

Final Proposal
H.E.R.E--Helping Emergency Response Efficiency
Grand Challenges
Georgia Institute of Technology

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Goal

Our goal for this project is to increase the awareness of users and the ones around them of their current intoxication level, and help them to avoid getting into dangerous situations. In many cases, the dangers of alcohol arise when people lack understanding of how inhibited they are. If successful, our project would allow users to more easily recognize when they are at a point that they should not consume more alcohol.

Background

Existing Solutions:

As scientific discovery of alcohol's effects upon the body has progressed, so has the existing technology to prevent alcohol-related tragedies. In 1936, Nyman and Palmlov estimated that 1% of consumed alcohol is emitted through the skin. This discovery led to the invention of the alcohol sweat-patch, the first transdermal alcohol testing. This patch was attached to the subject's skins for several days to absorb sweat and the quantity of ethanol, the most prominent alcohol in alcoholic beverages. Tests with these patches from 1980 to 1984 proved there was an apparent correlation between the amount of ethanol in sweat and the average amount of ethanol in blood. Therefore, the sweat patch was proven effective but needed to be implemented in a more efficient way that could alert the drinker when they had reached an unsafe level of intoxication.

The sweat-patch was further studied using gas chromatographs. Rather than directly testing the sweat content for ethanol, the atmosphere above the patch was tested for alcohol concentration. While proving ethanol concentrations above the skin show quantitative elimination and absorption phases similar to blood alcohol content (BAC), the peaks tested from the atmosphere were noticeably smaller by as much as 25%.

In the 1990s, development of transdermal alcohol sensors began. These sensors measure a person's Transdermal Alcohol Content (TAC) in a noninvasive manner without the need to be removed and tested by another process, but are not widely used today because of their design flaws. The Wrist Transdermal Alcohol Sensor (WrisTAS) from Giner, Inc. proved a strong relationship between TAC and BAC curves, but the TAC curve was delayed 30 to 120 minutes. This time lapse is unacceptable when warning someone of dangerous intoxication levels. The other transdermal alcohol sensor created in the 1990s was the Secure Continuous Remote Alcohol Monitor (SCRAM) by Alcohol Monitoring Systems, Inc. (AMS). SCRAM also proved the ethanol in sweat can reliably be used to estimate BAC. When the TAC curves were compared to Breath Alcohol Content (BrAC) curves, there was a distinct relationship of the shapes and magnitudes, but the peak TAC was delayed when compared to the BrAC. Further research with the SCRAM bracelet in 2005 at the University of Colorado affirmed the TAC peaks occurred later and were lower than the BrAC peaks. These results led to a conclusion that transdermal testing with the SCRAM sensor cannot replace breath testing equipment.

Further studies of BAC, BrAC, and TAC curves were conducted at the University of Washington in 2005. This study compared a mathematical model of ethanol travel through the skin to actual data, concluding peak TAC was less than peak BAC. In addition, TAC had peak delays from 30 to 90 minutes and the TAC curve took as much as three hours longer than the BAC curve to reach zero. Through this study, the University of Washington concluded TAC curves cannot directly replace BAC or BrAC curves when looking for real-time

According to the article “Alcohol Detection: Past and Present”, there is an invention called the tissue spectrometry. Skin sensors shine light through the skin to determine BAC. This estimates BAC by measuring how much light is absorbed at a particular wavelength from a beam of Near-Infrared (NIR) reflected from the subject’s skin. Skin sensors are touch-based and as such require skin contact. Future versions are expected to work with skin on the hand. Toyota has begun developing a steering wheel that can detect alcohol thru the pores of your skin (American Beverage Institute, 2015).

For alcohol sniffers, unlike skin sensors, sniffer systems do not require skin contact and can operate at a distance. Sniffers placed in the vicinity of a driver measure the driver’s breath or tissue for alcohol. This technology is small enough to be placed into law enforcement flashlights that can determine if a driver has alcohol on his or her breath or if a drink has alcohol in it (American Beverage Institute, 2015).

On a more external aspect, there is a device called Ignition Interlocks, which prevents the functioning of a motor vehicle if the driver’s BAC exceeds a pre-determined level, usually .02 BAC. The technology integrates alcohol breath detection technology to a vehicle’s ignition system. Before the vehicle can be started, the driver must check their BAC by blowing into the ignition interlock. If the driver’s BAC is over the pre-set level the engine will not start. An on-board data recoder logs the event along with other data that is reviewed periodically by court and probation personnel assigned to the case (LifeGuard, 2015).

There are also other automobile companies who are working on implementing alcohol detection into their vehicles. Nissan’s 2007 concept car showcased how numerous alcohol sensors could be fitted into a car. One sensor in the car was an alcohol sniffer placed in the driver’s seat, behind the driver’s shoulder (American Beverage Institute, 2015).

Stakeholders

The stakeholders include drinking young adults, parents, non-drinking young adults, and university staff. According to the University of Connecticut Health Center, young adults drink alcohol excessively most often, making them the greatest stakeholder in this problem statement. Further research from Victoria University has concluded students have a higher risk of alcohol related harms. In fact, in a New Zealand university first year students were put through an alcohol-related harm reduction campaign. Unfortunately, these same students did not find their binge drinking as a concern. Victoria University concluded one must consider how drunk students determine themselves to be as well as the factor of a student’s pleasure when considering why students binge drink, often resulting in harm. These factors often lead to students feeling they have a control over their drinking when they truly do not.

According to the National Institute on Alcohol Abuse and Alcoholism, each year an estimated 1,825 college students between the ages of 18 and 24 die and approximately 599,000 students are unintentionally injured under the influence of alcohol (National Institute on Alcohol Abuse and Alcoholism, 2015). Not only does over-drinking affect their physical lives, but it impacts their mental health which leads to poor academic performance. About 25 percent of

college students report academic consequences of their drinking including missing class, falling behind, doing poorly on exams or papers, and receiving lower grades overall (National Institute on Alcohol Abuse and Alcoholism, 2015).

Other stakeholders include drinking parents. Research was conducted at Ajou University in Korea to determine if there was a correlation between university students' mental health and their parents' drinking behavior. A questionnaire was given to 547 students and the result was a positive correlation between students' mental health problems and their parents being problem drinkers and there was a negative correlation between students' self-esteem and their parents being problem drinkers. In addition, there was a negative correlation between self-esteem and positive coping methods. This research shows the cycle of drinking from parents to their children and why parents are just as much stakeholders as young adults (Journal of Korean Academy of Psychiatric and Mental Health Nursing, 2011).

Young adults drinking, especially on the university level, not only affects the drinker, but also the people around them, drinkers and non-drinkers alike. Consequences for non-drinkers can include injuries, such as car crashes, sleep and study interruption, assault, verbal harassment, and campus vandalism. The most important of these is probably injuries to non-drinkers. Every year drunk drivers injure and kill innocent drivers. In 2013, 10,076 deaths in the United States were caused by drunk driving, some of those including innocent drivers (NHTSA Releases 2013 Drunk Driving Statistics, 2014).

The final stakeholders are the universities themselves. Universities do not want their students to drink to excessively because it causes tragedies that lead to poor publicity for the university. Not only the university in New Zealand, but universities all over the world have campaigns to end binge drinking and keep students safe. Since over drinking causes all these problems, it is clearly a very significant issue for people of all ages especially young adults. Our team has developed a solution to tackling the issue of reducing the consequences from over consumption of dangerous substances through increasing self awareness.

Objectives

Alcohol over consumption affects everyone, from drinkers to nondrinkers. Yet, nobody wants to be in a situation in which they are no longer in control and are inhibited from good decision making by their alcohol intake. Data was collected from 410 university students who completed the Student Alcohol Questionnaire and the Self-Control Questionnaire, it concluded that college students naturally attempt to control their alcohol consumption or the unwanted consequences related to drinking. However, this is not always an easy task. More dangerously, individuals overestimate their sobriety and erroneously think they are capable of performing certain tasks. Alcohol interferes with encoding processes fundamental to a state of self-awareness, thereby decreasing the individual's sensitivity to both the self-relevance of cues regarding appropriate forms of behavior and the self-evaluative nature of feedback about past behaviors.

As a team, our objective is to create a non-invasive, wearable device to help individuals recognize their level of intoxication in order to reduce the consequences due to overconsumption. We believe that by helping individuals become self-aware of their level of intoxication by use of an accurate and quick-response tool, they will be better informed and hopefully take appropriate measures to maximize their safety.

We hope to accomplish this task by first understanding the biological factors associated with alcohol intake and find a means to measure the changes in a noninvasive way. We'd like to

create a device that uses an NIR spectrophotometer that acts as a BAC through the skin. Ideally, using this technique, a light is beamed into the skin of the person's forearm and its reflection is measured by the NIR spectrophotometer. Since each molecule reflects a unique light, the spectrophotometer can determine the difference between alcohol, water, and other liquid particles in the skin. The alcohol molecules are distinguished from the others and can then be measured from this process. This method can provide extremely accurate results in under a minute. We'd like to create a device that integrates this technology into a wearable, visually discreet, and comfortable accessory that can be worn as a bracelet.

To determine the success or failure of this objective, we would measure the quantitative data such as the number of people that use this device or decreased number of alcohol-related incidents. However, in order to gauge the impact of this objective, we are not necessarily measuring the amount of products we sell on the market, but rather, trying to collect data that can be used to ameliorate this solution further. The success or failure of this objective is dependent on whether or not we are building towards something better, something that gets used, and something that significantly makes a difference.

Unfortunately, at the time, no one on our team has the skill set to design or program a solution of this caliber. We hope that as time progresses and we continue our education, we will be able to develop the necessary skills to create this solution. Another obstacle is making our device desirable to the market. No matter how advanced we make technology, it will essentially be useless if no one uses the product.

Building a strong partnership with an established company trying to accomplish our same goals is another objective that our team strives to achieve. Partnerships are a powerful avenue for a startup idea to achieve value. Established companies have capital, skilled labor, resources, and strong brand recognition. While startups are innovative and have large potential for growth, the most successful startups are backed by a larger company.

As a team, we recognize that our skills as students are limited and that the resources provided by a larger, more established company would be beneficial to our project, both initially to develop and introduce our product to the market and later to help grow and improve as our own entity.

We hope to achieve this objective by creating a well-defined project proposal that will entice larger companies to invest in our project. We hope to build professional relationships in market in order to better create, test, and distribute our project.

While it would be our team's idea, we hope that we could partner with a larger organization to create a working prototype and develop it into a viable product that can be utilized by the masses. In the future, we would be interested in working with CEO and Co-Founder of Fitbit, James Park, as well as the Honda Company, as they are also heavily invested in finding a solution for this problem.

We hope that by partnering with a large company, we will gain access to greater resources, capital, and expertise that will help grow and expand our idea. Our partnership with a larger company will allow us to create a working, viable prototype and give us a space and audience to test this prototype. If our prototype is deemed successful, the established partnership with a larger company will allow for easy distribution and marketing. More than likely, it will also provide a pathway to develop other relationships in the corporate world so we can continually build and grow as our own entity.

Partner with a large company is not a small feat. Success or failure is strongly dependent on the thoroughness of our project proposal, our own ability to persuade and work together as a

team, as well as how big of a risk the company is willing to take by investing in our company. Even if a company decides to invest in our team, our success can be dependent on how strong of an influence the company has on our project and how heavy their influence is on the continuous development. Success or failure is dependent on the relationship.

Once partnered with a large company, there is no guarantee for success. There's a possibility the company takes over complete control and our team no longer have creative and developmental control. There's a possibility that it morphs into the company's idea instead of what was previously our team's idea. There's a large possibility our team doesn't get what was promised or that the corporate world eats our fledgling team up and swallows us whole. There are many problems that can come about by partnering with a large company. However, our team believes that the benefits of partnering far away the cost.

Research Team

Our research team consists of seven students, each with a specific job that will benefit the team and further the progress toward our objectives. Person one, arguably the most essential person, has the job of secretary. This individual takes minutes at every meeting, coordinates schedules and meetings, sends out emails to the team. These efforts perform crucial team maintenance, coordinates our individual efforts, and ensure that meetings can be attended by all members. Person two serves as the group leader, taking charge at meetings to maintain focus and productivity. Our current project does require in-depth knowledge in manufacturing and design of our product, however, none of our members have any specific knowledge in this field. Therefore, all members are equally prepared and helpful in team discussions and work. For each step in our timeline, work is equally divided between members. Persons three through seven serve variably as communicators, researchers, analyzers, innovators, writers, editors and what ever else the team agrees needs to be done. All members of the team including the secretary and leader need to be diligent, responsible, and hard-working in order to get their assigned work completed so that they do not burden other members of the team. Our objective is to save lives by creating a noninvasive, wearable BAC-monitoring and creating partnerships.

Currently, each student will be responsible for researching more on different factors regarding BAC monitoring in order to get a better understanding of the process and current technologies so we may create the product in the near future. As we start working on the actual product, our group will be divided between actual manufacturing and design while working with a partner company and looking for more resources and partnerships to allow our project to grow.

We do not have an advisor at this time, but three people that we know would be interested in our project would be STAMPS Director of Health Operations, Mr. John Scuderi, CEO and Co-Founder of Fitbit, James Park, and Georgia Tech Interfraternity Council (IFC) President Jonathan Rodivoj. The STAMPS Director of Health Operations would have an interest in the health of the students and how to improve it. The CEO and Co-Founder of Fitbit would be useful to have as a partner for the use of design and manufacturing of our idea, since the product was inspired by a fitbit-style wearable device. While the IFC president is only a student, he still has a large influence on campus in the area of our problem space. At the very least he will be able to provide us with useful connections to many others who could aid us, such as executives of national IFC or those in Georgia Tech faculty that work closely with the Georgia Tech IFC.

Timeline

Fall 2015 - Develop a prototype of our project.

- This would be a much bigger and less portable than the final product, but this functions as more of a proof of concept.

Spring 2016 - Test the prototype on human subjects

- Administer tests to human subjects to test the prototype and find any flaws in the project.
- At this stage there most likely will be lots of flaws, so this stage would also include tweaking of the project and our design.

Summer 2016 - Work towards a final, portable version

- From the tests and data collected, start to work towards a version that could be worn on a daily basis.
- It may or may not be able to be completely finalized by the summer of 2016, but we should have a working portable solution by the end of the summer.

Budget

• **Materials and Supplies**

- breathalyzer-\$50
- concept design: the device we use to figure out what all must go into our prototype
 - kit workshop-\$37.90
 - sensors
 - 5x protoshield rev3 kits 5x\$9.75
 - sensor components \$150
 - motherboard-arduino mega ADK rev3 \$47.65
<http://store.arduino.cc/category/11>
 - wires \$20
- Prototype design: a relatively inexpensive mockup made from generic parts that serves as a close analogue for the preproduction and production designs-\$800
- preproduction design: functionally the final form of the product made with custom parts-\$3000
 - cost reduction achieved through use of 3d printing for prototyping the casing
 - sensors, chipsets, and power supply will likely need to be custom to keep size acceptably small
- production design: fully formed marketable product ready for mass production-production and sale prices to be determined

• **Services**

- We will require custom chips, sensors, and power supply for our pre production prototype which will need to be manufactured by a third party. Estimating \$2500 for these components
- We will need to attend trade shows and speak with manufacturers in order to obtain quotes on the cost of production models so for now this cost is unknown
- research budget at least \$500
 - we will need a research assistant to perform testing of our device as none of our team members can legally purchase or consume alcohol

• **Travel**

- Trade Shows

- needed to gain more knowledge of the hardware and software we can work with/develop. Also allows us to begin making connections with manufacturers and specialists whose help we may need later.
 - Micro electronics and sensing
 - SECON in Seattle
 - flight \$500 per person
 - admission \$575 per person
 - hotel total \$850 over 3 days for 2 people
 - food total \$120 per person over 3 days
 - transport: \$70 shuttle and cab fares
 - SEMICON in San Francisco
 - flight \$500
 - admission \$100 per person
 - hotel \$580 over 3 days for 2 people
 - food \$120 per person
 - transport: \$70 shuttle and cab fares

Expected Outcomes and Future Directions (10%)

Once we've completed the project, we hope to have made an easy way for people to help themselves and the people around them be safe, while enjoying themselves. Our project isn't about taking away the fun from people, but rather helping them to do so safely. If we could help just a few people to stay safe, we feel like we would have done what we have set out to do.

After our second year, our project most likely will still need work. Though we hope to have a working version by the end of summer 2016, we will most likely need to still work on it and make it better. There are many organizations that would help us complete this project, as there is a large demand for a product such as this. If needed, we could turn to venture capital companies in order to get the funding to mass produce the product, though its more likely we receive funding from other areas.

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