[Intelligent Water Project]

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FOREWORD

For my senior honors project, I pursued Departmental Honors through the CIS 411 and CIS 412 curriculum within the Information and Mathematical Sciences Department. The honors project was centered on the three-year ongoing project that the department elected to use within the capstone course.

As the majority of the work done was within the confines of a software system, there are few artifacts from the project that exist as prose. The majority of project artifacts are diagrams and process flows, as well as actual system code.

All of these artifacts are proprietary and confidential with respect to the project and will not be disseminated for publication due to constraints with respect to the project. However, included for archival purposes are the following:

SENIOR HONORS PROJECT PROPOSAL

For reference, the initial project proposal has been reproduced in this archive. This document includes the means and methodology of the capstone project as it relates to the course and the Department Honors Requirement.

SERVICE LEARNING REFLECTION PAPER

The Service Learning Reflection Paper is an unguided assignment for the course that also serves as the final paper for Departmental Honors. This is further explained in the Senior Honors Project Proposal document.

SCHOOL OF SCIENCE ENGINEERING AND HEALTH SYMPOSIUM PRESENTATION

An additional element of Departmental Honors was to present at the annual School of Science Engineering and Health Symposium. This presentation was delivered on May 2, 2014.
Final Project Retrospective Presentation

The last presentation included is the final project retrospective for the project, which was delivered on our final class period on May 6, 2014.

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BACKGROUND

The Intelligent Water Project (IWP) is a joint, three-year project between the Collaboratory for Strategic Partnerships and Applied Research (the Collaboratory) and the Information and Mathematical Sciences Department of the School of Science, Engineering, and Heath. The IWP project is being applied in the Computer and Information Sciences curriculum through the senior capstone courses. Each student in the Computer and Information Sciences program will take part in this ongoing project.

In order for the capstone course to satisfy the College Honors Program requirements for department honors, the honors participants must receive an A in the fall semester capstone course (CIS 411) and in the spring semester capstone course (CIS 412). Additionally, they will serve as a team-lead in the capstone course for further development of the IWP project.

PROBLEM STATEMENT

The primary goal of the Senior Honors Project will be to extend and enhance functionality of the existing IWP project. This will be done in two ways:

The first will be to enhance functionality that is already a part of the IWP project. This will require research into past implementation of previous problems, geared to past project documentation. With this research, current implementations will be modified in order to achieve desired project goals.

The second will seek to redesign existing functionality from the ground up. As the project matures, system requirements will evolve and will be further understood. This will require some elements of the existing project be redesigned.

APPROACH

In order to satisfy the extension and expansion of IWP functionality, the chosen aspect of the project will be specified using Sprint methodology. The Sprint methodology is an element of the Scrum software development framework, an agile development framework which focuses on aligning project goals to requirements as well as ensuring working deliverables at all stages of the project.
Thus, as project aspects are chosen, the Scrum framework and Sprint methodology will be applied to project work in order to meet project goals.

**Deliverables**

Adherence to the Sprint Methodology will determine the type of deliverables which will be produced throughout the duration of the project. In order to document requirements, a specifications document will be created which will detail the backlog under the Sprint methodology. This will highlight requirements for the specific project aspect that is selected for the project. From these high level requirements, a design document will also be created which details the implementation that will be developed.

Functional code will also serve as a deliverable for this project. Based off of the requirements backlog, solutions to project problems will be devised using various database, web design, and programming solutions, as required. With the Sprint methodology, a regular cycle of deliverables will be observed, keeping deliverables accountable to functional and non-functional requirements of the overall IWP project.

Additionally, at the end of the semester in CIS 412, a summary honors paper will be produced which will document lessons learned throughout the project research and development phases in the fall and spring semesters. The paper will also serve as a means to reflect on the project as a whole.

Finally, the project will culminate in presentation at the annual School of Science, Engineering, and Health Symposium in May of 2014.

**Timeline**

As the IWP project is a current project, currently being developed by students in Computer and Information Sciences as well as the Collaboratory, requirements for the project next year cannot be fully known at this time. Thus, the fall semester in CIS 411 will serve as a research period. In this semester, past successes and failures of the project will be taken into consideration with requirements and specifications for the continued project. This will culminate in the selection of the aspect or aspects of the project which will serve as the focus for spring semester development. This process will be completed by mid-November of 2013.

The spring semester in CIS 412 will serve as the development and implementation phase for the aspect or aspects of the project selected in the fall. All deliverables will be completed by the annual School of Science, Engineering, and Health Symposium in May of 2014. The entire semester will be aligned to the Sprint methodology.
Service Learning in CIS Reflection

The goal of this paper is to reflect on the process of service learning within the Computing and Information Sciences (SL in CIS) as observed from the student perspective in the Spring of 2014 with the preparation of the project occurring in the Fall of 2013. With this background in place, it is also important to realize that the work done on the Intelligent Water Project (IWP) this semester was the first work that I had done on the project. Some students, who took classes in a different sequence than I, had the opportunity to work on the project last year as well. In that this is a three-year project, my work in the project has come in between development stages. This required from my perspective the ability to become up to date with the current status of the project and to continue off of progress that had been made in the prior academic year.

In order for me to best reflect on the process of service learning as it relates to CIS 412 in the Spring of 2014 and CIS 411 in the Fall of 2013 with respect to the Intelligent Water Project, I think it is paramount that I first reflect on the System Lifecycle and Development Model that we utilized for our capstone course. I say this because it is through this paradigm that we engaged in our service. Without reflecting on our SDLC, any reflection would be incomplete because the manner in which SDLC occurred directly influenced the service learning that occurred this academic year.

Our prescribed SDLC model was through an agile method, SCRUM in which a regular cycle of (hopefully) functional deliverables can be presented so that at any time after a cycle, or Sprint, has occurred, we have a demonstrable product that can show—at least—limited
functionality of the system in a semi-stable environment. From the perspective of a student working on one aspect of a much greater whole, I found this method of development to be quite intriguing. By employing SCRUM, I as a co-contributor of the project could see the progress made by my classmates on a regular basis. Such demonstrations also allowed for us to further reign in on the requirements that we had and ask important questions to further our understanding of what it was that we were building. I believe that if this project were done with an alternative SDLC model we would not have achieved the intra-group transparency that we did during the development phase.

With respect to our observed SDLC mode, I believe that there are some concerns with the manner in which we proceeded this semester that I think should be discussed here as they relate to the overall process of the project and how it may have impacted the service learning aspect of what we accomplished this semester. Primarily, I believe that we had to tackle significant process and learning overhead in the beginning of the semester. It is my opinion that time was lost due to such overhead that could have been addressed in January or prior in CIS 411. While this is more of a logistical concern with respect to the project, I believe that the overhead required in the initial sprints detracted from work that could have been accomplished early on in the semester.

One additional concern that I believe impacted—to a small degree—was cross team collaboration. With respect to having the project housed in three academic courses, I believe there was some disconnect with the team in the database course with respect to communication with those in the capstone course and the web course. Since the entirety of the web team was also in the capstone course, there was no apparent disconnect with them, however with the database team this was not the case. I believe that they were not as integrated into the project
collective as the rest of the teams who were enrolled in the capstone course. I think that more should be done in order to promote accountability in those courses that are not entirely devoted to the work of the project as other members of the class are working on different projects. In the case of the capstone course, the entire course was dedicated to the work of IWP. However the database course had different projects as well and some of the database work was fragmented from the remainder of IWP course resources. Nevertheless, the team was able to adequately pull support from the database team when needed, however, more accountability for their role in the project would have been preferred. This can be thought of as accountability with respect to the academic duties or with respect to the service learning responsibility. However any further discussion along this route would be to digress from the primary purpose of this paper.

With the aforementioned considerations aside, I think it best to now direct the focus of the remainder of this exposition to the direct application of service learning that was observed through the course of this semester. With respect to the project as a whole, it is certainly clear how the Intelligent Water Project fits the mold of a service learning project. With real community partners, we have the privilege of working for a real cause, something that not many other undergraduate computing students have the opportunity to do. Furthermore, we can directly trace the path that our work will lead after we have moved on from the project. Through this, we have more accountability for the work that we accomplish because we know that once it is graded and demoed, it will not simply be thrown out and forgotten.

With respect to this accountability, we can trace the source to a certain community partner. In our case, this is World Vision and, to an extent, the Collaboratory. With regards to service learning, it is important that we observe the three critical elements of service learning with respect to IWP. These are to 1) meet the customer’s needs, 2) create a sustainable project
for the community partner in the long term, and 3) ensure that the project respects the environment. From the context of the student perspective in the software realm, it is difficult to respond to question number 3. This is one that would best be discussed with the firmware team to ensure that their physical implementation conforms to such an expectation.

However, the software side of the project can address both questions 1 and 2, above. In order to address question number 2, we must look at the community partner. World Vision has a clear understanding of how to employ service in the developing world in a manner that fosters the longevity of their projects and a sustained implementation for the long term. With regards to question number 1, I think further discussion is necessary. In order for us to ensure that the customer’s needs have been met, we must ensure regular communication with the community partner. The SCRUM methodology allows for this continuous communication with the client.

However, from the perspective of the student worker, I believe that direct communication was lacking. Our primary source of contact for requirements and further clarification was through our professors and Tony Beers, a para-professional in the Collaboratory who works primarily with water. As a student, we lacked communicational transparency with our community partner, as all of our communication on requirements and client approval of the system was through professors and our Collaboratory representative. While they did provide World Vision with mockups and previous versions of the system in order to verify their acceptance of previous work, from our student perspective we were significantly insulated from our community partner. I believe that this communication disconnect also lessened my ability to perceive my role in the community partner’s mission. An element of service learning allows for those serving to see how our work goes to support the mission of the community partner. While we all can understand the big picture goal of the project, it is sometimes difficult to see how the
work we have done will affect the community partner. Due to this, we may become blinded by our shortsightedness with regards to our current work.

Ultimately, working with a project where the stakeholders are real and the end goal is real, allows the project to have significantly more impact in the life of a student working on a “real world” project as opposed to some artificially crafted textbook project where the professors know the solution. This project doesn’t simulate the practice of software and systems engineering in actually is the practice. This project has real stakeholders, this project has real requirements, and the project has real outcomes. This is in essence service learning in the Computing and Information Sciences.
Problem Statement

- Problem:
  - Graphical User Interface
    - Pump Map
    - Charts and Graphs for integral pump data
  - Events Management and Notification (EMN) System
- Importance:
  - Manifestation of the "big picture" purpose of the project
  - "...to produce actionable information about pumps"

Our Focus

- Pump Map
- Clustering
- Custom Icons
- Information Window
- KML Export Functionality
- Pump Profile and Aggregate Pump Profile
- Graphs and Charts
- EMN System Conceptual Overview
Lessons Learned and Future

- Technology Learned
  - Database Triggers within MySQL
  - Google Maps and Charts APIs
  - Other web technologies
- System Engineering Lessons
  - Cross collaboration between teams
  - Delegation of appropriate work
- Future
  - Open Source Reporting Engine
  - More configurable Events Management and Notification System
Intelligent Water Project
Sprint 6 and Project Retrospective
Team 2 - Reporting, Analytics and Cloud
Andrew Yao, Ben Sheeler, Kevin Olchewsky, Matt Musselman, and Zach Kantner

Executive Summary
- Project Introduction
- Project Overview
  - Sprint Summaries
- Demonstration
- Project Retrospective
  - Application Impact
  - Overall Strengths and Weaknesses
  - Overall Lessons Learned

Project Introduction
- Produce actionable information about pumps
  - Pump Map
  - Pump Profile and Aggregate
  - Events Management and Notification System
    - Pump Status Derivation
    - Alerts, Incident Reports
  - Project Manager (PM)
    - Team and Owners’ Liaison

Project Overview
Sprint Summaries

Sprint 0
- Strengths
  - PT Epics and Sprint 1 Backlog
  - Team Member Roles and Focuses assigned
  - (PM) Canvas and PT configured
- Weaknesses
  - No Code
  - Lack of understanding of requirements and scope
  - Overhead of learning project background

Sprint 1
- Strengths
  - Figuring out the SVN with (PM)
  - Find, Review, and Interpret last year’s (poorly documented) source
  - Cloud Research
  - Build Initial Semester Backlog
- Weaknesses
  - No Code Artifacts
  - Organizational Overhead
Sprint 2
- Strengths
  - First iteration of EMN Process flow and Design
  - Google Charts and Maps begin to come alive!
  - CSV Export of Pump Data
  - Research documents on the above
  - Cloud Tech Stack Research
  - Cloud Vendor Coordination (PM)
- Weaknesses
  - Overhead of SVN Post-Commit Hook

Sprint 3
- Strengths
  - DB Trigger Research
  - Maps Enhancements (Clustering, DB Integration)
  - Charts Enhancements (Leakage, Daily Water Extracted)
  - Cloud Vendor Interaction (PM)
  - Site-wide SVN export for demo day (PM)
- Weaknesses
  - Spring Break velocity

Sprint 4
- Strengths
  - Mods to EMN triggers – not persisting status in DB
  - "Hello World" of stored procedures
  - Custom Google Maps markers
  - Charts enhancements
  - Information Acquisition Doc with DSS (PM)
  - Meeting with DSS
- Weaknesses
  - Triggers not implemented
  - Learning PHP for maps and KML overhead

Sprint 5
- Strengths
  - Mods to EMN triggers – back to persisting status in DB
  - Most Triggers Implemented!
  - Maps info Window and Pump Profile Integration
  - KML Export
  - Charts Enhancements
  - Cloud configured and accessed (PM)
- Weaknesses
  - Not all triggers implemented

Sprint 6 – Strengths
- Symposium Demo went well
- Charts
  - Documentation
  - Dashboard Pie Chart
  - PNG Export Functionality
  - TCO on Profile Page
  - MR Report Chart
- Maps
  - Aggregate Pump Select UI Feature and ID display
  - Info Window Toggle
  - DNS and site to intelligentwater.net for Symposium (PM)
- Alerts are IWP Spec Compliant
- Status Parameter Configuration Page

Sprint 6 – Weaknesses
- Alerts and Incidents miscommunication with other teams
Demonstration
Pump Map and Google Charts Demonstration

Project Retrospective
- Application Impact
- Project Strengths and Weaknesses
- Lessons Learned

Application Impact
- Current State – Framework to build upon
  - Visualize Pumps and associated data
  - Drill down to analytics
- Goal State
  - Improve UI friendliness
  - More advanced analytics
    - open source BI engine
  - Solidify Alerts and Incidents

Strengths and Weaknesses
- Strengths
  - Framework for Reporting and EMN
  - Learning
- Weaknesses
  - Requirements Coordination and Clarity
    - Alerts and Incidents confusion between teams and product owners
    - No direct communication with community partner
  - Excessive overhead and spinning wheels in February

Lessons Learned
- Project Management
  - Pivotal Tracker used to an extent...
    - Need to be intentional with usage
    - Should be set up ahead of time to calculate points accurately
  - Change Management Process
  - Cross Team Communication
- System Development Life Cycle
  - SCRUM followed rather closely
    - Some fringe discussions during standup meeting
  - SVN, and proper use of
- Techniques and Ideas for Future
  - New Web and Database Technologies