ENSC 305W/440W Grading Rubric for Post-Mortem

Criteria	Details	Marks
Introduction/Background	Introduces basic purpose of the project. Includes clear background and motivation for the project.	**/05%**
Body of the Document	Provides a high-level description of main functions and project modules. Outlines materials, costs, and schedule (both estimated and actual).	**/15%**
Problems/Challenges	Outlines major technical challenges encountered. Explains how these were resolved. Details any major changes in scope and design.	**/05%**
Group Dynamics	Includes a discussion of how the team was organized, any problems that arose, and how they were resolved	**/05%**
Individual Learning/Work-load Distribution Chart	Includes a one-page, individually written reflection upon what was learned from the project, both technically and interpersonally (each team member writes a page about their learning experience). **The workload distribution chart outlines major technical, administrative, and support tasks and indicates who participated significantly in those tasks.**	**/25%**
Conclusion/References	Summarizes outcome and evaluates the project. Includes discussion of future plans, if any (or explains why project will be abandoned).	**/10%**
Meeting Agendas/Minutes	Includes an appendix that provides all the meeting agendas and minutes produced by the team over the course of the semester. (NB. Neatness does not count here.)	**/20%**
Presentation/Organization	Document looks like the work of a professional. Ideas follow in a logical manner. Layout and design is attractive.	**/05%**
Format Issues	Includes title page, table of contents, list of figures and tables, and references. Pages are numbered, figures and tables are introduced, headings are numbered, etc. References and citations are properly formatted.	**/05%**
Correctness/Style	Correct spelling, grammar, and punctuation. Style is clear, concise, and coherent.	**/05%**
Comments		

E - Plant Innovation

Team Members:

David Hsu
Jae Sung Park
Mandan Vahabzadeh
Yang Zhang

Date: December 8, 2013

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Glossary

AC	Alternating Current
CEO	Chief Executive Officer
CMO	Chief Marketing Officer
CPO	Chief Product Officer
CTO	Chief Technical Officer
DC	Direct Current
LED	Light Emitting Diode
MIT	Massachusetts Institute of Technology
TM	Trademark
UNO	Universal Network Object
V	Volt

1.0 Introduction

The basic purpose of this project is to design and build the prototype of a self-sustaining system that is capable of performing a set number of tasks. The initial objective was to make a device that can be beneficial to the sustainability field. We felt that this was important, because like fuel source, the world is starting to shift to green solutions.

The scope of this project is for the system to be able to perform the above tasks in order to sustain the plant. The characteristic of the system is that it is made up of subsystems that are capable of communicating with Arduino, and the Arduino will give outputs to the required subsystem. For example, when the light sensor detects that there is an abundance of sunlight, the data is relayed to Arduino, which will then send out a signal to command the Shade system to move accordingly.

2.0 Project Description

The SmartPlant™ will automatically adjust the watering and shading system, based on the user choice of planting. The product design consists of three main sub-systems: the watering system, the sunlight protection system and the SmartPlant™ Android application.

2.1 Shading System

One the major components of the SmartPlant™ are the shading system. This system is composed of motor system, spring loaded shade and threaded rod. The motor system functions at 12V DC and provides the force to move the shade back and forth. The motor system is connected to the shade through the threaded rod. The threaded rod has a diameter of 1/4" and is 60 cm long. The one end of the threaded rod attaches to the motor using a set-screw shaft coupling and another end it goes through a coupling nut that is fixed to the shade using a screw. Figure 1 shows the components of the system.

Figure 1: Shading Design

The shade is 58 cm wide and can cover up to 182 cm in length. The nut which is fixed to the shade provides the force for the movement of the shade. The opening movement is merely done through the force that is provided by the motor. Whereas, the closing movement is reinforced by the drag the spring which is loaded in the shade provides. The speed of the opening and closing can be controlled by manipulating the voltage of the motor. Under current setting at 12V DC it take 6 minutes for shade to completely open and close. The opening and closing of the shade is controlled by Arduino and triggered by light sensor which is placed at top of the structure.

2.2 Android Application Interface

The Android application was chosen as an interface between the user and the SmartPlant™. In the beginning stage of design, putting physical buttons on the device was avoided because it should also perfectly work at the outdoor environment. If there is a rain and the device with buttons is placed outdoor, the rain drops may soak through the button holes and damage the electric circuits in the device or even can cause serious electrocution to the user.

As a prototype interface, the Android app is programmed to have two groups of plants, one group (cucumber group) that require a direct sunlight and a lot of water and the other group (jade group) needs an indirect sunlight and a less watering cycle. Once the Bluetooth connection is setup between the application and the SmartPlant™, the user can choose a group which he/she wants to plant. If the user decides to start with cucumber group, the android app sends character '1' to the Arduino Uno and when the user wants to plant jade group, it sends character '2' telling the Arduino which group the user wants to plant.

2.3 Watering System

The watering system of finished product consists of the water tank, the soil moisture sensor, the water level sensor and the controller package. The controller packaging includes a 5V battery supply, a relay, the Arduino UNO microcontroller and the small water pump 6V battery supplies. We have successfully implemented all the parts together and built communication between them. Furthermore, we were also successful in building communication between Arduino UNO microcontroller and Android Aapplication through Bluetooth. We have set two threshold values to control the activation of the water pump for two different planting options. For the first option, the plants need a short watering period; we set a smaller threshold value. For the second option, the plants need lower watering frequency, and we set a larger threshold value. When the microcontroller receives character '1' through Bluetooth path, the first watering option will be operated. When the microcontroller receives character '2', the second watering option is operated.

3.0 Budget

The estimated budget for this project was approximately $630 which E-Plant Innovation was fortunate enough to receive $500 funds from the ESSEF. Table 1 shows the estimated budget at the beginning of this project. There are some changes on our design which includes: using Android cell phone instead of touch screen LCD and borrowed the shade motor from SFU. These two factors helped this project to be in the estimated budget. Also we returned the tubular motor for shading design which is $119 but we have not yet received the money back. The actual budget for this project is $584, which shows on table 2. Therefore, if we receive the money from tubular motor it will reduce our total cost to $465. This is a huge accomplishment to end up under budget of our expected costs, while still meeting are specified requirements.

Items	Estimated Cost
Moisture sensor and Arduino	$30.00
Temperature sensor	$25.00
Water tank	$10.00
Water pipe	$20.00
Water pump + shipping	$50.00
Waterproof wire connector	$20.00
Wire	$20.00
Motor	$30.00
Shade	$45.00
Touch screen LCD	$300.00
Material cost	$550.00
15% contingency	$82.50
Total Cost	**$632.50**

Table 1: Estimated cost

Order Date	Items	Cost
09-Oct-13	Water pump	$36.86
10-Oct-13	Moisture sensor	$12.67
10-Oct-13	Arduino Uno	$11.73
12-Oct-13	BeagleBone Black	$5.96
21-Oct-13	Photo resistor sensor	$25.90
06-Nov-13	Bluethooth BEE	$17.51
22-Nov-13	Motor connection	$33.94
09-Nov-13	Tubular motor	$119.54
06-Nov-13	Water sensors(2nd order)	$5.26
10-Nov-13	RP Electric	$165.87
19-Oct-13	Relay and water tube	$10.00
15-Nov-13	Home depot	$139.24
Total Cost		**$584.48**

Table 2: Actual cost

4.0 Time Constraint

At the beginning of the semester, our team began preparations for this project and we followed our schedule. However, E-Plant Innovation slowly fell behind the schedule. By the end of October, we had some progress on the Android application and watering system, but for shading design we ran into numerous problems that set us back significantly. According to the original plan, we should finish the shading design by November 15, but we complete the design by November 26. Despite the flurry of last minute activities, we still manage to finish the project on time. Table 3 illustrates our initial schedule goal and the actual date of completion. The red highlights show the changes in our schedule.

Task	Estimated End date	Actual date of completion
Project proposal report	September 26, 2013	September 26, 2013
Ordering and have all Materials by	October 10, 2013	November 14, 2013
Research-Watering & Shading	October 15, 2013	November 5, 2013
Functional specification report	October 17, 2013	October 17, 2013
Research - Application programming	October 22, 2013	October 22, 2013
Oral Progress presentation	October 24, 2013	October 24, 2013
Design Specification report	November 7, 2013	November 14, 2013
Water system Design	November 11, 2013	November 11, 2013
Shading design	November 15, 2013	November 26, 2013
Watering system programming/Debugging	November 18, 2013	November 18, 2013
Shading system programming/Debugging	November 21, 2013	November 21, 2013
Android application	November 26, 2013	November 26, 2013
Testing & Combining all parts	November 29, 2013	November 29, 2013
Written progress	December 2, 2013	December 2, 2013
Presentation	December 6, 2013	December 3, 2013

Table 3: Schedule for SmartPlant™

5.0 Problem and challenges

There are different challenges in this project. The shading design was one the major challenges of this project. The first design had spring loaded roller shade and the tubular motor. The two side of roller shade could be attached to motor by wire or rope, so by rotating the motor forward the shade will open. In order to close the spring loaded shade, the motor should rotate for two seconds and then release the shade, which spring will be activated and closes the shade. However, the motor has limited movement, which rotates five turns forward and then stops for ten seconds. After that it turns the motor backward for five rotations. Due to the cost of the motor and limitation of movement we decided to return the motor and design a new shading system. The second design which is explained previously has been successful and the only challenge was to make a 1/4" threaded hole inside the coupling nuts. There is a machine shop at Burnaby which helped us to make that threaded hole.

One of the challenges during the Android App development aroused from the signal transfer over the Bluetooth. The initial plan was to directly send the moisture and sunlight thresholds in accordance with different plant groups to the Arduino over the Bluetooth and activate the shade and water pump with respect to transferred thresholds. However, as the program gets larger and heavier, this communication method added more complexity to the entire system programming. Thus, considering the simpler data flows and Lucky's recommendation, Android app has been changed to just send simple one character ('1' or '2' each for 'group 1' and 'group 2') instead of thresholds to the Arduino Uno board and let it activate the system based on the condition met with the received character. With this updated method, the efficient Android app could be built without bunch of threshold libraries and thus occupying less memory on the smart phone.

For watering system, we were unable to build a water level detection system in the water tank, because we underestimated the delivery time. The water level sensor has been ordered one month before the demo, but we did not receive it. The completed project only represents a proof-of-concept model; therefore there are many different aspects of this project where more work would be beneficial.

6.0 Group Dynamic

Initially, when we first decided on our project, we had just gotten to know one another. As we did not know the strengths and weaknesses of each other, it was a bit difficult to assign individual parts. Therefore, we had meetings and discussed everything as a group, and tried to get the general idea of the project going. For example, we tried to visualize how the prototype would look, and then we brainstormed the functionality based on our design criteria. This was done by splitting the product up into different sections: Android application, watering and shading system.

One of the biggest challenges that we faced was to set up meeting times for meetings and lab work for everyone, as most of our group members were attempting to juggle between their jobs with ENSC 305/440, as well as other courses that were taken concurrently. We solved this by having all the work and class schedules sent to Mandan, and after compiling a chart on the availabilities, we were able to see which days and hours is best for everyone. Alas, there were still days where only two members were able to meet, if at all, and that proved a problem, as it hindered our progress, but we made up for those lost time by working even harder in the days when we could get together.

In the primary stages, we had problems with time management, mainly with ordering parts and deciding on the design aspects of the project. We would be unsure of what design to use for our systems, primarily the shading system. This was primarily due to the fact that we were not sure of the individual talents and expertise of each of our group members, so the splitting of the tasks might have been better if it was thought out a bit more. However, we finally solved this after the presentation, when professor Lucky started to help us brainstorm for alternative methods. After a few sessions of brainstorming and 3 or 4 designs later, we finally were able to unanimously agree on the design of the shade system which uses a rotating bar to pull and push the shade.

Even though the project was split into three equal portions, the portions in itself was not the same. For example, the work that is put into the Android section would be different from that of shading and water system, and so progress was a bit unpredictable. We solved this by having Mandan help with the Android application first, then after that part is done, Jae Sung and Mandan could now help with the water and shading system together. By solving one problem at a time, we were able to free up more hands and pool our thinking power into the remaining issues of the project, and that was the final pushing force that helped us complete the prototype on time.

7.0 Interpersonal and Technical Experiences

7.1 Mandan Vahabzadeh (CEO)

During the last four months, I worked mostly as project manager and hardware design of SmatPlant™. I have gained very valuable technical skills in this project and I faced different challenges which will help me tackle real life problems. As a 5th year system engineering student and after finishing all the required engineering courses and co-op, this project gave me the opportunity to use my theoretical and practical knowledge into test and prove my technical capability.

As a CEO of E-Plant Innovation, I was responsible for researching, budgeting, scheduling, organizing the team and designing the shade. Researching and analysis of the problem is a key to understand how to solve the problem in order to meet all requirements and deadlines. Therefore, analytical and critical thinking skills helped me to evaluate the problem and make decisions. I have learnt that there are a lot of elements that can turn the budget in the wrong direction such as buying the improper or extra parts which was not suitable for this project.

At first I was working on the Android application part however, after multiple meetings I realized that there were some problem on shading system so I decide to move to shading design of the project and Jae Sung can complete the rest of the application alone. For designing the shade, I started by designing the small scale prototype which I have to think about stability, reliability and functionality of the shade. Moreover, time management and the ability to meet the deadlines was another skill that I learned in this project.

Also this project has taught me about the interaction of a team. Regardless of the differences we had, we all shared a common goal which was having a durable and usable product. Working in a team sometimes can be challenging as everyone has a different approach towards reaching a goal. I have to keep track of everyone's schedule and deadline of the project in order to organize the meetings. However, I learnt how a group can communicate effectively and solve the problems. It was nice being able to rely on each member of the team in order to accomplish your goal. Overall, I am very happy with our final product, and the experience I gained during this project.

7.2 Jae Sung Park (CTO)

Last four months with E-Plant Innovations will mean a lot to me in the future and will remain as one of the valuable experiences that will aid me to become a capable engineer. The group works we carried out during this semester not only gave me new technical experiences that cannot be learnt from other academic courses but also got me improve my interpersonal skills such as, how to communicate within a team, how to manage time in a limited length of time, and how to distribute the workloads in order to yield efficient progress.

As a Chief Technical Officer at E-Plan Innovations, it was my duty to make sure about everything on the device to work fine. Although, I was responsible for software part that includes development of Android App and programming of the Arduino Uno microcontroller, I also worked closely with the hardware and studied the functionality of both the mechanical and electrical aspects in the SmartPlant™.

I've learned the importance of background researches and found team work amazingly useful during the past term. In the beginning of the project, my group decided to assign me and Mandan for the software programming since we both were new to the Arduino Uno and Android application and it also had have Bluetooth communication capability. One of the well-done researches we have done was to use MIT App Inventor for Android app development. Choosing MIT App Inventor allowed easy-to-use layouts and intuitive GUI environment which helped a lot to save time for us. And unlike our expectations, the shading and the watering system turned out to be more challenging tasks. With the extra time gained MIT App Inventor, our group thus could allocate workloads and successfully complete the project by Mandan helping David with shading system and I being paired with Yang for the watering system in the extra time.

The time with Capstone project allowed tremendous opportunity to improve software skills, practice engineering team works, and build up my ability to overcome various difficulties. I would like to appreciate every SFU staff who has provided me with this opportunity and who always stand by E-Plant Innovations to give helps. Lastly, I also want to thank my fellow team members for their hard work and passion.

7.3 David Hsu (CMO)

I found this experience to be very helpful, as I did not get many chances to work in a group like this in which we had to brainstorm and complete a prototype of an actual product. One of the most important things I learned from this course is time management, and how important group dynamics and communication is. To succeed at a project, each member has to work together and communicate properly, so when a problem arose, some if not all the members would be able to help to solve the problem. Additionally, my previous experiences with circuit design and programming from previous courses helped out, and I was able to build upon those skills after getting more practice using them in this project. This included building the circuits we needed, as well as using Arduino IDE to program the codes for our microcontroller Arduino Uno. In addition, I found the last phase of our project, which was the work we did in the Underwater Workshop, to be a nice experience. We used different tools and had to solve each of our problems by using the scrap that was littered around the workshop. For example, we had to secure our motor so it doesn't move around too much, and so we had to find parts that we could use to secure the motor. That helped us think and engage the problem solving skills that we normally don't use in our courses, as I feel that we mostly learn about theories, and not actual hand-on work.

7.4 Yang Zhang (CPO)

The Capstone course has proved to be a challenge in many ways, but has definitely become an important learning experience. The challenges I faced in this project includes: researching of your problem in order to understanding how to solve the problem and improve it, analyzing your solution in order to ensure it meets all requirements and planning to be on time.

For our project, we didn't do enough researching of the planning. As a result, we had to set the threshold value of watering through guessing. We took more attention on researching of technical design but not took enough time on researching of planning knowledge. If we focused more on learning planning knowledge, the threshold value would be more accurate and our product would be able to tackle problems as efficiently as possible.

In addition, one of the most important things I learned from this course is time management. We were too idealistic; we never considered our course load, work, or sports when planning our time. So we changed our schedule many times during this semester.

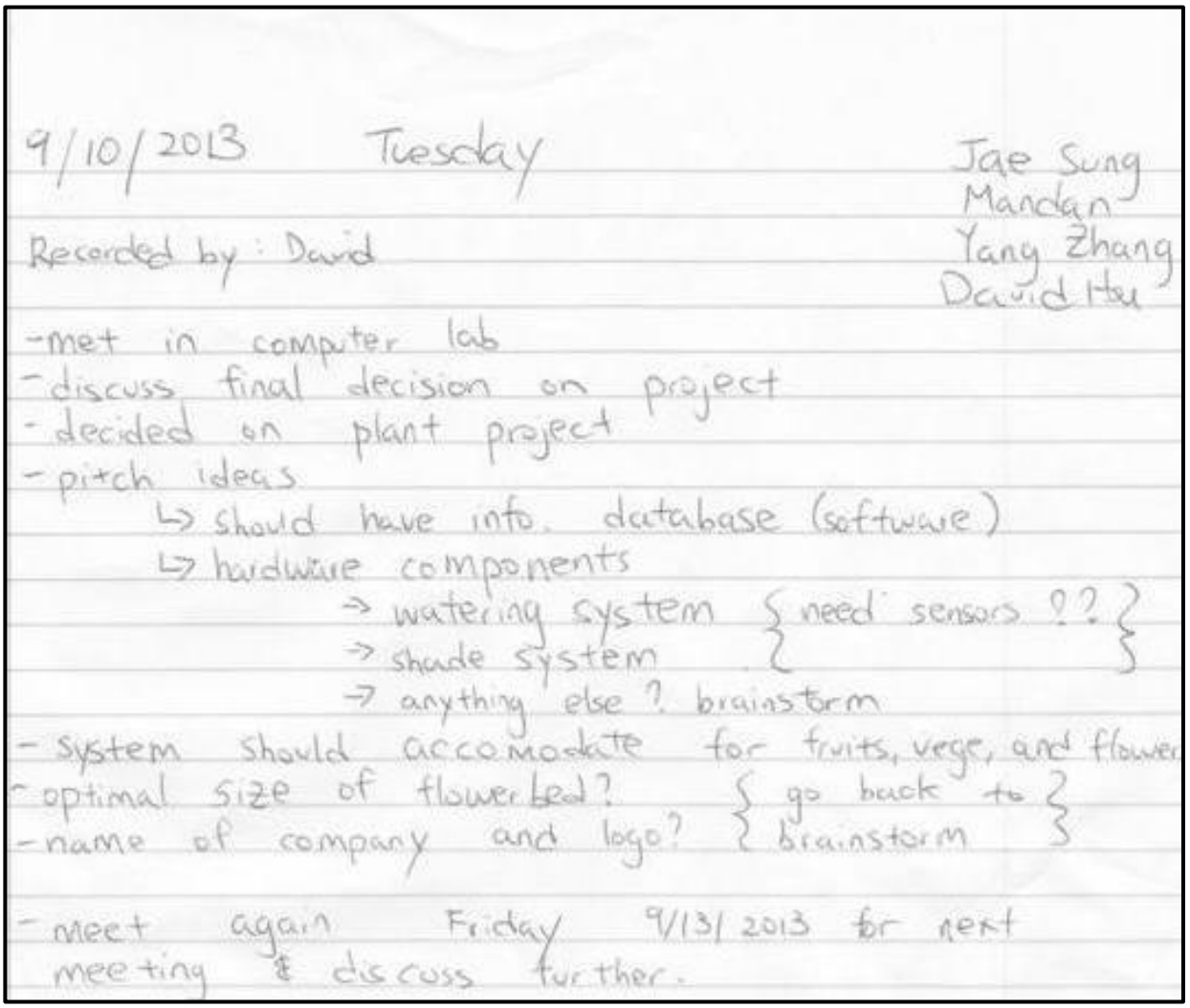
The challenges I faced in this project will help me solve problems in future life. Therefore, I am glad I was able to experience these problems in the classroom before heading out into the job environment.

8.0 Conclusion

Despite the various difficulties we encountered along the way, in the end, we were still able to complete this project. This was because we have team members that were willing to work on the project and sacrifice time and sleep to get their own parts done, and after that, to help the other members out on his/her own problems. Also, along the way, we were able to contribute by pooling our knowledge and experiences that the others might be lacking, and by exchanging information, we were able to learn off each other and improve individually, and that resulted in an overall positive experience that would carry on past our graduation, into our future careers.

Appendix

Meeting Minute



9/10/2013 Tuesday

Jae Sung
Mandan
Yang Zhang
David Hu

Recorded by: David

- met in computer lab
- discuss final decision on project
- decided on plant project
- pitch ideas
  - ↳ should have info. database (software)
  - ↳ hardware components
    - → watering system {need sensors ??}
    - → shade system
    - → anything else? brainstorm
- system should accomodate for fruits, vege, and flower
- optimal size of flowerbed? {go back to brainstorm}
- name of company and logo? {go back to brainstorm}

- meet again Friday 9/13/2013 for next meeting & discuss further.

Sep/13/2013 Friday

Joe Sung Park
Mandan Vahabzadeh
YANG ZHANG
David Hsu

Start 3pm
- Meeting minute by David
- met in ASB open area
- start writing executive summary
  - ↳ individual categorize
- discuss company names (everyone pitch in idea)
  - ↳ IPlant
  - ↳ IGrow
  - ↳ SmartSeeds
  - ↳ SmartPlant
  - ↳ PlantSitter
  - ↳ PlantGuide
  - ↳ [redacted]Seeds
  - ↳ EasyPeasy
  - ↳ [redacted]Plant
  - ↳ PlantHelper
- final decision: EPlant - Innovation
- assigning tasks next:
  - ↳ the flash work for logo: Park
  - ↳ cost & budget financial aspect: Mandan
  - ↳ Market aspect on global scale: David
    - * customer, needs, location of market
    - * sustainability, benefits vs. cost
  - ↳ introduction & background & conclusion & summary
    - * will write later (task: Yang)
  - ↳ project planning: Mandan
  - ↳ company profile, each needs his job
    - * CEO → Mandan
    - * CFO → David
    - * VP operation → Park
    - * VP marketing → Yang

    (name of position subject to change later)
  - ~~↳ company detail:~~
  - ↳ team organization: Mandan
  - ↳ should finish [redacted] proposal on [redacted] Sept 20th.
  - ↳ scope & risk / benefit: David
- contact on canvas about concerns & problems

Meeting adjourned
Meeting ends 3:55

Participants: David
Mandan
Jae-Sung
Yang

9/20/13 3:00 pm

Minute recorder: David
Location: CSIL

- Discuss proposal, integrate individual parts
- Extra part added: motor (+$30) for sun roof
- Finished & finalize member role
- will try out to work in pairs instead of individually

- Talk about main design
  - encyclopedia • saved in micro controller
  - decide on micro controller
    - ↳ features / 2's ratio
  - decide on where to store water tank?
    - ↳ size? shape? consider space-saving
    - ↳ sensor for if no more H_2O in tank.
  - *MAYBE* decide on changing micro controller to using cellphone (Android)
    - ↳ Benefit: cheaper & easier to make
    - ↳ Risk: back to drawing board (+ time)

- Next step: order parts (brand, type)
  - → est. time (2 weeks)

- Finalize proposal
  - → executive summary part
  - → project management part

- Sunday: Send parts to each other
- Monday: go to library for prof. correction

oct/1/2013 Tuesday
Start 2:30

Jae sung park
Mandan Vetrabadai
Yang Zhang
David Hsu

- Meeting Minute by Mandan
- Met in ASB 8 Computer Lab

- Things to order? Sensors, water pump, flower pot

- Moistur sensor: we need to order sensor, water pipe, water pump, Arduino Micro Controller,
- Pregramming: what is number for each plant? or is there any general number (need more search)

- Temp Sensor: it's better to have photoresister sensor instead of temp sensor. But is there any threshold because plant needs sunlight (need more research)

- Android pregramming & Micro controller Beagle Bone Micro Controller ~~need~~ has more space and can be use for Temp Part as well

- Use one Micro controller instead of 2 (Arduino)

Things to d:
Mandan: order the parts & Prepare functional Report templat

Jae sung: Research about Android Application Pregramming

Yang: research about Moistur level of each plant

David: More detail on photo resistor Sensor

Meeting end 4:00

Meeting Minutes 10/4/2013

Attendees: Yang, David, Jason, Mandan
Written by David
Start time: 2:30pm (~~ASB~~ renaissance area)

-> Start with discussing functional report
  ↳ Major parts are technical correctness(15%) and process detail (20%)
  ↳ Mandan's notebook -> looked up the individual requirements, for example, Engineering standards
  ↳ Looked up reports of previous groups and used as reference
  ↳ Jason raised a point where Mike commented that there was a similar project to ours a few years ago. Proceeded to try to find said project, without sucess. Will try later.
->Next, start assigning parts for func. report
- Need to understand specifics of each part in order to best assign parts
- Mandan suggest that for process detail and technical correctness, we can divide them into 3 sections (shade, watering, application?) for easier writing. [David] [YANG] [Jason]
- Looked at "Lumos Technology" for reference. Some are good, others questionable.

[
- David: talked about details of programs for photo resistors
- Some details about final presentation
*not related, going off-topic
]

- Water sensor: Adreno M.C.
- Photo-sensor: use Adreno or B.B.B
- Data (base): put on cellphone

- What should we use for LCD? Pending decision.....
  - ↳ final decision: don't use LCD
  - ↳ use android app (has to write ourselves) ~~pencil~~ in place of LCD ⇒ access plant system remotely
  - ↳ send signal by blue tooth?

- Assign part
  - Content → Jason
  - Intro → Mandan
  - Technical & process → split
  - Eng. Stand. → Mandan
  - Sustainability → David
  - Conclusion → Yang

- Yang: suggest that we have one type of micro controller (pref. BBB), but if we need, use BBB and Adreno

End meeting : 3:28pm

Meeting Minute 10/22/2013

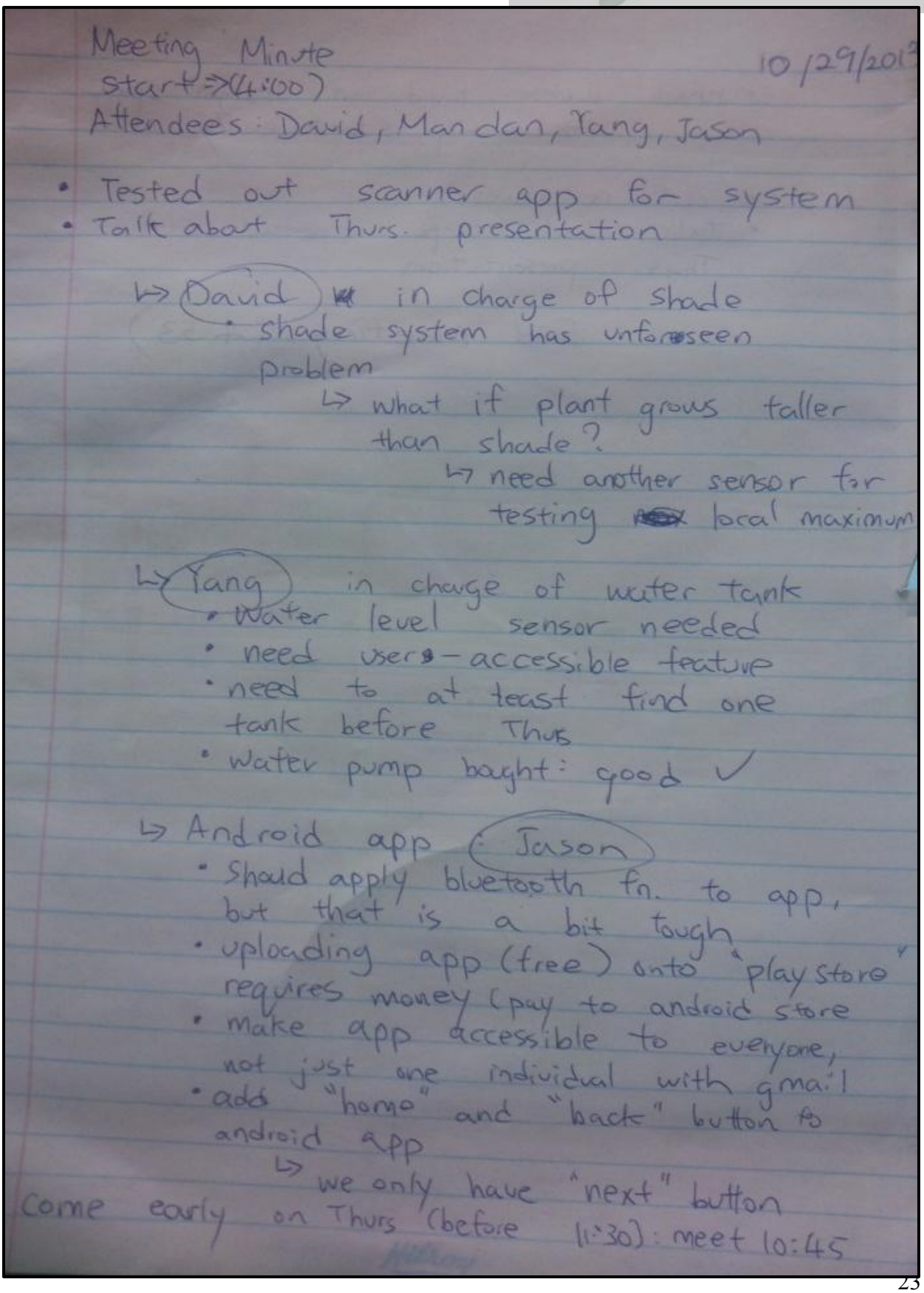
Attendance: Mandan, Yang, Jason, David

start: (3:30)

-> Ordered parts : some has arrived
-> Need to start planning distribution of parts to members of group for individual parts
-> talked about progress of each parts
  ↳ David: photoresistor & roof
  ↳ Jason: water system
-> busy with other things, so must pick up on progress soon

-> integration of each parts :
  ↳ roof + motor
  ↳ water system } need micro-controllers
  ↳ database + wireless system to cellphone
-> has to start putting these together
-> after putting together, we can start debugging
  ↳ ETA : 3 weeks

End: (4:15)



Meeting Minute 10/29/201?
start => (4:00)
Attendees: David, Mandan, Yang, Jason

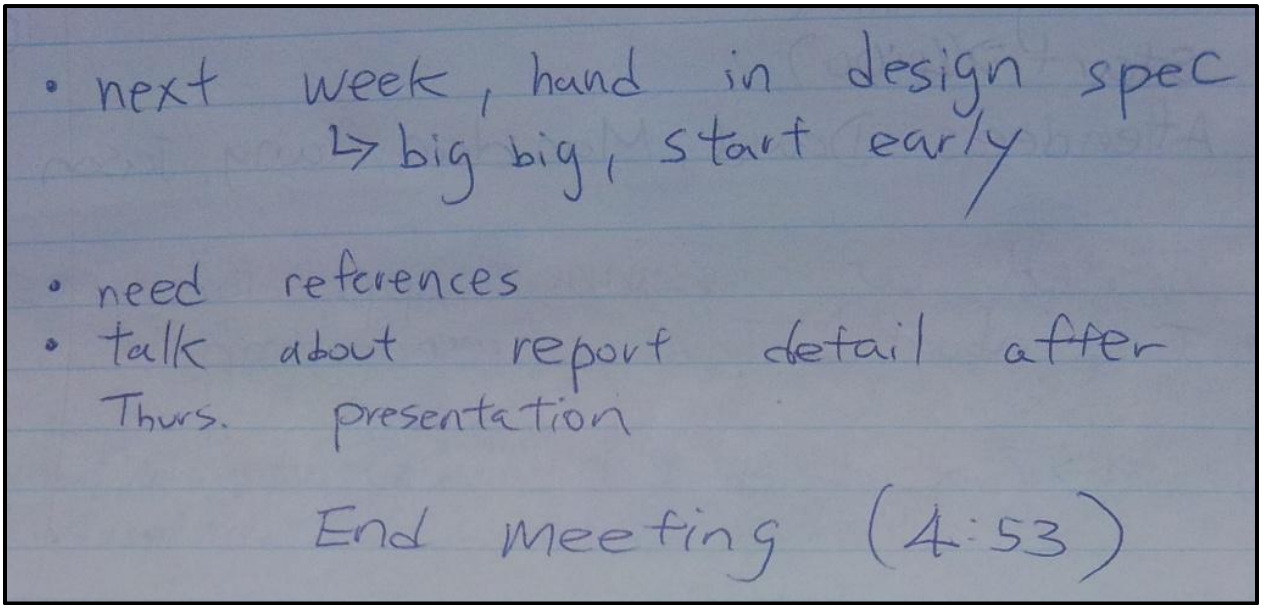
- Tested out scanner app for system
- Talk about Thurs. presentation

↳ David in charge of shade
- shade system has unforeseen problem
  ↳ what if plant grows taller than shade?
    ↳ need another sensor for testing local maximum

↳ Yang in charge of water tank
- water level sensor needed
- need user-accessible feature
- need to at least find one tank before Thurs
- water pump bought: good ✓

↳ Android app: Jason
- Should apply bluetooth fn. to app, but that is a bit tough
- uploading app (free) onto "play store" requires money (pay to android store
- make app accessible to everyone, not just one individual with gmail
- add "home" and "back" button to android app
  ↳ we only have "next" button

Come early on Thurs (before 1:30): meet 10:45



- next week, hand in design spec
  ↳ big big, start early
- need references
- talk about report detail after Thurs. presentation

End Meeting (4:53)