ILLINOIS INSTITUTE OF TECHNOLOGY

ENPRO 355: Augmented Reality

Tyche Technologies

Spring 2008

Midterm Report

SUBMITTED BY

ENPRO 355

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1.0 Revised Objectives

The objectives of EnPRO 355 have shifted from those established during the last semester. The plan of making this product available and attractive to consumers in arenas like sports venues and amusement parks was deemed to be less feasible than targeting non-discretionary consumers. Hence, the target market shifted towards construction safety. The goal of implementing a prototype demonstrating the core technologies of the product remains a priority of the team, however. Thus, the primary objectives for the team are:

- To develop a business plan and revenue model and begin planning exit strategies
- To construct a working prototype of the technology we intend to use in the system

2.0 Results to Date

Business Sub-team

Market

In the first few weeks of the semester, we re-evaluated the marketing strategy of our project from the last semester and looked for more potential opportunities. After we analyzed the characteristics of the three selected market segments from the previous semester - large cities, theme parks, and major sporting events at selected sporting venues - we decided to use Augmented Reality technology to address a more urgent and unique need. Among several possible markets we've looked at, we concluded construction safety to be the most appropriate market because of the crucial demand for sustainable safety enhancement in a variety of construction places.

One major pressure for construction sites is the occurrence of the utility line accidents. Current mitigating solutions include one call service such as J.U.L.I.E. and Common Ground Alliance, a government-lead organization that enforces regulations and promotes general awareness of underground utilities. However, the pressure remains severe in terms of the number of accidents and the cost of damage. In 2005, 51,600 accidents were reported nationwide with a 100% increase from that in 2004, covering gas, telecommunications and electrics. Over 75% of the time incidents caused service or distribution disruption. Significant costs resulted from utility accidents turn out as loss of life, cost of damage, service and project delays, and the consequently increased time and money. The extremely-high risk in construction sites is demonstrated by over 5,000 deaths in utility and heavy equipment accidents in 2006 alone while the average damage totals of $250 million per year since 1989. The goal of our product is to help ensure workers' safety and protect professional operations. In addition, our AR system will be able to reduce a company's cost for safety by both mitigating accidents and saving on tax and insurance expenses.

Exit strategy

We considered a whole range of exit possibilities including partnership, acquisition and stand-alone. Since one of the main implementations of our AR system will be integrated with professional construction equipment, we concluded that a partnership with Caterpillar would probably be the best option. However, we consented to make the decision later after we have a solid prototype worked out and complete business plan formulated.

Intellectual property
We researched for Intellectual Property information related to AR technology. Nearly 50 patents and many more applications have been issued for AR. We have yet to determine the number of those that are for safety applications. However, there is no patent that protects similar products as we are developing. We are also learning how to differentiate from the existing patents and how to apply for our own patent documents.

Primary research -- Questionnaire and interviews
Our primary research consists of interviews with professionals and business administrative officers. Before we conduct the interviews, we developed a generic questionnaire which addresses both business focuses and technical concerns. (See Appendix)

Technology Sub-Team

The technology team made numerous developments throughout the course of the term. They additionally established projected goals and needs for the rest of the semester. The main objective of the tech team for the semester is to create a working prototype capable of displaying an object observable in perspective from augmented reality (AR). The tech team developed the product concept and designed the product prototype. The final positioning technique chosen combines Wide Area Augmentation System (WAAS) and dead reckoning positioning. Dead reckoning uses physical sensors whose data can be implemented to determine changes in position. The tech team members developed the mathematical model to be used for this positioning. Analysis of the desired features of the whole prototype led to the development of general software architecture and refinement of the design. The necessary components for the prototype were determined and ordered. Imaging of objects in AR requires graphical software; the team decided upon Google Sketchup as the appropriate choice for this function and they learned to interact with it on a command line level. The tech team has worked on familiarizing themselves with all prototype components on both the hardware and software level to create a prototype this is marketable.

The implementation of the product in its environment has been analyzed by the tech team. Heavy construction machinery optionally comes with a vision system which provides a potential interface for the prototype. Durability is not yet believed to be an issue as all components should be able to withstand normal operating conditions of the equipment with which the product is designed to interact with. The WAAS system allows for GPS positioning data to be provided across the United States and Canada. In dead reckoning system will even be able to facilitate positioning in underground environments. Hence, the product will operate in a wide variety of environments and conditions.

General Tech Team Results to Date

- Designed the product prototype
- Determined and ordered the necessary prototype components
- Determined the software architecture
- Wrote the mathematical model for the dead reckoning system
- Learned to Interact with Google Sketchup on command line level

Individual Contributions

Devaraj Ramsamy

- Researched Caterpillar and associated technologies such as the Work Area Visions System (WAVS)
- Researched and presented utility accident and construction accident information
- Ordered components for prototype
- Headed weekly class meetings and submitted weekly reports and time sheet information
- Organized team to work on IPRO deliverables
- Helped construct business questionnaire
- Developed overall project schedule and time line
- Participated in weekly sub-team business meetings
- Headed weekly team leader meetings

Vlad Rusz

- Business team leader
  - Took minutes for Business Team meetings
  - Submitted weekly reports to team leader
- Worked on preliminary research/first presentation
  - presenting our target market
  - pain being addressed
  - What's in it for me? question
- Research into JULIE
  - Underground utilities and how a digger can get them identified
  - Researched free 811 service of which JULIE is part of
- Helped write the Objectives and Methodology portions of the project plan
- Helped in the planning and organization of midterm report work breakdown
- Worked on developing questionnaire for interviews
- Procured financial statement development information
- Contacted some friends in the construction/architecture industry

Savina Jose

- As a Business sub-group co-leader, I took down minutes for our weekly meetings.
- Submitted weekly reports for Business Sub-group.
- Met with Sub-group team leaders to set our goals for the semester
- Worked on the Background of the Project Plan.
- Worked with the team to put the Project Plan together.
- Worked and presented weekly updates of the Business Sub-group

- Worked on the questionnaire for market research
- Worked on the Barriers and Obstacles of the Midterm Report
- Worked with the team to put the Midterm Report together
- Worked with the team to prepare the Midterm Presentation
- Attended EnPro lectures with team members.
- Presented the Final Midterm Report.

Meng Zhang

- Took down minutes for class meetings.
- Participated in weekly business sub-team meetings.
- Worked on the Semester Budget and Team Member Assignments of the Project Plan.
- Worked with the team to put the Project Plan together.
- Worked with the business team on the market re-targeting.
- Worked with Savina on the Preliminary Porter's five forces.
- Worked with the business team on the questionnaire for market research
- Worked on the Results to Date of the Midterm Report
- Worked with the team to put the Midterm Report together
- Worked with the team to prepare the Midterm Presentation
- Attended EnPro lectures and workshops.

Jeff Mizek

- Guided team as team leader, setting team goal and organizing weekly meetings
- Drew initial holistic system diagram on which project was based.
- Worked with Adam, Max, and Tim to decide on possible positioning methods
- Created spreadsheet comparing each positioning technology across a variety of areas
- Chose appropriate compass sensor, tilt sensor, and accelerometer, chose the best vendor for each of the above components, and ensured that orders were placed as soon as possible (purchased tilt sensors himself)
- Worked with Adam, Max, and Tim to choose a WAAS receiver
- Worked with entire team to create project plan (specifically worked on member profiles and calender)
- Worked with Dev and Vlad to create Code of Ethics
- Worked with Adam, Max, and Tim to create questions by the tech team for the business team to ask subject matter experts
- Attended seminar along with Adam to obtain information and materials for prototyping
- Met with team leaders to distribute work for project plan
- Soldered leads on accelerometer to begin testing

Max Estrada

- Took minutes for the tech team meetings
- Developed mathematical model for dead reckoning
- Researched WAAS receivers for the prototype

- Investigated data acquisition from utility companies and one-call services, contacted Miss Dig
- Researched GPS and WAAS
- Presented the team status and the mathematical model before the team

Adam Bain

- Researched various GPS and other positioning technologies
- Came to consensus with technology team about which product to purchase for prototype
- Investigated NMEA data format and found libraries that would be able to read it
- Attended workshop on Programmable System on Chip (PsoC) hosted by Cypress Semiconductor and am prepared to integrate that system into our design
- Began working with Google SketchUp and experimenting with the included Ruby console
- In charge of learning Ruby to be able to write scripts
- Designing the software system architecture that will guide our coding process.

Tim Madsen

- Researched and identified dead reckoning as a potential positioning candidate
- Helped to decide on final components
- Began to learn Ruby and have investigated the SketchUp API
- Aided in constructing the position transform algorithm to allow the integration of real world data into the Google Sketch Up program

3.0 Revised Task/Event Schedule

Although some changes have been made to the project tasks and deadlines, these changes are very minimal. Some deadlines have been moved back; however these were maintained in the slack that was originally planned into the project tasks. Thus, our project is overall on schedule with the deadlines that were set in the project plan.

	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1	**ENPRO 355**	**94 days?**	**Tue 1/22/08**	**Fri 5/2/08**		
2	**Technology Team**	**46 days?**	**Tue 2/26/08**	**Sat 4/19/08**		
3	**Administrative**	**17 days**	**Tue 2/26/08**	**Thu 3/13/08**		
4	Approval and Purchasing	10 days	Tue 2/26/08	Thu 3/6/08		
5	Mid-Term Report	7 days	Fri 3/7/08	Thu 3/13/08		
6	**Software**	**46 days?**	**Tue 2/26/08**	**Sat 4/19/08**		**Adam Bain**
7	Software Framework Development	15 days	Mon 3/24/08	Mon 4/7/08		
8	API Review	6 days	Tue 2/26/08	Sun 3/2/08		
9	Learning Ruby	16 days?	Tue 2/26/08	Wed 3/12/08		
10	Data Intergration	26 days	Tue 3/25/08	Sat 4/19/08		
11	**Research**	**30 days?**	**Tue 2/26/08**	**Thu 4/3/08**		**Max Estrada,Timothy Madsen**
12	Intergrate Utility Data with Software	21 days?	Thu 3/6/08	Thu 4/3/08		
13	Algorithm Development	9 days	Tue 2/26/08	Wed 3/5/08		
14	**Hardware**	**29 days**	**Sat 3/8/08**	**Sun 4/13/08**		**Jeffrey Mizek**
15	Component Testing	8 days	Sat 3/8/08	Sun 3/23/08		
16	Componenet Interfacing	20 days	Tue 3/25/08	Sun 4/13/08		
17	Documentation Review	9 days	Sat 3/8/08	Mon 3/24/08		
18						
19	**Business Team**	**81 days**	**Tue 1/22/08**	**Sat 4/19/08**		
20	**Research**	**80 days**	**Tue 1/22/08**	**Fri 4/18/08**		
21	**Primary Research**	**18 days**	**Fri 3/7/08**	**Tue 4/1/08**		
22	Questionaire Development	5 days	Fri 3/7/08	Tue 3/11/08		
23	Professors	14 days	Tue 3/11/08	Tue 4/1/08		
24	Professionals	14 days	Tue 3/11/08	Tue 4/1/08		
25	Purchasing & Safety Managers	14 days	Tue 3/11/08	Tue 4/1/08		
26	Representatives	14 days	Tue 3/11/08	Tue 4/1/08		
27	Construction Crew	10 days	Tue 3/11/08	Fri 3/28/08		
28	**Secondary Research**	**70 days**	**Tue 1/22/08**	**Tue 4/8/08**		
29	Library	70 days	Tue 1/22/08	Tue 4/8/08		
30	Internet & Other	70 days	Tue 1/22/08	Tue 4/8/08		
31	Finalize Research	10 days	Wed 4/9/08	Fri 4/18/08		Meng Zhang
32	**Finance**	**12 days**	**Tue 4/8/08**	**Sat 4/19/08**		**Vlad Rusz,Devaraj Ramsamy**
33	Financial Models & Analysis	12 days	Tue 4/8/08	Sat 4/19/08		
34	Buyer Models & Analysis	12 days	Tue 4/8/08	Sat 4/19/08		
35	**Marketing**	**9 days**	**Wed 4/9/08**	**Thu 4/17/08**		**Savina Jose**
36	Marketing Analysis	7 days	Wed 4/9/08	Tue 4/15/08		
37	Market Models & Positioning	7 days	Thu 4/10/08	Wed 4/16/08		
38	Competitors & Environment Analysis	7 days	Fri 4/11/08	Thu 4/17/08		
39						
40	**IPRO Deliverables**	**55 days**	**Sat 3/1/08**	**Fri 5/2/08**		
41	**Mid-Term**	**14 days**	**Sat 3/1/08**	**Fri 3/14/08**		
42	Ethics Report	6 days	Sat 3/1/08	Fri 3/7/08		Vlad Rusz
43	**Mid-Term Report**	**7 days**	**Sat 3/8/08**	**Fri 3/14/08**		
44	Objectives	7 days	Sat 3/8/08	Fri 3/14/08		Adam Bain
45	Results	3.5 days	Sat 3/8/08	Tue 3/11/08		Max Estrada,Meng Zhang
46	Schedule	7 days	Sat 3/8/08	Fri 3/14/08		Devaraj Ramsamy
47	Tasks	3.5 days	Sat 3/8/08	Tue 3/11/08		Vlad Rusz,Jeffrey Mizek

48	Obstacles	7 days	Sat 3/8/08	Fri 3/14/08		Timothy Madsen[50%],Savina Jose[50%]
49	Mid-Term Presentation	5 days	Sat 3/8/08	Wed 3/12/08		TEAM
50	**IPRO Day**	**22 days**	**Fri 4/11/08**	**Fri 5/2/08**		
51	Final Report/Business Plan	16 days	Thu 4/17/08	Fri 5/2/08		
52	Abstract	8 days	Fri 4/18/08	Fri 4/25/08		Max Estrada
53	Poster	10 days	Wed 4/16/08	Fri 4/25/08		Timothy Madsen
54	Presentation	6 days	Sun 4/20/08	Fri 4/25/08		TEAM
55	CD	4 days	Tue 4/29/08	Fri 5/2/08		Devaraj Ramsamy
56	iKNOW Upload	2 days	Thu 4/17/08	Fri 4/18/08		Devaraj Ramsamy
57	Prototype	3 days	Thu 4/17/08	Sat 4/19/08		TEAM
58	Exhibit Requirements & Set-up	7 days	Sat 4/26/08	Fri 5/2/08		Vlad Rusz
59	IPRO Day Skills Session	2 days	Fri 4/11/08	Sat 4/12/08		TEAM
60	Meeting Minutes	5 days	Mon 4/14/08	Fri 4/18/08		Meng Zhang

- Business Team
  - Research
    - Primary Research
      - Questionnaire Development: The deadline as originally stated was not met because the quality was insufficient, thus a new deadline was set.
      - Professors: this task is on schedule but has been extended due to the seasonal vacation of spring break
      - Professionals: On schedule
      - Purchasing & Safety Managers: On schedule
      - Representatives: On schedule
      - Construction crew: The deadline has been moved up since the team decided that primary research should be completed by the end of March
    - Secondary Research
      - Library: work has been done, the task is on schedule
      - Internet & Other: work has been done, the task is on schedule
    - Finalize Research: On schedule
  - Finance
    - Financial Models & Analysis: On schedule, significant progress has been made due to procurement of financial projections excel sheet
    - Buyer Models & Analysis: On schedule
  - Marketing
    - Marketing Analysis
    - Market Models & Positioning
    - Competitors & Environment Analysis
      - All on schedule, these tasks are pending completion of research

- Tech Team
  - Administrative tasks (Entire team)
    - Approval and Purchasing: Started on time but was completed late
      - Delays were due to lack of clarity in purchasing procedures (petty cash vs. large order) and taking more time than expected to chose components
      - However, we were able to use the extra time to purchase wisely and use our savings to expedite shipping to help maintain our schedule
    - Midterm report: On schedule
  - Software (Adam Bain)
    - Software framework:
    - API Review: Complete
    - Learning Ruby: Still in progress, to be completed

        - Data Integration: On schedule
    - Research (Max Estrada and Tim Madsen)
        - Integrate utility data with software: Deadline has been extended because source of data has been necessarily been changed from J.U.L.I.E. to IIT facilities
        - Algorithm Development: Deadline has been extended because additional requirements (in the form of another tilt sensor) had been added
    - Hardware (Jeff Mizek)
        - Component testing: In progress; parts were ordered late, which lead to late arrivals, so deadline has been extended to compensate
        - Component Interfacing: On schedule
        - Documentation review: WAAS reciever was chosen late, so the deadline was extended – will be an ongoing process

All the IPRO deliverables are on schedule.

4.0 Changes in Task Assignments and Designation of Roles and Team Organization

Team Organization:

Please refer to section 3.0 for revised gantt chart for project schedule.

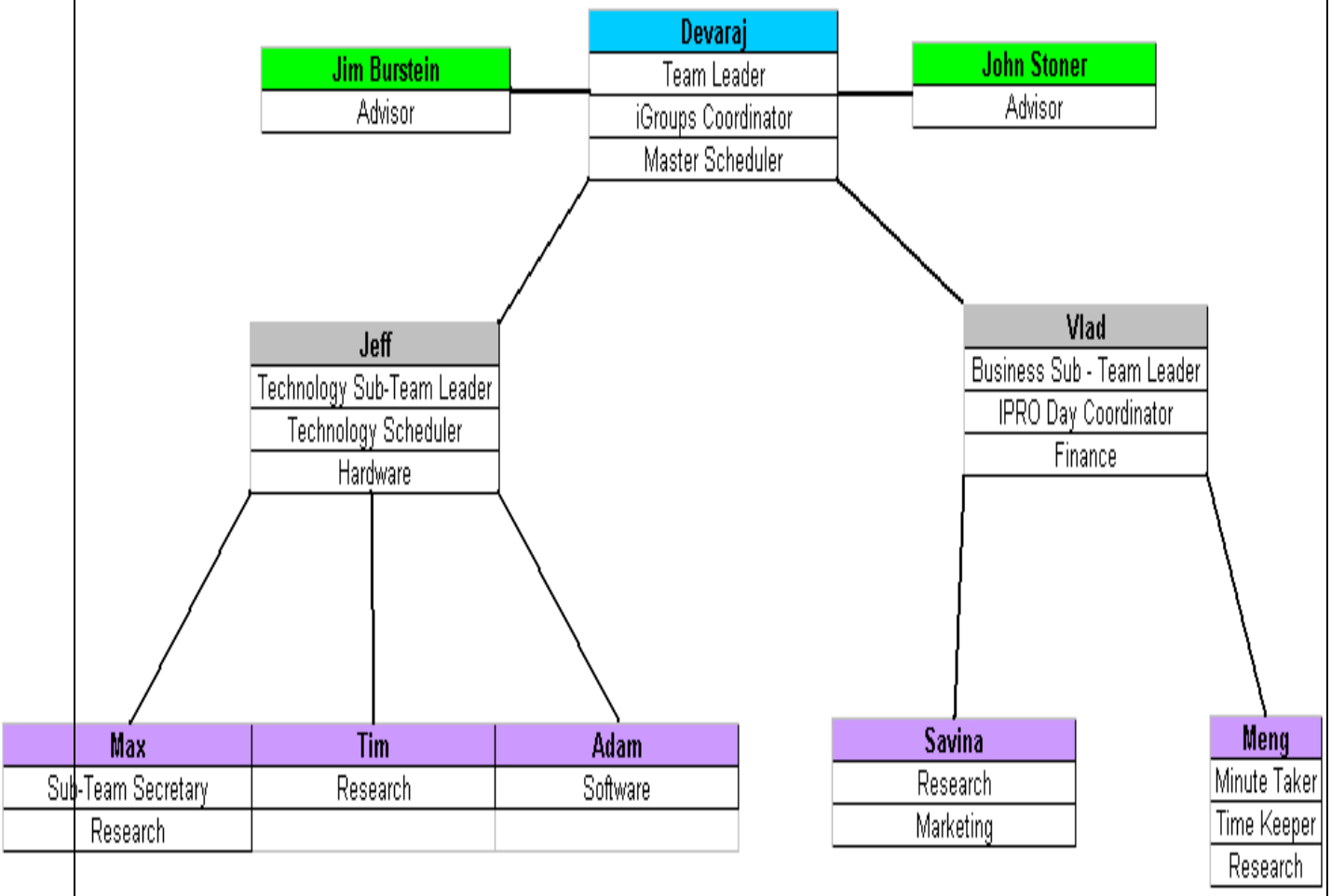
The EnPro team has been broken down into three sub-teams based on skill set and schedule of task assignments. The technology and business sub-teams are functional based teams and the IPRO day team is a cross-functional team, comprising of members from both of the functional sub-teams. The overall team structure has remained the same, but tasks have been assigned and delegated to appropriate team members. Devaraj Ramsamy is overall team leader, primary team scheduler and iGroups coordinator. The minute taker is Meng Zhang.

The technology team has broken its assignments into four categories: Administrative, Research, Hardware and Software. The team leader is Jeff Mizek, who is responsible for the team's overall leadership, task and scheduling assignments. He is also coordinating the efforts for the hardware requirements for the prototype. Within each major area of project tasks within the sub-group, a member from the sub-group will be responsible for completing that area and assigned tasks. The entire team is responsible for administrative tasks, such as IPRO deliverables and miscellaneous tasks. Max Estrada and Tim Madsen are assigned to head the research component and its associated tasks. Assigned to the task of software deliverables is Adam Bain. The overall goal of the technology team is to create a functioning prototype that can be displayed at IPRO Day.

The business team has assigned Vlad Rusz as the head of the business team, instead of having co-team leaders. This change was instituted to reflect a more efficient means of organization and to mitigate potential communication problems. The team has broken its functions down into three major functions: Research, Marketing and Finance. All these tasks are in support of the main deliverable of a business plan and all associated project deliverables. In addition, the work done by the business team is to complement and assist with the development of the technology team's goals and deliverables. The research area is broken down into two functions, primary and secondary research, with the entire team

taking responsibility for performing and organizing the research. The marketing analysis and functions are assigned to Savina Jose with support from Meng Zhang. The financial functions are assigned to Vlad Rusz and Devaraj Ramsamy.

The third group is the IPRO day team, which is lead by Vlad Rusz, will focus on the project deliverables such as ethics report, mid-term report and IPRO day itself. The team is comprised of members of both sub-teams in order to organize and present deliverables as one of the primary goals of the project. Aside from completing IPRO deliverables, producing a value-oriented product that would attract sponsors or investors to the project is an overall team goal for the semester.



5.0. Barriers and Obstacles

- One of our goals for the semester is to build a prototype of our product. In order to do so, we have certain requirements such as a room that is at least 10' x 12'. This is important so that we can move around the room and measure the responsiveness of the sensors. The room must also have grounded sockets for equipments and proper ventilation for soldering. Hence, not having a working and storage space can be a big obstacle for us. However, we have requested lab space through the proper channels.

- Our idea is completely new and we are targeting a market that is different from last semester. Our new target market is the construction industry. Thus, we need to do new market research – both secondary as well as primary in order to complete our project for the semester. This can be tasking as well as challenging because of the time constraint and the difficulty in making an appointment with and talking to professionals in the construction industry. Our team foresaw this problem and scheduled appropriately to ensure that it is completed. We have formulated the questions that we have decided to ask the professionals and our goal is to conduct interviews in the next two weeks.

- Our team is divided into two sub-groups – Tech Team, consisting of students from technical background, and Business Team, consisting of students from business background. The Tech team will work on the prototype and the tech part of our project. The goal for the business team is to do market research and provide financial projections. Because of this division, there can be several issues of communication. However, we try to ensure that this does not become a barrier for us and that there is full communication between the two sub-groups. We meet with and e-mail each other frequently; and upload any information or research documents on IGROUPS for everyone to see. Also, each sub-group conducts weekly presentations to the team. This helps us tremendously as we get to know the progress of the other sub-group.

- We do not have any sponsors currently and plan to work within our team budget. However, building a prototype and creating a product such as ours can be tasking and expensive which can be a hindrance. Hence we are also developing an exit strategy, including the possibility of partnering with or acquisition by companies such as Caterpillar or Komatsu.

- The acquisition of prototype components have been delayed due to shipping delays from the vendors. This has not affected the overall schedule on the technology side as work has continued on software development. If further delays occur, then it will have an impact on the prototype schedule.

6.0 Midterm Presentation Slides – (Attached as a Separate Document)

Appendix

Questionnair:

1. We will first talk about our idea briefly.

2. How do you acquire your heavy duty construction equipments? Do you rent/Buy/Lease these equipments? Do you have your own that you rent to others?

3. How do you deal with locating underground utilities for construction?

4. How many bull dozers have the Work Area Vision System?

5. What measures do you use to ensure safety (in relation to heavy machines and utilities)? What do you do better than your competitors to ensure safety?

6. What technologies do you use in heavy machineries? What hi-tech safety equipment do you use? What is the cost? (What is the adoption rate for new technology?)

7. What does your liability insurance cost per year or per month?