Abstract: The existing med flight helmet is researched and analyzed. Three new unique designs for the medflight helmet are presented and compared. The goal of these designs is to improve the heavy, bulky, military style helmet used currently. The creation of a lightweight helmet that would still protect a helicopter physician or passenger from a head strike, but contains all the necessary functions of the existing helmet is explored.
**Problem Statement:**

The goal of our project is to create a more practical helmet for a med flight physician. The helmet needs to be lighter and more comfortable than the current military grade helmet. Our design platform is based off of a bike helmet with medflight communications gear attached. The communications gear has to be attached in such a way that the microphone is positioned very close to the lips of the physician and the headphones block most of the noise from the helicopter. Two final features are an attachable light that can be used hands free in the helicopter and a mount for a camera used to take video while in flight.

**Product Function:**

The product being produced is a helmet that is worn by physicians, nurses, or other helicopter passengers. The helmet’s main goal is to protect the flight physician in case of a head strike. The helmet is not worn to save the passenger’s life in the event of a crash. It is merely a safety device worn to prevent being knocked out or banging one’s head in the confined helicopter cabin during turbulence or other situations that might result in a head strike. The helmet also serves as a communications device. A helicopter produces extremely loud noise, but the physicians have to talk to each other, the pilots, and in some cases the patient. To facilitate this communication, the helmet comes equipped with tight fitting earphones, an adjustable microphone boom, and connections to hook directly into the helicopter’s sound system. The boom needs to adjust easily so that the microphone can rest close to the user’s lips. The helmet requires a comfortable chin strap to keep it secure on the user’s head. Size adjustability is a concern for future work. Currently the helmet is being designed in one size to meet our client’s needs but
making the helmet adjustable would be a positive addition. Another possible function for the helmet is a light source. The helmet could contain an attachment for a small flashlight or LED so that the physician can see what is being worked on and still retain the use of both hands.

**Background Information:**

The product's function is extremely important for members of the medflight team. Medflight is composed of physicians, nurses, pilots, and dispatchers that are specially trained in transporting patients in emergency situations. This flight service has provided emergency care and transport for victims of crashes and disasters for more than twenty years. The University of Wisconsin's Medflight has three rotating helicopters available at all times. This medflight works in a 225 mile radius around Madison. The helicopters can be in the air within minutes of receiving word of an accident. Many pieces of emergency equipment are carried in flight such as: ventilators, blood pressure monitor, heart monitors, IV equipment, defibrillators, pacemaker equipment, emergency medicine, and medication. During the transportation of a patient, the physician's task is to maintain life and stabilize the person until they arrive at a location where better care or treatment can be provided. Figure 1 illustrates a medflight pilot wearing the currently used helmet.

![Figure 1: Medflight pilot wearing the current helicopter helmet](image-url)
During the research process we consulted a specialist at Oregon Aero named Dan Baxter. Mr. Baxter is an avionics specialist that assists Oregon Aero customers with helmet design and communications related questions. His expertise was helpful throughout the conversation because he was careful to point out the positive and negatives concerning our design ideas. Initially, we briefly prompted him on the objectives of the assignment. He noted that our main concern was not necessarily the total weight, but how we distributed that weight across the surface. Later, we carefully described our design ideas to Mr. Baxter. He recommended that the standard avionics communications equipment would better suite the project because of the significant importance of communications to the client. The standard communications equipment allows the client to still operate comfortably while granting him/her the most efficient communication method of our design ideas. Mr. Baxter was against the idea of the noise-canceling ear phones because of the fact they did not have a microphone attachment. He was quick to describe how adding a separate microphone would create a whole new facet of problems. He noted that although the two-piece combination provided many of the same advantages as the merged bike helmet in terms of communication, the two-piece combination lacked the robust design that the client might prefer given the accessories considered to be included along with the helmet. As an employee of Oregon Aero, Mr. Baxter is part of one of the leading retailers of avionics equipment in North America. His experience and cooperation, along with the company allowing us to speak with him, was greatly appreciated during the research process. Our conversation with him brought us closer to being able to clearly distinguish many of the advantages and disadvantages that went along with our design ideas. This resource broke down the communications process
and made it simpler for us to understand and realize some of the most important factors to consider when designing the helmet: efficient use of space, compatible electronics equipment, and comfort.

Materials and Methods:

Our client provided communications gear and let us examine several different types of helmets. The team purchased a helmet from Dick’s Sporting Goods, and has been using that when designing alternative solutions. Research of existing helmets has lead to an understanding of the needed improvements. Our methods include brainstorming our client’s needs and creating unique designs to meet them. Physical implementation of the designs has not yet taken place so our materials are limited.

Management Planning:

We believe that we can accomplish most, if not all, of the fabrication ourselves. We estimate that it will take approximately 20 hours to find a suitable method of attachment for the communications gear and then to execute that plan. A typical headset that we would normally need to purchase costs around 250 dollars; however, our client has provided us with one of their headsets that we can use on our prototype. The helmet that we have chosen to use is just a basic bike helmet that costs approximately 30 dollars and can be purchased at any sporting goods or bike store. The total material cost will be between 280 and 320 dollars depending upon the cost of the materials used to attach the communications gear to the helmet.

Ethical Considerations:

Currently, there are no regulations for flight physicians regarding safety gear. In fact, some medflight workers currently choose not to wear helicopter helmets, opting to
simply wear a communications headset. It is our responsibility to produce a comfortable helmet that will protect the head from injury in the event of a head strike. To compromise the effectiveness of the helmet would be to compromise the safety of our client. Thus it is imperative that we are sure our helmet is reliable and will always be in operable condition. The safety of the client must be considered the primary goal of the design. It is also important that our helmet contains working, reliable communications gear so that in case of emergency the physician is not limited in caring for the patient. Together, these two systems must work flawlessly at all times for the design to be considered a success. The helmet is not bounded by any other constraints or conditions other than protecting the head against mild head-strikes.

**Design 1: The Ultra Light**

The Ultra Light design consists of a bike helmet, noise canceling ear buds, and alternative mount for the boom and mic. The ear buds will be part of the helmet, coming out of the helmet just above the ear. The length of the wire that comes out of the helmet will be adjustable to adapt for each user’s needs. The wire will exit the helmet in the back of the head and have enough slack so that it can easily reach the communication boxes. By having a rear exiting wire we can increase the ease of use experienced by the user; entanglements can further be avoided by designing the wire such that the slack recoils much like a telephone cord. The difficulty in the design will be in merging the microphone with the earplugs and making it an operable com-set.

A main advantage of the Ultra Light design is that it optimizes the use of new technology in the product. Also, it will be extremely light because of the small ear bud headphones, which is an important concern of our client, and a drastic change over the
heavy military grade helmets currently used. These state of the art headphones also take advantage of noise cancellation technology. In a helicopter this is extremely important for communication purposes and even more so because of the necessity to talk to another physician on board. A final advantage is that the headphones are extremely comfortable and fit snugly inside the ear, held tightly by ear clips.

Although the technology makes this design very appealing, there are still some major difficulties to overcome. First, the attachment of the microphone boom to the ear buds creates an issue. Not only do we have to be concerned with the weight and stability of the boom but also the ability to maneuver the microphone. A related difficulty is the issue of combining the electronics of the ear bud headphones with the microphone. These should not only be compatible with each other, but also have to be adapted to fit the helicopter communications equipment. A final issue is the increased cost of this design. Because of the technology invested in the noise canceling headphones and the purchase of the boom and microphone separately, the cost increases dramatically. As is the case in most designs it is disadvantageous to increase the cost of a product beyond what might be within the acceptable limits of our client.

**Design 2: Two Piece Compatible**

The second design under consideration has been named the two piece compatible system. As the name suggest, this design consists of two pieces: the helmet and the communications gear. In this system the user would wear the existing communications headset shown in figure 2.
An adapted helmet is then fitted directly over the headset. The communications gear used consists of the current headphone and microphone set used by medflight, with the possibility of a LED or Maglite flashlight attachment. The helmet would be a modified version of a skateboarding/rock climbing helmet currently available at local sport equipment retailers. To make the design fit in a comfortable fashion, the helmet’s interior padding would be cut away, and an elevated ridge inserted from ear to ear to make room for the communications headband and wiring that would be located underneath it. This would allow the communications headband to slide into a niche in the helmet and allow a comfortable and secure fit. Figure 3 shows a basic drawing of the helmet with an elevated ridge in it.
This system has many advantages pertaining to the simplistic design. Due to the two piece design, the helmet can be taken apart from the communications gear. This would allow the user to remove his/her helmet while keeping the communications gear active, which could prove to be useful in situations where the helmet was interfering with the surroundings. Also, present day communication gear would be used for this design, thus making the transition between communication gear avoidable. The helmet also would allow for the advance in communication equipment to transition smoothly. If an alternative headset was to be incorporated into the design, only the dimensions of the niche created would have to be changed.

The two piece compatible design contains a few disadvantages also. The largest disadvantage is due to the option of the helmet in the design. Part of the problem with the helmets at present is many people are not wearing them because they are inconvenient. Because the helmets are bulky, wearing one is seen as a negative by many people. This design allows the user the option to wear the helmet, which could lead to many people not wearing the helmet and just using the communications gear. Another disadvantage of the two piece compatible system is the niche created in the helmet padding. This niche could reduce the efficiency and/or comfort of the helmet. The ridge, especially near the temples where the communication band would be located, could grind into the clients head and cause discomfort over long periods of time.

**Design 3: Merged Bike Helmet**

One of the solutions to this problem is to merge the existing communications gear to a lighter, more practical helmet. Our design platform is a smooth surfaced bike helmet, and our goal is to reattach the earpieces from the headset to the helmet, creating one
cohesive piece. The basic concept of attaching the earphones to each side of the helmet is illustrated in figure 4.

Figure 4: Basic diagram showing that the individual earphones are attached to each side of the helmet in the Merged Bike Helmet design.

Although this process sounds simple, there are a few difficult problems that must be addressed in order to create a good working model. First and foremost is the mechanics of the attachment to the helmet in order to create a tight clamping force around the ear. One of our solutions to this problem was to create an external adjusting screw that attaches to the helmet via a small hinge. The user would be able to manually tighten the earphones to the head after the helmet has been put on, creating a virtually sound proof environment. Another way of accomplishing this task would be to use a small spring force that attaches to from a hinge to the inside of the helmet in order to hold the earphones tight. An advantage of this design is that is requires no manual adjustment and works much like the headphones without the helmet.

One of the main advantages of this helmet design is that it uses existing communications gear and requires no electronic merging to be compatible. This is an important advantage not only because it effectively eliminates
potential obstacles but also because it is cost effective. Although this design has many advantages, it also has some shortcomings.

One of the main issues with this design is the actual attachment and accurate sizing to create a comfortable fit for our client. Overcoming this obstacle will require that we consult an ergonomics or mechanics specialist. Another disadvantage is finding a way to rewire the communications system through the helmet. This could be done easily with some helmets that have removable interior padding by running the wire along the inside surface of the helmet shell.

**Discussion & Results:**

Initially, the helmet project began as a clutter of ideas and group planning. The objective was fundamental: find a way to make better use of space and material in order to increase comfort and its effectiveness. The previous helmet is easily characterized as being bulky. From any angle, it appears to be ineffective for the type of work environment that our client works under.

The helmet is primarily going to protect the client in the case that his head strikes another object. It is not a life saving device, but primarily a method of light protection that enables the client to operate more efficiently than in the case of the previous helmet. But while our helmet was primarily designed to be less bulky and thus more efficient, the great debate was over how to make use of the accessories that would assist our client.

At the time, the client had not adapted a method for mounting a flash light that did not include his mouth. His other accessories were either taped or attached to the frame of the helmet. His previous helmet was not adapted to include any accessories to aid the
client. We decided that it was imperative to include more efficient plans for several accessories (i.e. light, microphone, etc.) into the discussion. When choosing accessories, we are looking to increase the efficiency with which our client can perform his job.

After reviewing the needs of our client we were able to come up with seven criteria with which we would evaluate each of the three designs.

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Together, these factors combined to help us make our final decision. These factors were considered equally when making decisions regarding what direction to take with the helmet. We will briefly discuss how these factors influenced our decision.

The protection issue was never a matter of how the helmet would perform in the instance of a crash but rather how susceptible it was to the wear and tear that came with everyday flight operation. Although each design will utilize the same helmet, the Ultra Light and Merged Bike Helmet designs received higher scores than the Two Piece Compatible in the protection category because the user of the Two Piece Compatible has the opportunity to choose to simply wear the communications gear alone without the helmet. Conversely, the Ultra Light and Merged Bike Helmet designs do not afford the opportunity for the user to choose to not wear protection. It is for this reason that the Two Piece Compatible design received a lower score in the protection category than the other designs.

Communications Quality was essential to the decision making process because it was one of the main goals of the project along with improving the bulky nature of the helmet. In this case, the Two-Piece design was the best solution. From a communications aspect, the idea was stable and required no risk or educated guesses. The Merged Bike Helmet was merely a design that was crafted out of molding the Two-Piece into one. When doing this it is necessary to remove the bridge between the two earphones which may result in the earphones not fitting as tightly to the head of the user. With the Ultra Light, we were unsure how we would even make a microphone piece work since the ear buds do not possess a practical surface for mounting a mic boom.
Since the main idea for the flight helmet stemmed from how hard it was to operate in unfavorable conditions and remain comfortable during long periods of flight, this was a crucial step of the process. The Ultra Light was the obvious choice because it was light and easiest to wear in hot or humid conditions because it lacked any bulky accessories. The Merged Bike Helmet was not far behind because the one-piece design was sleek and effective while still granting above average ventilation and relief from the heat. Clearly, the bike helmet made it so that each design was far better than the present helmet in terms of ventilation and overall comfort.

In the formulation of each design it was important to keep cost to a minimum. Luckily, some materials were already given to us allowing us greater flexibility with some designs. Cost was one of the main reasons the Ultra Light design fell out of question, because the communication gear and overall implementation could prove to be expensive with the purchase of noise canceling ear buds. How the communications gear would operate in the helicopter was a huge risk and outweighed the cost that went along with the design. Having the communications gear already in hand without having to spend a significant amount of money made it more practical for us to attempt the Two-Piece and Merged Bike designs. This was an incentive because it may allow us to use our resources to accomplish some of the added objectives, a light and camera mount.

Ease of Implementation and Ease of Use were the last factors we considered when the group some of the last individual design constraints and factors figured out. The Two-Piece was the easiest to implement because it required no preparation or construction. But the Merged Bike Helmet was intriguing because it granted use almost the same product as the Two-Piece along with a sleek design. The Ultra Light was easy to use, but with the
added cost and increased difficulty without a significant pay off in the end there was little
incentive to choose it over the other designs. We could not decide how the microphone
would be constructed and perform under the conditions of the current ear buds and it is
for these reasons that it received a lower score than the other designs.

We came up with a decision that was a collaboration of all of these factors and
accomplished the primary objectives of the project: communication, protection, comfort
and lightweight. The designs were crafted out a bike-helmet design to perform a much
different function. Despite this, every one of the designs seemed geared to be more
effective than present military-style helmets. In the end, the group knew that the best
product was going to come from the design that was the best reflection of the factors
described.
References

Abernathy, Mike. Personal Interview. 11 Sept. 2005


   http://courses engr.wisc.edu/ecow/get/bme/200/webster/courseinfo/.


Product Design Specification

Medflight Helmet

September 14, 2005

Team Members:

Patrick Schenk  Team Leader
Brett Mulawka   Communications
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Mike Oldenburg  BSAC
Richard (Joe) Long Assistant Leader

Function:

The primary function is to develop and produce a more ergonomically acceptable helmet for use by Medflight personnel on medical rescue helicopters. The design must be more compact, less bulky and more tolerable in unfavorable conditions than the present helmets in use today. The current flight helmets features are designed for military use and unnecessary for most Medflight situations. The new design will consist of a modified standard bike helmet equipped with standard communications gear that is able to withstand mild head-strikes that may occur while in flight and grant Medflight personnel greater mobility and comfort during field operation.

Client Requirements:

- Lightweight
- Compact
- Equipped with communications gear
- Durable and comfortable (Helmet and Chinstrap)
- It must be able to withstand mild head strikes
- Able to mount a small camera and LED light
- Tolerable in uncomfortable conditions (i.e. rain, heat)

**Design Requirements:**

1) Physical and Operational Characteristics

   a. *Performance Requirements:* Able to withstand mild head strikes, maneuverable, ventilated to alleviate uncomfortable high temperatures and perspiration during flight.

   b. *Safety:* The helmet must provide adequate head protection.

   c. *Accuracy and Reliability:* Its needs to be dependable under many different conditions the operator might experience during operation.

   d. *Life in Service:* The device should last 25 years depending on how it is treated by the owner and the conditions it was used in.

   e. *Shelf Life:* The shelf life will be extremely long considering the only way it will deteriorate is through extensive and heavy use.

   f. *Operating Environment:* Since Medflight operation takes place year round, the device will be able to endure a variety of weather conditions experienced during field operation throughout the year.
g. **Ergonomics:** The device will be able to withstand normal effects of Medflight operation. The device will be built so that no reasonable force should damage it while still being comfortable for the user.

h. **Size:** Our design will be an extra large to accommodate our clients needs.

i. **Weight:** The final weight of the helmet with its components should be less than 4 pounds.

j. **Materials:** There are no material requirements or restrictions.

k. **Aesthetics, Appearance, and Finish:** Smooth texture on the surface of the helmet, equipped with several attachable features. The device will be pleasing to the eye.

2) **Production Characteristics**

   a. **Quantity:** 1, with the ability to produce more in the future.

   b. **Target Product Cost:** Yet to be determined, likely to include costs of helmet, communications gear and other requested accessories.

3) **Miscellaneous**

   a. **Standards and Specifications:** None.

   b. **Customer:** Dislikes large, bulky military grade helmets that are susceptible to adverse weather conditions and prefers a more practical, lightweight, and easy to use product.

   c. **Patient-related concerns:** Prevent injuries from head strikes that can occur.
d. *Competition:* Other Helicopter Helmet Manufacturers, Oregon Aero (retailer), US Military.