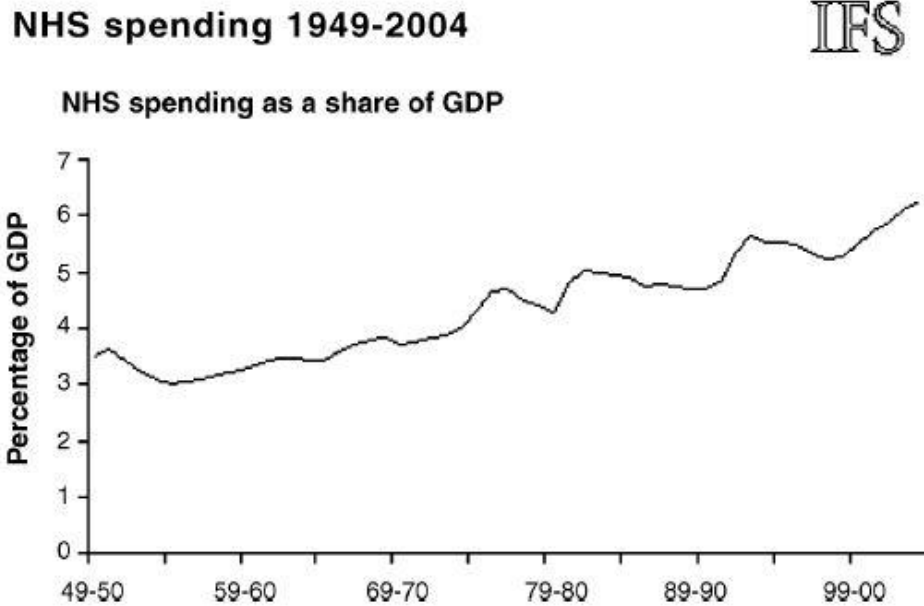


Figure 2: EMS spending as a percentage of GDP (International EMS)

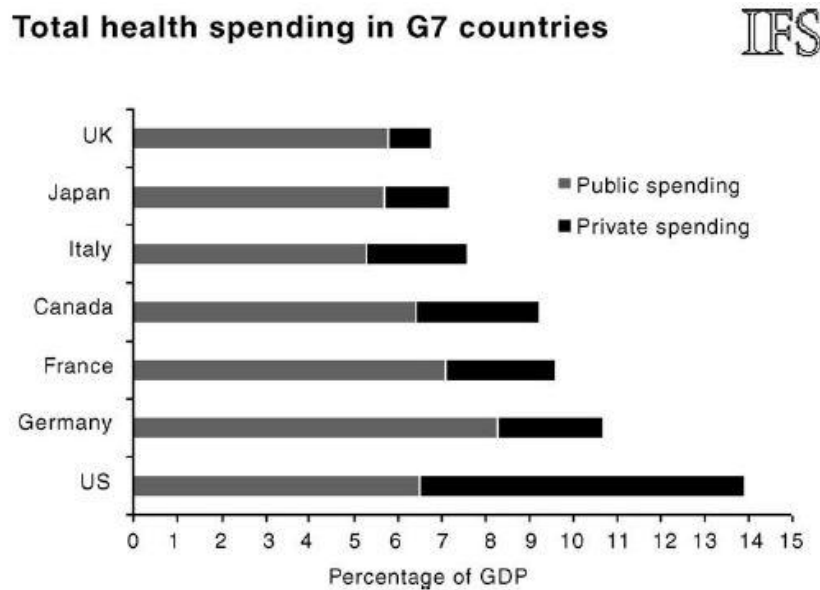


Figure 3: Healthcare spending as a percentage of GDP (International EMS)

The bicycle teams are comprised of both EMT's and paramedics and respond to a wide array of emergencies from trips and falls to more severe emergencies such as cardiac arrests or drug overdoses. The technicians who ride the bikes have to go through rigorous training and testing. This includes a week long course on an emergency services cyclist training course operated by Public Safety Cycling. The rider must also pass a physical fitness test that includes a one kilometer sprint among other things (Goodchild, 2010). All of this training and testing is to ensure that the rider can handle the approximately 140 miles a week that these riders must travel (The Bicycle Ambulance, 2014) and maintain the average six minute response time of the cycle response unit (Cycle Responder, n.d.).

Proper equipment is crucial in the success of a bicycle medic team. The London Ambulance Service equips their riders with a custom built aluminum Rockhopper mountain bike. These bicycles are further customized with blue lights and a siren. The rockhopper bicycles are lightweight, and have front and rear pannier storage system. The front two carry the rider's personal belongings, and the rear contains all of the necessary medical supplies. The bike also has a strengthened, puncture proof Schwalbe marathon-plus road tires and stronger spokes. They are also equipped with a water bottle, repair kit, cycle computer, and lights (Cycle Responder, n.d.). Each bicycle costs about 1,000 pounds but the cost to equip each one up to specification cost 5,000 pounds. The rockhopper bicycles each have a twenty-one gear selections and weigh over fifty pounds when fully loaded. This fifty pounds, however, includes all of the equipment carrier by a standard ambulance (MacFarlane, 2008).

Apart from the accessories, each bicycle also carries an array of medical equipment. Included in the large rear pannier bag and two front wheel bags is a defibrillator, an oxygen tank, Entonox, a blood pressure monitor, pulse monitor, bag and mask resuscitators, a variety of life

saving drugs, bandages, dressings, gloves, as well as other important medical equipment. Much of this medical equipment is specialized for use by the bike medic units. The defibrillators used are the size of the palm of your hand and much of the other equipment is miniaturized too. All of this equipment is further separated into eight separate “grab bags” that contain the materials and tools required for common specific emergencies (Sparkes, 2009). A special vest is also used by the riders to carry narcotics and other controlled substances. Drugs such as these must be double locked by regulation. In the case of bicycle medics, the first lock is on the small lock boxes in the vest and the second is considered the rider themselves. The riders themselves are also provided specialized clothing to withstand the weather. They wear a specially designed uniform that consists of a helmet, glasses, gloves, pants (or shorts), reflective jackets or jerseys, waterproofs, base layers, cycling shoes, skull cap, padded undershorts, an anti-pollution mask, body armor, a radio, a utility belt, and a mobile phone with a Bluetooth headset (Cycle Responder, n.d.). Each medic also carries a specialized torch that can alert the medic to biological threats (MacFarlane, 2008).

2.2 TORONTO PARAMEDIC SERVICES

The Toronto Paramedic Services first started using EMS bicycles in 1996 to provide medical coverage to large events. The service currently owns sixteen mountain bikes designed to withstand the high stresses put on them when navigating stairs or curbs. The bicycles have aluminum frames and suspension forks, and are equipped with high powered lights for night operations. The bicycles are fitted with a rear wheel pannier bag system that stores all of the necessary equipment needed for normal operations. This includes an airway kit, suctioning unit, oxygen, glucometry kit, first aid kit, semi-automated external defibrillator, and a symptom relief kit that contains five medications. They still do not have dedicated bicycle medic teams year round however (Bicycle Unit, n.d.).

The main use of Toronto's bicycle response team is to provide medical coverage to large events and to respond to medical emergencies at Toronto's club district on the weekends (Peters, 2009). Some of the major events staffed by the EMS bike teams are the Toronto Grand Prix, Caribana (a weekend long festival in Toronto), the Canadian National Exhibition, and the Waterfront marathon which can attract as many as 50,000 competitive and spectators (Bicycle Unit, n.d.).

2.3 BOSTON EMS

Boston EMS was one of the first cities to adopt an EMT based cycle response unit and currently has a fleet of twenty operational bicycles. Durable, light-framed mountain bikes are used in conjunction with a basic pannier bag system on the rear rack. The bicycles operate both BLS and ALS levels with drugs being stored in a lock box or on the rider's person. A defibrillator is mounted on top of the rear rack between the two panniers. The bicycles are outfitted with lights and sirens powered by a battery designed to fit into one of the two water bottle holder on the inner frame. These are activated by a set of three buttons easily accessible to the riders left thumb. Boston EMS has a list of the items that must be carried on the bicycle at all-time but encourages additional items to be packed. Among the items that must be carried is an AA oxygen cylinder, defibrillator, trauma kit, symptom relief kit, and first aid kit. Boston EMS utilized its bicycle teams year round, most often operating in two or four person teams that staff special events such a first night or the fourth of July celebrations. Events such as the Boston marathon can attract as many as 250,000 people and during coverage, Boston EMS bike teams will treat as many as 2,300 patients.

2.4 INTERNATIONAL POLICE MOUNTAIN BIKE ASSOCIATION

The International Police Mountain Bike Association (IPMBA) is an organization responsible for standardized bicycle training for all aspects of public safety, including EMS. The IPMBA teaches how to ride in crowds and across rough terrain both off-road and in urban areas. The organization also trains public safety members in maintenance of bicycles and even martial arts for self-defense in the field. Their program is known nationwide, training in cities such as Tampa, Florida, and small cities and towns like Attleboro, Massachusetts. The EMS-specific class held by the IPBMA focuses on challenging riding with a fully-loaded bike, as compared to police who carry little to no equipment beyond their duty belts. The IPMBA also prides itself in advancing the niche and often unregulated field of cycle-based public safety. They address challenges seen

in large gatherings across the country where bike teams are seen in a public forum. However, the organization does not seem to define any equipment standards. They, instead, focus on training quality riders who can perform safely in their environment.

2.5 TYPICAL EMS BAGS FOR BIKE TEAMS

Ever since EMS had progressed past the point of simply going to a house and taking someone away without any major medical care, they have been using bags to carry their equipment. The type of bag used can vary greatly with many companies manufacturing them. Organization and compartments in the bag is one of the major attributes of the bag that need to be evaluated. The bag needs some sort of organization to it so that you are not digging through a pile of things that you don't need to find the one small tool that you do need. Many bag manufacturers include dividers in the main compartment or pouches along the sides of the main compartment to allow the EMT to keep things more accessible. Other manufactures will have smaller bags inside of the main first in bag, each smaller bag has equipment for one purpose, such as an IV kit, an intubation bag, a drug bag, etc. Other companies make flexible dividers that can be repositioned and moved around in the main compartment so that the EMTs can adjust and customize the interior of their first in bag. Finally aside from the main compartment most first in bags also have a pouch or pocket on each side of the bag with zippered openings.

Zippers are the next big things that EMTs look at, they can really help or hurt the effort to get into the bag and could slow down EMTs. Usually a large metal zipper with large teeth is one that is preferred. The large zipper tabs make it easier to grab onto them so that they can be quickly grabbed. Having two tabs on each zipper is also incredibly helpful as the tabs can be positioned at the center of the zipper, which makes them easier to locate quickly instead of having to check each side. The zippers have also been color coded by manufactures where each pocket gets a

zipper with certain pockets getting certain colors, for example the pocket to access the regulator on the oxygen tank would have the green zipper since green is the color all EMTs have been trained to associate with oxygen.

Finally, durability of the bag and its components is a huge aspect to choosing since you don't want to be replacing the bag every few years or so, it is preferred to have one that can last many years. The materials of the bag, where it is kept, how it is treated, can affect durability. However when choosing a bag you can really only look at the materials being used to make it, you'd have to send all your EMTs to obedience school to eliminate the other two components. The outside of the will be the biggest part that needs to be strong since it will be expose to all of the elements all of the time. The outside will want to be at the very least water-resistant if not water proof. It will want to be resistant to cuts and abrasions so that the material won't be torn or ripped open by rough ground it gets placed on. It will want to be a material that could be easily disinfected if necessary, though that doesn't happen all too often. Many bags are made mainly out of nylon (Dyna Med Mega-Medic BLS XTRA Complete Kit, n.d.) materials of different strength depending on the company.

Manufacturers also typically include a waterproof bottom of the bag for when it is placed on the ground outside and some manufacturers will have impact resistant runners or parts on the bottom for when it gets dropped down to the ground (Iron Duck Ultra Sofbox Plus BLS LVL II Kit, n.d.). When deciding on a material for the bag that will be used on a bike, it will need to have a strong resistance to water since the rear wheel can kick up a lot of water onto the inner edges of the bag and on the bottom of the bag. Other than nylon a potential material would be Gortex® material as it is waterproof but would not be as flexible as nylon would (Our Fabrics - GORE-TEX® Products, n.d.). The other benefit of Gortex® is that it could easily be cleaned with the

same wipes that EMTs use on the rest of the equipment since it wouldn't absorb any of the material at the scene and could be wiped clean instead of being put through a washing machine.

Finally, something that is important is the purpose. The way the bag will be used will affect which components are more important and how the EMTs will set up their bag. On the bike the bag will be used as source of immediately necessary equipment for a first responding EMT. It will contain the absolute necessary equipment for a Basic EMT to provide BLS care for any patient in any situation. This means it will need the basic equipment to maintain an open airway, keep a patient breathing and stop any major hemorrhage, carry and AED to restart a heart with a fatal arrhythmia. Keeping the equipment list down to basic necessary equipment will help keep the weight down; while still maintaining the standard of care that EMT basics owe to their patients?

CHAPTER 3: OUR EMS BICYCLE-BAG DESIGN

3.1 DESIGN PROBLEM STATEMENT

The purpose of an EMS bike patrol is to provide care at the scene before an ambulance is available. To provide such care efficiently, it is important that the EMS equipment be lightweight as possible, easy to use, and secured. The weight of the bag cannot be less than the objects inside of it. This being the case, it is important that the weight of the bag itself be as light as possible. Ease of use is a broad subject. Some aspects that could contribute to ease of use are: the number and locations of handles and straps, the number location of compartment compartments, Types of compartment openings, and setup steps for efficient use. The security of the bag includes: the bags ability to resist contamination, water resistance, and any locking mechanisms on the bag. Currently there are three types of bags used by EMS squads. Each is adopted for a specific task. For instance, a bag may be used exclusively for trauma. Currents there are no bag that satisfy these requirements. A removable bag that contains needed equipment will make emergencies more convenient for the user, but adds an extra step in the process of response. This step is where the user physically removes the backpack form the bike. This step has to be easy and fluid in order for the use of the backpack to be justified.

3.2 The Nature of EMS Bikes

The first type of bag currently used is the backpack. The backpacks used currently have few differences from normal backpacks. Like all backpacks this style gives the wearer the ability to carry the bag and still use both of his hands. This makes the bag more mobile than other types of bags. These bags also tend to be smaller than other bag types further increasing their mobility. Backpacks tend to be relatively lighter than other bag types, but this comes at a cost. Backpacks also tend to have a lower volume than other bag types. A low bag volume restricts what the user can bring with them, and often results in a specialized bag that isn't useful in many situations.

Back pack tend to be easy to use. Backpacks usually have a handle at the top so that they can be held in the hand easily. Though some backpacks have zippers that allow the bag to be opened from the front, backpacks tend to open from the top. This requires the user to dig from the top to retrieve an object that is at the bottom of the bag. Security tends to be the weak point of backpacks. Backpacks can easily be made water resistant, but that does not protect against blood, other bodily fluids and mud. Backpacks get dirty easily and can be difficult to wash. It is possible to have padlocks on the zippers, but the removal of the padlock adds an extra step in the use of the backpack. The mobility of the backpack becomes a disadvantage when it comes to security. This is because it makes it easy to steal.



Figure 4: Rackpack (Dyna med, 2014)

Shown in figure 4, the rack pack is similar to a duffel bag. The most notable difference between the rack pack and the duffel bag is the fact that a rack pack is specially designed to be mounted on a rear pannier rack. However they are not designed to come off the bike rack easily. Because it takes too long to remove the bag from the bike, the user would be limited to places they can take their bike in the event of an emergency. Rack pack tend to be larger with more volume than back packs. This means that they can hold more, but this also means that they are heavier.

Because it is mounted to a bike, its weight would normally not be a concern. However, the way the rack pack is mounted to the bike raises the center of gravity above the wheel, making the bike less stable. Compared to weight that it carries the rack pack is very light weight. This is because they tend to be completely made of fabric with no structural integrity of its own. Rack packs are more difficult to use than back packs because they are attached to the bike. Rack packs have a larger floor area making it easier to find objects inside of the bag. Similar to the back pack the rack pack can easily be made water resistant, but that does not protect against blood, other bodily fluids and mud. Rack packs get dirty easily and can be difficult to wash. Like the backpack, the removal of the padlock adds an extra step in the use of the backpack. The rack pack is slightly more difficult to steal than the backpack because it is physically attached to a bike. It can still be stolen by taking the bike and the bag (Combination Pannier Bag, 1974).

The last type of bag currently used is the pannier. Like the rack pack, the pannier is a bag that is permanently attached to the rear rack of a bike. This bag is set up as two bags. One on both sides of the rear wheel. This setup gives the pannier a large volume, allowing the user to pack more equipment inside for a wider variety of emergencies. One notable difference between backpacks and panniers is that panniers have a frame that provides structure for the bag. The fact that panniers only open from the top makes navigating the contents of the bag difficult. It has all of the benefits of being mounted to a bike like being harder to steal and allowing faster service. However, it also has all of the inconveniences of being attached to the bike like being limited to places accessible on bike. Panniers can be made water resistant, but the bag is difficult to clean because of its rigid frame. (Combination Pannier Bag, 1974)

An efficient way to design a universal mounting mechanism would be designed around the rear pannier rack. Though rear pannier racks are common, the design of each is slightly different.

In order to design a universal mounting mechanism, you must first design the mounting system to be universal for all rear pannier racks (Combination Pannier Bag, 1974).

3.3 DESIGN ATTRIBUTES

The goal of this project is to design a system that maximizes space for equipment, detaches from a bike, and maintains rider's safety. The design needs to be: water resistant, must not come into direct contact with the ground, durable, light weight, and safe. The device also must resistant to dirt and other contaminants. These constraints limit our design space, to produce a device well-adapted for the conditions of large cities and large crowds, making the design useful to EMS squads all over the country. Bike squads are typically used outside in large cities or at large events or gatherings. Though different regions of the world have different climates, the weather is still unpredictable. In the event that it is raining during an emergency or during a routine patrol, the backpack must be resistant to water. If water were to leak into the backpack, it could cause damage to its contents and lead to odors and mold growth.

In situations where it has been raining, the ground is muddy, or someone has been bleeding on the ground, the backpack could get wet, dirty, or get soaked with bodily fluids. Though the backpack is water resistant, extra precaution must be taken to ensure that the backpack does not get dirty or contaminated. On that note the backpack must not be in direct contact with the ground. The user must be able to set up the backpack near the patient without having to think about the fact that the ground is wet or messy. Besides serving its purpose for storage and portability, it is important that the backpack is both comfortable and safe for the wearer. Because this is a device that will be used frequently small changes in posture can add up over time and lead to significant back problems. The ergonomics of backpacks usually surround gait and posture. To preserve a natural posture and gait it is important that the backpack be as light as possible. Studies have shown that long usage of a bag that is more than 20% of your body weight can cause spinal deformation

(gait, Hong). According to the CDC the average weight of an adult male American is 195.5 pounds. This means that the weight of the backpack should be below approximately 39.1 pounds filled with equipment. Staying below 39.1 should ensure that the backpack will be comfortable and safe for the majority of users.

The goal is to maximize the lifespan of the device, minimize maintenance costs, and purchase costs over time. Though the backpack must be light weight, build quality cannot be sacrificed. The backpack is intended to be used in emergency situation by a different person for each emergency. This being the case the backpack will be subjected to abuse and common wear and tear. The frame of the backpack must be rigid and able to flex without failure or permanent deformation. The device cannot suffer from significant degradation from repeated use, with a lifespan of several years.

Table 1: Backpack Pairwise Comparison Chart

Goals	Water resistant	Elevated	Durable	Light Weight	Safe	score
Water resistant	*****	1	0.5	1	0	2.5
Elevated	0	*****	0	0	0	0
Durable	0.5	1	*****	0.5	0	2
Light Weight	0	1	0.5	*****	0	1.5
Safe	1	1	1	1	*****	4

Our team created Table 1, a pairwise comparison chart, to help prioritize the attributes of the bag. According to this table, the attributes of the bag should be prioritized as safe, water resistant, durable, light weight, and elevated. In order to design a more useful system a few attributes of the mounting system had to be established. The design needs to be: adaptable to different bike racks, easy to wash, durable, light weight, simple to install, and safe. These attributes will limit the design space, in order to design a useful system that can be fitted to many different pannier racks and therefore fitting many different bikes. The mounting system is to be design to be used on virtually any rear pannier rack. In order for this to be useful it must be simple and able to be installed using common tools. This way not only can the mounting system be fitted to a number of bikes, but needed adjustments can be made in the field by the user.

Table 2: Mounting System Pairwise Comparison Chart

Goals	Universal	Easy to Wash	Durable	Light Weight	Safe	score
Universal	*****	1	0.5	1	0	2.5
Easy to wash	0	*****	0	0	0	0
Durable	0.5	1	*****	1	0	2.5
Light Weight	0	1	0	*****	0	1
Safe	1	1	1	1	*****	4

Table 2 shows a pairwise comparison chart for the mounting system. According to table the attributes of the bag should be prioritized as: safe, Universal, durable, light weight, and easy to wash.

3.4 DESIGN ALTERNATIVES

Over the course of the project, we brainstormed many different designs for the backpack. We considered several different compartment configurations and backpack/bike interfaces. It was ultimately determined that a design similar to the pannier setup would be ideal. Something like the pannier design is preferred because of its low center of gravity. Over the course of the year, a total of 5 different designs were devised each with several variations. This section follows our process through each of the designs starting with “The Book”, “The Tripod”, “The Robot”, and “The Pannier 1”.

3.4.1 THE BOOK

The book design, shown in Figures 5(a) and 5(b), was a rectangular backpack that was divided into two large compartments when opened. The two halves of the backpack could be held together with clips or a zipper that circumvents the all but one side of the backpack. Another feature of this design is the fabric sheet shown as a two dimensional square in figure 5(a). This fabric sheet would have elastic bands on it that would help store small items like pens and scissors. The backpack is mounted on the back of a bike on one of its larger faces. This type of design would provide plenty of room for equipment. However, having two large compartments makes categorizing materials more difficult. To have order within the compartments, there would have to be another level of compartmentalization. One method considered to correct this problem was removable bags. Within each of the large compartments there would be smaller bags. Each containing a category of equipment.

The use of removable bags would allow the user to remove only the equipment needed for the specific emergency. All of the designs can be made water resistant, light weight, durable, and Elevated with certain materials that will be discussed later. Drawbacks that made this design unfavorable were its lack of natural compartmentalization and its high center of gravity when

mounted on the bike. The high center of gravity would make maneuvering on the bike more difficult when the bag is attached.

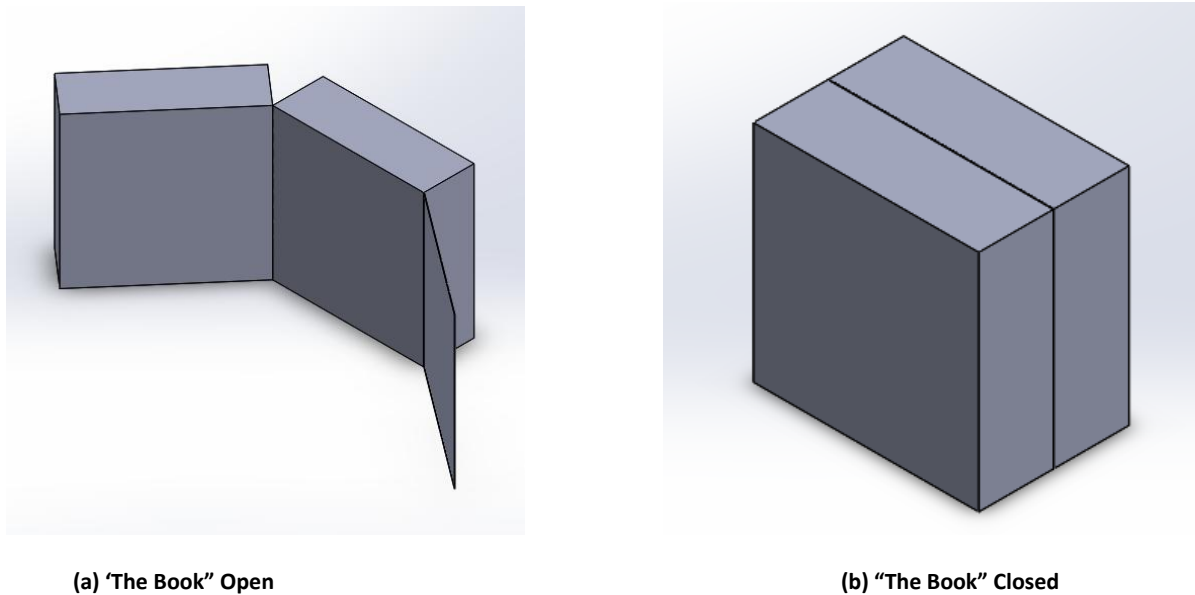
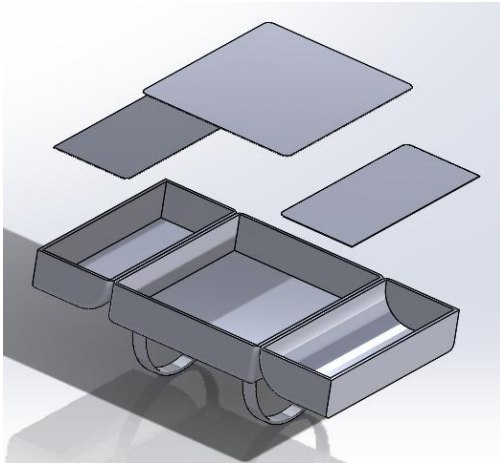


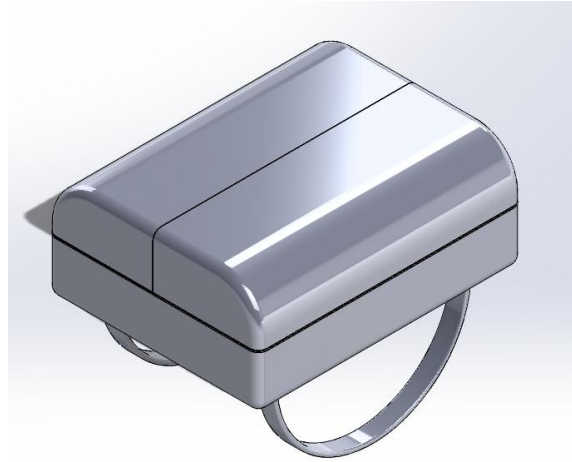
Figure 5: Solid modeling sketch of "The Book" bag design

3.4.2 THE TRIPOD

Figures 6(a) and 6(b) show "The Tripod" design. It was a rectangular back pack that divided into one large compartment and two medium sized compartments when opened. The two medium compartments of the back pack could be help together with clips or a zipper. The back pack is mounted on the back of a bike on the face of its largest compartment. While providing ample space for equipment, it still lacks the natural compartmentalization needed categorize equipment. To have order within the compartments, there would have to be another level of compartmentalization. Drawbacks that made this design unfavorable were its lack of natural compartmentalization and its high center of gravity when mounted on the bike.



(a) The Tripod Open



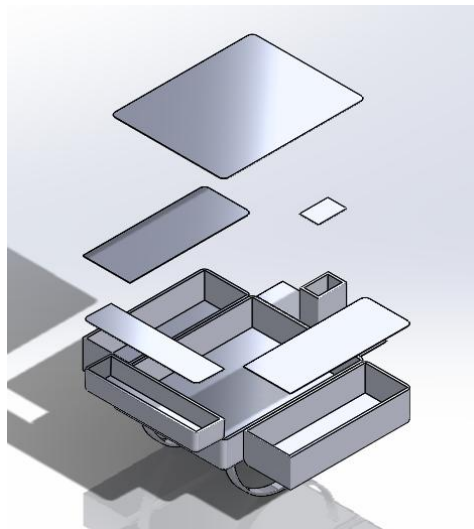
(b) The Tripod Closed

Figure 6: Solid modeling sketch of "The Tripod" bag design

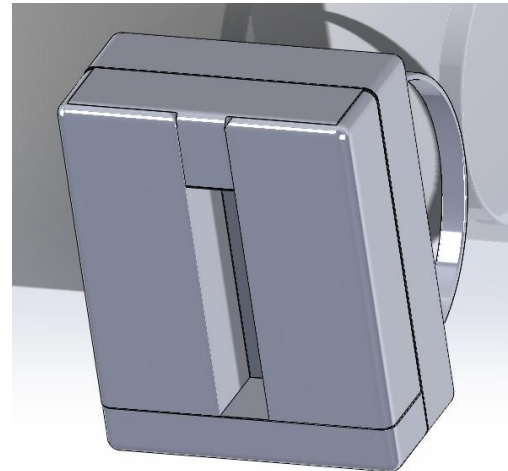
3.4.3 THE ROBOT

The robot design was a more cubic backpack that divided into one large compartment, three medium compartments and one small compartment. It can be seen in figures 7(a) and 7(b). This design features a natural compartment in the center when closed. This compartment is large enough to store a size C O₂ tank. The small container at the top of the backpack would be best used to store pills and other medication. This would make finding and monitoring the medication easier. This compartment could also be adapted to control the environment inside to cater to the needs of its contents. An example would be insulation for temperature maintenance. The best way to close this backpack would be to fold all of the compartments into their closed position and cover them with the sheet. The sheet is then secured in place using a zipper. This design has ample space and

is naturally compartmentalized. The only Drawback that made this design unfavorable is its high center of gravity when mounted on the bike.



(a) The Robot Open



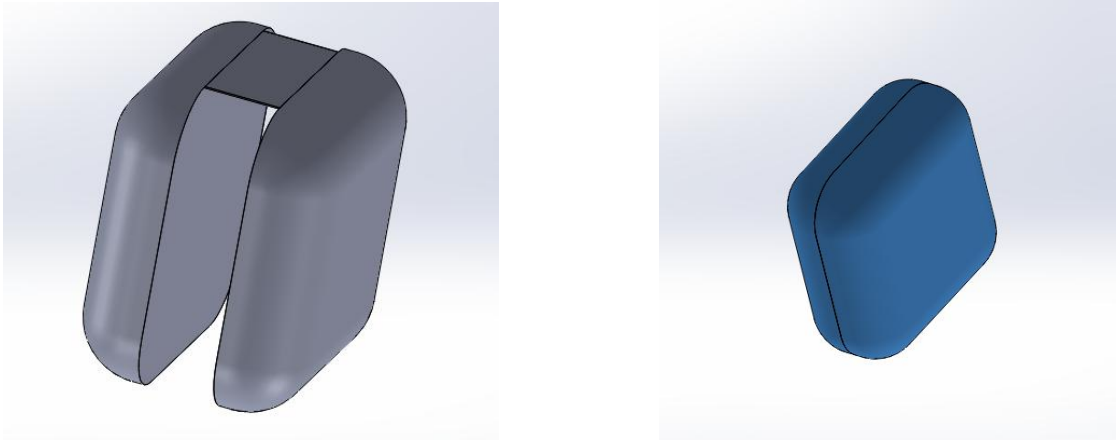
(b) The Robot Closed

Figure 7: Solid modeling sketch of “The Robot” bag design

3.4.4 THE PANNIER 1

The Pannier 1, shown in figures 8(a) and 8(b), is modeled after the current pannier bags. It is divided into two large compartments. The two medium compartments are located on both sides of the rear wheel of the bike when mounted. Connecting the two bags is a sheet of fabric. The sheet of fabric is used to secure the bag to the bike. This design like many of the designs before it lacks the natural compartmentalization. With no other methods of compartmentalization, the contents of the bag will quickly become disorganized. Disorganization makes navigating the bag more difficult and waists precious time that could have been spent saving the person’s life. This design

also lacks the space required to carry all necessary equipment. Drawbacks that made this design unfavorable were its lack of natural compartmentalization and lack of space.



(a) The Pannier 1 Open

(b) The Pannier 1 Closed

Figure 8: Solid modeling sketch of “The Pannier 1” bag design

3.5 SOLUTION AND SUMMARY OF FINAL DESIGN

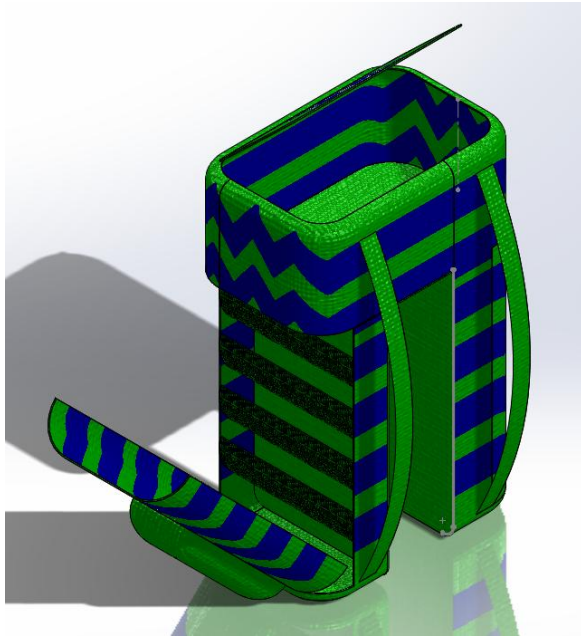
We chose “The Pannier 2”, shown in Figures 9(a) and 9(b) as our final design. As the name suggests it is also based on the pannier setup. It has one large compartment and two medium compartments. The large compartment rests on top of the rear pannier rack. The medium compartments hang on both sides of the rear wheel. Though this design still lacks the natural compartmentalization, it is perfect for a two person team providing ALS care. Using a two person team means that the equipment can be divided between the two identical bags. Two person teams will easily be accepted by the user because it conforms to the status quo. This bag system is capable of carrying all needed equipment, including a size CO₂ tank and a defibrillator.

There are a number of sprays that can be used to water resistant fabrics. Two examples are PVC spray and “Ultra Ever Dry” spray. PVC spray coats the fabric in a polymer that is not permeable to water. “Ultra Ever Dry” coats the fabric in a hydrophobic material that both prevent water from penetrating and prevents dirt and contaminants from sticking to the surface. This makes

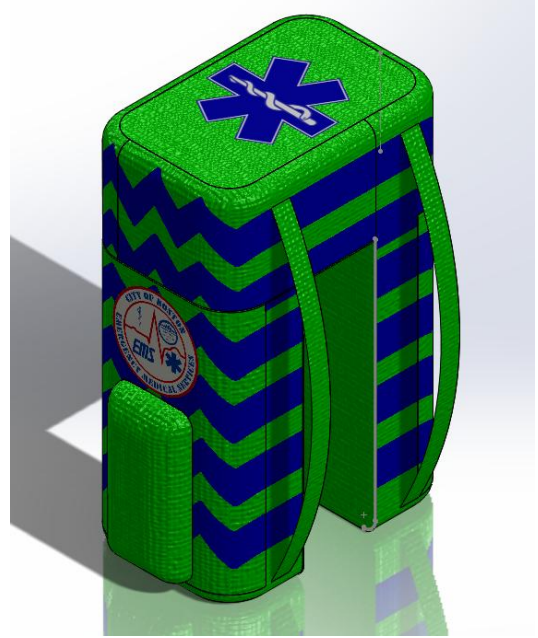
the fabric both water resistant and easy to clean. To help prevent contact with dirt and contaminants the bag also had rubber stands to prevent the bag from touching the ground.

To reduce the weight of the bag, the frame of the bag is made of Polypropylene Block Copolymer (PPC). This material is Ideal because of its low density. Despite the low density, PPC is still a strong material. Polyvinyl Chloride is a popular polymer used for many purposes. Among those purposes is construction. PPC has a higher Specific Strength than both rubber and PVC. PVC is known for being strong, but also brittle. PPC has a significantly lower young's modulus making the material significantly more elastic. This means that the material will deform before it breaks. The deformation absorbs force and further increases the durability of the bag. The mechanical properties of PPC and two other common materials can be found in figure 11 and table 3.

The mounting system for the bike is an aluminum plate with aluminum adjustable aluminum clamps that hold it in place, shown in Figure 10. Though there are eight possible position for the clamps on the plate, only four are needed. This gives the user choices that would best fit the rack of their bike. The mechanism for attaching the backpack to the bike is a sliding system. One rail is attached to the bottom of the bag and the other is on the bike mounting system. The two interlock making a strong connection. At the end of the bag rail is a handle and lever that are used to lock on to the mounting system. When in place, it prevents the bag from sliding off of the bike. Aluminum is used for the parts in this system so that it can be light weight and durable.



(a) The Pannier 2 Open



(b) The Pannier 2 Closed

Figure 9: Solid modeling sketch of “The Pannier 2” bag design

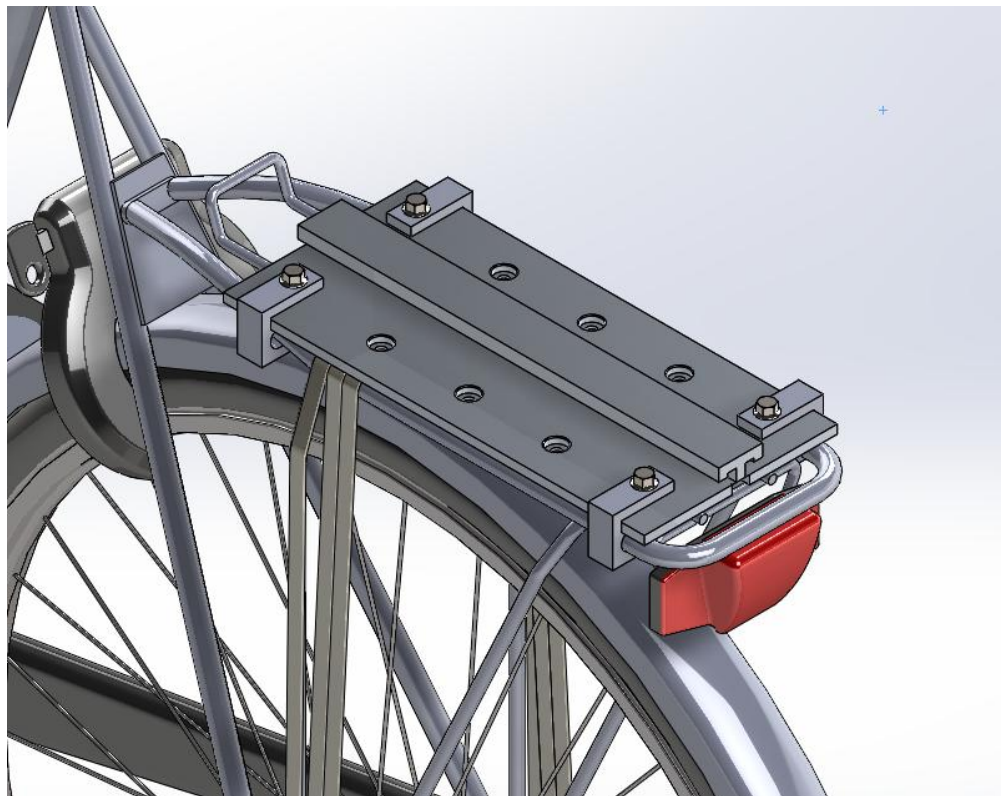


Figure 10: Mounting plate for pannier rack

Table 3: Mechanical Properties (POLYPROPYLENE BLOCK COPOLYMER)

Property	PPC	rubber	PVC
Density (g/cm³)	0.9	1.52	1.42
Young's Modulus (Gpa)	1.1	0.05	1.4
Specific Strength (kN/m*KG)	26	16.3	20

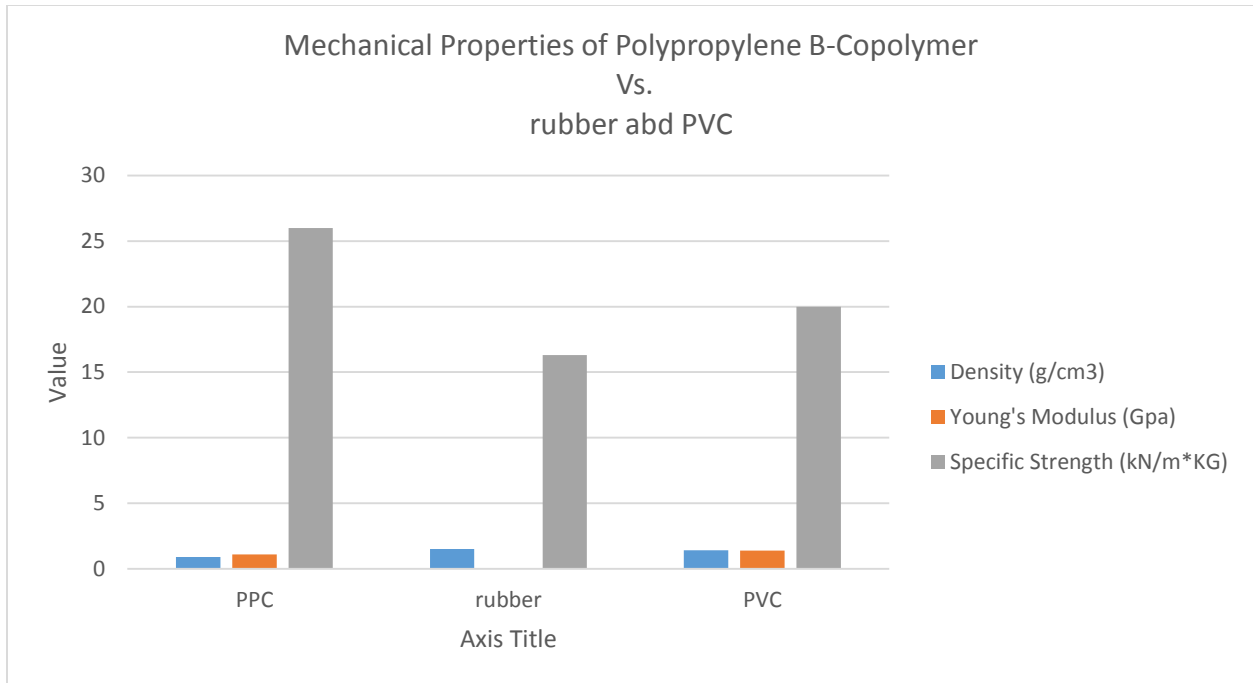


Figure 11: Mechanical Properties of Polypropylene B-Copolymer vs. Rubber and PVC

3.5.1 OPERATION

In an emergency the user would simply place one hand on the backpacks top handle, lift the handle located at the back of the bike, and pull, as labeled in Figure 12. Pulling the back handle unlocks the rail so that it can slide freely with little friction. Once the backpack begins sliding, it will detach from the bike at the end of the rail. Now the user can put the backpack on and proceed to the emergency.



Figure 12: Instructions for removing the bag

3.5.2 ASSEMBLY

The backpack's hard shell panels are made of polypropylene block copolymer. Each part is covered on both sides with fabric. The two sides of fabric are sewn together at the edge of each part. A small lip of fabric at the edge of each part for ease of sewing. Once every part has been cover in fabric, each part is sprayed with waterproofing material. After every part has been water proofed the parts are sewn together in their correct position and orientation. At this point the main body of the backpack has been assembled. Pockets, straps, and elastic bands are added. Mesh pockets are then sewn into the inside of the left sub compartment.

3.5.3 DETAILED DESIGN

For the creation of our prototype, there were five main components: the shell, the fabric, the waterproofing spray, stands, and the mounting mechanism. The materials for each component are contained in table 4 and the design styles are address in table 5.

Table 4: Bill of Materials

component	Material
shell	Polypropylene Block Co-Polymer
Fabric	Kevlar
Water proofing	Ultra Ever Dry®
Stands	Rubber
Mounting Mechanism	Aluminum

Table 5: Design Comparison

Design	Advantages	Disadvantages
“The Book”	Spacious	High center of Gravity Lack of natural compartmentalization
“The Tripod”	spacious	High center of Gravity Lack of natural compartmentalization
“The Robot”	Natural Compartmentalization	High center of Gravity More complicated
“The Pannier 1”	Low center of gravity	Lack of space Lack of natural compartmentalization
“The Pannier 2”	Spacious Low center of gravity	Lack of natural compartmentalization

Our EMS bag design draws on many current bags both used for emergency work applications or civilian use. The bag features a large top compartment to house items that require quick access or cannot fit into the smaller side compartments. The right pannier is also left void of compartments to allow for customization by the user depending on the equipment carried. ALS services may utilize this space for bags containing intubation equipment or IV supplies. Since BLS services cannot provide this care, the compartment could be used for bags containing vital sign assessment equipment, blood glucometry supplies, or airway and breathing kits. The left pannier

is designed with horizontal pockets stacked vertically. These pockets are meant to contain supplies that are not part of a kit or are often used alone without any other equipment. For example, bandages could be kept in one of these pockets so that it is not necessary to open several bags to access a single bandage.

A main feature of the bag is that it is highly customizable. Many EMTs are accustomed to certain arrangements of equipment and one main goal of our bag is to allow for the user to pack the bag in the arrangement that best suits their needs. The EMS bag is also highly reflective allowing for greater visibility during the day and during the night. Furthermore, the larger surface area allows for larger identification to be placed on the bag clearly labeling them as medical providers or members of a certain department.

3.5.4 PACKING SCHEME

An important aspect of creating a new first in bag to be used in bicycle EMS is the consideration of where all the equipment needs to go. Now, each EMS agency using the bike may very well decide that they are going to put the equipment wherever they will please, but the design of the bag would not be complete without the idea of where each piece of critical equipment is meant to be located. The few things that need to be considered when deciding where equipment needs to go are as follows. First, and most important, what equipment will be carried, next how much will be carried, and lastly where will the equipment be placed. Another aspect that was considered is using the bags in pairs, which will be discussed soon hereafter. The Pannier 2 provides enough packing space for all if the necessary equipment. The Pannier 2 is also light weight and is detachable. This makes possible for the EMT to take the equipment where a bike could not navigate, such as smaller buildings.

The decision of what equipment to carry is something that hasn't been standardized by any emergency service authority. When speaking with Boston EMS and Worcester EMS officers it was discovered that they design their own equipment lists for their bike teams. The Office of Emergency Medical Services in Massachusetts has not set a minimum required equipment list for personnel using bikes. Further than that there was no national authority that had standardized equipment lists for EMS bicycles. This leaves each agency using bikes and left our team in a place to start from scratch and create our own minimum equipment list. The list that has been created is based off of the equipment list for ambulances regarding their first in bags. The equipment was then organized into categories for which they are used. The categories are Airway, Trauma, Assessment, and Medications. They are general categories, which were then assigned to a pocket. Since the bag has three pockets (top, left, and right) it was decided that each pocket would hold one category of equipment.

The only category that would have a pocket not part of the bag is the medications category. The United States has strict laws regarding controlled substances and narcotics. Since narcotics are an integral medication used by EMS there needs to be protections and locks in place. Laws require there to be two locks in place before accessing narcotics. Typically this is handled in an ambulance by considering the first lock to be the exterior of the ambulance and having locked doors. The second lock is the actual box that the narcotics are stored in which has a padlock on it, the key to which is held by the paramedic. After discussion with Boston EMS and Worcester EMS and talking with them about how they handle securing the narcotics on a bike a strong and secure method was established. The Paramedic will carry a fanny pack, or pouch that has a small padlock through the zipper, that paramedic will carry the key for that lock. This method is consistent with laws regulating the narcotics. The first lock in place is the paramedic who has the pouch strapped

to his or her body, which prevents access to it. The second lock is the small padlock so that even if someone were able to remove it from the paramedic they would still have difficulty accessing the narcotics.

The discussion of having the bike service as ALS or BLS also arose along with what equipment would be carried on the bikes for each level of care. After much deliberation the levels were separated and set in place. A rough display of equipment locations can be seen in Figure 13. The bag developed can be used for both levels of care with some differences for each. In the Basic Life Support Level, the bag can be used on its own, the top pocket will carry assessment tools. Assessment tools include blood pressure cuffs, stethoscopes, glucometers, pulse oximeters, thermometers, penlights and gloves. The top pocket will also carry an AED, which would be used in the case they respond to a cardiac arrest. Those are all the standard tools that are needed to assess a patient to determine the illness or injury. The right pocket would carry basic level medications and oxygen (including oxygen delivery devices), and airway equipment.

The basic level medications do not need to be locked like narcotics do because they typically are not controlled substances, even when they are they are not ones that are required to be locked away. The oxygen will go on this side because, as reported by our Boston EMS contact, the bike will naturally fall onto its left side when balanced. By putting the oxygen on the right side as Boston EMS does, it prevents damage to the cylinder if the bike were to fall. The reason airway is included in this pocket for the Basic level bag is because there are only two airway adjuncts for a basic, Oropharyngeal airways and nasopharyngeal airways. The last pocket for the Basic Life Support bag is the trauma pocket. This will hold the equipment necessary to control bleeding and splint a small extremity. The most important task a Basic EMT can do for trauma is control bleeding and as such there are many tools that they have available to use ranging from

simple gauze to tourniquets. All of those tools will be stored in that pocket along with SAM® splints, which can be used on, lower leg/ankle injuries or forearm injuries.

The Advanced Life support setup is slightly more complicated than the Basic one. It was decided that if the bag is to be used in an Advanced level then it would need to be used in pairs. The decision to have the bag used with a second bag for advanced life support is because of that fact that if there is only one paramedic with the bag of advanced tools, he will not be able to intervene efficiently. A common phrase in EMS is “BLS before ALS” which means make your basic level interventions before focusing on your advanced level interventions, such as keeping the airway open, controlling bleeding, etc. If a paramedic arrives on scene with a very sick patient they are going to be too busy maintaining that airway to doing CPR to use any of the advanced level equipment he or she may be carrying, therefore it would be better to have a second paramedic or EMT and to have them work in pairs.

The bag with advanced level equipment would be used with a bag carrying basic level equipment. The bag is capable of storing a Zoll® E-Series monitor in the top compartment. Other models of monitor which sit taller might not be able to fit. The left pocket would have IV/IO supplies and carry bags of saline solution in both the 500ml size and 1000ml size, and some other trauma equipment such as large bore needles for needle chest decompressions.

This pocket would also carry some of the non-narcotic medications that are used more frequently like Narcan, Zofran, or other cardiac drugs or IV medications. The right pocket would carry advanced airway tools. These would be tools such as supraglottic airways, combi-tube airways, and kits for needle cricothyrotomy. This pocket will also contain the biggest advance airway used is the endotracheal tube, the equipment for that is the tube itself, laryngoscopes, and

batteries for the laryngoscope's light. Lastly that pocket would have magill forceps, which are used to remove objects obstructing the trachea that cannot be removed by abdominal thrusts.

The two bags in an advanced crew combined will have all of the equipment necessary to be able to treat patients effectively until further care and transport can arrive. Overall any bike should be travelling with a second EMT or paramedic as providing quality care can be hindered if you are on your own without a second pair of trained hands to be able to assist in treatment. That is why it is recommended that the bag is always used in pairs. At any level a second EMT there will greatly improve the ability to treat any patient they may come across.

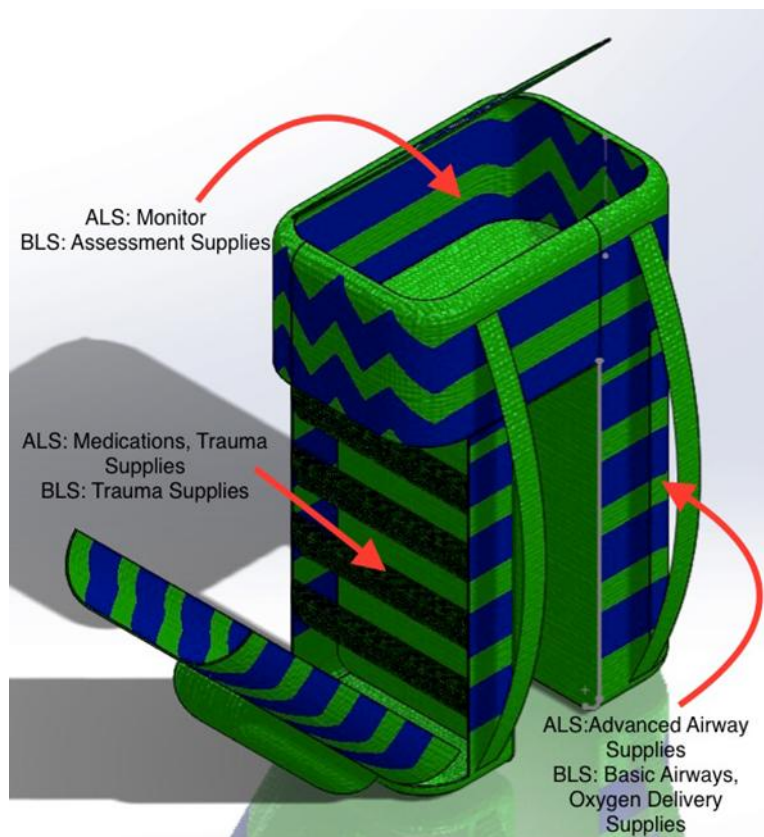


Figure 13: Suggested Packing Scheme

3.6.1 OVERVIEW AND DEVELOPMENT OF WEBSITE

The EMS bike pannier website was developed in Adobe Muse, which provides graphic user interface for designers. With basic website design skills and some drag and drop of text and images, Adobe Muse software converts the design into real HTML code and upload to web servers. Figure 14 shows the basic layout of Adobe Muse.

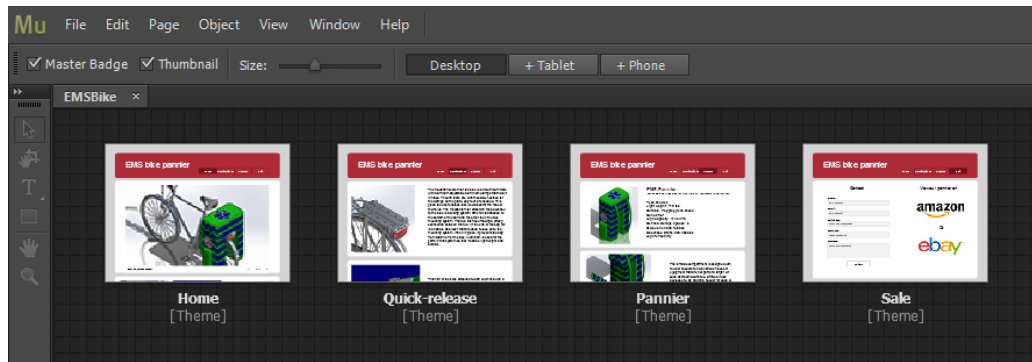


Figure 14: Adobe Muse website design layout

Figure 15 shows the window for selecting the appropriate files. First, HTML files are used to store plain text on the website and the relationships and connections between all other files. Second, Cascading Style Sheet (CSS) files specify the styles of the website. All the alignments and positions of elements on the website are declared in CSS files. Colors, fonts, margins and padding stuffs are also stored in these files. Third, JavaScript (JS) files are used to state the logic throughout the website. All logics, like navigation, background gradient, and button hover are stored in these JS files. With Muse, developers can focus more on the design aspect and let Muse take care of all the code.

Name	Date modified	Type	Size
css	4/17/2015 6:18 PM	File folder	
images	4/17/2015 6:18 PM	File folder	
scripts	4/17/2015 6:18 PM	File folder	
index	4/17/2015 6:18 PM	HTML File	12 KB
muse_manifest	4/17/2015 6:18 PM	XML File	4 KB
pannier	4/17/2015 6:18 PM	HTML File	10 KB
quick-release	4/17/2015 6:18 PM	HTML File	8 KB
sale	4/17/2015 6:18 PM	HTML File	12 KB
sitemap	4/17/2015 6:18 PM	XML File	5 KB

Figure 15: The website utilizes separate files for each web page

3.6.2 STRUCTURE AND DETAIL DESIGN OF THE WEBSITE

The style of EMS bike pannier website is inspired by WPI's official website. The background is colored light gray (Color code #D3D3D3) because a clean color like this will be perfect as section separators. We needed to separate the whole page to several sections as well as preventing viewers from feeling that we are doing so intentionally. Light gray and white work perfectly together. Elements in a block surrounded by a white frame are related to each other or should be together for some other reasons. Figures 16 and 18 illustrate the basic color scheme of the website.

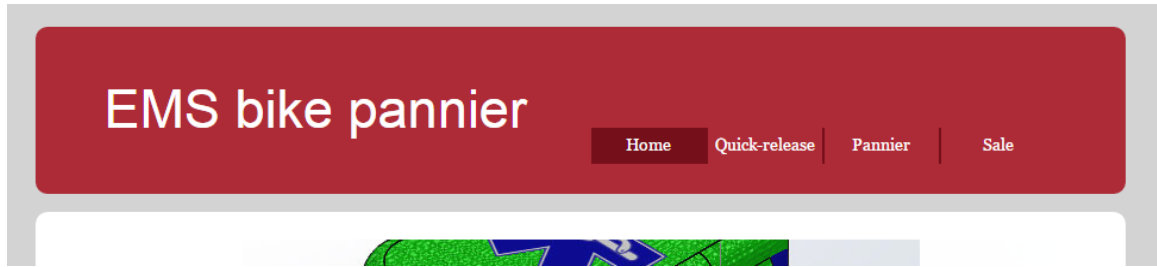


Figure 16: Website color scheme of main banner

The header (navigation area) of each page uses color dark red with color code #AD2B37. This color is copied from the header of WPI official website. Figures 17 and 19 show WPI's color scheme; compared with Figures 16 and 18, the colors are very similar.

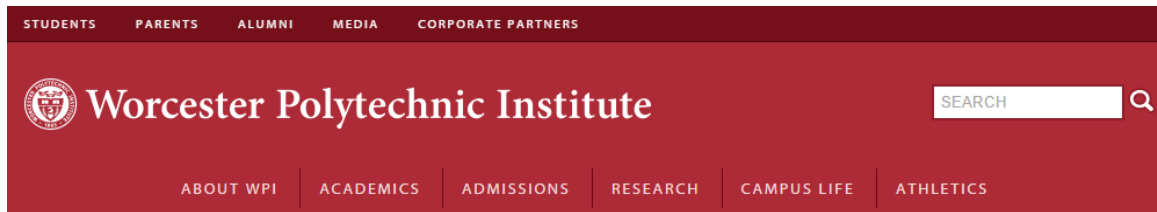


Figure 17: WPI color scheme of main banner

When hovering the mouse on the navigation tags, the color of the selected tag becomes darker with color code #750F1A. This color is also copied from WPI official website. The style was copied from WPI official website to make the two websites consistent. In this case, anyone who knows WPI before will recognize our website by its style and associate it with WPI. The title and navigation bar in the header are placed on two sides of the diagonal. Since we only have four navigation bars, doing so will make sure that the header section will not look empty. The footer of EMS bike pannier website, shown in Figure 18, also used the same style as WPI's, shown in Figure 19. The color, with code #292929, is copied from WPI's website.

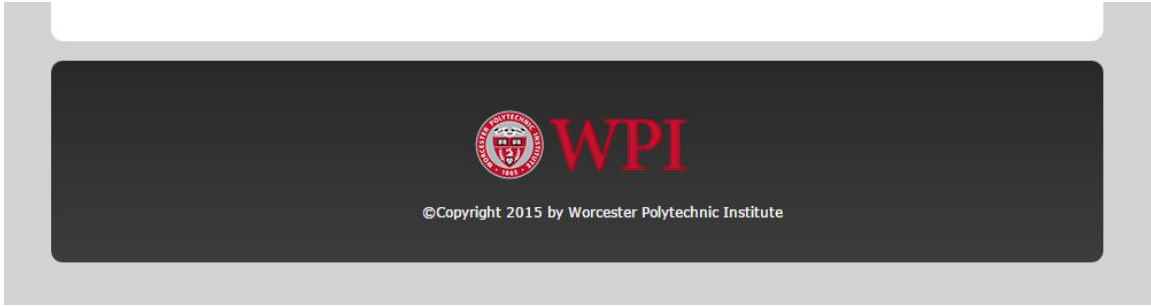


Figure 18: Website color scheme of footer

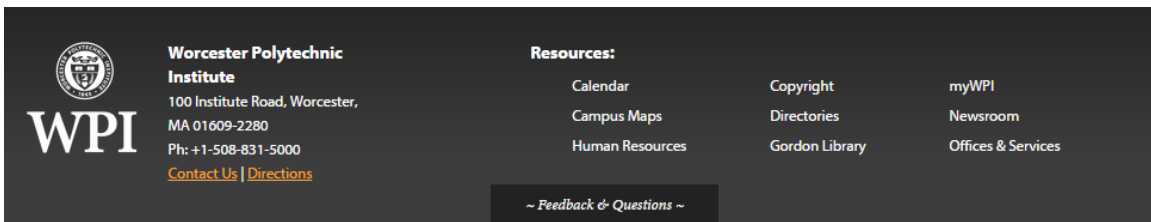


Figure 19: WPI color scheme of footer

For the content of footer, we added a WPI logo, which contains a link to WPI official website. We also included a copyright statement in the footer section to prevent unauthorized uses of any contents. For all the headers, footers and sections, the four corners are rounded to increase aesthetic appeal.

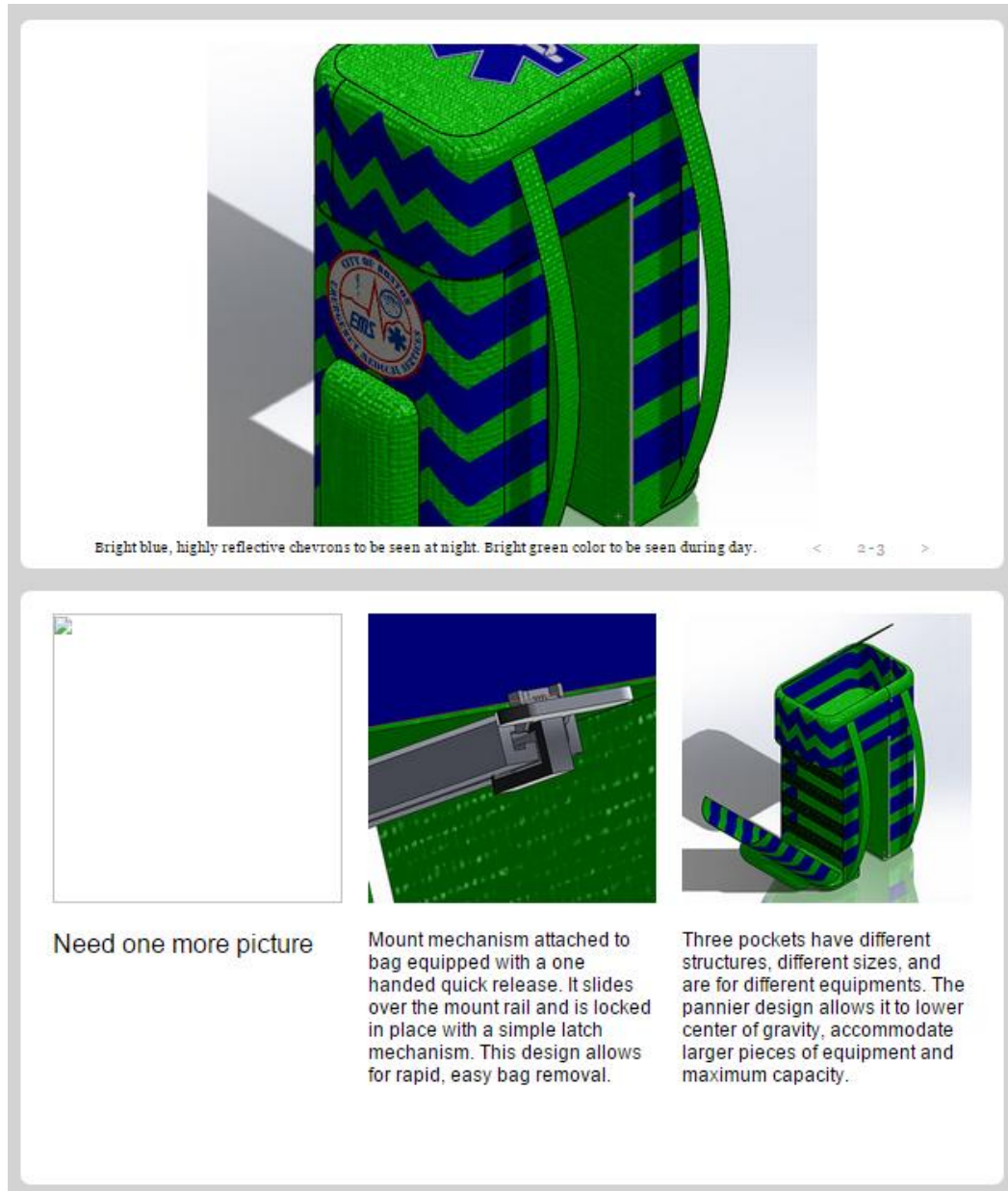


Figure 20: Pictures of the bag showcased on the website

The first page, shown in Figure 20, (i.e. home page) uses a popular style with a large image slide show on top and three small picture-text combination sets under it. All pictures in the slide show are key features. These images are used to catch attentions of viewers. If the viewer are interested in these pictures, they will be more likely to keep reading our website. The image slide will automatically turn to next picture in 3.5 seconds and wrap around if reaches the end. Each pictures,

shown in figure 20, has a one-line brief description. On the right side of the description there is a navigation status bar for the image slide. Viewer can manually go forwards or backwards using the two buttons. Underneath the image slider, the three picture-text combination. There will be some features that have not been used in other places and will attract attention. With short description, the viewer must be convinced that this product is superior and worth looking at. In conclusion, everything on the first page is used to attract attention. If the home page catches the viewer's attention, he or she will move forward to the quick-release and pannier tag. In these two tags, there will be many texts to explain our project.

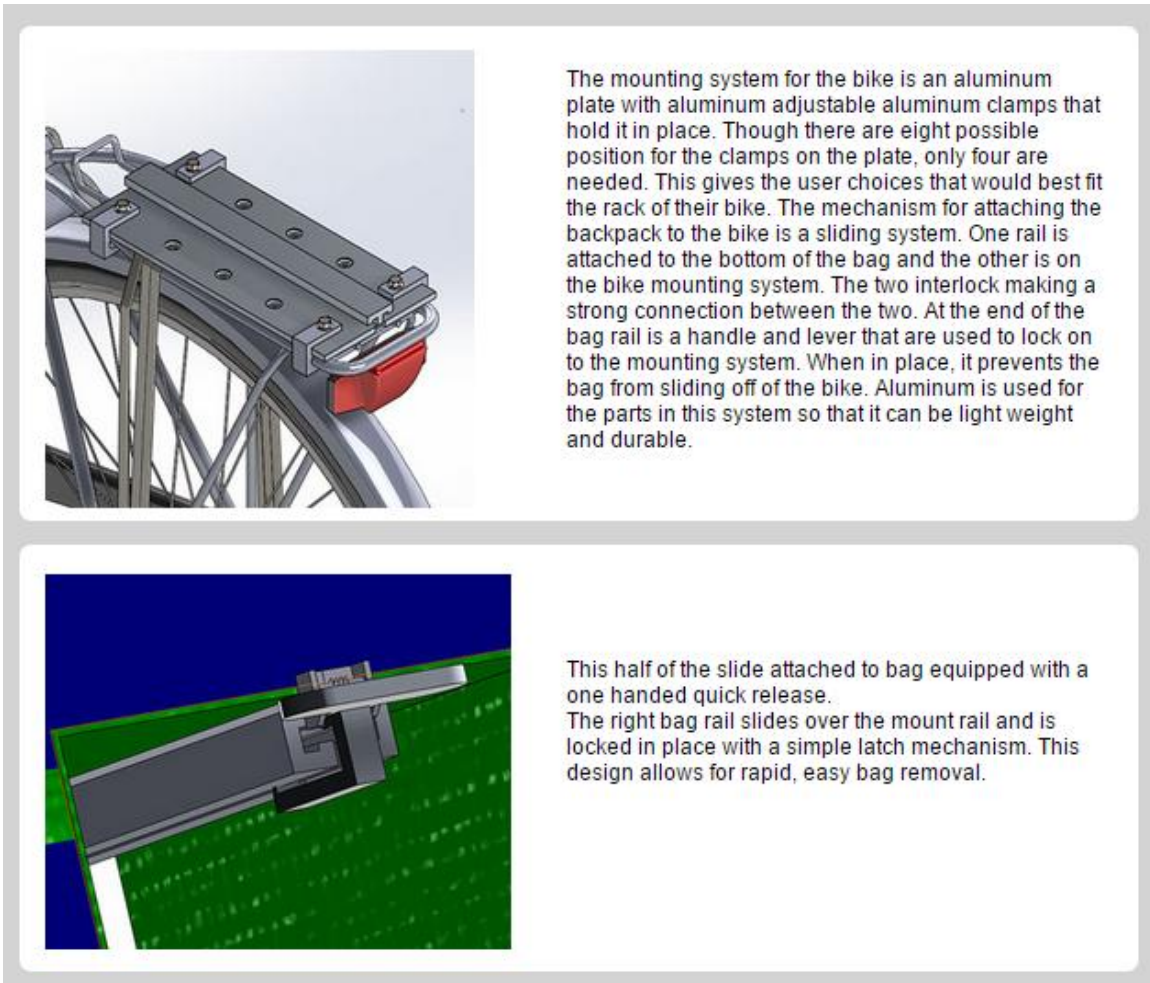


Figure 21: Pictures of the rack showcased on the website

In the quick release tag, the whole page is divided into two sections, mounting systems both on bike and backpack, since they are equally important. The picture and text, shown in Figure 21, used in this page are more detailed and technical. Long and detailed texts are used to thoroughly describe the quick-release system. These descriptions captures all the functionality of the quick-release system and its advantages over the traditional mounting system. The technical pictures and texts are suitable here because this page is not for attracting attentions. Instead. These features should be described well and the descriptions are used to convince the reader that this product is better than traditional ones. In this way, readers may choose to buy our products.

3.6.2 EXPANSION AND FUTURE DEVELOPMENT

Because of the limit of Adobe Muse, website features such as PHP, shown in figure 22, and html5 are not possible to be add into this website. Due to a lack of time, the website was not our main focus. Currently, if they are to be added, it must be done manually after Muse exports the HTML code. Many features like GIF images and background audio are hard to implement. But since Muse is still developing and updating, it can be expected that, in a year or two, it will support these PHP features. In this case, developers will only need to drag and drop to implement the website and leave all the code generation to Muse. Or, to make the website looks more professional, Professor Fofana can hold a CS major MQP. If a MQP team of three CS major students work together on the website, more and more features can be done by hard coding.

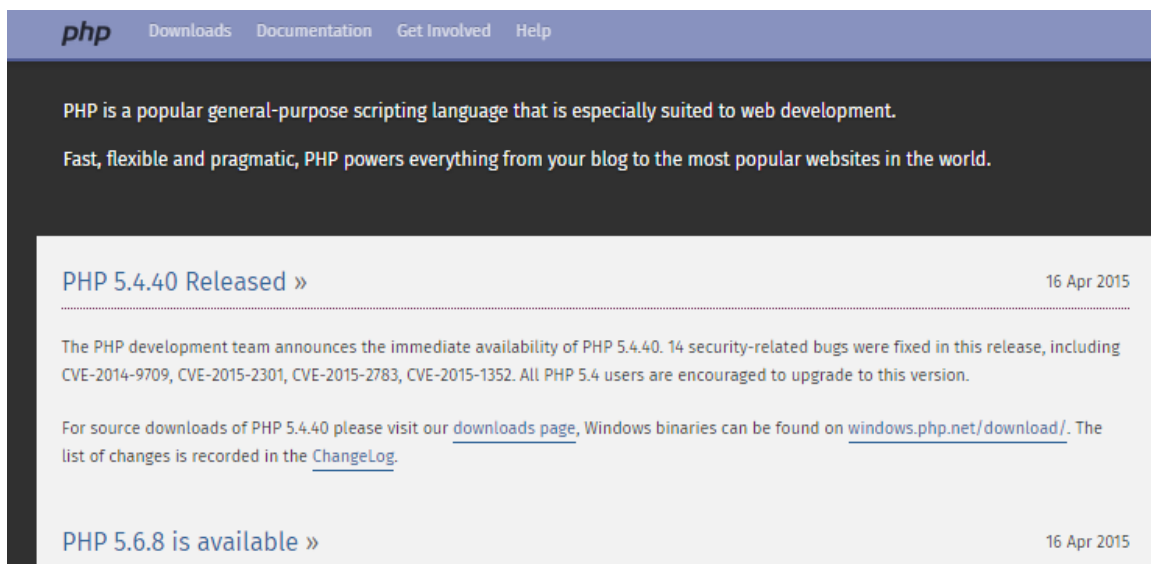


Figure 22: PHP is a popular website feature

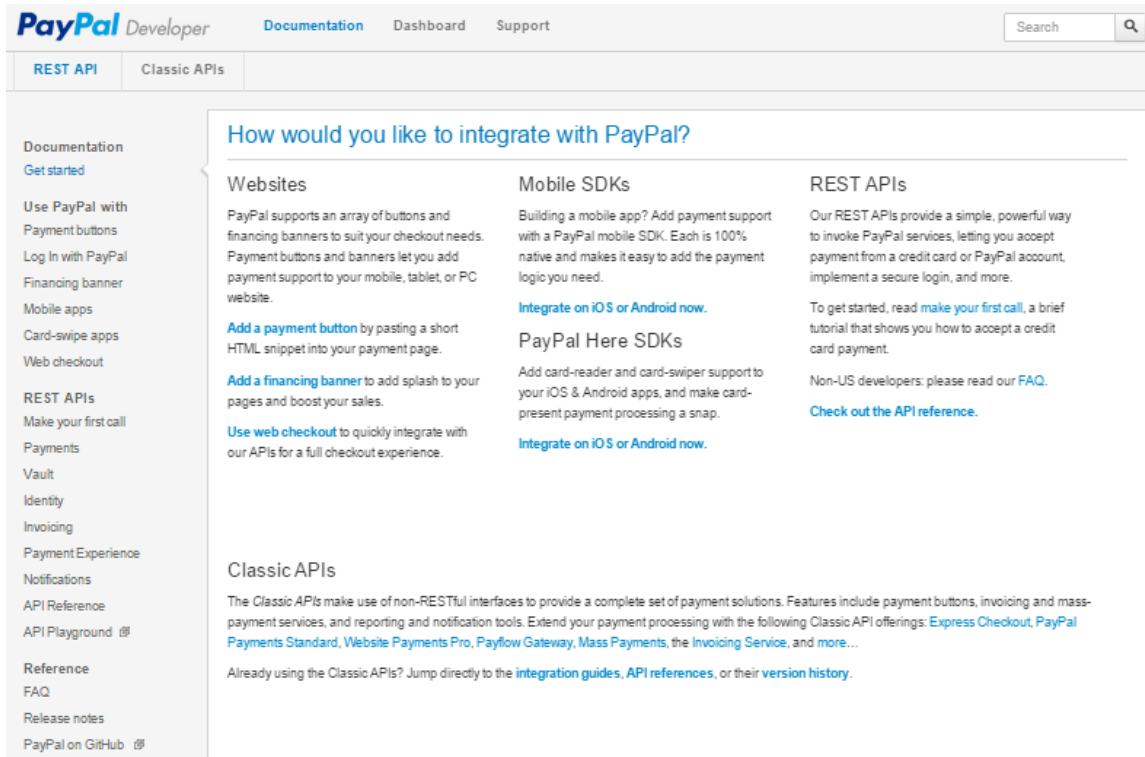


Figure 23: Paypal would be utilized as a payment system for the website

There are many ways to implement a sales page. The first and easiest way is to use marketing networks like eBay and Amazon. The contact information can be left on this page and just place the link of our products on Amazon or eBay. Although we need to pay 15% to amazon, there are many advantages. For example, we don't need customer support, which will require someone to do it; this generates extra costs. Also, this marketing will handle the delivery stuff for us, which saves a lot of time and labor. If we choose to do the marketing by ourselves, PayPal, as shown in Figure 23, should be the first choice. PayPal provides its API (Application Program Interface) for developers. With the API, we just need a few lines of code to connect our website with PayPal. Instead, if we just provide some text fields for entering card info stuff, it will be hard to secure the card information. If our website is hacked, since it's related to transactions, we will be responsible for the loss of our customer's information. Also, PayPal will handle all the different payment method for us such as Visa, MasterCard, credit card and debit card. In this way, we just

need a PayPal account and everything is completed by PayPal. In the sale page here, we just need to leave a contact information and the user interface that PayPal gives us. Everything is done here and will save time and money.

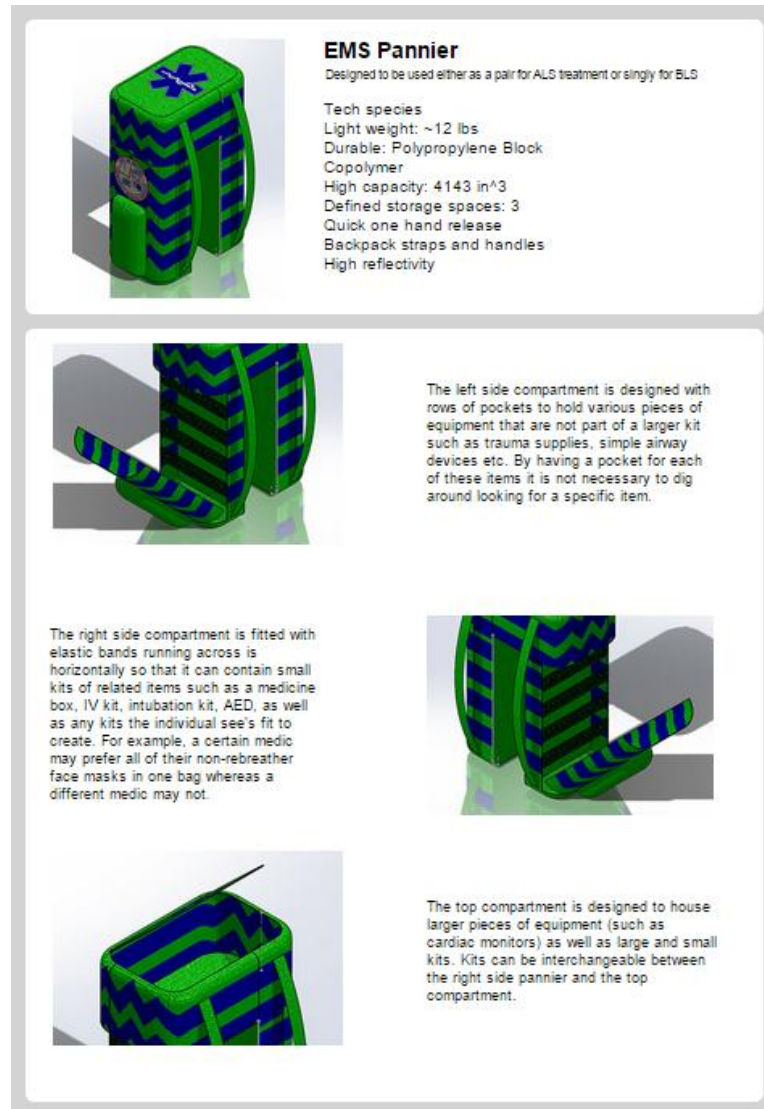
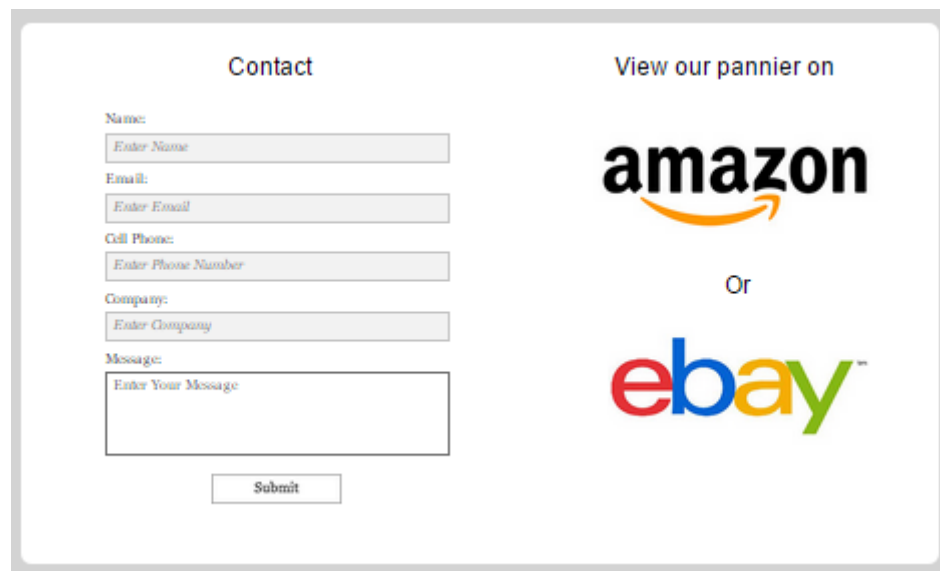


Figure 24: The website displays various angles of the bag with a short description

On the pannier section, shown in Figure 24, the page is also divided into two sections. Since this is the most important part of our project, we create conclusive description in the first section. Inside it, we place a closed pannier image. This image shows viewers how the backpack looks like overall. Under the title, we use one conclusive sentence to describe the usage of this

backpack (i.e. Designed to be used either as a pair for ALS treatment or singly for BLS). Statistics are also put into this section which conclusively shows the capacity, size, and material usage. In the second section, we describe every parts of the backpack. Three pockets and their functionality are all listed in this section. To avoid the singularity of layout design, we exchange the position of a text paragraph and a picture. Line breakers between the three pockets description may be added in the future.



The image shows a web page layout with two main sections. On the left is a contact form titled "Contact" with the following fields: "Name:" with a text box containing "Enter Name"; "Email:" with a text box containing "Enter Email"; "Cell Phone:" with a text box containing "Enter Phone Number"; "Company:" with a text box containing "Enter Company"; and "Message:" with a larger text box containing "Enter Your Message". A "Submit" button is located below the message field. On the right is a promotional banner titled "View our pannier on" which features the Amazon logo and the eBay logo, with the word "Or" centered between them.

Figure 25: Website uses Ebay or Amazon to sell the bag

The last tag is about sales. If our description of the quick-release system and backpack are good enough to attract buyers, this section maybe used for selling our backpack. However, this page, shown in Figure 25, is currently just a templet. This is because we are not sure if we need it or not. We haven't found a manufacturer that can manufacture the backpack design yet, so our bag is not ready for selling yet. Also, WPI prohibits student project team from using their domains to sell products. If this website is hosted and launched on WPI's domain, we are not allowed to put sale information on it. Because of these two reasons, this page is not implemented yet. If there's a chance in the future that our design seems good and there are potential buyers, we will host this website somewhere else and implement the sale page. Currently, this templet page has two parts.

The left side contains contact information for someone who is interested in our product. An email will be sent to Prof. Fofana if the submit button is clicked. On the right side, there are links for our products on Amazon and eBay.

CHAPTER 4: CONCLUDING REMARKS

This project serves as a reminder that there is always room for improvement in the field of emergency medicine. The growing field of bicycle medics will prompt more innovations aimed towards improving patient care and safety of the medics. The bag design described in this report is meant to contribute to such innovations. In only a few short years, bags have gone from repurposed touring bags to state of the art material specially designed for emergency medicine. This chapter reviews the project and proposes future developments for EMS bicycle bags. The ideas brought forth in this project should be considered as a sum of individual creativity. Such creativity can be utilized in other aspects of emergency medicine not considered in this paper. It is the groups hope that this bag design will improve emergency medical care in the field of bicycle medics as well as inspire and serve as reference to future developments.

4.1 PROJECT SUMMERY

In a field as dynamic and important as emergency medicine, only the best will do. Recently, bicycles have proven themselves to be a more effective role in providing pre-hospital care. It was this group's goal to further develop their growth into this field. Working alongside MIRAD Laboratories and Boston EMS, this team aimed to develop a more effective bag for use by bicycle medics.

The goal for this project were developed through extensive research into the history and current applications of bicycles in medicine. Areas of improvement were found by studying currently available products. Armed with this information, the team set out to design a bag that could meet and exceed the challenges other bags could not address. The top priority of the bag was to be capable of carrying all of the necessary equipment in a way that optimized organization and customizability. Factors such as weight, strength, portability, and durability were addressed with the first priority in mind.

The many facets of emergency medicine create many considerations that must be addressed. This project attempted to implement solutions to all of the challenges posed. However, as is common in engineering, there is no perfect way, only the best way. The ultimate purpose of a product dictates how it will be designed to fulfill the requirements placed upon it in that role. A design is only best for the specific task and will be subpar in any other environment. The bag described in this paper was designed for large scale bicycle operations that operated on a regular basis in an urban environment. Many features of the bag reflect this constraint.

Several iterations of the design were considered before the final design was agreed upon. Each draft is important because it represents a design that was not optimal. The subsequent generation of bag is an evolution relative of the one before. This process of design, consideration, re-design was the major driving force behind the bags development. A website was also created to showcase the bag and all of its benefits in order to establish a marketing tool for the design. Using the internet as a medium, which the world has grown accustomed to, will provide access to the team's ideas and designs allowing for implementation and further development.

4.2 FUTURE CONSIDERATIONS

The project described in this paper represents a specific goal to a specific problem. It was not the intention of this project to solve all of the inadequacies of bicycle mounted EMS bags, but rather to provide a suitable prototype for further development. Due to time and funding constraints, a physical model was never produced. Future developments of this bag would be based on building and field testing a bag. The intended user can more effectively find design flaws than its creators. Having the bag tested in the field is an important step to fixing these design flaws. There are many protocol based problems that need to be addressed and tested regarding the use of bike medics. Things such as coverage, level of care, resupply, rider safety, and training are in their infancy.

These protocols must be created with bike and bag designs in mind. Other physical considerations for future projects are bike design, protective equipment, effective drug storage, visibility, and identification. Although our list is brief, there are many more advancements to be made.

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APPENDIX
ADDITIONAL IMAGES

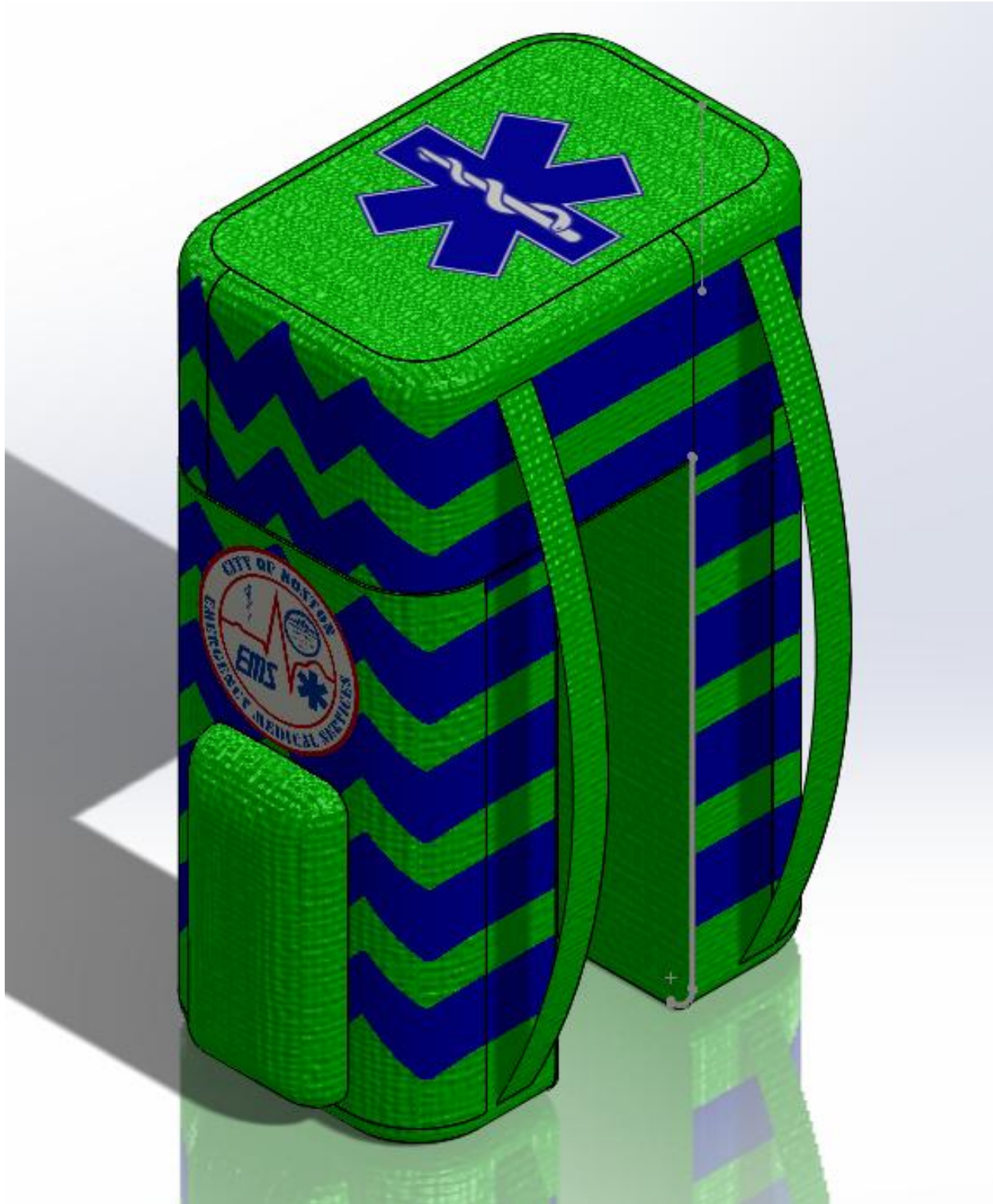


Figure 26: Larger Image of “The Pannier 2” Closed

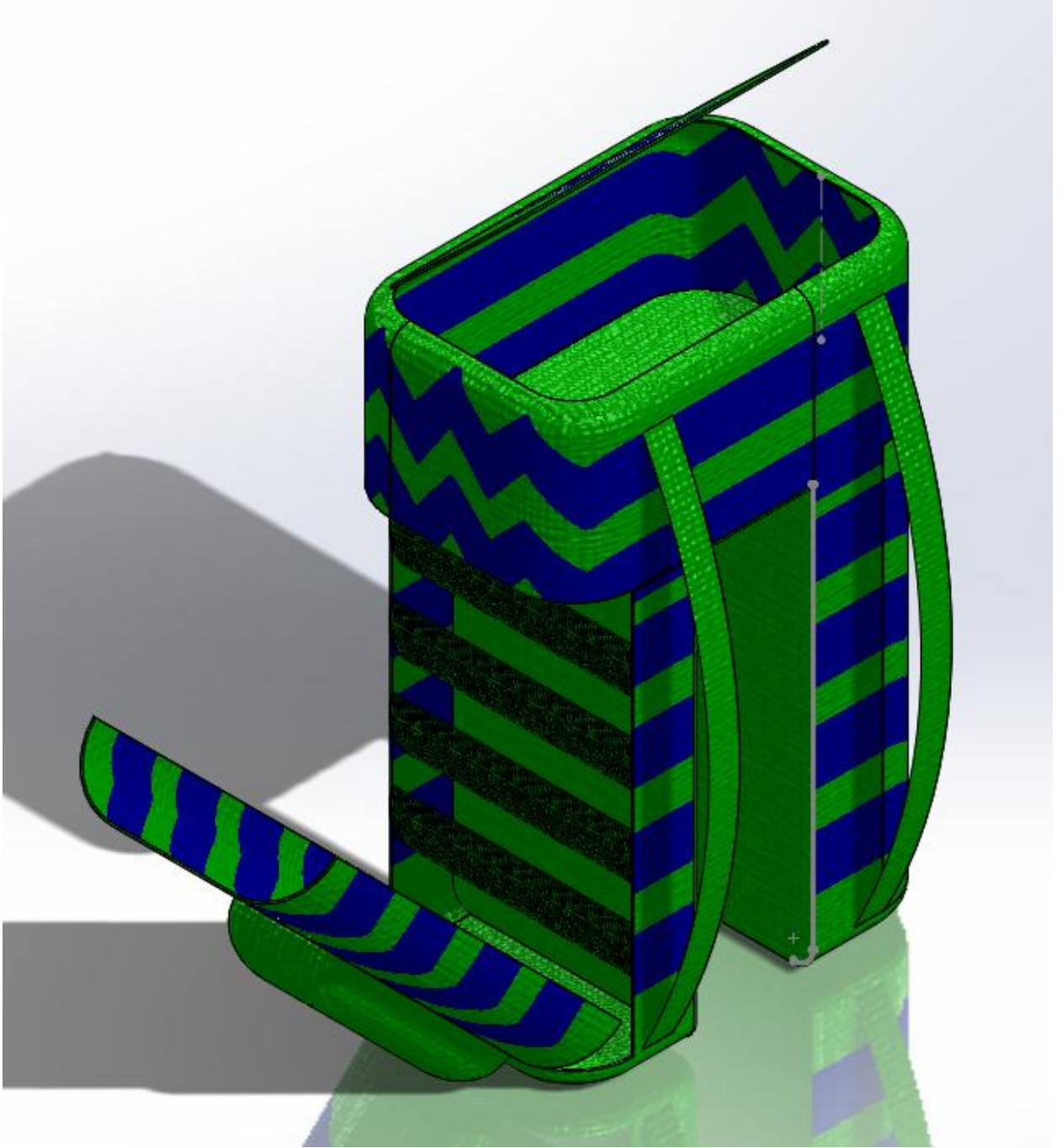


Figure 27: Larger Image of “The Pannier 2” Open

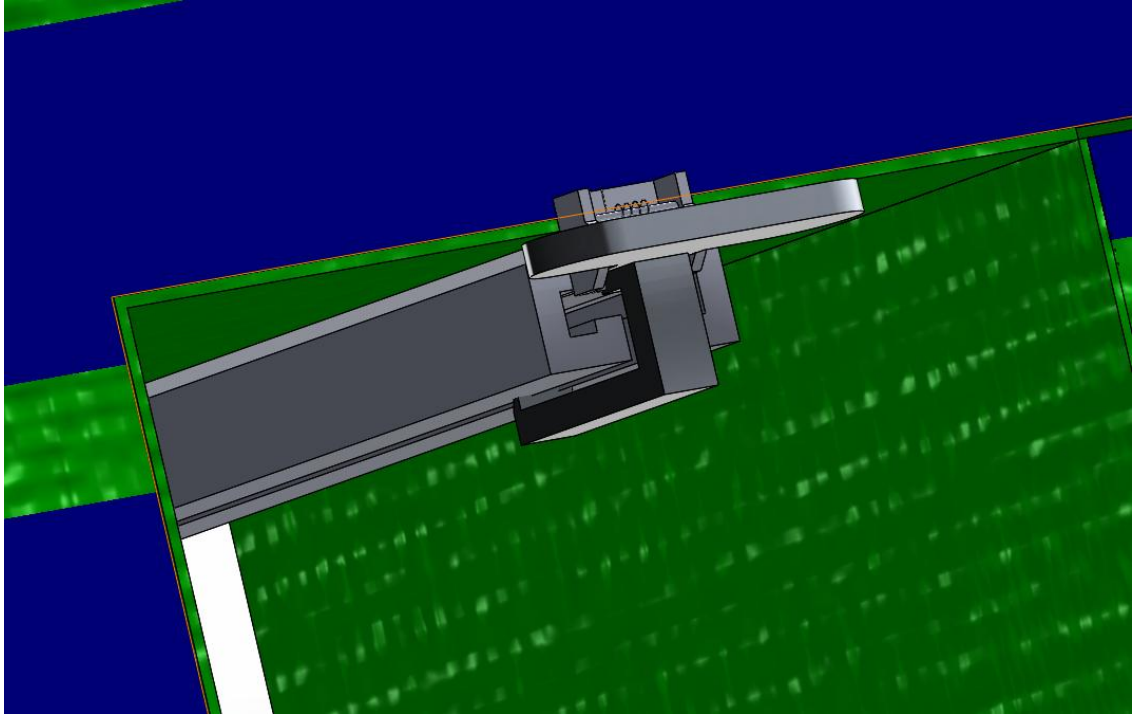


Figure 28: Larger Image of Sliding Rail

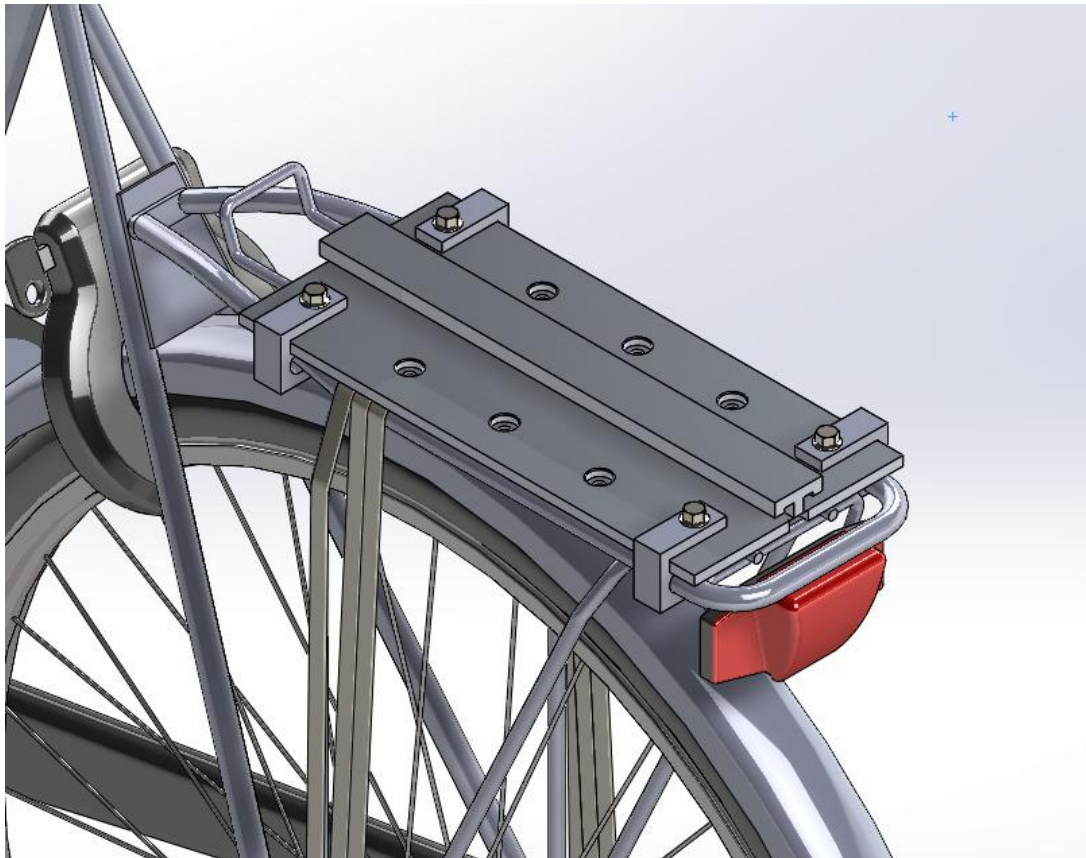
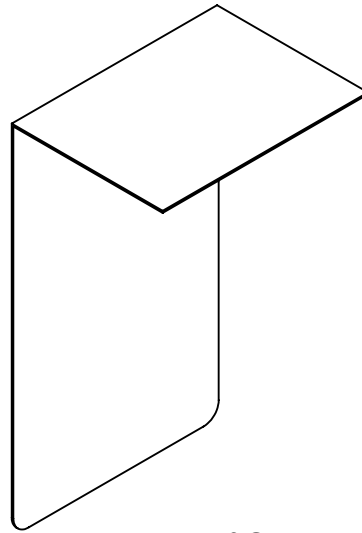


Figure 29: Larger images of the Bike mounting system

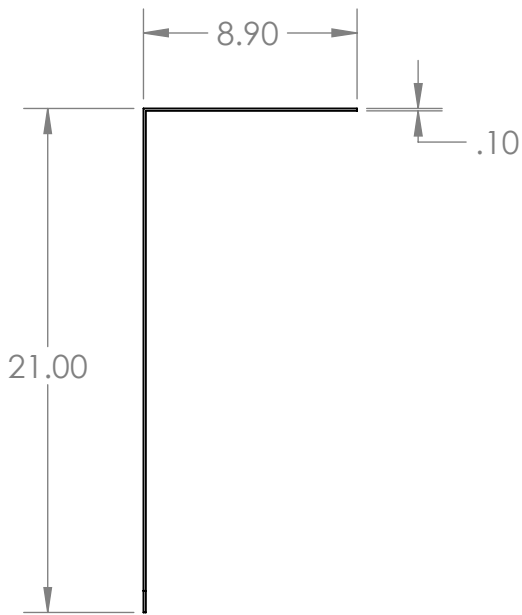


Figure 30: Larger image of the mounted bike

ENGINEERING DRAWINGS



ISOMETRIC



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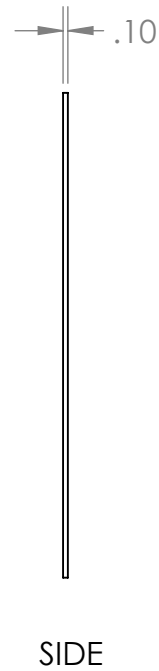
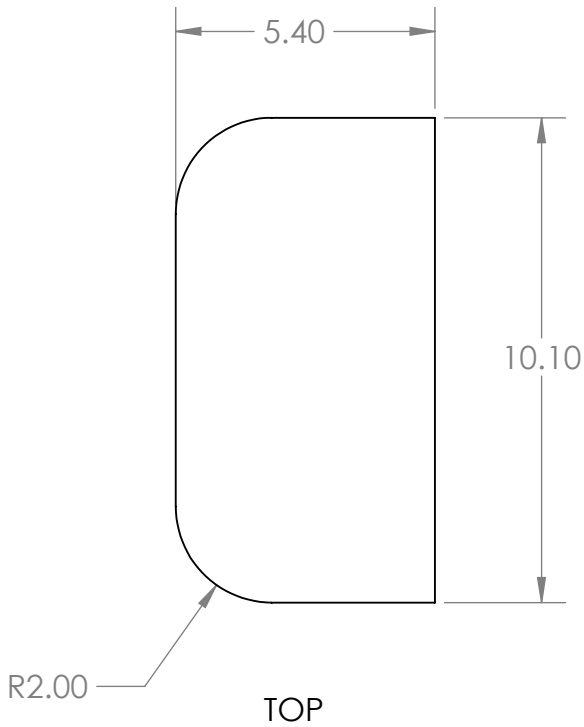
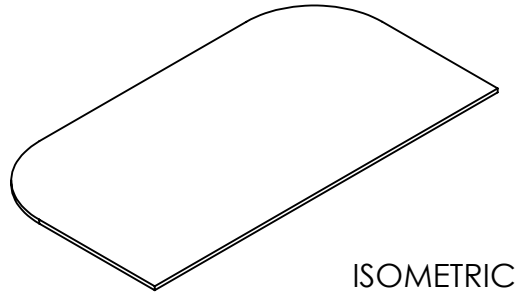


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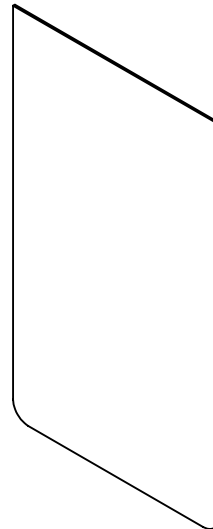
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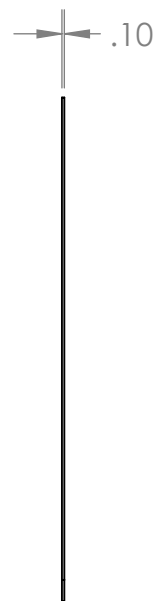
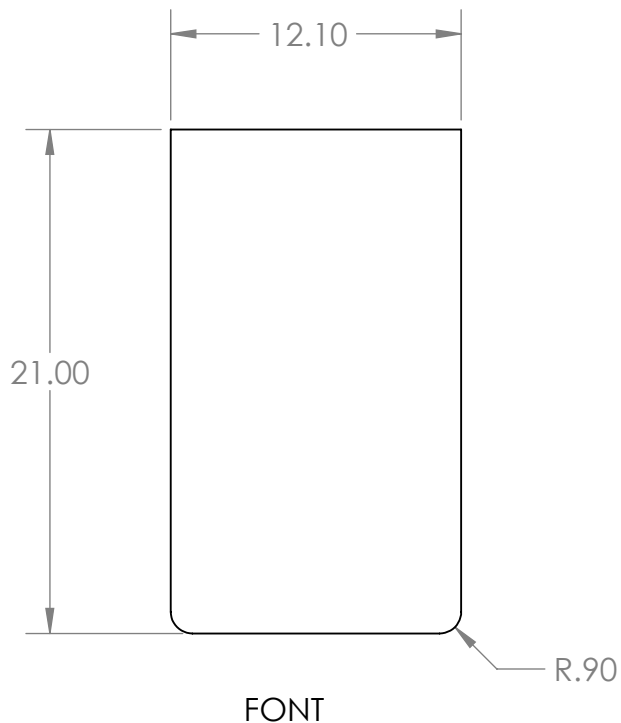


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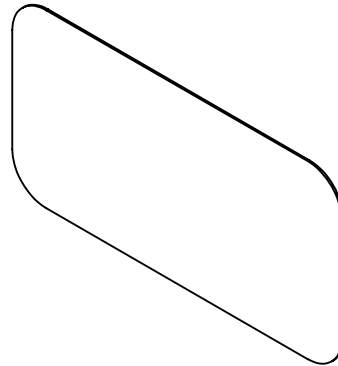


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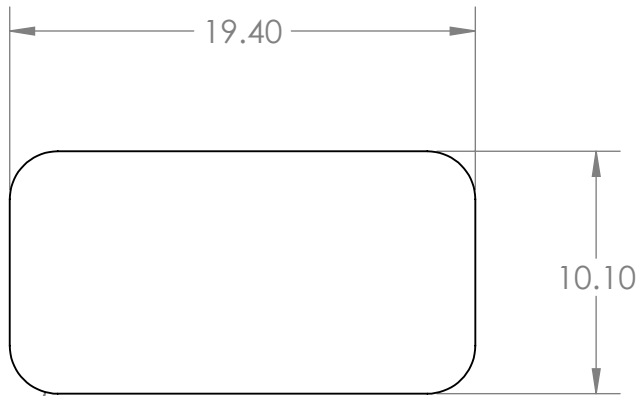


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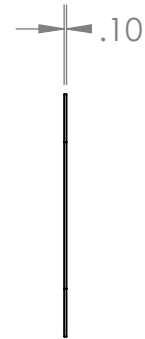
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ISOMETRIC



TOP



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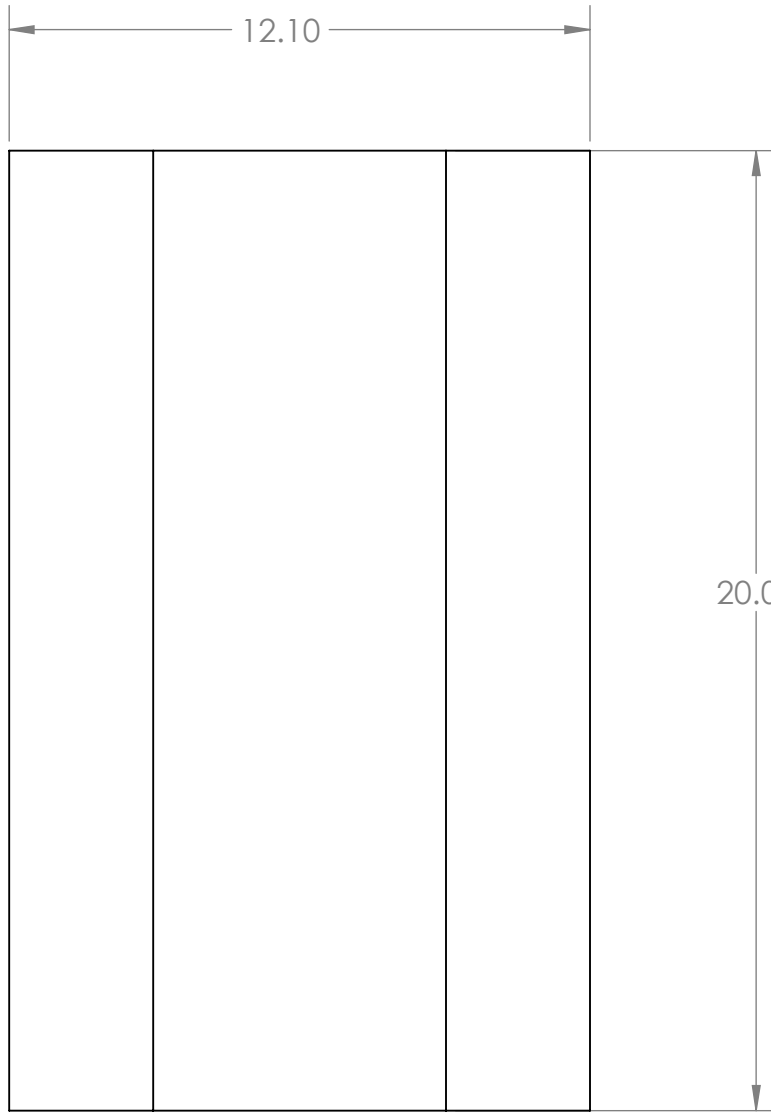
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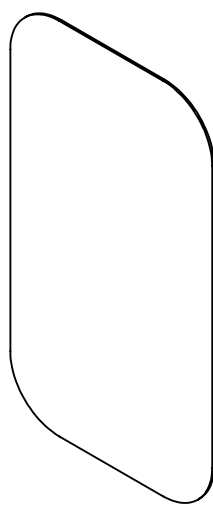
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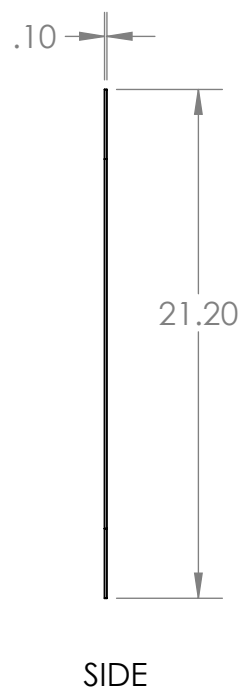
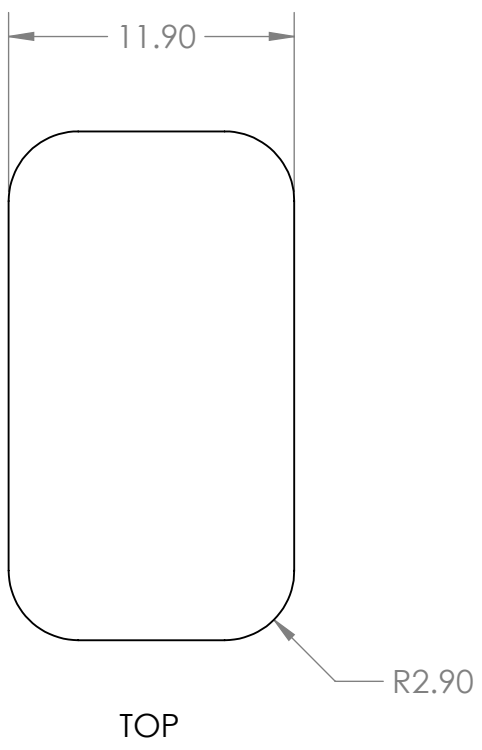
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ISOMETRIC



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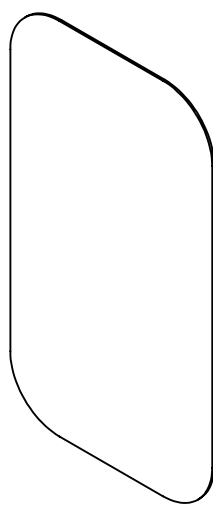
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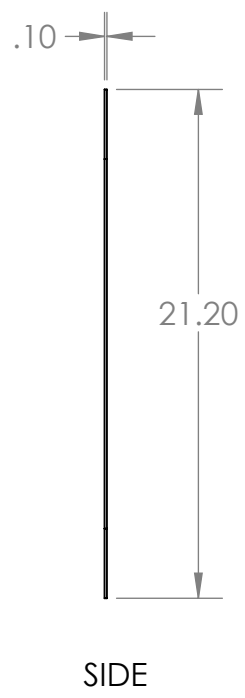
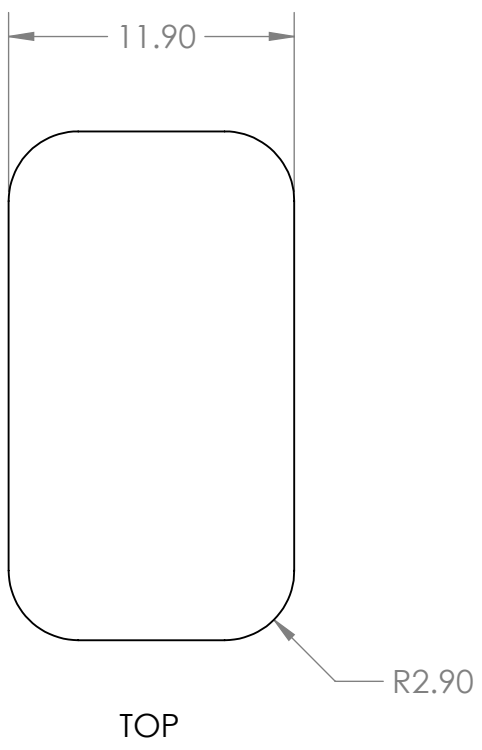
IQP MIRAD LABORATORY

MAIN FLOOR

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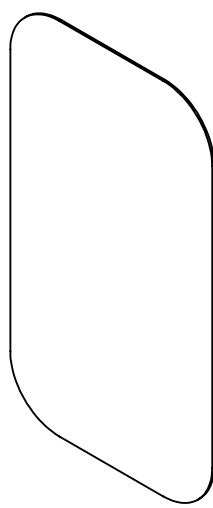
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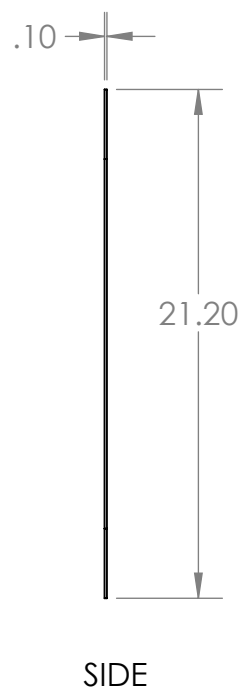
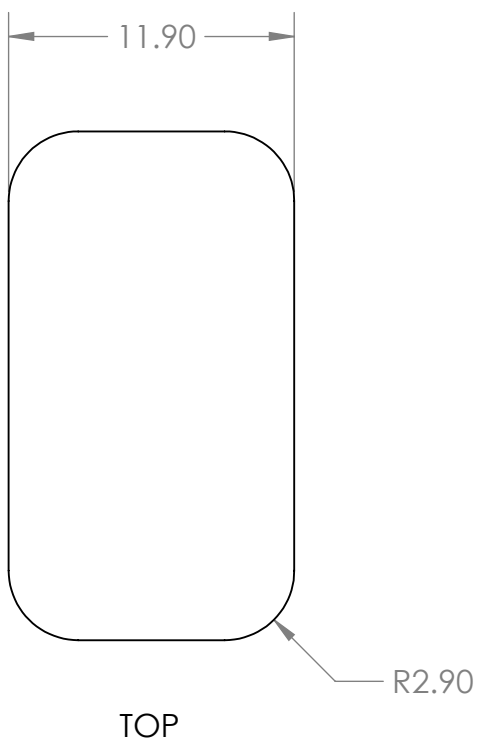
IQP MIRAD LABORATORY

MAIN FLOOR

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SCALE: 1:8	WEIGHT:	SHEET 1 OF 1



ISOMETRIC

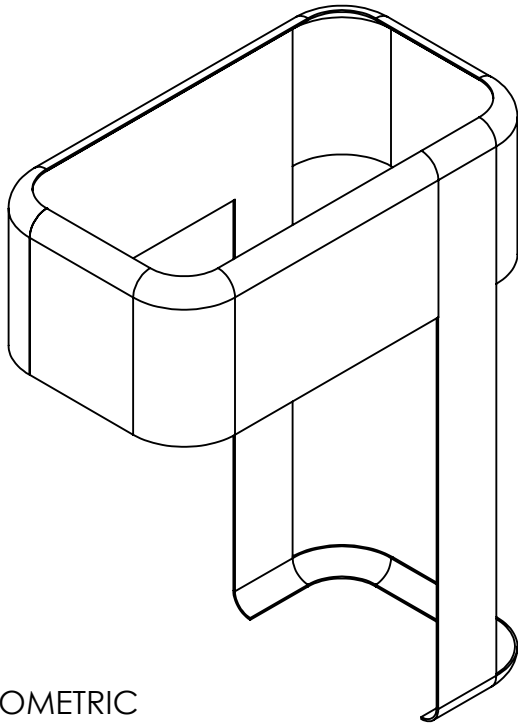


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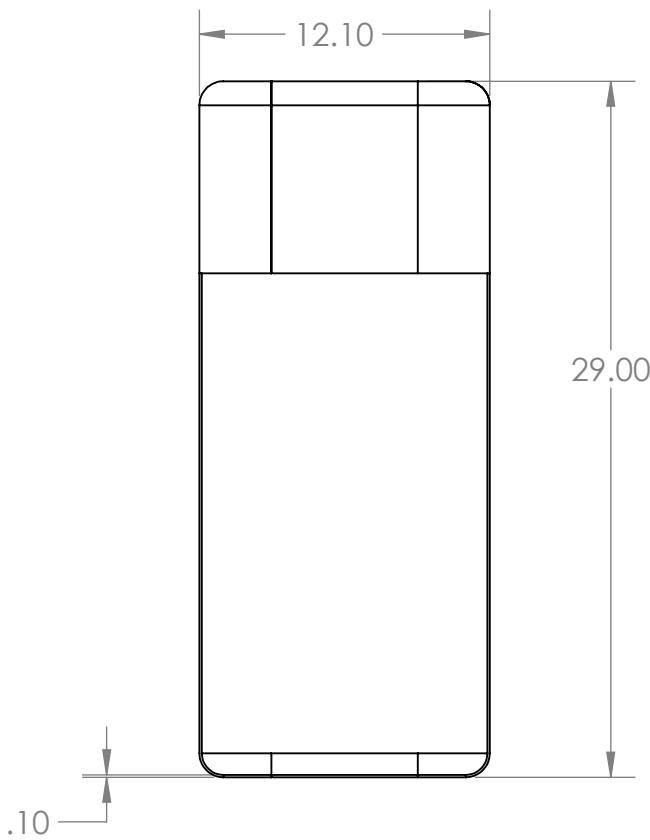
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		MATERIAL POLYPROPYLENE BLOCK COPOLYMER	
NEXT ASSY	USED ON	FINISH	
APPLICATION		DO NOT SCALE DRAWING	

	NAME	DATE
DRAWN	JDJ	3/6/15
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

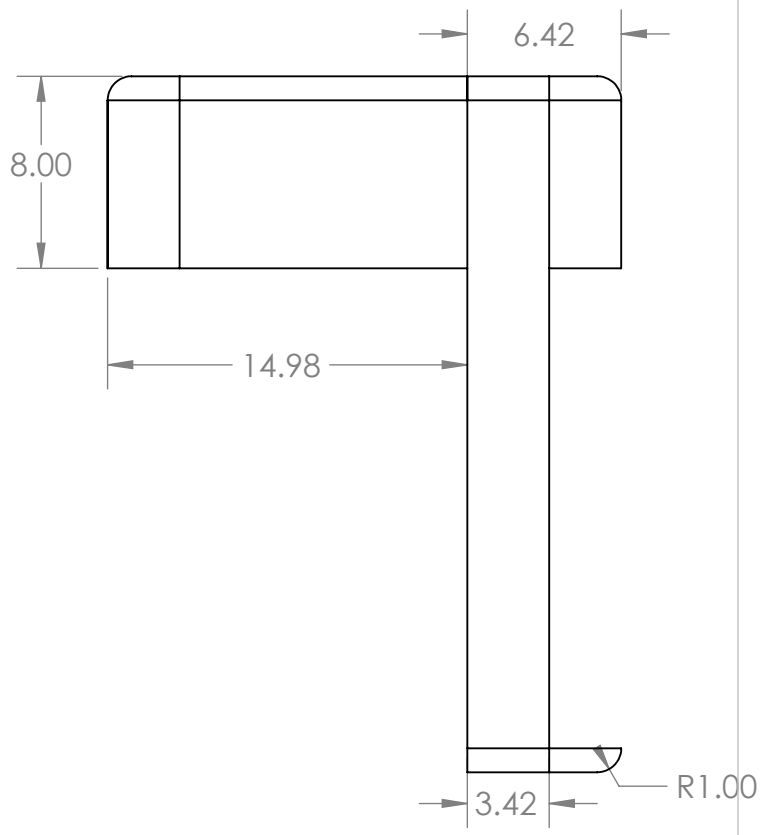
IQP MIRAD LABORATORY		
MAIN FLOOR		
SIZE A	DWG. NO. IQP.15.6	REV.
SCALE:1:8	WEIGHT:	SHEET 1 OF 1



ISOMETRIC



SIDE



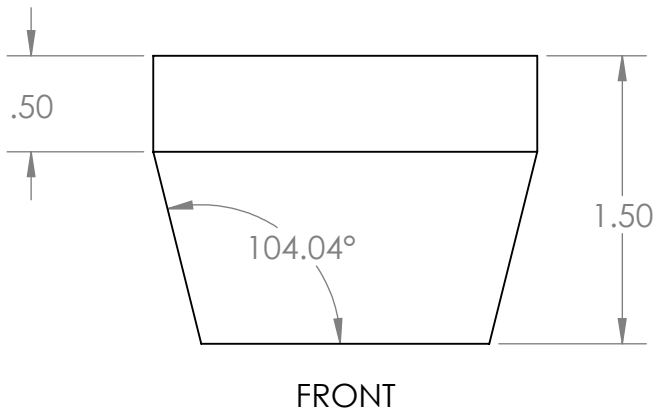
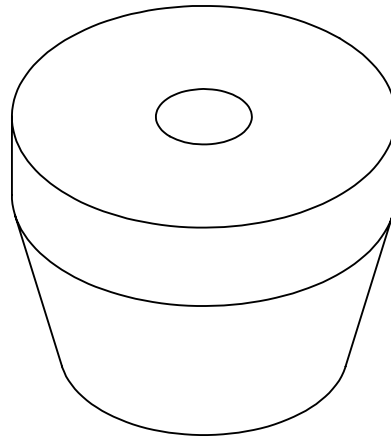
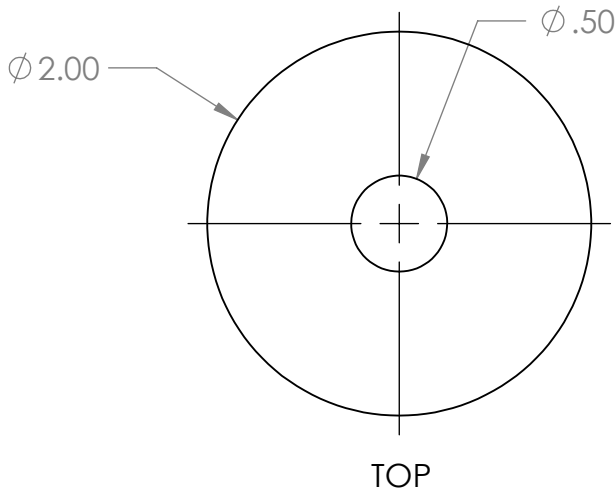
FRONT

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			DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 0.05 ANGULAR: MACH \pm BEND \pm TWO PLACE DECIMAL \pm THREE PLACE DECIMAL \pm
			MATERIAL POLYPROPYLENE BLOCK COPOLYMER
NEXT ASSY	USED ON		FINISH
APPLICATION		DO NOT SCALE DRAWING	

	NAME	DATE
DRAWN	JDJ	3/6/15
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

IQP MRIAD LABORATORY		
FRONT/BACK PANEL		
SIZE	DWG. NO.	REV.
A	IQP.15.15	
SCALE: 1:8	WEIGHT:	SHEET 1 OF 1

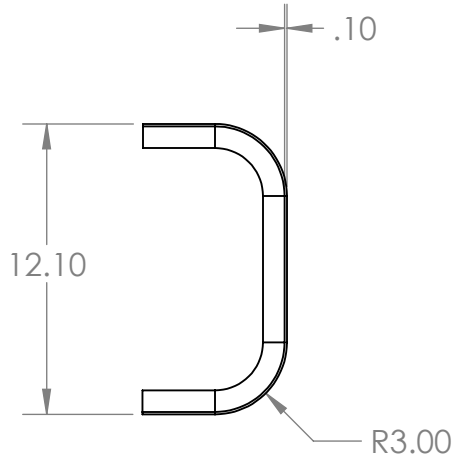


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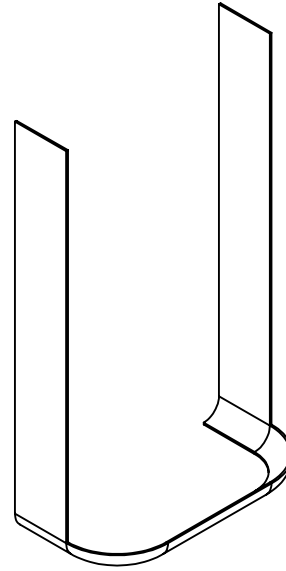
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		MATERIAL RUBBER
NEXT ASSY	USED ON	FINISH
APPLICATION		DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	JDJ	1/27/15
CHECKED		
ENG APPR.	JDJ	1/27/15
MFG APPR.		
Q.A.		
COMMENTS:		

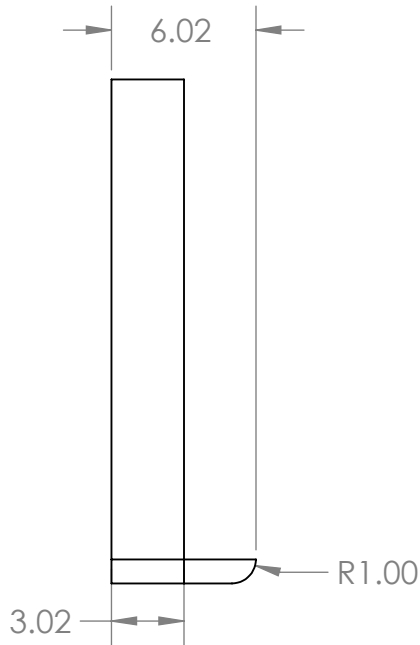
IQP MIRAD LABORATORY		
STAND		
SIZE A	DWG. NO. IQP.15.12	REV.
SCALE: 1:1	WEIGHT:	SHEET 1 OF 1



TOP



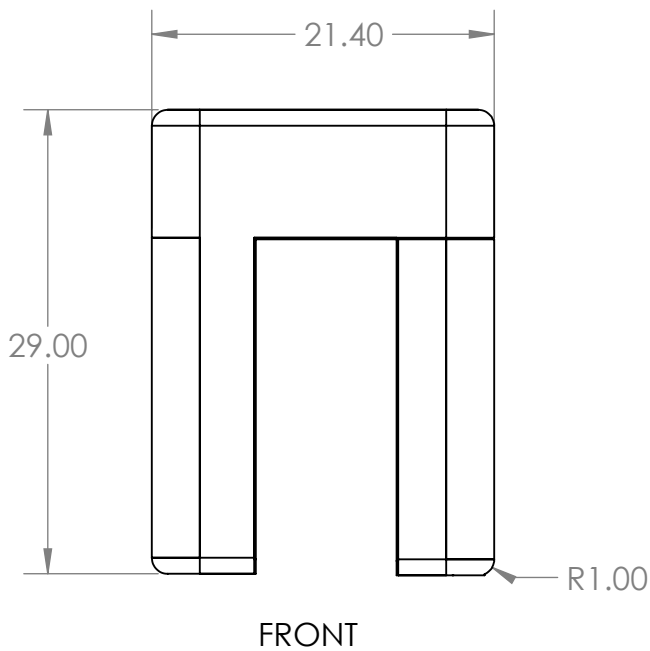
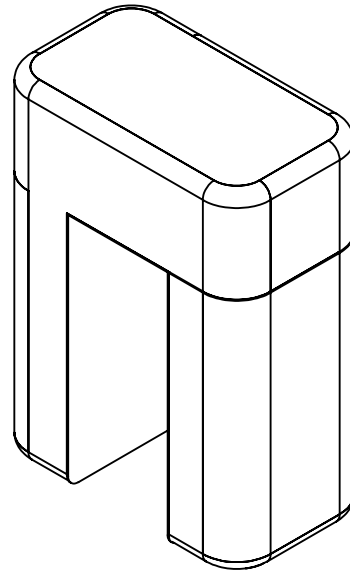
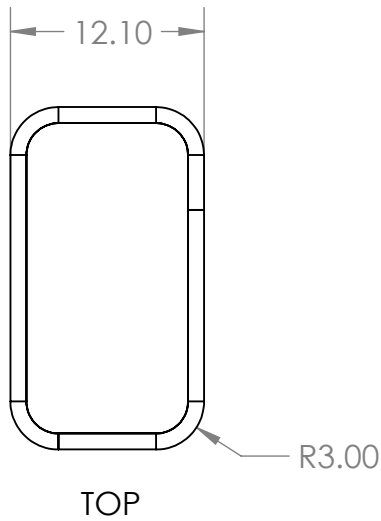
ISOMETRIC



FRONT

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		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 0.05 ANGULAR: MACH \pm BEND \pm TWO PLACE DECIMAL \pm THREE PLACE DECIMAL \pm		NAME	DATE	IQP MIRAL LABORATORY	
		MATERIAL POLYPROPYLENE BLOCK COPOLYMER		DRAWN	JDJ		
		FINISH		CHECKED			FRONT/BACK PANEL 2
NEXT ASSY	USED ON			ENG APPR.			
APPLICATION		DO NOT SCALE DRAWING		MFG APPR.			
				Q.A.			SIZE DWG. NO. REV.
				COMMENTS:			A IQP.15.7
							SCALE:1:8 WEIGHT: SHEET 1 OF 1



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		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 0.05 ANGULAR: MACH \pm BEND \pm TWO PLACE DECIMAL \pm THREE PLACE DECIMAL \pm
		MATERIAL POLYPROPYLENE BLOCK COPOLIMER
NEXT ASSY	USED ON	FINISH
APPLICATION		DO NOT SCALE DRAWING

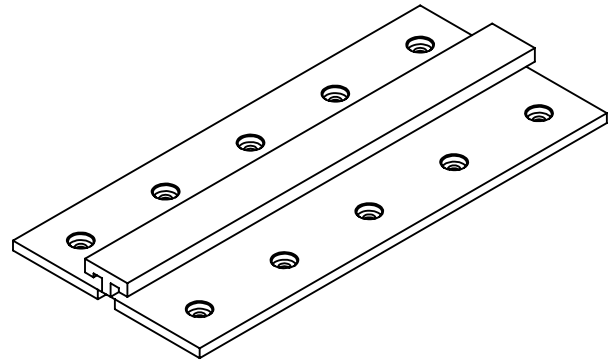
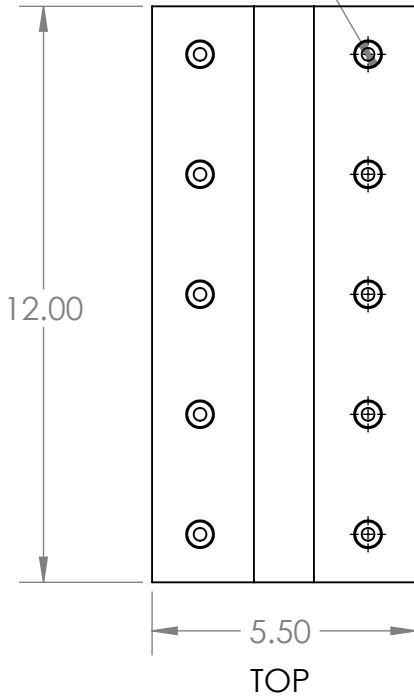
	NAME	DATE
DRAWN	JDJ	3/6/15
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

IQP MIRAD LABORATORY		
EMS BACKPACK		
SIZE	DWG. NO.	REV.
A	IQP.15.13	
SCALE:1:12	WEIGHT: 8.39 IBS	SHEET 1 OF 1

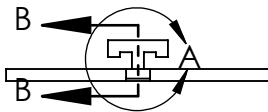
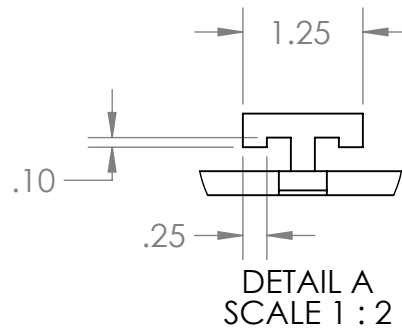
5X ϕ .27 THRU ALL

\square ϕ .53 ∇ .18

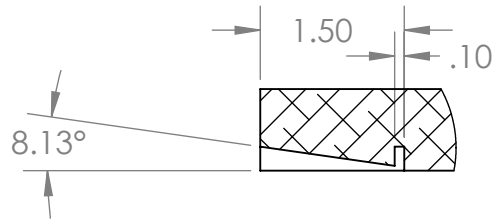
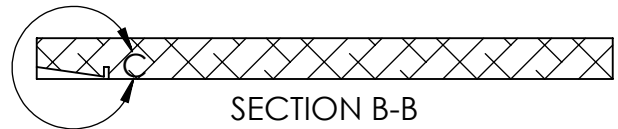
\sphericalangle ϕ .58 X 90°, NEAR SIDE



ISOMETRIC



FRONT



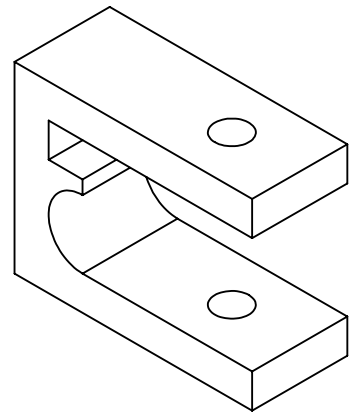
DETAIL C
SCALE 1 : 2

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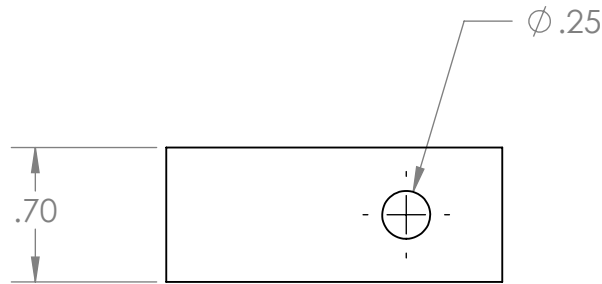
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		MATERIAL ALUMINUM
NEXT ASSY	USED ON	FINISH
APPLICATION		DO NOT SCALE DRAWING

	NAME	DATE
DRAWN	JDJ	3/6/15
CHECKED		
ENG APPR.		
MFG APPR.		
Q.A.		
COMMENTS:		

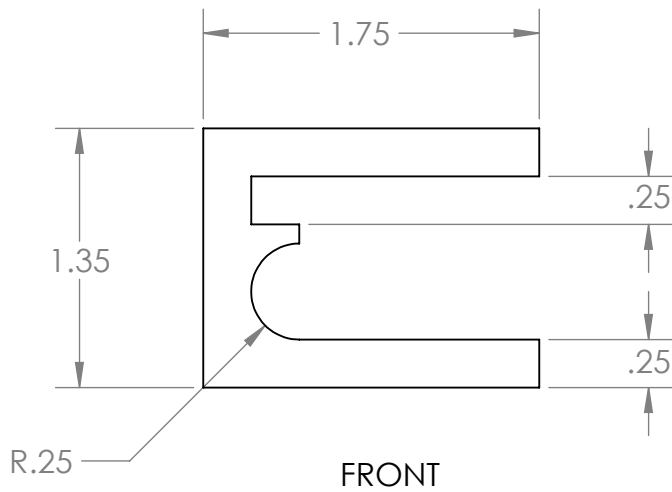
IQP MIRAD LABORATORY		
BIKE FITTING		
SIZE A	DWG. NO. IQP.15.8	REV.
SCALE: 1:4	WEIGHT:	SHEET 1 OF 1



ISOMETRIC



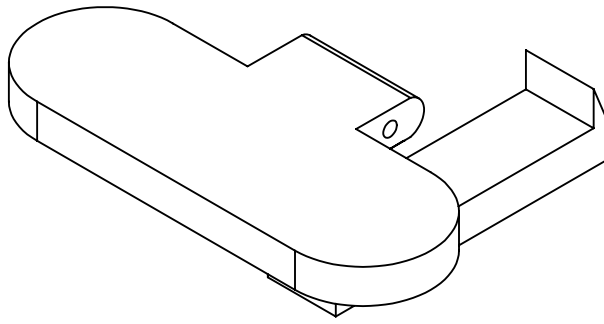
TOP



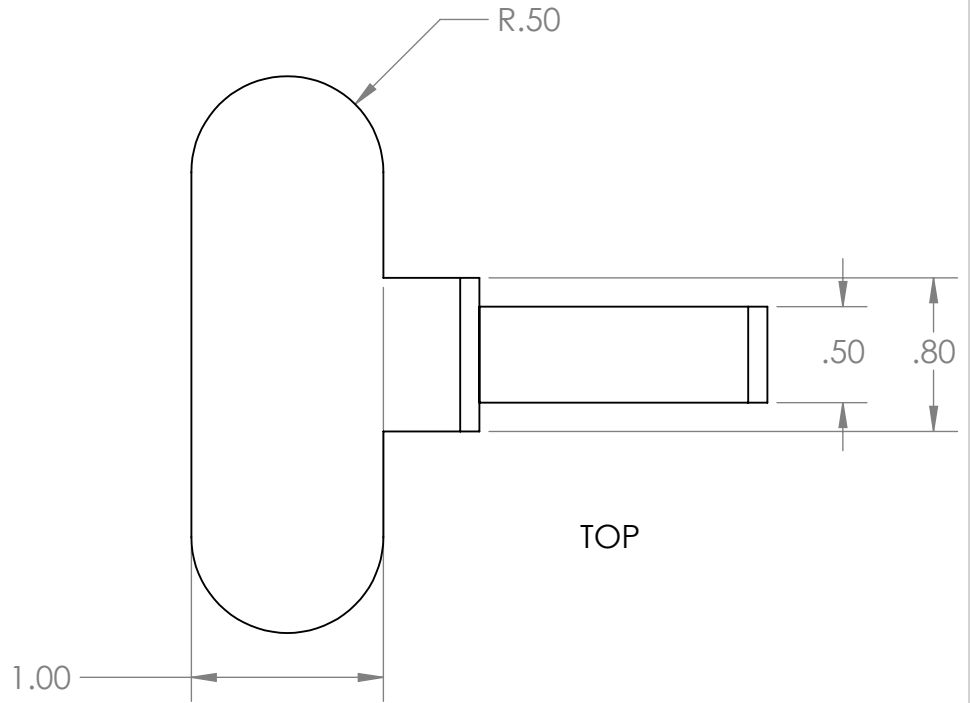
FRONT

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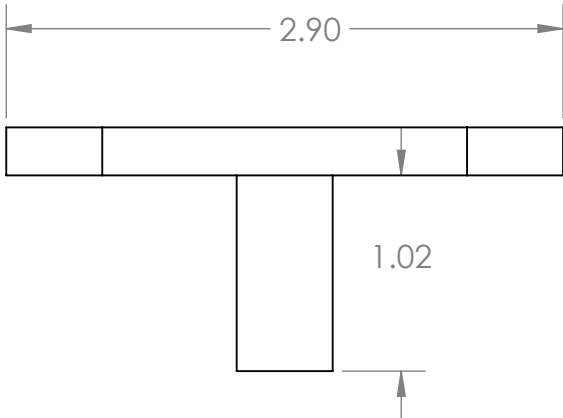
		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±0.05 ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±		NAME	DATE	IQP MIRAD LABORATORY BRACKET		
		MATERIAL	ALUMINUM	DRAWN	JDJ			3/6/15
		FINISH		CHECKED				
NEXT ASSY	USED ON			ENG APPR.				
APPLICATION		DO NOT SCALE DRAWING		MFG APPR.				
				Q.A.				
				COMMENTS:				
				SIZE	DWG. NO.	REV.		
				A	IQP.15.9			
				SCALE:1:1	WEIGHT:	SHEET 1 OF 1		



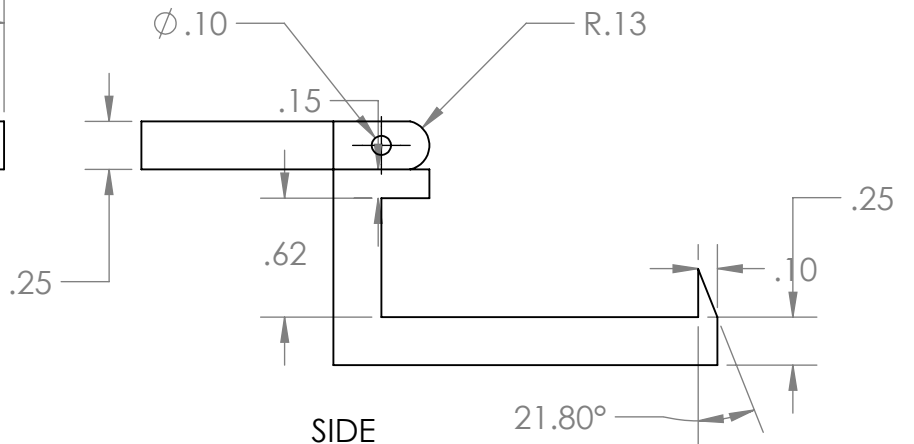
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TOP

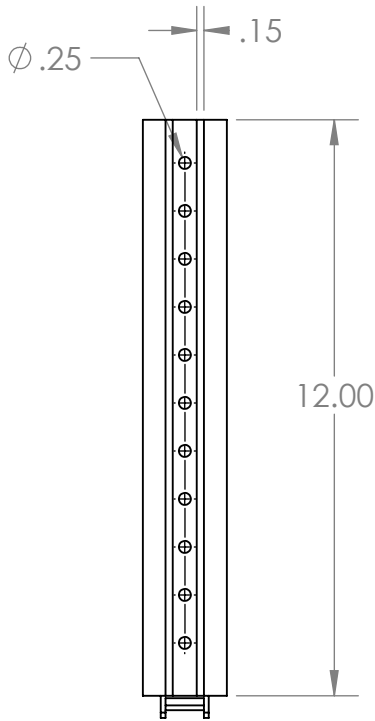


FRONT

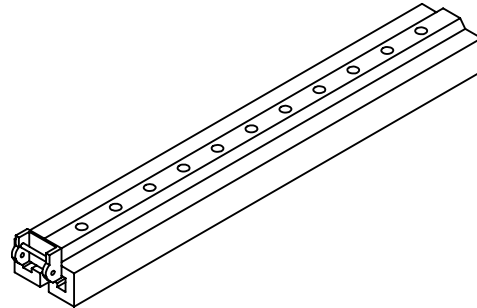


SIDE

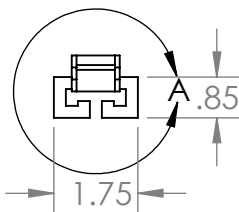
<p>PROPRIETARY AND CONFIDENTIAL THE INFORMATION CONTAINED IN THIS DRAWING IS THE SOLE PROPERTY OF MIRAD LABORATORY. ANY REPRODUCTION IN PART OR AS A WHOLE WITHOUT THE WRITTEN PERMISSION OF MIRAD LABORATORY IS PROHIBITED.</p>			<p>DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ±0.05 ANGULAR: MACH ± BEND ± TWO PLACE DECIMAL ± THREE PLACE DECIMAL ±</p>	NAME	DATE	<p>IQP MIRAD LABORATORY</p> <p>HANDLE</p>
				DRAWN	JDJ 1/27/2015	
				CHECKED		
				ENG APPR.	JDJ 1/27/2015	
				MFG APPR.		
		MATERIAL		Q.A.		<p>SIZE DWG. NO. REV.</p> <p>A IQP.15.10</p>
NEXT ASSY	USED ON	FINISH	COMMENTS:			
APPLICATION		DO NOT SCALE DRAWING				
				SCALE:1:1	WEIGHT:	SHEET 1 OF 1



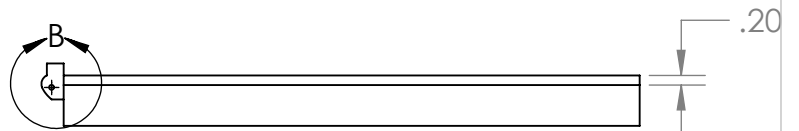
TOP



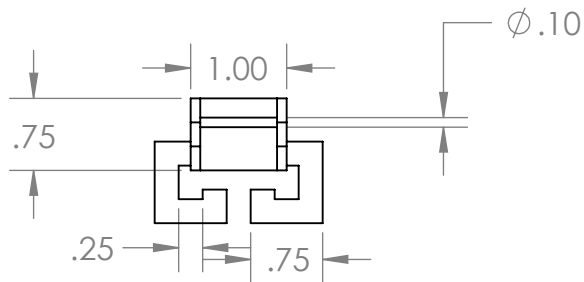
ISOMETRIC



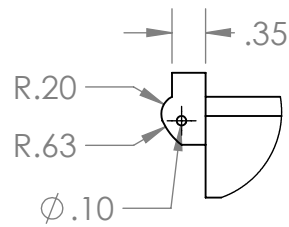
FRONT



SIDE



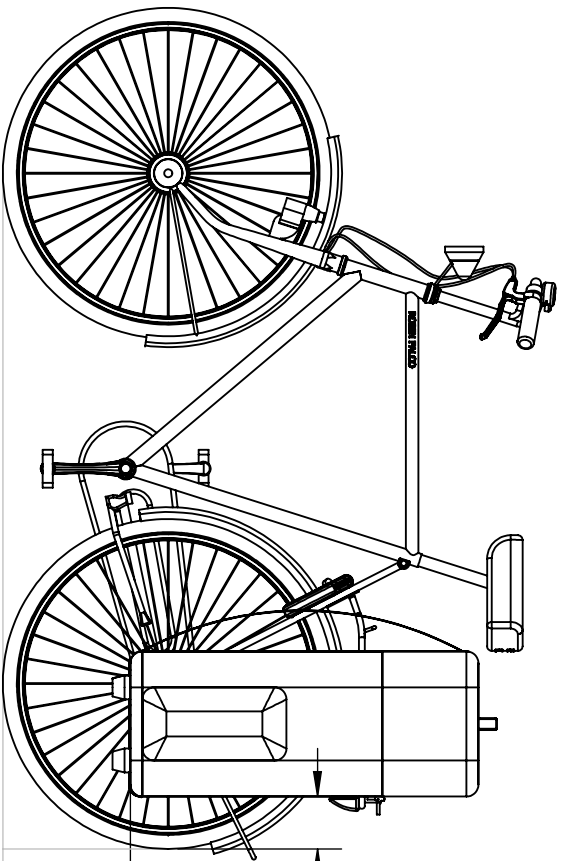
DETAIL A
SCALE 1 : 2



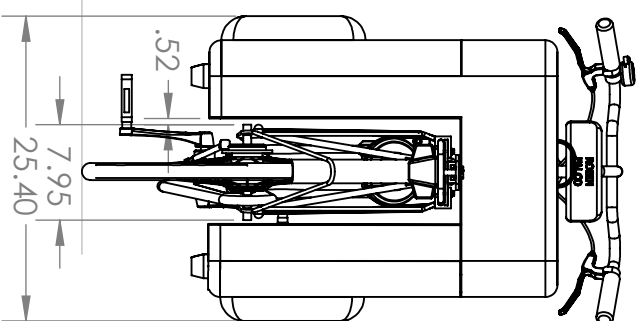
DETAIL B
SCALE 1 : 2

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		DIMENSIONS ARE IN INCHES TOLERANCES: FRACTIONAL ± 0.05 ANGULAR: MACH \pm BEND \pm TWO PLACE DECIMAL \pm THREE PLACE DECIMAL \pm		NAME	DATE	IQP MIRAD LABORATORY		
		MATERIAL	ALUMINUM	DRAWN	JDJ			3/6/15
		FINISH		CHECKED				
NEXT ASSY	USED ON	APPLICATION	DO NOT SCALE DRAWING	ENG APPR.				
				MFG APPR.				
				Q.A.			TOP SLIDER	
				COMMENTS:				
				SIZE	DWG. NO.	REV.		
				A	IQP.15.11			
				SCALE: 1:4	WEIGHT:	SHEET 1 OF 1		



SIDE



BACK

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5

4

3

2

1

UNLESS OTHERWISE SPECIFIED:
 DIMENSIONS ARE IN INCHES
 TOLERANCES:
 FRACTIONAL: +0.05
 ANGULAR: MACH ± BEND ±
 TWO PLACE DECIMAL ±
 THREE PLACE DECIMAL ±

INTERPRET GEOMETRIC
 TOLERANCING PER:
 MATERIAL
 FINISH
 DO NOT SCALE DRAWING

DRAWN NAME JDJ DATE 3/6/15

CHECKED

ENG APPR.

MFG APPR.

Q.A.

COMMENTS:

APPLICATION USED ON

NEXT ASSY

REVISIONS

DATE

BY

IQP MIRAD LABORATORY

TITLE:

BIKE/BACKPACK SYSTEM

SIZE DWG. NO. **A IQP.15.14** REV

SCALE: 1:1.6 WEIGHT: SHEET 1 OF 1