The Final Report:

The skills and concepts I learned in "How to build a physical and digital system" has guided my understanding of the frame work required to go through the design process from first identifying the goal or problem, to designing the system, then to implementation. The final project completed for the class is a testament to skills acquired in class and our ability to create a physical – digital system.

How we came to identify the goal for our project was through the class assignment where we presented our cars and how we keep them, what we put in them, what we do in them. From there the class was instructed to take their notes from the presentations and organized them into categories. These categories ranged from "health and safety", to "entertainment", to "control and comfort". As we later found out that these categories were to be the topics for our group project I immediately was drawn to the category: "Freedom, Adventure, Discovery." I gained my group-mates and we began brainstorming ideas on a device that would aid in or mediate "Freedom, Adventure or Discovery." This process was important because it revealed aspects of driving/life that people value. Those are things worth making a system for.

I first thought of a concept where there would be a map that would act as sort of a wiki of maps. It would be blank and it would be left to the users to fill in the pieces with key areas of interest and land features. There would even be a sort of "X marks the spot" buried treasure function where people would leave something at that location and mark it on the map so that someone else may find it. I called it the "Social Map." I planned on developing if so mobile apps or just a standard web page. Because this didn't require us to fabricate our own physical system, it didn't fulfill the requirements for the assignment and we had to rethink of our approach. I like the social map idea because it encourages exploration. By users indicating points of interest or value, it would motivate other users to go to that area. I really wanted to continue with this concept.

It was during class that a compass was mentioned. This resounded with me because it reminded me of *The Legend of Zelda*, a video game where to player uses a compass to locate

items of value in the dungeons he explores. To me this offers the best physical translation of the Social-Map idea. A compass has great tactility, would be aesthetically pleasing, and if done right could offer a sense of novelty and magic. Serendipitously my group-mate Zane had the same idea and it was clear that that was the direction that we wanted to take. From then it was effortless to come up with the rest of the design. We ended up deciding on 3 modes: buddy mode, bread crumb mode and treasure mode. You can find in depth documentation explaining the system at:

http://dc-bdps.wikispaces.asu.edu/Freedom%2C+Adventure%2C+and+Discovery.

When it came to designing the aesthetics, I based the design off the *Zelda* model. It's simple, elegant and functional design seemed to fit our needs. At this point all we needed was an "illustrative" model for presentation purposes so I modeled and rendered it in 3D Studio Max. Then it came to creating the story boards. Truth be told, I spent way too much time drawing the story board for the bread crumb mode; I just wanted to flex my drawing muscle at the time.

When it came to actually constructing the system we divided the work into three different sections: Zane did the circuitry, I did the coding, and Aziza did the fabrication. We all took areas where we had the most expertise. I have never considered myself a programmer but I did have the most experience out of us. When creating the code I did a lot of copying from the past practical's and just combined them to fit the needs of the system. Once you get used to assigning hardware, Arduino code isn't so tough. The hardest thing really is not knowing if your code works with the circuits correctly.

I felt that actually creating the physical working prototype posed the largest challenge and definitely required the most work out of the process. There is always a discrepancy between how one imagines the designed finished product and how it turns out in reality. One of those discrepancies occurred during the fabrication process. Aziza and I had spent a lot of time in Rhino designing the "fabrication" model complete with component housings, and built in buttons. We made sure that everything was lined up perfectly and everything was the size it needed to be. But as it turned out the 3D printer was too backed up for us to print in time for the showcase. This forced us to adapt a backup plan by modifying a previous enclosure design using laser-cut particle board. It was really disappointing to have to compromise the vision of

system, not to mention losing the time spent of having to redesign an enclosure. The 3D fabricated enclosure was supposed to be one of the strongest aspects of the system. Nevertheless our new particle board enclosure worked out for us in the end.

One of the biggest issues involved with the implementation process was troubleshooting dysfunction in the system (or lack of function rather.) By this I mean that when we encountered problem, it was hard to say whether the error lied in the circuitry or if the issue was in the code. This was especially a problem because Zane would be focusing on the circuits where I would be focusing on the code and we really couldn't check each other's work reliably because . I don't have enough experience in had to trust in each other's work.

In particular there was a couple times where we hit a wall. I checked over my code multiple times. Zane checked his work. I ran him through my code. He showed the circuit and how it was supposed to work. We even had Ben Luke try helping us but to no avail. It wasn't until Ozzy offered his help and proceeded to use the voltage meter to check our bread board that he was able to find that one of the digital pins on the Arduino was defective. This kind of problem was totally beyond our ability to solve. We had already wasted plenty of time on that problem but thankfully we had Ozzy backing us up otherwise we would have been lost there forever. Ozzy's expertise comes handy yet again when the RGB LEDs were not behaving like they should. Ozzy was able to notice that those LEDs were different that the LEDs that we used in the practical so they require different wiring. After that we were able to get the basic functionality of the lights toggling completed and the lab was closing so we agreed that we were done for the day.

This segways nicely into our next problem. As we left, we stuffed the Arduino into the enclosure to ensure everything was tucked away nicely. When we came back the next day to pick up where we left off the system wasn't working. We hadn't changed anything and everything seemed to be correct so we were stumped because just the day before it had been working great. We went to such lengths as completely reworking the bread board, changing the Arduino and commenting out some of the code. After many hours, Ozyy yet again saves us when he notices that the wires of the bread board looked really sloppy and that there were wires touching that were shorting the other components on the bread board. Zane was very

liberal when stripping his wires for soldering. There were wires that had and inches length of exposed metal. This is another example of how our lack of experience came into play. It amazed me how a mistake so subtle and easy to make could cause so many problems. Shorted wires are definitely something that I will be looking out for in the future.

I would just like to say that something that made this project very interesting for me was that this project was the first time I actually felt like the group leader by necessity. It was a new experience to feel like people really depended on me to coordinate the operations. It felt this way because I was helping both Zane and Aziza with both their parts with trying to get my code done at the same time. I felt the need to find/suggest task if it looked like someone wasn't busy so we could stay productive.

Throughout the class and through this project I learned a lot about myself and what it takes to build a physical- digital system. I have a new appreciation for well designed electronic devices because I know how hard it can be to make them. This class has definitely broadened my horizons. I plan on expanding on the skills that I learned in this class.