

Post-Mortem

LumenX³

Version 1.3.2

April 13, 2015

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◆ 1.0 Introduction

The following documentation describes the post-mortem of the LumenX³ project. High-level functionality of our proof-of-concept model and accompanying hardware and software will be highlighted. A comparison between the estimated schedule and costs will be compared to the actual schedule and costs incurred. In addition, a section describing the resulting group dynamics and individual reflections on the project will be provided. All meeting minutes will be in Appendix A at the end of this document.

▶ 1.1 Project Background

The LumenX³ (pronounced "lumen-ex-cubed") is the next addition to everyone's smart device portfolio. Designed with portability and collaboration in mind, the device will utilize projection to display a screen that is not limited by the physical size of the device and employ hand tracking techniques to give users a whole new dimension of interactive experience [1].

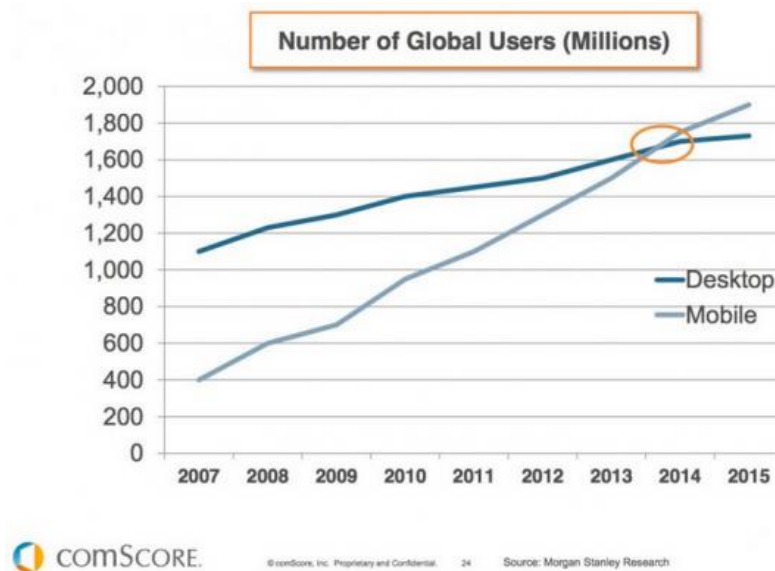


Figure 1 - Number of global users for desktop and mobile devices from 2007 to 2015 [2]

The mobile market is growing fast. Shown in Figure 1, as of 2014 the number of active mobile device users has already exceeded the number of desktop users. The modern day consumer is always on the go but wants to keep their technology close to them, thus portability and durability are extremely important. These portable devices are also expected to deliver an exceptional experience whether it be creating or consuming content over the web. This connected device market has an amazing projected growth of 80% over the next 5 years [3], indicating a rapid increase of market demand for portable devices in the near future. This is extremely encouraging to us for entering the portable device market at this time. We strongly believe that consumers will enjoy the innovative projected computer experience of the LumenX³, especially in situations where conventional touchscreens do not provide a

satisfying experience. The LumenX³ builds off of the already existing market for touchscreen devices but offers more benefits, including a great collaborative experience and an unbreakable display, all integrated into a portable device.

By replacing the glass screen with a projection, we remove one of the most fragile components in modern smart devices, where 25% of all iPhone touchscreens break [4]. Damage to the glass screen is a very common occurrence that renders the device useless, as the user is unable to continue interacting with it. Touchscreens are also limited by the fact that they require a user to directly touch a glass screen. For example, a consumer's finger may be compromised by residual food when cooking or covered by pigments when painting, outright preventing or at least complicating the process of interacting with the device via touchscreen.

In addition, having a larger projected screen allows multiple users to interact with the device and therefore encourages collaboration amongst many users. By implementing hand tracking in a 3-dimensional space, users will be able to provide input in ways not previously possible: drawing in the air, sculpting in the air, and hovering, which traditional touchscreens do not have. This makes the LumenX³ a complete alternative to using a mouse and more. Our aim is to create a durable, lightweight device that promotes interactivity and collaboration among groups using the surface of the projected screen as well as the space above it to take in touch input.

In our proof-of-concept model, the LumenX³ will demonstrate projection of a perspective corrected screen onto the surface where it is placed. It will also be capable of tracking the user's hand movements to detect single finger touch gestures such as tapping. All components of the device will be fully enclosed in our custom designed case that compresses to half its height to promote portability.

◀▶ 2.0 Product Design Process

▶ 2.1 Core Subsystem

The Core Subsystem consists of our main computing unit, the MeegoPad T01 [5], as well as an Arduino Uno for status LED control [6]. The challenges in the development of this subsystem mainly revolved around hardware selection. We strived to find a computing unit that would be powerful enough to run software for the Touch and Projection Subsystems, yet small enough to make our device as portable as possible. In addition, the computing unit should also be running a touch-friendly Operating System, namely Google Android or Microsoft Windows 8.1 [7]. With the above criteria, we narrowed the choices for our development boards to the Jetson TK1, the Minnowboard, and the MeegoPad T01.

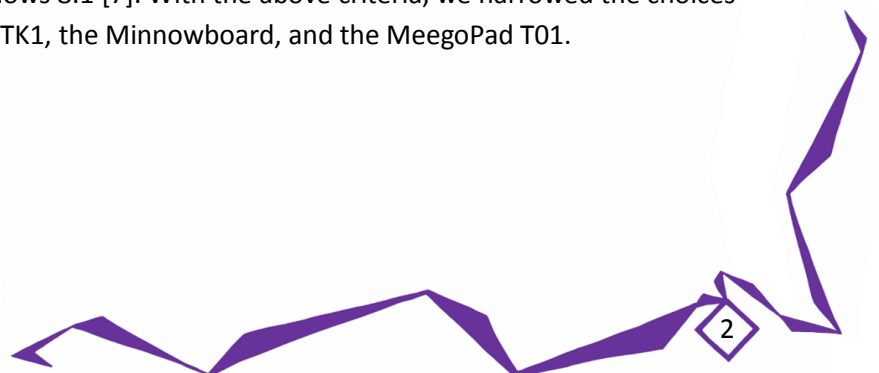




Figure 2 –MeegoPad T01 Computer

We eventually chose the MeegoPad T01 for its considerably powerful Intel Atom CPU that runs on Microsoft Windows 8.1 and also for its small form factor, being the size of a Wi-Fi dongle.

► 2.2 Projection Subsystem

The Projection Subsystem consists of the AAXA P3 Pico Projector [8] and a perspective correction driver that compensates for projection at an angle. The major challenge in the development of this subsystem is with the development of the perspective correction driver. We originally planned to use an open source library called OpenCV that has a collection of functions, which are very useful to computer vision projects. However, during development we discovered that the driver was unable to compile external libraries. Consequently, we researched how the OpenCV functions worked and in combination with research done on Homography estimation [9], we successfully developed a perspective correction driver.

We developed a separate program to calculate the Homography matrix that would map the (x,y) coordinates of the operating system's display to the perspective corrected (u,v) coordinates of the display bitstream sent to the projector. The driver was optimized to only update 'dirty rectangle' subsets of the screen in which pixels have changed, improving the speed of the driver.



Figure 3 – Perspective correction on original computer screen (left) and the resulting projected screen (right)

One of the challenges found during testing after the driver was written is the resolution compatibility between MeegoPad T01 and Pico Projector. The projector has a 720p projection mode by default, meaning when the original connection is made the system has affinity for a screen size of 1280 by 720p. However, when the MeegoPad T01 was connected to another source, for example a Sony TV, it was fully capable of switching to other resolutions using the driver we wrote. Because Windows Apps are not

supported at resolutions lower than 1024 x 768, for the purposes of demonstrating Windows Apps we found a quick workaround in order to achieve 768p, which involved using the Intel Graphics Drivers to help switch resolutions.

► 2.3 Touch Gesture Recognition Subsystem

The Touch Gesture Recognition Subsystem consists of the Leap Motion Controller [10] and a software program that injects touch inputs into the Operating System. The challenge with this subsystem lies in the development of the touch software that is responsible for manipulating 3D fingertip position data from Leap Motion Controller, and translating it into meaningful touch gestures that are relayed to the operating system as user inputs. Through experimentation we found that if the Leap Motion Controller is mounted at an angle of 45 degrees below horizontal, it would maximize its detection area over the projected screen. However, the Leap Motion Controller did not support usage in this orientation and had extremely low accuracy in tracking fingertip positions, making it extremely difficult for us to write the touch injection program.

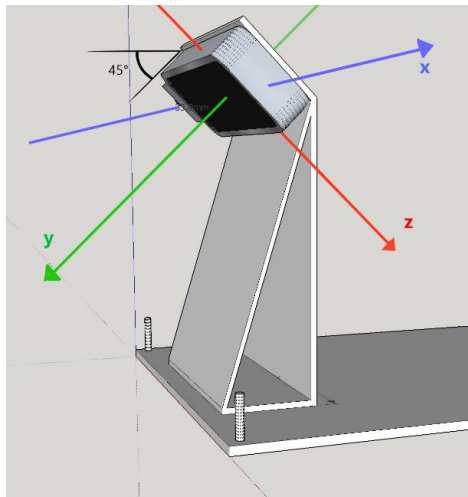


Figure 4 – Orientation of the Leap Motion Controller mounted 45 degrees below the horizontal

Using the Interaction Box function of the Leap Motion Controller's, we were able to determine whether or not a finger was touching the surface using the 3D-coordinate data of the finger given by the Leap Motion Controller, however it was not accurate because it was oriented at an angle from above. Thus we turned to taking and analyzing sample points and discovered that tracing a finger on the surface meant traversing an imperfect and erratic plane of curves and bumps. These results were also not consistent, and thus we spent a lot of time testing and trying to reverse engineer the Leap Motion Controller in order to compensate for its unreliable behaviour. After receiving the correct 3D data, we then determine the 2D location of the pixel corresponding to the fingertip's position on the surface. The combination of these two achievements allowed the development of a touch software that is able to recognize touch gestures and inject them into the operating system as user input.

► 2.4 Mechanical Case

The mechanical case was designed to house all the components of the LumenX³ system. As our goal is to develop a portable device, we strived to minimize the overall size of the device. After experimenting with the projector hardware, we considered many factors including the screen focus, screen size, projector height, and Leap Motion Controller detection range, and decided to mount the projector at 29cm above the surface tilted downward at an angle of 60 degrees. This resulted in a fairly large device. Consequently, we decided to make a two-shell design for the case so that it can also be portable. This case is able to extend upward to a Projection Mode at a height of 40cm for the user to interact with the device, and once the device is no longer in use it is able to transform into a Compact Mode only 23cm in height.

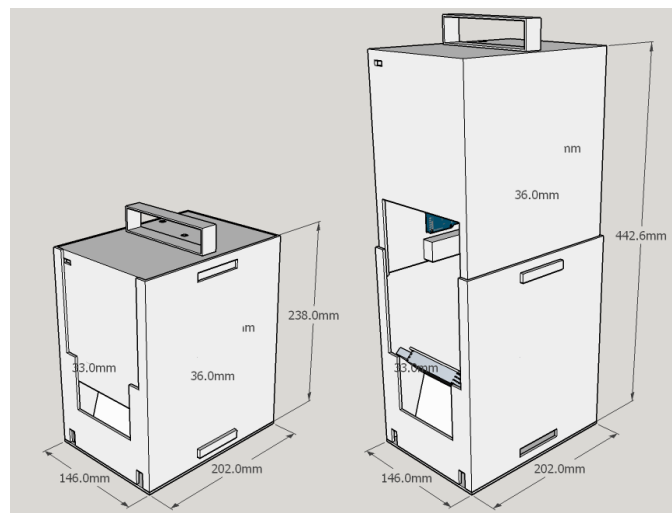


Figure 5 - Compressed and Expanded Case

The biggest challenge with the mechanical case was designing a mechanism that allows a stable transition between the two modes. We experimented with many different locking mechanisms that included hooks and latches, however many of these mechanisms proved to be unstable when the device was expanded. This was an issue since both the perspective correction driver and touch software were designed to operate at a specific height and angle. If the extension of the case was not consistent, the projector would be at a different angle, shifting the resulting projection and decreasing accuracy of the touch recognition. As a result of these experiments we designed the buttons to be long and flat, in order to keep the inner case and its components completely stable atop the outer shell. The buttons operate using springs and pop out at designated cutout locations when the device reaches a specific height. It was also challenging to place all the components and wiring such that there was no interference with the case each time it would rise and fall nor with the projected light when in Projection Mode. This required a thorough understanding of the 3D space each component filled within the case. The case opening was also quite small, making it hard to use our arms and hands to adjust the positions of the components.

3.0 Finances

Our first prototype was estimated to cost \$748.12 to build. We have received \$705 from ESSEF and an additional \$622.85 from IEEE. We have spent \$683.30 on parts, which is approximately 91% of our estimated budget. A comparison of actual costs is shown in Table 1 below:

Table 1 - Project Estimated and Actual Costs

Item	Estimated Cost	Actual Cost	Difference
Microsoft Windows 8.1	\$119.99	\$0.00	+\$119.99
AAXA P3 Pico Projector	\$184.91	\$184.91	\$0.00
MeegoPad T01	\$138.03	\$138.03	\$0.00
Leap Motion Controller	\$89.59	\$79.68	+\$9.91
Arduino Uno	\$30.00	\$35.00	-\$5.00
Minor Electronics and Other Accessories	\$55.60	\$72.82	-\$17.22
Plastic Enclosure	\$30.00	\$41.43	-\$11.43
Contingency (15%)	\$100.00	\$131.43	-\$31.43
Total	\$748.12	\$683.30	+\$64.82

We were well within budget and will be using the excess money to start on our prototype as we seek to bring this market. Once we go over budget, extra costs not covered by funding will be split evenly amongst the team members.

4.0 Schedule

Gantt charts detailing our original estimated schedule followed by our actual schedule are shown below in Figures 6 and 7.

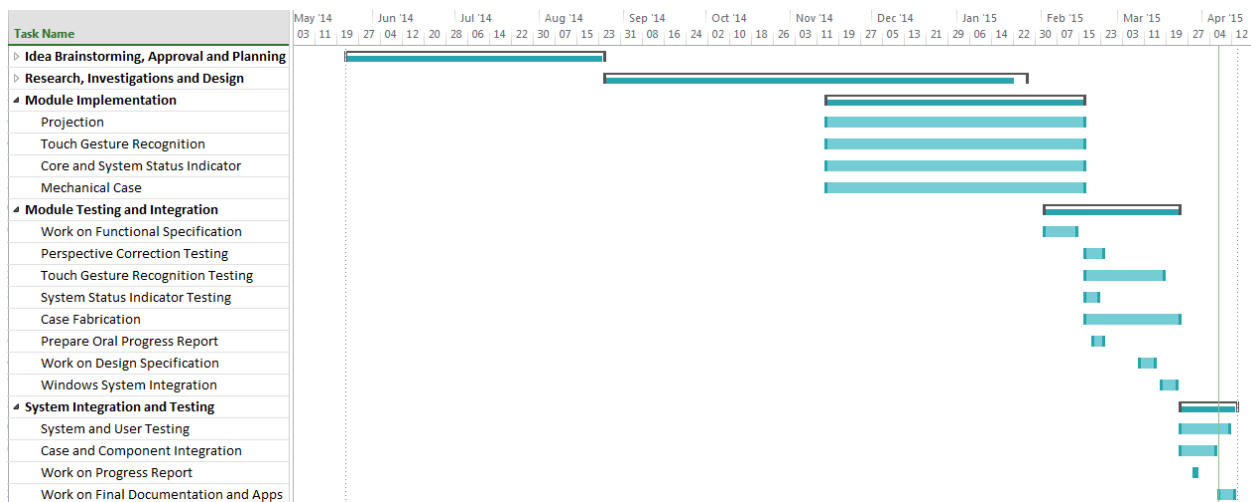


Figure 6 – Estimated Schedule

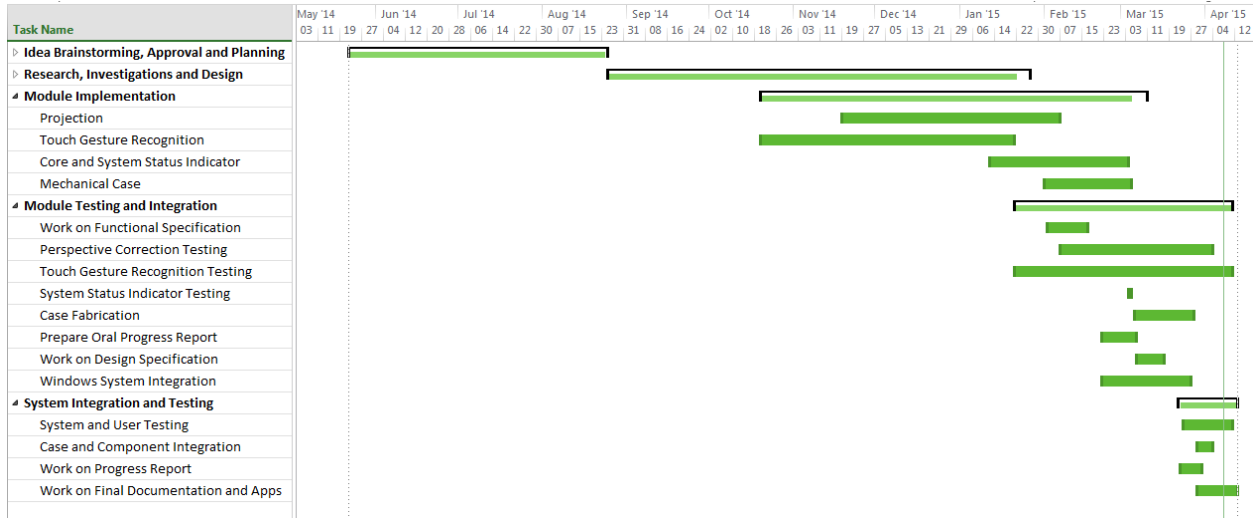


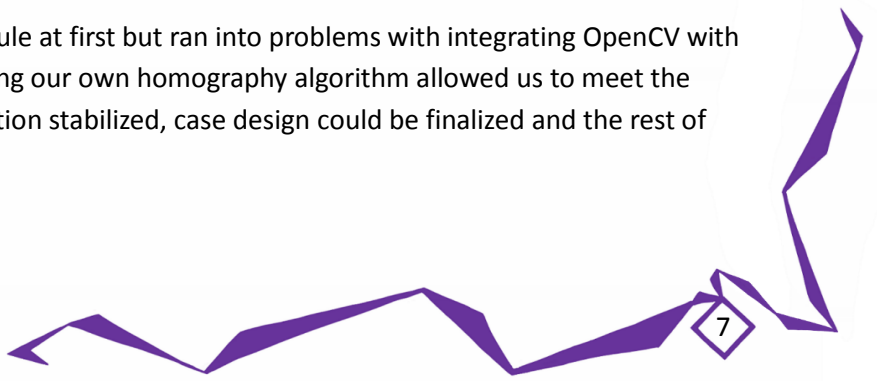
Figure 7 – Actual Schedule

The initial phases of “Idea Brainstorming, Approval and Planning” and “Research, Investigations and Design” followed closely between estimated and actual as we allowed very generous time ranges for all tasks and had flexible deadlines throughout the beginning. We prepared and applied for funding in the Fall 2014 semester, giving us a head start on ordering the final components we decided upon and waiting for delivery.

Starting in Module Implementation, we diverged from the estimated schedule due to the results of our individual research. We tried several hardware boards to implement our core computer function including the Raspberry Pi, Galileo and Jetson TK1. Significant work was done in research for evaluating the operating system, compatibility with sensor technologies and form factor. However, it was found the systems running Android were not compatible with our eventual implementation and instead ordered the Meego Pad. Once our core computer system was decided, the rest of the Core subsystem followed shortly.

Initial investigation into various touch gesture recognition methods quickly provided us with several avenues of possible implementations including testing with two webcams for stereovision, and color differentiation using a webcam paired with IR emitters and filters. This allowed us to start ahead of schedule on implementing the two trials. However, results from these implementations were unsatisfactory and inconsistent, and we abandoned these methods in favor of the Leap Motion. In hindsight, we should have researched in greater depth on the limits of the detection methods before spending so much time in implementation.

Perspective Correction followed the schedule at first but ran into problems with integrating OpenCV with the Windows driver; however, implementing our own homography algorithm allowed us to meet the module deadline. After perspective correction stabilized, case design could be finalized and the rest of the modules followed.



During Module Testing and Integration, additional improvements in performance and accuracy were required after initial tests. Perspective correction for various resolutions was explored and touch gesture recognition improvements continued on until the end of the project deadline as there were many areas for potential improvement. System status indication was quickly verified while case fabrication delayed due to 3D printing problems due to its size limitations. However, final integration of the entire device started on time and stayed within the schedule relegated for System Integration and Testing.

Documentation followed all its deadlines successfully but certain documents took longer to complete than planned. The Proposal underwent several revisions and the Function Specification took time to define with our extended development time.

◆◆ 5.0 Team Dynamics

The ObelXTech team is a group of capable engineers of varying disciplines and different experiences. The majority of the team members have had previous experiences working together and so there was minimal difficulty assigning roles and working cohesively. The team approached the LumenX³ project by breaking down its complexity into its smaller, fundamental modules. Although all members contributed towards all modules, the development of each module was tasked to one or two of the team members as their main focus. The modules consisted of the projection subsystem, touch recognition subsystem, and core subsystem/mechanical casing.

Being the key way of delivering content for the LumenX³ device, the individuals focusing on the projection subsystem influenced other members over the course of the entire project. Carmen led the module's development as her main focus. She worked on the majority of aspects related to projection such as projector placement, hardware analysis, matrix algebra, and driver development.

The Touch Recognition team consisted of Davin and Michael. The team worked extensively with the Carmen because the software highly depended on the specific resolution and physical sizing of the projected screen. Michael developed the coordinate mapping and desktop application while Davin developed the touch recognition code that determined whether the user had interacted with the device. Both members performed the hardware analysis for the Leap Motion controller's orientation, and placement. The Core Subsystem/Mechanical Casing team was comprised of Gary and Herman. Gary worked on the design, fabrication, and parts acquisition for the acrylic casing and all 3D printed components, and Herman developed the System Status Indication using the Arduino as an interface for the LED's.

Problems came up frequently during the development of the LumenX³. However, when problems arose every member of the team contributed to resolving and debugging issues as quickly as possible. In order to move quickly, we held weekly in-person meetings to demonstrate new developments, prioritize current issues, and assign future tasks. This along with supplemental Skype meetings meant that our schedule was always updated and our time was always used effectively.

The following table demonstrates the contribution of each member to the defined task:

Table 2 – Work Load Distribution, **XX** = primary responsibility and **X** = secondary responsibility

High Level Task	Gary	Carmen	Herman	Michael	Davin
Research	X	X	X	X	X
Projection Subsystem		XX	X		
Touch Recognition Subsystem				XX	XX
Mechanical Casing	XX		X		
System Integration	X	XX	X	X	X
System Testing	X	X	X	X	X
Status Indication			XX		
Material Acquisition	X	X	X	X	
Documentation/Graphics	XX	XX	X	X	X
Administrative Tasks	X	XX			
Funding/Financials	X				X

► Individual Reflection – Carmen Tang

This entire project has been an extremely unique and eye-opening experience for me, although we merely only scratched the surface of how it is like to be in a startup. It was extremely enjoyable to have been able to brainstorm and select an idea that we thought was marketable and then experience the long, difficult journey in order to make it a reality.

Most of the lessons I learned were from failures in our work process. Numerous times, the data in our reports were reverted due to synchronization problems as we were using Microsoft OneDrive. Although it was a fantastic option for storing all our documents and online collaborative work, there were occasional times when out-of-sync copies of files caused us to lose a lot of data and increase the amount of time spent on the documentation. To deal with this, we decided to keep our own local copies of the cloud file each time after a major edits, and communicated with each other to ensure edits propagated to all our online versions of the file. After constantly taking these small steps for extra insurance, sync problems ceased completely, which was a major benefit. There were also some times when we believed we had thoroughly taken all important factors into account, but neglected a tiny matter that later causing massive constraints across the whole product. I was not able to accurately predict most of the times we hit difficulties even by the end of the project, thus reminding the lesson that unexpected things will always arise and also showing that I do not yet have enough expertise in these fields and require more experience in order to become a better manager.

Looking back, it was extremely beneficial to have started early, in May of last year. However, if we had completed our first round of investigations and tests earlier we would have stumbled upon better resources and parts for our proof of concept design. It was quite unlucky that we found the Nimble VR, a perfect alternative to the Leap Motion, only a few days after it had stopped selling on Kickstarter. Now I believe that, during any initial investigation and experimentation stage, one should never close

the doors to other major paths we could take because at any one time the perfect resources for a different route may appear.

It also would have been great if we could have started speaking to physicists and experimented to fix the focus problem at larger angles at the beginning of our project, however we did not realize this problem until we laid our hands on the actual projector months later. Thus I also learned that it is extremely important to get one's hands on the actual hardware related to unfamiliar technology as soon as possible, whether it be temporary borrowing or buying, in order to check for unexpected but important factors one wouldn't have thought of simply from reading product specifications or understanding the basic theory behind the product.

Having students with different personalities and engineering skill sets in the group worked out extremely well for us. Since everyone in the group was already acquainted with each other, it was quite easy to divide work and split off into subgroups, and for people to swap work groups or pick up for each other in times of need. We also strived to socialize outside of work by going on trips together, dinners and playing sports, in order to enjoy each other's company and maintain good relations while working.

► Individual Reflection – Davin Mok

In my undergraduate career I have worked on many different projects of varying scopes, but nothing comes close in comparison to the LumenX³. This capstone project has been the most ambitious and rewarding project I have ever undertaken. To be able to work with 4 other talented engineers, each with their own specific set of skills and knowledge, was an enjoyable experience. I am delighted to have developed a product with such an amazing team and to be able to demo the LumenX³ with its set of innovative features for all to see.

I was introduced to this group through the assistance of Herman and I quickly knew we were going to make something great. During our initial meeting I was excited to see that our goals were aligned. That is to make a product which is not only innovative but also marketable. Each member came up with different ideas ranging from vacuum cleaners to drones and it was apparent that I was amongst a group of very intelligent and creative people.

For the development of the LumenX³, I partnered up with Michael (Him Wai) to develop the whole Touch Gesture Recognition Subsystem. Michael is very ambitious with his goals and often times those goals are far too difficult to implement given our schedule. I, on the other hand always try to alleviate risk. Instead of pushing for more amazing features and over promising on our documents, I try to remain as practical and realistic as possible which sometimes hinders our innovation. I believe it was fortunate that Michael and I partnered up as we were able to strike a balance between my practicality and his ambition to create a touch system that is advanced and reliable in a timely manner.

Through the development process I have tried various methods to achieve hand tracking to determine a touch event and I got stuck numerous times. I learned that an effective way to overcome design obstacles is to remove all previous assumptions and tackle the problem from the very beginning once more. It was also hard to stay enthusiastic about the product over time since we started planning and

developing 8 months before class started. This would in turn impede my development as I was less motivated. Once ENSC305/440 began I found my motivation again and development was going at an efficient pace. This is a valuable lesson for me if I ever start a business of my own. There will be times where my determination will waver but I must stop and rekindle my passion as it will ultimately result in work that is of greater quality.

In terms of technical knowledge, I learned a few things about drivers and how they cannot make use of external libraries. I also learned you can use a 3 by 3 matrix to move every pixel on a computer screen to perform perspective correction. Aside from learning new things, I also applied a lot of knowledge that was gained through previous classes. In the Touch Determination Algorithm, I made use of data points to generate a virtual plane that would be viewed as the surface in the software. We also made sure our projection was projecting only the visible spectrum while our detection device utilizes the infrared spectrum. This ensured both systems do not interfere with each other. I believe project classes like this are what makes undergraduates appreciate the classes they have previously taken.

When all is said and done, this experience has been an invaluable one. To be able to develop such an exciting device with a group of wonderful engineers is my honour as a member of ObelXTech. I wish all the best to my teammates in their future endeavours.

► Individual Reflection – Gary (Guo) Yu

ENSC 305/440 has been one of the most challenging yet rewarding, frustrating yet affirming, and overwhelming yet enriching projects I have undertaken at SFU. When our group first started brainstorming for the idea of a projected computer, we envisioned a futuristic cube capable of generating breath-taking projections and handling next-level user interactions. Although we found our vision to be fairly ambitious in scope and technicality after further research, everyone in our group decided to commit to a project that we would be proud of working on and bringing to realization. Working on the LumenX³ with the amazing group of fellow team members in ObelXTech has not only given me a chance to apply all the schooling I have received over the years but also the chance to grow as an engineering student.

As the CEO of ObelXTech, I had the chance to engage with all aspects of project development, from start to finish. I was involved in project direction, coordinating with and in between group members and stakeholders as well as acting as the team representative. In leading the applications for project funding, we were extremely successful at obtaining grants at an early stage in our development, allowing us to take advantage of our earlier start. Project scheduling was also a critical component of our success where the completion of the tasks followed reasonably well according to my original projections given our extended timeline.

One of my largest contributions to the project was the overall mechanical casing design. Having a background in designing and crafting 3D printed projects gave me the skills to tackle the height requirements of our physical projection and rising mechanism of our case. The use of modelling software allowed me to model all of our components and design the placement of everything in the case, in addition to the case itself. However, one of the key lessons I will always remember from this project is

that no matter how accurately one models and plans for something, unexpected setbacks or blockades will inevitably arise. Since our case design went through several iterations, its physical sizing became so great that it was no longer physically or economically feasible to 3D print the whole thing. After much trial and error, and fighting for hours with the 3D printer, we decided to make the case out of acrylic instead. Although this was not part of our original plan, the meticulous design and planning that went into the case design actually helped tremendously in transitioning to our back-up plan. The importance of remediation has been a recurring theme in our project development, for it is easy to become narrowly focused on accomplishing things one way, when more often than not, plan B necessitates becoming plan A.

Beyond the technical aspects of the project, I have also learned to value and capitalize the group dynamics of working in a team. As part of the traits that allowed us to tackle such an innovative project, our team members have exceptional motivation and individual points of view, which can lead to some disagreement in implementation logistics and project direction. I became well-versed as the mediator between these conflicts, whose resolution ultimately made our team stronger and our solutions more fitting. Communication within our team and between our subsystems also started off fragmented and disjoint, but became stronger as we learned to adapt to the different styles of each of our members.

As a group, we have spent the better part of a year working on the LumenX³. From our initial vision of the product to our final realization of the proof-of-concept, I can confidently say we have accomplished all that we set out to do. My team members have been invaluable in supporting my role in the twists and turns of this project, and I owe them my sincerest gratitude for their support. The LumenX³ would not have been the achievement it is today without the time, effort and belief of a more eclectic team.

► Individual Reflection – Herman Mak

Bringing the LumenX³ from our imaginations into a working product has been the most tedious, but undeniably rewarding experience that I have undertaken at SFU. It was a different environment working cohesively with a group comprising of individuals with different backgrounds but one unified goal. I am extremely happy to have worked with my team to develop and produce our product from its conception to a working prototype that is capable to demonstrating a different take on portable content consumption.

Being the CMO of ObelXTech has allowed me to positively influence the design of the LumenX³ using proven marketing and product placement strategies. I think that my goal is to bring a relevant, and accurate customer perspectives into the development of the company and products alike. This includes the initial design of multiple aspects of the LumenX³ as well as the component selection to bring exceptional value and experiences to our users and consumers. At many points during the development of the LumenX³ we experienced unexpected problems pertaining to product feasibility and parts compatibility. I am happy that the solutions to multiple design problems always kept the consumer as our main focus.

I was lucky enough to work on multiple subsystems throughout the development of the LumenX³. Initially, I worked with Carmen on the projection subsystem. Doing the development on perspective

correction using OpenCV was great practice for my coding skills and it opened my eyes to the wide array of open source tools available on the internet. While we ended up not being able to utilize the OpenCV in our project, I think that this knowledge will be very helpful in the future. Afterwards, I worked on the Mechanical Casing with Gary. While I do have some basic background understanding of mechanical design from ENSC 230, helping with designing the casing and its mechanisms was something much more than I expected. We went through several implementations of the mechanisms until they met our expectations, even though some only performed seemingly simple tasks. I think that dealing with the minute imperfections between design and implementation is something I will take with me moving forward. Finally, I worked on the status indication system that displayed system status in the form of a LED. Doing this part of the project helped me understand the Windows operating system more. Previous to this project I never understood what a Windows Service was let alone implement one.

Working on the LumenX³ has improved my interpersonal skills in a number of ways. Firstly, working through the project at such a high pace has taught me the usefulness of clear communication. In such a large team, clear and concise communication can save everyone valuable time by minimizing lost time and reducing communication errors. Secondly, I think that I am more capable to dealing with criticism and improving from it. Learning to match each group member to tasks, which align with their strengths makes the development of the product quicker and more efficient is something I take away from ENSC 440.

Overall, I very much enjoyed working with my ENSC 440 group and am thoroughly impressed with the product that we came up with. Taking an idea through a complete development cycle is not something we have the chance to do very often so this was a great experience. I wish the best to my teammates in their future endeavours.

► Individual Reflection – Him Wai (Michael) Ng

The LumenX³ is the most challenging and fantastic idea that we have ever imagined, and it is also the product that all of us most wanted to have. During the initial estimation of the difficulty and complexity of the problems we would have to solve, we realized the scope of this project was bigger than we originally thought. We almost gave up on it and switched into another idea. But fortunately, we were all challenge takers and would not easily give up on problems, or we would never be able to witness the success of the LumenX³ today. I am really grateful to be able to work with my brave and intelligent teammates. Without their diverse skillsets and viewpoints we would not have been able to solve some of the fundamental problems and turn this idea into an actual device. Although we sometimes had very different opinions on certain topics. We could always agree to one approach by discussing over the pros and cons of all opinions in a friendly manner.

As the CTO of ObelXTech, my role was to decide the hardware components, software architectures and implementation techniques to employ in this project, such that they fit us the best within the time and resource constraints. I also gave advices to other members when technical problems occurred. Therefore, I had to research a lot to make sure we were heading in the correct direction and to prevent any foreseeable conflicts between different functional modules in later stages. This was a challenging yet

rewarding task since many of the techniques that we ended up using were very new to me. I had to learn them and incorporate them into my thinking and design process in a relatively short period of time. So this was like a meta-learning experience for me, not only I learned a lot of new hardware and software skills, I also learned how to learn quickly. After all design details were finalized, we were separated into groups to work on implementing the core, projection, touch gesture and mechanical case modules. I decided to join the touch gesture group.

Developing the touch gesture module was probably one of the most challenging parts of this project. There were little to none related work published online or in literatures, so we had to come up with our own design and implementation without knowing how well that would work out. By developing and testing on various hardware and software iteratively, we minimized the risk of end up having non-functional product. We finalized the use of Leap Motion Controller after this process. The 3D sensing capability of Leap Motion greatly reduces the amount of work for us since we didn't have to reinvent the wheel and make our own 3D image sensor. Although Leap Motion Controller was not officially supported to use in a tilted orientation in our setup, with some compromises in accuracy and computational efficiency, we were able to combine the detection tools provided by the SDK with our own scaling and calibration algorithms to overcome this limitation. If I were to do this project again, I would start implementing this module early and buy the Nimble Sense, which would enable us to implement a more accurate and functionally complete system.

As an engineering student in SFU, I have always been wondering how I can apply knowledge that I learned from classes into solving real world problems. The capstone project class gave me the exact opportunity to explore and figure this out. Throughout the making of LumenX³, I found myself constantly and subconsciously applying knowledge that I learned in previous classes, such as product design, software programming, electric circuits, into this project. This was an invaluable experience, not only it bridged the gap between academic knowledge and practical development, it also allowed me to have the chance working with a group of bright engineers to bring our futuristic idea into reality.

In conclusion, I think this is a very successful project. We were able to implement the prototypes of all the functionalities that we originally designed and had them working together to demonstrate this futuristic idea in real life. I would like to thank all of the team members for constantly supporting each other and never discouraging anyone when things did not go well.

◀▶ 6.0 Conclusion

The LumenX³ is a new addition to a consumer's smart device portfolio. It is designed with collaboration and portability in mind by utilizing projection instead of having a physical screen. Consequently, we must also employ a fingertip tracking method by means of infrared cameras. As a result of all these innovative approaches to redefine how a user can interact with a smart device, more hardware space is now available for greater computing power meanwhile keeping the LumenX³ as a portable device one can bring anywhere.

The post-mortem document clearly describes the journey that ObelXTech has taken in the development of the LumenX³. We have modified the scope of our proof-of-concept model many times due to

unforeseen hardware and software limitations. However, we have successfully brought out the main functionalities outlined in our functional specification. They include: projection of a perspective corrected screen, detection of touch gestures, and a case design that embodies the equilibrium between functionality and portability.

Further research and design is needed to bring the LumenX³ to the market. With a custom printed circuit board, a more powerful processor, an even smaller projector capable of wide angle projection, and an in-house designed infrared detection unit, we feel the LumenX³ will be powerful and portable enough for the competitive smart device market. ObleXTech is still in discussion in regards to the future of the LumenX³ but nevertheless it is undeniable that we have developed a truly innovative device with great market potential.



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◆ Appendix – Meeting Minutes

Since we have started working on the project since May 2014, we had semi-monthly meetings before the current semester. However, only detailed Meeting Minutes starting in January are included in this document. A list of our previous meeting dates prior to January is supplied below.

List of Meeting Dates Prior to January 2015

- May 22, 2014
- May 25, 2014
- May 29, 2014
- June 20, 2014
- May 24, 2014
- July 4, 2014
- July 5, 2014
- July 8, 2014
- July 12, 2014
- July 14, 2014
- July 17, 2014
- July 23, 2014
- August 24, 2014
- September 7, 2014
- September 12, 2014
- September 20, 2014
- September 28, 2014
- October 11, 2014
- October 20, 2014
- November 1, 2014
- November 11, 2014
- November 15, 2014
- November 20, 2014
- November 21, 2014
- November 22, 2014
- November 23, 2014
- December 3, 2014
- December 14, 2014
- December 21, 2014
- December 22, 2014
- December 27, 2014

ObelXTech
MEETING AGENDA AND MINUTES
January 8, 2015
18:00 – 19:15
Online Skype

Agenda:

- Update on individual progress
- Back to official start of semester
- Herman's update on perspective correction

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Herman has made the projection full screen (output takes up whole screen). Next step is making it work with video. Currently he is working in his VM with 1680px, so he moved it to mac and then output it
 - Using OpenCV for his projection
 - His image output works apparently
 - His video output is apparently working as well
- Carmen's been reading up on Windows drivers
- Davin is sick. Poor thing. Davin to read up on LeapMotion book.
- Mike's still sick. Not as poor.
- Gary has tried Arduino in Motion circuit using LED, look into motors and steppers

Action Items:

- We are going to meet up (Carmen, Herman, Gary, Mike) at school between 305 and 440 classes, in one of the AQ 4000 rooms.

Next Meeting Date: January 9, 2015



ObelXTech
MEETING AGENDA AND MINUTES
January 9, 2015
10:30 – 14:10
SFU AQ 4115

Agenda:

- Go over driver theory
- Updates on proposal revisions

Present: Carmen, Gary, Mike, Herman

Minutes:

- Display driver:
 - Carmen looked over the sample display driver, explained idea to Herman/Gary/Mike
 - It seems that there is a BltBits function that is called, with a BLT_INFO struct for Source and Destination screens
 - BLT_INFO contain width height and PVOID* bitstream that you cast into (BYTE*) to access the data.
 - 32 bits/pixel, 4 bytes/pixel for data.
 - This sample driver IS NOT ROBUST AND SECURE and we need to look at what drivers normally do (e.g. hardware interrupts, may need to split rectangles instead of just 1 rect.
 - If we can access the const source's bitstream, make a copy of the source data that has opencv acted on it, then use that in the rectangles, should be good.
 - However, to use opencv, we cannot make any changes to it.
- Gary started going over the proposal:
 - He will make changes to Android, the parts to reflect Meego, and removing device parallelism into a dream idea.
 - Replacing it with stretch goal of increasing screen size when pinching screen and elevating projector.

Action Items:

- Mike/Davin: LeapMotion, write code to detect hand gestures at the right angle. Then detect a 'touch' and the other kinds of touches.
 - Next step is work with Carmen potentially on writing firmware for touch.
- Carmen/Herman: Display Driver, write driver to display transformed output.
 - Make it 'work' first , with opencv, and then work on making it a solid piece of hardware.
- Gary: Arduino light on and off, and how to make it work with the system? Via power or via usb driver with windows?
 - Proposal edits, and refining of IEEE requirements for IEEE FUND

- Carmen: page design is good, keep same logos. Make a cool design/splash for front page.

Next Meeting Date: January 11, 2015



ObelXTech
MEETING AGENDA AND MINUTES
January 11, 2015
14:00 – 17:30
Davin's Home

Agenda:

- Test Leap Motion ranges and detection
 - Get measurements
- Test driver perspective correction demo

Present: Carmen, Mike, Herman, Davin

Minutes:

- Leap Motion
 - Doesn't work with paper towel background
 - The projection doesn't interfere with LEapMotion because it's VISIBLE LIGHT, but Leapmotion only detects IR Infrared
 - Mike didn't return other Leapmotion, so we currently have 2
 - Gary to check budget amount and see if we can keep 2, one for Davin to use since Mike/Davin live so far apart.
 - 4ms delay for leapmotion, so people can actually type well
- Measurements
 - Can Gary make a 3D Print of a structure to put the projector on? Need to give him requirements/measurements
 - Height from bottom of structure to bottom of the projector: 24cm
 - Projector Stand: 24cm from surface to bottom of lense
 - LeapMotion Stand: 4.5cm from surface to bottom of LeapMotion
- Touch actions
 - TAP
 - TAPHOLD
 - DOUBLE TAP
 - DRAG
 - TWO FINGER DRAG
 - PINCH IN and OUT
- OpenCV perspective correction
 - 39 seconds to run opencv display transformation on 1:21 video

Action Items:



- Next time bring a protractor to measure the angle
- More work with Leap Motion settings and background
- Gary start more designing for parts

Next Meeting Date: January 16, 2015



ObelXTech
MEETING AGENDA AND MINUTES
January 16, 2015
10:20 – 14:10
SFU Sunny Room

Agenda:

- Meego Pad arrival
- Separation of hand detection development
- IEEE grant application

Present: Gary, Mike, Herman

Minutes:

- Meego Pad
 - Meego: Intel inside logo has no TM, so gg lol
 - Computer name: Blackbox
 - User: Reika
 - b2box
 - Running windows 8.1
 - All seems good!
 - Mouse slightly laggy sometimes, only slightly
 - Processor: Intel(R) Atom™ CPU Z3735F @ 1.33GHz
 - Installed memory (RAM): 2.00GB
 - System type: 32-bit Operating System, x64 based processor
 - Pen and Touch: No Pen or Touch Input is available for this Display
 - Windows is not activated.....
 - Product ID: 00266-70000-00000-AAOEM
 - Also bought a \$14.55 USB 3.0 A/A M/M cable from NCIX
 - It will work with 2.0 ports.
- Mike and Davin coding separately
 - 1 mini milestone: VR mode completely calibrated for our use by Friday, Jan 24
 - 2 mini milestone: pinch, zoom, poke, touch surface gestures usable by Jan 30
- IEEE grant deadline is actually January 30, not 20 hooray!

Action Items:

- Davin focusing on tilted 90degree coordinate system
 - Davin TBA?
- mike focusing on VR mode hand detection and gesture creation

- Mike to be done by January 30....that's in 2 weeks/ pretty late. Does he have smaller milestones?
- Herman send draft email of asking letter recommend from andrew, he needs to incorporate edits and then we send, talk to andrew asap e.g. monday to get it
- Herman to try integrating opencv project projection code into driver stuff. Will try to windows on his mac or just send carmen code to deploy on her machine setup
- Sunday meeting to discuss proposal, and other requirements for grant. Proposal complete by Jan 21, then final edits and hand in by Jan 24.

Next Meeting Date January 18, 2015



ObelXTech
MEETING AGENDA AND MINUTES
January 18, 2015
13:00 – 17:20
Davin's Home

Agenda:

- OpenCV update and problems
- Graphics tests with Leap Motion, projector, Meego Pad
- Proposal edits

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- OpenCV
 - Looking into the DLL method of utilizing OpenCV in Visual Studio projects, an issue has come up. It seems like Visual Studio 2013 is too new for the OpenCV 2.4.X such that some files won't work when trying to setup on VS2013. Our current driver test deployment that Carmen has is setup on VS2013...don't know if it will be huge difference swapping to VS2012.
 - ISSUES
 - OpenCV 2.4.X does not have the specific DLLs for Visual Studio 2013
 - OpenCV 3.0.0-Beta changelog states that some functionality was moved around/removed so it might cause compatibility issues with the existing OpenCV image correction code
 - Potential Solutions
 - Downgrade to Visual Studio 2012 (Proposed solution)
 - VS2012 might not support Windows 8.1 targets??? Check please
 - Upgrade OpenCV to 3.0.0-Beta
 - Can only use VS2013 to write for Windows 8.1! GG can't use VS2012
 - Therefore we prob need to use OpenCV3, which apparently has differently worked modules and less stuff (maybe that's okay for us because we're not using a lot? Need to check)
 - Herman is going to try adding 2.4.10 to his VS2013 project, see if it works
- Projector
 - Meegopad testing with the projector - heart attacks at first because it wasn't working
 - Potential problems:
 - Projector needs software update? But couldn't find it online on main website....
 - Graphics problem on the Meegopad? It works on the Sony TV perfectly though.
 - Changed it to 60Hz refresh rate from 59Hz

- Mike tried it on his Windows 8 machine...had some difficulty at first, but after extending/duplicating, and setting to 1280 x 1024 it worked. So maybe Windows 8 driver problem?
 - Trying Windows+P to cycle between displays blind.....AND IT WORKED
 - Windows+P 3 times then enter to select the third option: Duplicate Display.
- Leap Motion
 - Tried Leapmotion install o it, ran leapmotion
 - ~36ms delay, quite smooth but still a noticeable TIIIIINY delay. Both hands work fine, quite precise as well. Aka looks good.
 - Hopefully there won't be too much accumulated delay with the projection correction algorithm
 - Adding two hands, is about 60ms or higher (couldn't see from window) but it's still quite responsive. (y) again.

Action Items:

- Gary: modelling, scheduling and references to remove
- Carmen: title page design + page design
- Mike: glossary + pg/ 11 budget
 - Bluetooth, wireless, functionality, VR mode = front mode
- Davin: update block diagram image
- Herman: marketing write-up
- Do all by Wed Jan 21, then Fri Jan 23, then do IEEE work and declaration
- Gary to talk to Andrew when he goes to class tomorrow and send email

Next Meeting Date January 25, 2015



ObelXTech
MEETING AGENDA AND MINUTES
January 25, 2015
13:50 – 16:00
Herman's Home

Agenda:

- Driver testing and tutorial
- Proposal drawings and edits
- New avenues for research OpenCV

Present: Carmen, Gary, Herman

Minutes:

- Driver
 - Carmen unable to get driver installed on Samsung in her regular setup!
 - Went over set-up to do coding and driver
 - Herman tried on his mac but due to using bootcamp cannot run
- Ended up drawing proposal designs instead
 - Work on title page graphics
- OpenCV method of perspective correction may not be viable
 - Including libraries via DLL or Static Linking causes errors with preprocessor defines
 - Upon closer research, OpenCV may be directed towards application development and may not be designed for driver development
- Research summary
 - [https://msdn.microsoft.com/en-us/library/windows/hardware/ff570595\(v=vs.85\).aspx](https://msdn.microsoft.com/en-us/library/windows/hardware/ff570595(v=vs.85).aspx)
 - Upon further research, usermode portion of driver is a DLL loaded by direct x
 - Research has found that people do keystone correction through plugins
 - <http://visution.com/downloads>
 - This is a freeware that we might be able to edit for our needs
 - We can probably decompile this freeware to see how it is doing its changes
 - <http://freeframe.sourceforge.net/>
 - This is what the above thing utilizes, FFGL
 - Luckily,
 - GPU is based on Ivy Bridge Intel HD Graphics, with 4 execution units, and supports DirectX 11, OpenGL 4.0, OpenGL ES 3.0 and OpenCL 1.1 (on Windows).
 - From http://en.wikipedia.org/wiki/List_of_Intel_Atom_microprocessors
 - This document was written that uses a camera to detect distortions and then change accordingly, ours is a fixed correction so easier than this

- http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6738647&url=http%3A%2F%2Fieeexplore.ieee.org%2Fexpls%2Fabs_all.jsp%3Farnumber%3D6738647
- Keystone using FPGA
 - http://www.midem-drustvo.si/Journal%20papers/MIDEM_40%282010%293p204.pdf
- Using a current generation graphics card (ATI Radeon) on a PC, we have implemented a rendering system that loads images, updates the texture memory and displays pre-warped images in real time. The rendering technique of perspective correct texture mapping exploits the high quality texture filtering available on the graphics cards. As seen in Figure 5, we can skew the projector with respect to the horizontal flat surface and still correct the image so that it appears aligned and rectangular with correct aspect ratio. For comparison, we show the outline of the keystoneed image in the bottom window. The vertical edges in the pre-warped image (in this case a PowerPoint slide) appear to be parallel to the edges of the whiteboard.
 - <http://web.media.mit.edu/~raskar/Pocket/KeystoneCorrection/selfCorrectingProjector.pdf>
 - http://www.virtualdj.com/forums/160623/General_Discussion/Horizontal_keystone_correction_for_video_output.html

Action Items:

- Herman to add in his edited part
- Carmen to finish design of pages, page numbers, and special executive summary and titles of sections
- Davin to update block diagram
- Redo list of figures

Next Meeting Date January 27, 2015



ObelXTech
MEETING AGENDA AND MINUTES
January 27, 2015
13:30 – 18:25
Mike's Home

Agenda:

- Various updates on all components
- Leap motion tests and projection variations

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Leap Motion
 - Demoed 45 degree top down can track figure coordinates
 - 10 cm above
 - Front most finger
- New fixture 2000 and leap motion distance issue
 - Measured distance between projected image and the tower is 20cm
 - this caused leap motion detection to become fuzzy at the edge
 - if needed, background light is an important control factor
 - orientation-related detection limit need to be checked
 - Optimized detection range: majority of the UI within 15-20 cm range, with furthest corener no more than 25cm
- Made new projection testing fixture for more accurate development and reproducible environment
 - Observations
 - Decreasing angle
 - Reduce distance from stand to projection
 - Reduce projection size
 - Increase range of focus
 - Increasing height
 - Increase image size
 - Increase distance from stand to projection
 - Currently the image measures 15.5cm x 10cm (WxH)
- Touch
 - Whether occurs using distance and location
 - Triangle
- Onto Windows
 - Multi touch driver needs firmware
 - Research ASAP after Mikes single touch and skeleton and/or pinch

- Not Linux
 - Don't waste research
- Display Driver other options
 - FF GL for v-jaying as a plugin; probably program
 - Carmen's keystone correction program but its screen shot, auto start program
 - NVIDIA NV keystone driver GFORCE but old, outdated
 - Other algorithms: matlab
- OpenCV
 - Use its matrix for actual image
 - Matrix multiplication
 - Translate data into matrix, do operation, retranslate
 - $1000^2 * \text{data size?}$
- Done pixel 3x1 vector, mult by 3x3 (x,y,alpha)
 - Set alpha to 1
- IEEE SEC
 - Go with software standards

Action Items:

- Complete and hand in proposal
- Do more research and tests with other perspective correction
- Look into IEEE standards more
- Perspective Correction
 - Next step: determine ideal angle and height for best leap motion gesture recognition
 - GOALS:
 - Full usable gesture cognition
 - 10 inch screen
 - Height under 35cm

Next Meeting Date: February 1, 2015



ObelXTech
MEETING AGENDA AND MINUTES
February 1, 2015
13:20 – 17:30
Davin's Home

Agenda:

- Image perspective research
- Actual projection dimensions
- Case placement and dimensions
- Windows driver implementing homography

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Image information
 - Found out some useful information about image typing for the correction:
 - Mat Type
 - frame 8UC3 Vec3b
 - distortMtx 64FC1 double
 - Seems like the driver will use some form of 4 dimensional (R,G,B,Alpha)
 - Problems: correct locations of pixels are computed (I think) but copying the pixels over causes loop to stop
 - Copies the bits over now, cannot save image so I cannot verify if image is correct
- Herman brought his fixture 2000, with the projector on it, we measured the screen distance and dimensions again, and determined leap motion works best when the whole projected screen's furthest edge is within 30cm from the base of the box.
- Case and component placement
 - Final decision of the box height is 40cm, with projector located at 28cm from ground. Projecting angle is 60 degrees with projected screen being an 7.5 inch 5:4 (15cm x 12 cm) output. The projected screen is from 15 to 28 cm away the bottom of the box.
 - This allows for a larger screen of at least 7" in size, and is still within LeapMotion's range.
 - Gary to print out the casing in parts in his lab's smaller 3D printer. (For unibody/larger parts, may have to use SFU or BCIT larger 3DPrinter)
 - For now, we plan to implement the rising tower mechanism.
 - Leap motion position remains 10 cm above ground and tilted down at 45 degrees.
- Davin demo the touch function based on our new dimensions, it worked.
 - was hardcoded to detect at a certain distance and height, but the tap seems to actually work (yes when touching table, no when not, roughly).

- Windows Driver
 - Windows touch firmware development:
<http://channel9.msdn.com/Events/Build/BUILD2011/HW-182P>
 - Carmen implemented the perspective correction using a linear algebra library without openCV, she obtained the matrix, and applied it on 1s and 0s and proved it was useful, but the deployment onto the test machine still need more work. More info can be found in her journal in onenote.

Action Items:

- Herman to transfer perspective correction to Carmen
- Gary: use new measurements in case design
- Davin: work on integration with Mike's code
- Improve driver deployment and algorithm

Next Meeting Date: February 2, 2015



ObelXTech
MEETING AGENDA AND MINUTES
February 2, 2015
21:00 – 22:20
Online Skype

Agenda:

- Functional Spec overview and assign work
- Case functioning update

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Functional Spec:
 - Gary to ask Jamal/other TA about requirements, because we're unsure
 - Looking at <http://www2.ensc.sfu.ca/~whitmore/courses/ensc305/pdf%20files/Example%20Functional%20Spec.pdf> for reference - it's very good!
- Case
 - Herman/Gary going to start with non-motorized casing.
 - Mike says servos can control angular velocity etc to calculate the height and control how high it goes

Action Items:

- Func Spec
 - Davin - add in subsystem information into system overview
 - Carmen - look over requirements
 - Carmen - do Test Plan based on IEEE <http://standards.ieee.org/findstds/standard/829-2008.html>
 - And this one 730-2014 - Software Quality Assurance Processes
 - Davin to write Conclusion
- Gary/Herman to work on the servos - need to make deadlines
- Gary to work on Arduino/LEDs
- Davin/Mike to make own LeapMotion casing for now, hack it up
- Next Monday: sketch/design and understanding. At meeting: need to talk
 - MEETING NEXT MONDAY: at Davin's?
 - By end of month: non-motorized casing?
 - Go over functional spec

- Decide on where the components are, what is visible, where is ventilation, how to suspend them, etc.
- Carmen: to optimize display driver.

Next Meeting Date: February 6, 2015



ObelXTech
MEETING AGENDA AND MINUTES
February 6, 2015
14:30 – 17:50
BCIT and Metrotown

Agenda:

- Projection screen updates
- BCIT speed dating
- Case design

Present: Carmen, Gary, Mike

Minutes:

- Projection updates
 - Carmen got screen to work, more optimized
 - Basically just only changed the 32 to 32 function, else will replace whole screen and fill black sides
 - Only problem now is: stretched when projected, lines of black
 - P1 Mouse leaves a black trail when moving upwards....missing a bit from dirty rectangles?
 - P3 Screen a liiiittle bit fuzzy sometimes (because of mapping of more than 1 source to 1 destination pixel)
 - P3 Ever so tiniest lag
- Carmen took screenshot and video of her new driver, sent to everyone. Herman to project it and tell Carmen the vertical indentation/offset to fix stretching vertically.
- Problem: Carmen's laptop only goes down to 1024 x 768 lowest resolution. MeegoPad/Pico is 1024x600 .
 - Solution: Carmen going to mask the top 168 lines into black...test with Herman. Herman says $0.7692308 * y$ indent
 - Is this one right I thought it should be 1.0something...
- Facebook Quote to Easily Find Conversation: the multouch firmware only takes very general location parameters
 - Then SCROLL UP
- Checking up on the arduino: the MeegoPad does not power any of its usbs (aka arduino) when it is not POWERED ON (button pushed).
 - Therefore, arduino can only run when meego is on. This is okay for servos, rise up when power pushed on, except when you force unplug, the servos never go back down.
 - Light LED doesn't HAVE TO be on when meegopad is off (lower priority is to get it to light up red or something when off).

- Power is a lower priority, but large problem outside of our expertise. Must tackle this problem later on.
- Other detectors
 - Herman found an ultrasonic detector that can detect accurately down to 2mm distance, but detection diameter is unknown
 - he was thinking to use for adjusting the heights of the projector with servos, but since it depends on sound echo, so no idea if it will work in our enclosed casing.
 - Also found something called a wheel encoder that should be good to look into: it says it can be used to measure speed and distance a wheel travels. Sounds like the right one. It utilizes an IR sensor and a disc of alternating black and white lines, the IR sensor hits these lines and whatever bounces back will be different
- BCIT
 - 2D metal/glass/Styrofoam
 - 3D print – abs, pla, not as strong, mixture of 2
 - Human factors guy is not an engineer, he's designer
 - Talk to him about case design guidance
 - Brian_keavn@bcit.ca
- Case design
 - Locking mechanism ideas
 - Poles like tripods with screw to tight and loose
 - Not good b/c has to be outside, cannot control height lots manual labor
 - 2 stage lock with springs or something else, cannot push back out after lock and user has to manually pull
 - Side L -> R designs, at top and bottom, inside outside differ
 - Placement
 - Top wedge meego top or bot?
 - usb hub
 - hdmi male to female cord
 - power to bot
 - 40 cm? place projector behind

Action Items:

- Gary/Herman working with cardboard to try and make design of casing/box draft by Monday
- Mike is currently working on studying Firmware, getting the dev environment set up and trying examples.
- Davin has finished writing Conclusion, and fixing subsystem writeup to be more explanatory.
- Carmen: to fix indentation/offset
- Gary: sketch up more designs, esp in locking and case

Next Meeting Date: February 9, 2015

ObelXTech
MEETING AGENDA AND MINUTES
February 9, 2015
14:00 – 17:10
Davin's Home

Agenda:

- Firmware research and implementation
- Case design review
- Func spec revisions and edit

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Firmware research
 - <http://social.technet.microsoft.com/wiki/contents/articles/6460.simulating-touch-input-in-windows-8-using-touch-injection-api.aspx?PageIndex=2>
 - <http://stackoverflow.com/questions/7507568/is-there-a-way-to-simulate-touch-events-in-windows-8>
 - Application level only, not integrated into driver
 - When OS is on, needs to run this software automatically
 - <http://www.wenda.io/questions/3006220/emulate-touch-event-in-windows-8-using-python.html>
 - Directly interact with the driver, written in python
 - Also application level only (needs to run the script in order to simulate the touch)
 - Thing to do for now:
 - Implement an application-level touch simulator which is controlled by leap motion inputs.
 - Turn on auto-run in windows to run that software when windows finish booting
 - Estimated code complete date: Feb 14th, 2015
 - More examples:
 - <https://software.intel.com/en-us/articles/handling-touch-input-in-windows-8-applications>
- Case design review
 - Sketch up mock ups are good but missing some Leap motion and component cables
 - Are we doing 2-plug power bar inside?
 - USB Hub? New design for stick to power MeegoPad?
 - Ideas for lifting up the box:
 - One handle connects to both sides, so you only have to lift one thing
 - Big Handle at the back on the inside box, with locking on the sides.

- One big spring
- More drawings of lock mechanism, spring, usb hub for everyone to visualize and see

Action Items:

- Everyone have func spec changes done by Wednesday night 8pm
- Gary: make changes to design

Next Meeting Date: February 14, 2015



ObelXTech
MEETING AGENDA AND MINUTES
February 14, 2015
20:00 – 22:00
Online Skype

Agenda:

- Func spec revisions and edit again

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Func Spec
 - Went over requirements, added in the numbering, priorities
 - Davin's section needs to redo with the 3 subsystems
 - Go over new changes
 - Restructure organization
 - Still need to add:
 - Herman add usability
 - Mike add operational require
 - Usability from 304
 - UI stuff
 - Carmen to add more scenarios for subsystems as well
 - Add some of the details back in?
 - Glossary
 - References
 - Letter
 - Figures
 - Picture showing user with UI on surface
 - Maybe too hard?
 - Pic of windows ui
 - Complete analysis of problem. Justification for chosen functionalities

Action Items:

- Mike to finish the glossary
- Mike (or Gary?) to add in references for the parts
- Edit Davin's new Justification section (AAXA P3 Pico Projector)
- Mike to give him Visio to change the block diagrams
- Carmen

- write more in the test plan (more use cases and more details, maybe like 2 pages long)
- finish user drawings
- add in the purple style/formatting

Next Meeting Date: February 19, 2015



ObelXTech
MEETING AGENDA AND MINUTES
February 19, 2015
21:00 – 22:50
Online Skype

Agenda:

- Case update
- Work assignment for next in person meeting

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Case
 - Gary and Herman made the case following the cad design today
 - Because of ease, we reused Herman's shell front/back and made new longer sides according to sketchup
 - Because of our boxes being handmade and because of cardboard material....friction is high
 - Proposed solution Result
 - Reduce inner box size slightly Smooth Action
 - Line with low friction material
 - Teflon and/or silky fabric
 - Change composition materials to 3D printed
 - Made lifting mechanism and discussed as in table (check one note for details)
 - key factors:
 - stability in both modes, solid locking at top and bottom that can resist shaking etc.
 - ease of lifting

Action Items:

- Davin/Mike:
 - Davin to make temporary stand for LeapMotion
 - Davin to fix his touch code for Leapmotion touch detection, and send to Mike
 - Mike to put his tracking code in with Davin's, and then into TouchInjection program.
 - DEMO OF A 'TAP' EXPECTED BY THIS SUNDAY
- Gary/Herman:
 - Focus on making the manual lifting part of the case (make sure it's consistent with height changes, else we'll have to measure every time.....or use a different method that's more consistent)

- Make the stand for projector and leapmotion. These may need tweaking for the next week. (meanwhile we have Carmen's tripod and Davin's makeshift leap stands)
- BRING THE CASE SO WE CAN CRITICIZE LIFTING METHOD, and also check for any design problems now that we have a real 3D model to actually look at and play around with.
- Carmen:
 - Get screen size and distance from box, then send to Mike and Herman/Gary
 - Write driver for this specific screen height/angle
 - Try to get it running by installation, not debug.
 - DEMO THE PROJECTION AT THIE HEIGHT, SHOULD BE CORRECTED
 - TRY TO HAVE DRIVER INSTALLED NOT VIA DEBUG
- March 6th is our Oral Report Presentation at 3pm
- March 16th is when Design Spec due

Next Meeting Date: February 22, 2015



ObelXTech
MEETING AGENDA AND MINUTES
February 22, 2015
13:30 – 18:10
Davin's Home

Agenda:

- Review current case prototype
- Updates on other modules
- Start oral progress report

Present: Carmen (by Skype), Gary, Mike, Herman, Davin

Minutes:

- Case review
 - Wants
 - Locks at the bottom
 - Locks at the top
 - Takes at most 2 hands to operate at top and bottom
 - Does not fall due to gravity - has graceful falling at the end, cushion
 - Buttons will be the locking mechanism - it goes with the inner case
 - See herman's design on paper
 - Longer button will keep it more stable to prevent pivoting (almost like the push out design)
 - Rods will be connected to inner shell but there will be a plank that loops through the rods
 - The planks will push on the spring wrapped around the rods to allow the button to squish into the inner box and allow the inner box + button to slide up and down
 - Have springs at the bottom to kind of help cushion fall, and to pop the box up once you push the two buttons (because one button on each side requires two hands)
 - THEN you can grab the top handle with one hand
 - The locking will happen at the top and bottom.
 - STILL NEED A GRACEFUL FALLING MECHANISM, because if you unlock at top it will freefall = badddd
- We are keeping the cardboard prototype - we will be working on fitting the parts on this, meanwhile designing next case by 2 weeks later
 - This prototype cardboard will be brought for oral progress report, as an intermediary, no need to 2d print
- LeapMotion work:
 - With the cardboard cutout, need to make it black inside the cardboard
 - Good range up to 20cm away
 - Spotty from 20-25/27cm.

- Oral prog
 - Introduction and Scope - What we're aiming for?
 - Schedule - Gary
 - Financial - Davin (ESSS and IEEE) Wighton?
 - Progress + Remediation (talk about problems we faced)
 - We split into smaller subgroups
 - Herman/Carmen prospective correction
 - Herman/Gary case and Arduino (
 - Mike/Davin firmware/touch application (went from firmware to touch application)
 - Remediation - We're already on plan B or plan C for everything right now, and they all seem to work
 - Summary - Gary - overall we're doing okay, still have stuff to finish and things to smooth out

Action Items:

- Carmen and Mike to get end to end leapmotion and projection working by next week
- Decide locking mechanism
- Figure out how large cutout we need for Leapmotion to detect everything
- Parts to buy for next time:
 - HDMI 6" cable
 - 270 degree elbow
 - 2 springs

Next Meeting Date: March 1, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 1, 2015
14:10 – 18:00
Davin's Home

Agenda:

- Oral progress report writing
- Module updates
- Start Des Spec

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Driver
 - works but only in 720p, starting off connected to the projector. But if the meego starts off with a 1080p tv, then connects to the projector, it will show all the higher resolutions.
 - For now this is fine, we can show off the desktop stuff, not the apps
 - we forgot that the projector AC into the projector is at the back, will add 2.5cm upwards, but not anything extra to the back.
- 3D
 - Gary brought some samples of 3dprinted materials, 5mm is a little too thick, 1mm is flimsy, but 2cm is like just enough.
 - We will be using 3mm for each case thickness
- ...have to install VS2013 to run the Touch Injection code, but the LeapMotion can detect properly.
- Gary took all measurements of everything, problem with making the case super fat now,, thought of other ideas but whatever we'll start with a fat box then think about cooler designs
- We made Design Spec, assigned parts. Carmen to share the word doc.
- Gary still waiting for IEEE money

Action Items:

- Carmen to put CONFIDENTIAL watermark at the bottom beside Logo
- DEADLINES:
 - Tuesday night - Skype meeting with speeches for the Oral Progress Report
 - Friday - draft 1 of the design spec
 - Sunday - draft 2 of the design spec
 - Final polishes by next Friday
 - Next Sunday final read over
 - Monday hand in.

- Carmen to optimize driver by next Sunday
- Herman to get springs to Gary by Thursday (check Rona, or use pen springs)
 - Next Sunday March 8: Button mechanism working, then finalize the spacing inside the box
 - Sunday March 15: 3D print first draft
- Herman to get the MeegoPad first, Carmen to take projector stuff home
 - Then Herman and carmen to pass these onto Mike at Friday meeting
- Mike to get the MeegoPad to do LeapMotion stuff.
- Davin to focus on Design Spec, and then also help write Mike's stuff

Next Meeting Date: March 5, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 5, 2015
21:00 – 22:45
Online Skype

Agenda:

- Oral progress report practice

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Oral prog report timing
- Run 1
 - 1:05 logistics
 - 2:00 gary end
 - (15 sec wasted here)
 - 2:15 start Davin
 - 2:40 Davin end
 - 4:00 Carmen End
 - Holy frak that's long...actually not really
 - 4:10 Herman start
 - 6:26 - status indicator
 - 6:40 future plans
 - 7:00 Herman end, Mike start
 - 8:54 Mike end, Davin start
 - You two need to shorten this. Like, seriously. Like, freaking, seriously. Stop blabbing.
 - 10:20 Davin done
 - 10:30 Mike future talk
 - Stop-
 - 11:55 Mike done
 - 12:20 - Gary recap
 - 12:45 Done.
- Times
 - 1 minute - Gary's Intro
 - 1 minute - Gary Schedule
 - 25 sec - Davin
 - 1:20 - Carmen
 - 2:50 - Herman
 - 4:45 - Mike and Davin

- 25 sec - Gary
- $1 + 1 + (25/60) + 1.4 + 2.8 + 4.75 + 0.45 = 11.8167$
- Run 2
 - 0:00 start Herman
 - 1:11 Arduino
 - 1:50 - Herman done
 - Sounded good
 - 4:35 Mike start - nope.
 - 4:55 Mike start
 - 6:30 Mike done
 - 6:50 Davin start
 - 7:48 - Davin end
 - 1:35 Mike
 - :58 Davin
- Run 3
 - 0:00 Gary start
 - 1:30 end Gary
 - 1:45 Davin start
 - 2:02 Davin end
 - 2:20 3:23 Carmen
 - 3:31 Herman 5:35
 - 6:12 Mike 8:02
 - Davin 8:50
 - Gary 9:17
- Times
 - 1:30 Gary
 - 0:17 Davin
 - 1:03 Carmen
 - 2:04 Herman
 - 1:50 Mike
 - 0:48 Davin
 - 0:27 Gary
 - $1.5 + 0.4 + 1.05 + 2.05 + 1.8 + 0.9 + 0.5 = 8.2$
- Run 4
 - 0:00 Gary start
 - 1:45 Davin start, 2:20
 - 2:20
 - 3:31 Carmen start, 4:41
 - 4:38 Herman start 7:50
 - Mike start 9:02
 - Davin start 9:53



- Mike start 10:20
- Gary start 11:00

Action Items:

- Practice for oral prog tomorrow

Next Meeting Date: March 6, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 6, 2015
15:30 – 19:30
Mike's Home

Agenda:

- Review oral progress report
- Work on des spec

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Oral Presentation went well
 - We need to work out for the future demo who should answer questions, and how we should answer questions to help the audience understand
 - e.g. blocking the projection - not 'by design', but this is a known flaw with the technology we are using? Say that as long as it does not impede user's experience
 - Jamal picking on our use of the arduino.....be prepared to give valid reasons for WHY we decided to use arduino (which he believes is overkill) instead of some simpler hardware to control LEDs.
 - e.g. it'll kill more power, but...we were considering using it for servos?
Lifting/lowering the case electronically while allowing user to manually override to prevent
 - Hence we picked the Arduino to make it scalable for other uses.
- 3D print updates
 - Gary has the 8 pen springs, he will test them
 - He 3D printed the meegopad stand but had problems - there's a certain way he has to orient it...he'll try again
 - Bonnie Gray said we need to pay for 3D Print material if we use a lot (a lot = like 10 cases or something so not really a problem)
- Some case mechanism designs in one note

Action Items:

- Des spec DRAFT DEADLINE BY SUNDAY

Next Meeting Date: March 8, 2015

ObelXTech
MEETING AGENDA AND MINUTES
March 8, 2015
15:30 – 19:30
Davin's Home

Agenda:

- Major work on des spec
- Discussion on component placement

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- 3D
 - We are keeping the handle at the top for now - no way to 3Dprint any indents
 - Gary need to 3Dprint in halves, many limitations
- Placements
 - Going to have USB hub at the bottom with the Power plugs and extension cord
 - Give the user one USB port near the bottom (definitely not the top, too far away from user)
 - Then have M/F USB cable to go back up to the Arduino at the top, since it's at the top with the LEDs
 - Arduino must be connected to USB hub, LeapMotion will need a microUSB adapter because it needs its own port, no sharing rawr
 - Mike to go home and check if the MeegoPad's two USB ports are connected internally...qq
- Des spec
 - Interacting with the screen with after davins block diagrams
 - User experience power on there will be some preview with less details
 - Gary to explain all the justification of placements and go over limitations of leapmotion and projector again
 - Leapmotion: detection range
 - Projector: screen size and focus
 - Specify values
 - Cables onto meegopad
 - Add handle, usb port, led why dangle
 - Cylinders for projection
 - Usb cutout in front
 - Corner spring
 - Move led to bottom
 - Carmen: LEAP MOTION two words
 - Finish Homography Section

- Add in diagrams to section
- Remove module name
- Davin to add in why 45 degree and 10cm LeapMotion at beginning of Touch Determination Module
- Pic of leapmotion at 45
- Pictures and discussion of 3D printing limitations on one note

Action Items:

- Carmen to make Test Plan from high level, except make specific test cases for each subsystem (case, projection, leap motion). Make some extreme cases (e.g. corners) but don't kill it. Make forms of like Expected result, Actual result, Test Pass/Fail?
 - 1 button handle user drawing for herman
 - + redo the user experience drawings
- Herman to buy the USB M/F cables
- Gary: make changes in des spec, esp drawings

Next Meeting Date: March 10, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 10, 2015
20:40 – 22:10
Online Skype

Agenda:

- Revisions and read over on des spec

Present: Gary, Mike, Herman, Davin

Minutes:

- Went over parts that Gary, Mike, Davin and Herman wrote
- Herman's Parts
 - Wrote UX paragraph wrong again
 - Herman to fix
 - Maybe Carmen has a better idea
 - Other stuff ok
 - Add some words to Glossary
 - Connect Glossary words
- Davin's Parts
 - Ok so far
- Mike's Parts
 - Some grammar problems
 - Otherwise Ok
 - Files complaints on MS Word for Mac 2015 beta
 - Add UML to Glossary
 - Mike to make part shiny
- Gary's Parts
 - OK
 - New an updated CAD model
 - Skype Connection problems
 - Farewell, have a safe trip!

Action Items:

- Add Carmen's Parts
- Herman still working on Windows Service
- Davin to write conclusion

Next Meeting Date: March 12, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 12, 2015
21:10 – 22:50
Online Skype

Agenda:

- Updates on des spec

Present: Carmen, Mike, Herman, Davin

Minutes:

- Need to fix Mike's section for grammar badlies tomorrow
- Carm/Mike/Herman going to 440, will meet before? After w/e
- Test Cases:
 - Push one button only - shouldn't tilt
- WE NEED TO DO 2 RUN THROUGHS THOROUGHLY
 - Friday no good - Davin at work then ball, Gary away
 - Saturday - Carmen doing 450 at SFU, the other 4 will meet over skype to do a THOROUGH RUN THROUGH - CHECK FLOW
- Sunday - we all meet and KILL THIS THING, ALL THE SPICES, ALL THE SPECS
- Mike/Herman re-wrote usability section, basing it off Apple
- Carmen wrote up test cases, still has some diagrams to do

Action Items:

- Skype meeting Saturday (tomorrow) afternoon, without Carmen because she'll be doing 450 at school
- At this meeting they should be checking for:
 - Formatting
 - Grammar
 - Content/flow
 - Information accuracy
 - Diagram consistency/correctness
- Sunday in-person meeting

Next Meeting Date: March 14, 2015

ObelXTech
MEETING AGENDA AND MINUTES
March 14, 2015
14:00 – 17:30
Online Skype

Agenda:

- Updates on des spec, missing parts

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Davin to do:
 - executive summary - DONE
 - Add kitten pictures
- Updated date on Design Spec
- Herman to do:
 - TOC
 - Revise UX again
 - Add mention of Table 2 Arduino follow carmens projector
 - Change Arduino UNO R3 to Arduino Uno
 - Make sure the reference matches citation
- Mike to do:
 - update Glossary
- Do we need equation numbers

Action Items:

- REFERENCES
- Herman place his using diagrams
- Gary uses Projecting State, Carmen used Projection Mode, WHICH ONE? - Updated all to projection mode
- Add equation numbers - added
- HEADING IN MIKE'S SECTION STILL UNDONE - f
- Gary to put button pressing and handle-bar raising diagrams in his mechanical raising design section
- General user images in UX section
- Get everyone to finish updating book up to end of February by March 22
 - Then up to date by March 26 THURSDAY

Next Meeting Date: March 15, 2015

ObelXTech
MEETING AGENDA AND MINUTES
March 15, 2015
13:50 – 18:00
Davin's Home

Agenda:

- Final changes on des spec
- 3D printing updates

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Big stuff editing the DESIGN SPEC DOC TODAY!
- Herman tested out Arduino - to no avail...why? Will have to work with Mike (sharing the Meegopad and projector) before deadline for all the stuff to be functional by this Friday
- 3D
 - Gary asked if anyone checked with Gary Houghton - nope, Gary will ask him to see if we can use their 3D printer because it is big enough to print each case in one go (Gary's lab 3D printer requires it in 2 parts)
 - Gary has printed out the top wedge thing for the projector: only problem is the circle on the angled side should be an ellipse/oval, not a circle. Other than that, only has some minor round edges on one side, will need to sand off. Very sturdy
 - Gary also 3D printed the Leap Motion Controller stand - looks great! Stable. No holes in it for USB female ports, these will be on the side
- Using: Projection Mode, Compact Mode
- Learned: Mike's writing lacks flow, needs someone to edit afterwards every time

Action Items:

- Carmen:
 - Write a few more test cases?
 - Make edits to the drawings (my rectangle/trapezoid line one, Gary's bar raising one, pusheen????)
 - Big CONFIDENTIAL watermark over TITLE PAGE
 - Company OBELXTECH logo at bottom left
- DEADLINES:
 - Friday: Herman's arduino, Mike's touchInjection, Gary's case
 - Sunday: all notebooks up to end of February
 - Will be starting the Written Progress Report document

Next Meeting Date: March 22, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 22, 2015
13:10 – 18:20
Davin's Home

Agenda:

- Lots of updates on case making
- Case pieces melding
- Leap Motion performance issues and solutions

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Old case news and follow ups
 - Gary Houghton/Gary Shum? School 3D printer which is big enough to print cases in one piece each, but it's like \$276 for one case.....too expensive
 - Gary emailed inquiring about BCIT costs
 - If not, will have to look into other alternatives (plywood, board, etc.)
 - Meanwhile, he will be 3D printing the case in 2 parts in his own lab tomorrow. Will need to hot glue gun it after and see if it works out
 - Gary's lab's 3D printer didn't work out, long case objects keep bending early on :(
 - Chopping it up into many pieces is not ideal.
 - Metal? Need someone to help us cut it.....no certificate/training
 - Wood? Same thing, need someone to help cut precise holes
 - GARY EMAIL JAMAL to follow up on Oral Presentation and help with our case
 - BCIT people/Andrew said to look outside 3D printing, traditional methods
 - Look at finding own case at RPElectronics? Too small...
 - Plywood? Most are not 3mm thin and are heavy
 - Gary/Carmen walked around and found plastic sheet, reinforced with tubes like cardboard - better than cardboard, still easy for us to cut
 - Also, Gary's lab has laser cutting machine!
 - Herman checked rona, \$34~ for 3mm acrylic sheet (2mm too bendy), also needs cement glue, paid rona to but into 10 face pieces
 - Herman to bring to school on Wednesday (tomorrow), leave it there, then work with Mike on Arduino.
 - Gary made laser cut things on computer ready today, will cut on Thursday
 - Carmen/Herman/Mike will meet on Friday to see Arduino/Touch/hot glue the case together!! Left in Gary's lab 8811 ASB
 - Herman to pick up NCIX cables tomorrow!!

- Herman got the ncix m/f usb converters, mike now has the hdmi elbow
- Hdmi cables still in shipping :(
- Mike/Herman need to buy a powered usb hub (plugs into power source not via computer)
- Herman has acrylic weld and some free acrylic pieces to test it on
- Gary has the cutouts of the acrylic case that he made on Thursday (also on Thursday, Mike/Herman met to work on arduino at mike's place)
- Case fabrication
 - Herman brought the acrylic melding concrete and Gary brought the pieces of the case - EVERYTHING FITS AND LOOKS AMAZING!
 - We started gluing the inner case first, then we started gluing outer case after we made sure that inner case will fit around it
- Leap Motion performance issues
 - When LeapMotion plugged in but no touch injection running: 20%
 - Hand is in view of LeapMotion, no touch injection: 80%
 - Touch injection running, no leap motion: %40
 - Touch Injection running with LeapMotion hand in view: 99% THEREFORE LAGGY
 - Ideas to help performance:
 - <http://blog.leapmotion.com/understanding-latency-part-1/>
 - Set the LeapMotion to Low Resource Operation Mode
 - NOW WE SET IT AND IT'S AMAZING
 - MAX 80% cpu usage when running the touch injection
 - 30-40% CPU usage when hand in view but no touch injection.
 - (Also make main thread sleep like in a while loop of 5ms or something before checking again...but wait, does the program create its own other thread when a listener comes up?)
 - BUT if the main thread is the one that is concurrently executing both functions, then we're screwed because it'll sleep midway through the onFrame function.
 - SO just not going to sleep.
 - Just going to create thread to send touch event to Windows once everything has been calculated, every time.

Action Items:

- [Herman] get a usb m/m to plug into a phone's usb/AC adapter base, then it gets power! get solution for power ub so herman can get Red LED working (his green works)
 - Need to put LeapMotion in case so they can work on accuracy of touches.
- [Carmen] to buy USB m/m short cable from Lee's tomorrow
- [Davin] to finish sanding the box by this end of Tuesday, then if the sanding works to make inner box fit in outer then perfect! Else need to look into alternatives. Right now, the cases don't...fit. :(Inner stops like 6cm into outer from both directions.
- [Gary]: Sanding the holes of the buttons to fit the springs and make the mechanism work

- Also to make the hole in the projector's ramp stand's diagonal side an ellipse instead (also because it's one degree off, we will need to re-calibrate leapmotion and projector after putting it into the case for sure)
- Also need to figure out how to cut out the circles at the top acrylic inner box piece [Gary] might do laser cutter again
- Bring everything together
- [Mike] focus on Accuracy of touch and top and bottom
 - Also needs to implement set axes in order to improve accuracy
 - Mike to get accurate precision by Friday
- [Carmen] optimize driver to reduce lag by Friday
- [Davin and Herman] make a draft of the Written Progress Report by this Friday

Next Meeting Date: March 23, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 23, 2015
19:50 – 22:00
Online Skype

Agenda:

- Start prog report
- Case melding update and fixes

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Prog report started
- Big discussion on case
 - Davin says that both inner and outer are skewed, and they're both basically an hourglass shape so the middle parts are curving inward, approx front sides are angled at 2-3 degrees
 - All in all, the cuts and the gluing were probably off, but because we want close fit, even 1 degree will be bad /:
- Carmen went to Lee's today and found USB M/M, shortest is 6ft or 1.8m, but they had a thin one for \$3.45 before 10% SFU student discount - will get it before Friday! (Wed night)

Action Items:

- Also need to call Rona, Home Depot, and Canadian Tire to see if any of them have a 90-degree/corner clamp/miter , hoping for \$8-\$15 range of price.
- Herman to buy another 2x4 acrylic sheet (Black or purple), then Gary will laser cut on Friday (3-4 min per piece to cut).

Next Meeting Date: March 27, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 27, 2015
10:30-17:30
SFU ENSC Lab 1

Agenda:

- Case fixes with new prints and make
- Progress Report updates
- Touch determination updates

Present: Carmen, Gary, Mike, Herman,

Minutes:

- Mechanical case
 - Gary laser cut the acrylic pieces with larger spacing in between in order to make a second version of the case
 - Experimenting, the outer case parts were too large. increasing mm to 4mm gap but turned out to be too big, so gary tried to laser cut just the front/back pieces and we salvage sides
 - Herman and Mike measured the previous inner case and determined it to be of quit even construction, with only about 1mm skew from one side to another side
 - Carmen and Mike did hand sanding on the laser cut edges in order to make them bond better and form a more perfect box.
 - Previous outer box was broken into individual pieces, then fitted with new pieces to form a fitted case around the previous inner case.
 - Eventually we just broke off like two sides of the old case and attached with the new sides and voila we have a decent outer case, to work with the old inner case (which was decently rectangular, only slight skew of about 1mm b/w front/back)
 - Buttons were tested on both sides within, looks good and is currently cementing at my place.
- Written Progress Report
 - Herman looked over parts of the progress report and made some edits.
 - Davin (over online chat) pointed out that we are over the 3-page limit in our draft and suggested to shorten the progress explanations.
 - Carmen suggested that less explanation be made on the technology itself, with small context introductions and more remediation and problem discussions.
- Projector Power Button Pushing Mechanism
 - A stick with one slanted edge needed to be made in order to turn the projector on/off at an angle.

- Two ways: one stick, or one tube melded with the ramp on which the projector is mounted with the stick inside the tube.
- To use chopsticks for the stick button pressing before he 3D prints it, however he already 3D printed a small tube. Chopstick was too large and unable to fit in the 3D tube printed by Gary.
- Mike's update
 - Mike's update: he got touch to work in the lower half section, seemed to be difficulty with the plane of touch, not completely accurate. Also the leapmotion stand was lower on one side by 1mm so we moved it to Gary's stand.
 - Mike to get this DONE BY SUNDAY MAN GET IT OVER WITH
 - Will need to recalibrate with case after too

Action Items:

- Carmen to bring home the case via car and bring it to the next meeting to finish top and bottom melding.
 - Carmen to bring USB-USB on Sunday to try USB hub
- Each group member to individually look at the written progress report and make edits and leave comments by the end of today, Friday, March 27. Then each group member shall edit his or her section by Sunday, March 29.
- Gary to 3D print two button-pressing sticks and one tube for the projector and the MeegoPad and will bring it to the meeting on Sunday, March 29.

Next Meeting Date: March 29, 2015



ObelXTech
MEETING AGENDA AND MINUTES
March 29, 2015
12:30 – 23:30
Davin's Home

Agenda:

- Device Integrations/Case/Placing
- Test IR Emitter
- Plan for ahead

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Mike has optimized touch so that it works across whole screen - we'll need to calibrate it and put everything together, all stands included
- IR emitter
 - found one at Lee's for \$1.20, not sure how far it goes, will have to
 - Herman has an IR emitter, will bring entire Arduino case
 - Found LED barely lights up, too weak to influence
 - IR sensors do not pick up projection light
 - Tried using other leap motion, but freq of flashes did not sync and help
 - frequency of the LED's are off so doesn't work
- Tested touch software, accuracy increased significantly.
- Case remaking
 - Cement buttons to case, worked very nice. SAU NAICEEE
 - Due to the projector mounting ramp being inconsistent with our design, we had to readjust where to mount the projector and drill additional holes for the power buttons for both the projector and meegopad
 - Fixed projector angle to project to desired location on the surface
 - Mounted projector, meegopad, arduino/leds, usb hub, and leap motion (all internal components) inside the encasing LUMENX3 IKIMASU
 - Cable management applied
 - Glue dots ftw
- Everything works out good
 - Clear case so we can see while we are setting up
- Case size was thought to be big, but it just barely fits everything
- Used power drill to drill holes in acrylic went well

Action Items:

- April 7 - Test Plan
- April 10 - 2nd Peer Review
- April 10+
 - Post Mortem
 - Meeting Minutes
 - Presentation
 - LumenX3 Product/Demo
- Everyone do their individual reflections by wed

Next Meeting Date: April 3, 2015



ObelXTech
MEETING AGENDA AND MINUTES
April 3, 2015
14:00 – 22:30
SFU Gary's Lab

Agenda:

- Fix projector stand angle and placement
- Redo all component placement and cable management

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Redid the cable/component layout inside of LumenX3
- Gary printed some pieces to re-offset the projector into the right angle - decided to print only the small wedge instead of whole thing because, what if it starts bending and stuff and warping and isn't accurate and blah blah blah - might as well print small wedge that will take shorter time, and just glue dot both pieces together. Took so many trials - we had two different wedges, were going to make a third one but herman found group with a drill and we made the wedges work by pulling them back to reduce angle or pushing them in to increase angle until we, by massive luck and trial and error, I slapped everything together with final glue dots randomly and it was amazing. Except slightly offset, fixed later and explained below in later points. Thank you thank you thank you world- Melded it together with gary's crazy acetone - ninja found it in the dark because Herman didn't BRING THE ACETONE MAN WHY DIDN'T YOU BRING IT, and boy is that thing super concentrated and strong and smelled super bad, but it melded quite fast so's.....MIKE'S HANDLING WITH DRIP DROPPER THING ISN'T GOOD DESPITE WHAT HE SAYS
 - Herman sanded and drilled holes
 - Davin sanded the wedges because they were never made consistent. 3D MakerBot isn't consistent. Always makes them round or something.
- Davin changed LED's wiring to solder
 - RED LED died
 - But Gary had spare RED LED, THANK THE LAWD
- New wiring much better but still some work needed - use of GUIDING TAPE to help bundle wires together so they won't go into crowded areas or towards the sides where the case clamps down.....Needed to be aware that we could only tape wires to the inner case near the top because it would affect the power cords when it came down to the bottom. Hence why guides were good. Great use of the extra space at the front and front sides to place a lot of the loops, because space behind the projector was extremely tight from the power plugs. Decided to put the usb hub on top of the button in inner case, instead of outer case at bottom because not enough room under the projector. Very hard as we had to work around so many factors: not impeding projection in lifted

state, taut wires during lifted state that will, as a result, bend when put back into compact state (we can't change this) - but we can guide them! Placed a lot of these wires together and guided them to bend around the left open side beside the projector, because no room behind projector. Moved arduino to side because has long plug usb b :(Everything mostly set with tape, not completely stable.

- Projection almost perfectly aligns with paper - had to cut the existing green connections because it needed to be offset from underneath the 3D printed ramp (used some acrylic pieces to help it stop sliding back into the centre), and then this also got the button to show up in the hole again.
- Decided to ditch the tube in the projection power button mechanism and just have the pen top, taped at the bottom so it can slide up and down just enough to turn on/off, but not fall out, and tube not needed! Ta-da
- Perhaps next time find some small circle thing to top off the buttons?
- Carmen is ALWAYS IN THE BOX WITH HER TINY FREAKING ARMS AND HANDS, GODANGIT UGH IM SO GLAD EVERYTHING WORKS NOW AMAZINGLY EVERY TIME WE LIFT AND COMPRESS THE BOX IT'S BEAUTIFUL AND MAKES ME CRY
- Driver
 - Carmen reinstalled old rectangle-algorithm driver because it was lagging when mike was doing touch - shows that rectangle worked better than one whole screen at a time algorithm - ignore how movies were rectangling because it's all INTERNET EXPLORER'S FAULT JEEZ. And forget about getting 1080p, too hard to understand driver code and carmen has no time from 450 and 300
- Post Mort
 - Davin worked on the project progress
 - Herman worked on group dynamics
- After melding the projector stand the projector was off
 - Fixed via green tape see above notes
 - Herman did not bring the applicator so melding the bottom plate is hard
 - Attempt to do it via the dropper - MAN NEVER AGAIN QQ

Action Items:

- Fixes
 - PROBLEMS WITH ARDUINO SERVICE NOT WORKING????
 - If you don't sign in and then shut down right away?
 - Mike's touch code completely off? But how....Carmen uninstalled a bunch of things though but nothing related to LumenX3 Light blah blah Service
- Post Mort
 - Everyone's self reflections done now - need to put them together in post mortem
 - Need to get last funding \$'s from Mike and put into post mortem
- Need to meet and start working on demo preparation and stuff. Everyone to get slides done by Tuesday, but we need to meet to talk over what we are even saying and the flow, arguments/process

of our entire project, and who's saying what. PLEASE LOOK OVER THE POWERPOINT FROM LAST LECTURE STEVE'S ENSC 305

Next Meeting Date: April 5, 2015



ObelXTech
MEETING AGENDA AND MINUTES
April 5, 2015
17:00 – 20:30
Mike's Home

Agenda:

- Go over all fixes to projection and Arduino
- Go over demo and wrap up docs

Present: Carmen, Gary (by Skype), Mike, Herman, Davin

Minutes:

- Arduino
 - status indication code still iffy, works better if there's no log in screen?
- Notes about presentation:
 - Need marketing numbers / research. Target market, audience and price bracket.
 - Need a gantt chart that has both the actual/estimated time lines in 1 picture
 - Need a template made
 - Demo: 1 in like 3 to 15 taps in order to open an icon
 - Double taps automatically on desktop screen
- Post Mort
 - Drawings of ideal device in one note

Action Items:

- Mike to continue working to improve touch gesture detection
- Everyone else work on demo presentation, post mort, meeting minutes, pics

Next Meeting Date: April 7, 2015



ObelXTech
MEETING AGENDA AND MINUTES
April 7, 2015
20:00 – 22:30
Online Skype

Agenda:

- Touch update
- Demo presentation slides

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Touch
 - Mike has made the touch beastly, as in, it is satisfying.
 - He said he'll be (correct me if i'm wrong) implementing a hover mode so you can see the mouse cursor movement instead of infinite taps, so that we can demo how beastly the finger tracking is (without tapping everything you go across.....so annoying)
 - Which led me to think....ANOTHER GREAT THING ABOUT ditching the capacitive touch screens is thattt *drum roll* we can implement hover EASILY! No need to extra things, you can have full functionality of a mouse without a mouse!!! You can now hover over objects! Touch screens couldn't!
- Demo Presentation
 - Should we talk about market void first, then present our solution to it -> boom the lumenX
 - Decided to do:
 - Overview: next addition to everyone's smart device portfolio
 - does this
 - does that
 - does this
 - Motivation - what problems sparked us to think - scenarios to impose on audience
 - Solution - what we came up with - Gary's slide
 - Marketing - analysis of our product market and analysis of competition markets
 - Gary already started working, shared the ppt with us all
 - https://onedrive.live.com/redir?resid=B8C2CF45BE22D0C7!2298&authkey=!ABY_HS SVNmtxBRs&ithint=file%2cpptx
 - Make the schedule estimated the same (except add documentation and make titles clearer)
 - Make actual like this in order to show we tried developing but went back to R&D because we hit problem
 - R&D ---- -
 - Develop --- -

- -----
- -----
- Split Module into Projection, Core, Touch, Case
- Links from Davin about pitch presentations:
 - <https://www.youtube.com/watch?v=S3n5YRZD4Cw>
 - <https://www.youtube.com/watch?v=i6O98o2FRHw>

Action Items:

- Mike to complete drag by tonight, getting hover working as well.
 - We need to know this so we can figure out what kind of demo we give! Need to WOW them
Carmen's friends were 'meh' when they saw our video so far - not good!
- Get slides done by tomorrow (Wed) night, meet over skype again.
 - Meet in person Friday after the guys finish work, then Saturday again.
- Hoping don't have to meet Sunday but if we do, then we do. LAST WEEK LETS GO
- Carmen
 - Finished test plan, prob we will pass all tests
 - Email Steve about multimedia/prop use and ratio of projector

Next Meeting Date: April 8, 2015



ObelXTech
MEETING AGENDA AND MINUTES
April 8, 2015
20:00 – 23:00
Online Skype

Agenda:

- Touch update again
- Demo presentation slides again

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Touch
 - Mike to video and show works:
 - start in desktop
 - open my computer
 - close my computer
 - drag icon on desktop from left to right
 - open paint
 - draw a big circle in paint
 - can you type in keyboard yet?
 - Type
 - Still need some more work, done and freeze by Friday!
- Demo Presentation
 - Motivation and marketing problems
 - Davin to work with herman in target marketing, benefits of product vs others, user learning
 - Advantages between this and tablet
 - Disadvantages of touchscreens:
 - Fragile and easily crack
 - Requires physical touch (dirty hands)
 - Unable to perform hover behaviour
 - Tradeoff between collaborativity and portability
 - Can we find a better way to interact with computers?
 - Future plans
 - Funding
- Demo
 - Schedule and breakdown in one note

Action Items:

- Meeting Friday at 12:30PM at SFU
 - Everyone have slides ready (except Mike)
 - Everyone to have draft speeches (mock casual talk to each other on Fri to criticize)
 - Mike to get accuracy going
 - Friday we need to solidify speeches and demos - THE DEMOS WE SOLIDIFY ARE WHAT WE ARE SHOWING
 - Someone talking
 - Someone doing

Next Meeting Date: April 10, 2015



ObelXTech
MEETING AGENDA AND MINUTES
April 10, 2015
12:30 – 22:00
SFU

Agenda:

- Edits and beef up Post Mortem
- Go over Powerpoint, edits and practice
- Plan Demo and plan
- Pamphlet/Brochure?

Present: Carmen, Gary, Mike, Herman, Davin (after 6PM)

Minutes:

- Feedback
 - Showed people today and biggest things:
 - It's really big
 - It looks like you just took a bunch of things and put them together, where's the work done?
 - Arduino is just controlling lights why is it there?
 - Concept of having a projecting touchscreen is new, it's cool, it's awesome
 - They like how you can use your own table
 - They like the kitchen idea, that you can use it on anything and it feels like a touchscreen without a need for a touchscreen
 - Concept of being able to collaborate instead of large touchscreen not very popular (I think this is because nowadays everyone is so used to enjoying their own personal devices and we have cloud syncing technology to 'share' and 'collaborate', but there are sync-ing problems.
 - Many people were amazed by the components we used - tiny projector, tiny computer on stick that's Intel Atom, etc.
 - Once I showed them the touch and it didn't work it was a big turnoff
- Post Mort
 - Edited to all sections
 - Intro – add more motivation, background, marketing
 - Core sub – add more sections
 - Schedule – replace pic and add blurb
 - Add more to group dynamics
 - Add all individual reflections
- Powerpoint
 - Revamps to all sections
 - Relegated slides to even distribution again
 - Did one run through to measure timing, roughly 33 mins

- Demo
 - Run through what we can do for it
 - Show projection, casing, windows driver then touch
 - Do not show them touch yet, just open the computer and explain to them everything else, the case, the design, the projector, the layout, the cable wiring, how we didn't want to ruin the components for future use, how reducing the cables will remove a lot of space
 - How the things work together, get them to use their imagination to understand how cool this is, that it's new and different
 - Bring back in the motivation of ours, and bring back in our views for the future
- Updates
 - Carmen got 768 working but requires script to run to install driver AFTER intel running, and must uninstall before shutdown
 - Mike's touch seemed to be a little off - if I lift up my finger directly upward, the mouse cursor moved up and down. But that shouldn't be the case! Is it because he only uses y axis? But that should be fine because z is finicky and doesn't provide much extra, can't have that big of an effect
 - Mike investigated - turns out that he only detects things while thinking it's constantly at a 45 degree angle to the leap motion....which isn't true, there are various different angled rays of IR. He needs to get the origin point of the leap motion and then make calculations of the angle based on the two points.
 - Hopefully it's more accurate.
 - Mike to finish getting the fix done by 4pm
 - Then to try 768

Action Items:

- Meeting Herman's tomorrow
 - Bring wireless mouse and keyboard
- Carmen
 - Finish all images, blender of lumenx3
 - Rendering of scenarios
 - PPT slides
 - Projection sub in post mort
- Everyone
 - Peer evaluations
 - Ppt slides and write speech

Next Meeting Date: April 11, 2015



ObelXTech
MEETING AGENDA AND MINUTES
April 11, 2015
14:30 – 20:10
Herman's Home

Agenda:

- Finalize Post Mortem
- Practice Powerpoint, and final edits
- Practice Demo and run through

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Took team profile picture
- Post Mort
 - Took more device pictures, need to add them in
 - Completed to all sections
 - Additions to projection sub
 - all individual reflections
 - Reformatted a little, final edits, pics and headers needed
- Powerpoint
 - Carmen completed her slide
 - Practice round with prepared speeches, 34:30
 - Need to short mikes and gary's sections
 - Finish all speeches
 - Add formatting and headers
- Demo
 - Prepared complete outline and action steps
 - Went through run, roughly 30 mins
 - Highly dependable on how much people want to play with it
 - Find tuning needed

Action Items:

- Do more run through of presentation and demos
- Finish all powerpoint sections and port mort
- Update journal entries

Next Meeting Date: April 12, 2015

ObelXTech
MEETING AGENDA AND MINUTES
April 12, 2015
14:30 – 18:30
Davin's Home

Agenda:

- Run through presentation and demos
- Final edits, polishing of documents

Present: Carmen, Gary, Mike, Herman, Davin

Minutes:

- Presentation
 - Added final slides and pics
 - References section from post mort
 - Practice Run
 - Need to prep individual speeches more
 - 34 mins, slightly over need to cut
- Demo
 - Bring 2nd leap motion for visualizer on Mike's computer
 - Install right drivers, bookmarks, etc

Action Items:

- Rest well for presentation tomorrow!
- Pamphlets
- Bring journals, other equipment just in case
 - Bring extra leap motion
 - Mike's laptop

Next Meeting Date: N/A

