**STEM SCRIPT - CODE BLUE**

**INTRODUCTION - *STEPHEN ANDERSON***

I want everyone here to think back to your morning today. It probably went by in a haze of sorts, an unconscious, routine part of the day. It started with an alarm. You pushed off your cozy, warm blanket and slipped, groaning, from the soft caress of your bed. Outside, it’s below freezing, and maybe you find it a tad chilly in your house. With a flick of the thermostat you solve that problem. The house will take an *agonizing* fifteen minutes to warm up, so you escape into the heat of a steaming shower. Done washing up, you stay under the pleasant stream of hot water just for a few extra minutes. Next, you dress yourself. Choosing from among a hundred potential outfit combinations is truly a hassle. Eventually, you make up your mind and make sure to have plenty of layers because it’s cold out there. You brush your teeth and comb your hair. While you eat a hearty breakfast, you turn on the tube to catch up on the news and remotely start your car to warm up the engine. You head out to the Chester County STEM Competition, inside your car frigid at first, but a heater blasting and heated seats mean you are toasty by the time you’re on the highway. A typical morning...Routine. Inconsequential. Forgettable.

Now imagine you’re homeless. How would your morning be changed? No heated seats, no car at all. Probably no breakfast, your stomach growling from the missed meal. No T.V. No toothbrush, no comb. A single set of dirty, wet, insufficient clothes, covered in your cold sweat, in dirt and grime. You haven’t *seen* a shower in days, let alone felt that hot stream of cleansing water. No roof over your head. No house to warm up. Your bed is the ground. Frozen. Hard. Painful. A morning you wish you could forget, like we all barely remember our mornings today, but you can’t forget. Never will

Homelessness. It’s a *human* problem. Our project aims to help people in this unfortunate state of life in a real and important way. In an attempt to help homeless in harsh winter conditions, we have constructed a weather monitoring and GPS device integrated into a versatile cart. Our hope is that this system, in conjunction with homeless shelters and law enforcement personnel, can speed the process of locating homeless persons before the weather can pose a serious risk. Ultimately, it is about preventing suffering and maybe even saving lives.

**ADDRESSING COMMUNITY NEEDS/REAL WORLD PROBLEM (Matt)**

There’s no question that homelessness is a problem not only in Chester County, but in our entire state as well. By addressing this complex issue, we aim to reduce the risk for homeless men, women and children in cold weather. We hope to bring them out of the cold and into warm shelters across the county, across the state. In doing so, as Steve mentioned, we intend to help those who are struggling in their life. By providing them with a warm place and a sense of security, their lives will be changed for the better. Also, we aim to improve the code blue program by providing effective means of reaching out to the homeless. In doing so, we are promoting health awareness as well as community outreach.

**PENNSYLVANIA HOMELESS STATISTICS (Angela)**

Homelessness is an increasing problem across the United States and in Pennsylvania. In fact, over *16,000* Pennsylvanians are known to be homeless on any given day. In addition to this, school districts in our state serve around *13,000* *children* without homes. The city of Philadelphia has one of the highest poverty rates in the entire nation, 27%. This fact results in a high population of homeless persons in the city. Over 650 people are said to be homeless at any moment in Philadelphia. Overall, Pennsylvania is ranked 28th for the number of homeless persons out of all the states in the nation, with 120 out of every 100,000 people being without homes. With the consideration of our harsh winters in Pennsylvania, we should be *concerned* by these statistics and the health risks that come with being left outside in the cold.

**THE BASICS: HOMELESS IN THE COLD (HEALTH RISKS) (Andrew)**

Winters in Pennsylvania are cold. The outside temperature in our area regularly drops below 32 degrees Fahrenheit between December and March. Below freezing temperatures combined with precipitation can pose a serious risk to the health and safety of individuals outside. Exposed and lacking optimal clothing for cold and wet conditions, homeless persons are caught in a threatening situation.

The most common health risk in cold weather is hypothermia, the lowering of a person’s body temperature below 95 degrees Fahrenheit. Heat escapes from a person’s body through a number of pathways, including direct contact with cold surfaces, wind breaking the warm barrier over the skin, and wet clothes losing their insulative properties. Hypothermia is accompanied by frostbite, and can lead to irreparable damage to organs or even death if left untreated. Survivors of long term exposure frequently lose limbs, fingers, and toes.

Normally associated with hot and dry conditions, dehydration is actually a threat in cold weather. Trudging through snow requires considerable exertion and can make people sweat, causing them to become colder and lose water from their bodies. Our device will allow shelter personnel to quickly locate and retrieve persons at risk of or suffering from these conditions, and bring them to shelters where they can be treated and taken care of for the duration of the inclement weather.

**PRECEDENT- CODE BLUE INITIATIVE (Conor)**

Any truly effective device created utilizing STEM skills must operate within the existingsystems of a community, not against them. Our device is a prime example. Throughout the country, an alert known as Code Blue exists to help all homeless in harsh weather conditions. This system connects local authorities to homeless intake programs and shelters in an attempt to reduce the suffering of the homeless during winter weather. The alert is issued by the Office of Supportive Housing (OSH) which is then assisted by the Department of Behavioral Health (DBH). The Office of Court Compliance (OCC) then works to alert those in charge of finding the homeless and reports the locations of shelters where the homeless may stay. As you can see, this is a very involved process and facilitating communication in any way can provide a potentially enormous benefit. Our device does just that.

So what conditions does this program encompass? A Code Blue can occur only from December to March. This alert is announced when the National Weather Bureau predicts below freezing temperatures or wind chills less than 20°F. Obviously such conditions pose a serious threat to anyone without a home.

An alert not as severe as a Code Blue is a Code Grey. This can be issued in conditions such as high winds, heavy rain, or frozen precipitation when the temperature is above 32°F.

We saw the Code Blue initiative as an existing system we could work to enhance. By building a simple, yet effective and practical device, we aimed to strengthen communication in this program. With our device, a Code Blue alert can be issued and carried out more efficiently so more homeless can be helped.

**BLACK BOX FEATURES/DEMONSTRATION (Matt)**

Building the prototype device was not easy; each part required extensive hours of coding and research. Included in your binders today are copies of our code used during this project. One main component to our prototype is the **Adafruit GPS module**. This inexpensive module provides us with the ability to store GPS coordinates as variables and send them to our data collection server. Utilizing a **Python TCP server**, which is an internet hosted service on our local computer, allows us to “talk” to our device. (tell judges to view code in binder). The prototype device sends our coordinates to this server so that it can be stored in a database. The database is written in MySQL language (again, accessible in your binder). Then, a content management system called **Plone** retrieves the coordinates and uses **Google Maps API** to implement the coordinates into a real time map. This provides us with an easy, visual guide for locating the device. Not only can social services view this map, but police personnel can as well. Our **Content Management System Plone** allows anybody who has the secure access login to view the locations of the devices. At this point, we would like to demonstrate our visual guide from the perspective of someone accessing Google Maps.

**Demonstration**

(I will turn on device and Andrew goes to judges, showing them the circuit). (I will talk while I bring up the arduino and map). (After I explain the map and all, we will resume the powerpoint presentation).

Our prototype is also equipped with a **DHT11 temperature sensor**. This sensor is both a working barometer and thermometer. For the purpose of our prototype, only the thermometer is used in our Arduino program to automatically detect the temperature of the surroundings. If the temperature is less than 32 degrees fahrenheit, the device will start sending the coordinates to the server. This serves two purposes: 1. it helps **conserve the power** of the device by not constantly sending coordinates. 2. it **automatically detects code blue situations** so the cart recipients do not have to worry about turning on and activating the device.

Our prototype device has a built-in **SIM card**. This allows for our GPS coordinates to be sent to our TCP server. However, it only functions whenever it can acquire a satellite fix on T-Mobile’s network. This can prove an issue in some environments where the homeless can be, such as rural areas where cell coverage can be spotty. Nevertheless, the SIM card in experimental testing in the Downingtown area acquires a fix almost 100% of the time, both inside and outside buildings.

The prototype currently has an **Adafruit Powerboost Shield** installed. This shield has a 3.7Volt, 1200 millamp battery that can hold a charge for up to 8 hours when in use. When drained, the device takes about 5 hours to charge, based on experimental testing. This shield must be charged by a direct USB connection. We integrated a power cord within the black box for convenient charging by social service personnel when the homeless return to the shelters.

**CART FEATURES (Stephen)**

Our cart component of the project began with design plans. We knew the cart must be a height appropriate for walking and maneuverability. The cart therefore is 21” x 24.5” x 40.1” in dimension, The internal lining is 18” x 15” x 24”, a size tailored to fit within the dimensions of the cart. Our “Black Box”, described by Matt is attached to the back of the cart in a prototype encasement 7” x 5” x 3” in dimension.

Our cart had to meet many criteria to be successful. One main concern for various shelters is storage space. Our cart is foldable (demonstrate) and can easily be stored underneath a bed in a shelter. The cart is of a height favorable to easy walking and has a considerable volume to hold numerous possessions and a variety of attached items. The cart is also very durable, consisting of high quality epoxy-coated steel. The four wheels at the bottom of the cart provide maneuverability on many terrains including pavement and grass, as well as snow and ice covered surfaces.

Another important part of the cart is its’ removable lining. Attached to the cart at 4 places via velcro, the flexible fabric can easily fold up with the cart. Yet, homeless users will likely have their possessions inside the cart, so it can be removed and used as a carrying tool for ease of transport. This waterproof liner can withstand the wear and tear of a homeless life and can easily be replaced if damaged.

In addition to the removable liner, we have made various modifications to the cart. We added 2 pairs of reflectors to reduce the probability of night time accidents. A flashlight, with a crank so no battery is required, is included to improve nighttime visibility. We also included 2 first-aid kits in case of emergencies. Finally, we’ve supplied the cart with hand warmers and a sleeping bag for those cold days when the homeless are outside or unable to make it to the shelter.

Altogether, our entire prototype consists of a GPS tracking, temperature detection, and server communication device implemented into a versatile and useful cart for the homeless.

**PARTNERSHIPS (Angela)**

We have had the opportunity to connect with many different organizations through the course of our project. Back in December, we met with Communications Test Design Inc. and discussed our project idea. They gave us some helpful insight into a workable plan for our project and agreed to assist us with the creation of our own cart design in the future.

In addition to CTDI, we organized a meeting with Safe Harbor of Chester County. Safe Harbor is a homeless shelter which focuses on designing individualized plans to help overcome whatever issues the homeless may face. At our meeting, which happened to be during a Code Blue, we met with Karen, the volunteer coordinator, who provided us with plenty of information about their program. This discussion led us to two of our other contacts.

First was Decades to Doorways, a Chester County program, whose mission is to create a network to prevent and end homelessness in the county. They provided us with information about the Code Blue program within Chester County. The other organization we collaborated with was ConnectPoints, a service of Decades to Doorways. ConnectPoints is a 24 hour service that works to find shelter for the homeless and identify resources to help prevent homelessness. Both programs provided us with valuable insight into how the county deals with homelessness and assists in finding shelters, especially during Code Blue conditions.

The Covenant House of Pennsylvania is an outreach program in Philadelphia that offers stability and sanctuary for runaway, homeless, and trafficked youth. They provided us with information related to their street outreach program in Philadelphia, as well as, their shelter and vocational services.

The American Civil Liberties Union of Pennsylvania is a nonprofit, nonpartisan organization dedicated to defending and protecting our individual rights and personal freedoms. ACLU works for the protection of every American’s right to privacy, especially as technology continues to advance, which is crucial knowledge to the legality of our device. We plan to work with them to create a human consent form, which will allow our device to be legally implemented into the carts of the homeless.

Through our business and organization connections we have discovered that it *is* possible to make our device a reality in Pennsylvania.

**STEM SKILLS NEEDED (Conor)**

A project like this, with so many intricate components, requires a great deal of STEM skills and knowledge. Working with professionals, doing research, experimenting, and utilizing prior knowledge all played important roles in making our device a reality. We utilized Autodesk Inventor skills to plan and design both our black box, with its delicate technological components, and our versatile cart. Computer engineering skills were crucial to the programming of our system and setting up our server for the GPS and weather monitoring technologies. Making the technologies work as a single, cohesive unit required electrical engineering skills. Securing our tech in a workable encasement required materials engineering skills. Planning future improvements such as a wearable version of the technology and a custom cart lining also necessitated material engineering knowledge. Because our project focuses on working with a specific human population, we also needed to research and be aware of the legal aspects of actually implementing our device. Therefore, we needed legal application skills to work safely and properly with the homeless, shelters and local law enforcement. Finally, as we look to the future, we hope to run an experimental trial of our project within the Code Blue program to calculate the effectiveness of our device. This would require data collection and statistical skills.

Overall, our entire project, understanding why it is important, the actual build, and its implementation in the Code Blue program meant utilizing a slew of STEM skills. Any future improvement or use will necessitate even greater knowledge and skill.

**FUTURE IMPROVEMENT (Matt)**

There are various improvements that we would like to make given the extended budget of $750. Our first improvement would be the creation of a custom cart from scratch. By manufacturing our own cart through either 3D printing or loose materials, we can have our prototype device and added modifications built into the cart. Costs for loose materials start around $250-$300. We would also like to improve the security of the prototype device. Creating a tamper-proof circuit would deter theft and tampering with the device. We would also like to explore replacing the Arduino circuit with a Printed Circuit Board which could be used for mass production. The cost of such a change would range from $25-$50 per board, but would be much cheaper in bulk production. We also would like to include a panic button in case the user feels unsafe and requests pickup by personnel. This panic button would be $10 for the button itself and $30 for wiring materials.

We believe our prototype device has the potential to be something wearable. Wearable, weather-resistant, and flexible fabrics to mount the device on would cost from $50-60 per yard of material. Finally, we would like to increase the power supply of our device. Extending the battery life of the device past 8 hours to possibly a full day without charging would increase the practicality and efficiency greatly. Costs for this improvement would be around $100.

At this point, I would like to direct you to view our budget for our project.

**BUDGET (Doesn’t really need a speaker - just point it out and direct them to their binders)**

**MASS PRODUCTION (Angela)**

As we look to the future of our design, we have begun to consider how to mass produce our device. We created a 3D computer model of our current design using Inventor and will eventually create a model of our final cart design as we progress with our idea. Our current arduino circuit is connected with wires, but for mass production we would use an improved printable circuit board with the same functions, saving both money and time. Critical to the success of mass production is an agreement with a cellular service provider to receive a discount on SIM card service fees, lowering the cost of maintaining our device. Another goal for mass production is to receive sponsorships from businesses within Pennsylvania to help fund the cost of our device. With mass production, we hope to make our design and device a reality that can be used to find and save the lives of the homeless.

**TEAM REFLECTION (Andrew)**

Creating a complex project like ours required a coordinated effort among all of the members of the team. Stephen Anderson organized and edited this presentation and our other written reports. Matthew Horger, our team leader and lead programmer, created the code for our device and organized meetings for the team to work. Our head communicator, Angela Herb, established connections with our many business and government program partners. Finally, Conor Waldt and I, Andrew Johnson, created the computer model of our device and researched the optimal cost-effective components for the construction of the cart. In addition to our specific roles, all members of the team contributed to the building and testing of the cart and helped one another with the many different pieces of the project. We each brought something unique, but we worked best together as a team.

**CONCLUSION (Stephen)**

It is our earnest hope that by this point you have come to see the practical purposes of our device and also the great need for such an invention in our community and beyond. We know our cart and monitoring systems have great importance. Our research and partnerships have validated this claim as well as allowed us to see the potential impact our device. Our device is simple, but by pinpointing the specific needs of homeless in the cold, it can improve our society in a focused manner. The code blue alert program acknowledges and works to address the dangers harsh weather poses for the homeless. Our device makes the process faster, safer and more comprehensive. This means less suffering, more security and the potential to save the lives of the many homeless of Pennsylvania and beyond.

With an increased budget and the plans we have mapped for the future we can guarantee marked improvement. Enhancing our device will ensure it is truly ready to revolutionize the code blue program. With our sound technological base and clear structure, improvement is not just a theoretical idea, but an obvious reality waiting to be grasped.

All of our designs, constructions and future plans aside, we must return to the core of why our’s is an important cause. Homelessness. It’s a terrible reality, of our country, of Philadelphia, even of our own community, Chester County. Most, if not all of us here today are incredibly fortunate not to have even an inkling of an idea of what such a life is like. Imagine the hopelessness. Imagine the worry. Imagine an eroding perception of self-worth. Add in winter conditions like those we have here in Chester County and now one must imagine a life under constant threat.

I began by asking you to think back on your morning. It may not have seemed it, but it was a pretty good morning indeed, wasn’t it? Tomorrow when we wake up, and the day after, and the day after that, let us all remember what our morning could be like without a home. Then we will see how the homeless *must* be helped. Our group has made that our mission. We know our device can make a difference. That is what matters. We will all return to our cozy homes later today, but hopefully we will do so with a new perspective on the reality of homelessness all around us. To us, that is more important than any ribbon or trophy. Thank you for your time and dedication. It has been a privilege.