Providing a Real World Experience in the Teaching of Computer Technology

By Joel Weinstein, Andrew Gilchrist IV, Kyle Hebsch, Jefferey Stevens

Northeastern University

Abstract

One of the greatest challenges facing engineering technology educators is preparation for what graduates will face in the real world. Unlike the classroom, problems are not predefined, solutions do not come from answer books and personnel are not nearly as expert as the instructors that have prepared the students. This paper describes a course and its methodology that helps to better prepare students for the real challenges that they will face—most of which are not technological in nature. In the course, students are exposed to a deadline-based problem, given little formal guidance and chartered with the responsibility for solving a real problem. The results were encouraging and the students ranked the class activity as one of their best.

Introduction

Modeling the real world is one of the greatest challenges for engineering technology educators. Technology training has always been easy because students are surrounded by computers, innovation and course work. What is needed is a program that will show students what they will face in the real world and teach them about important skills such as teamwork, communications, time management and problem recognition/solution skills.

Simulating an industrial environment in the classroom is difficult. This paper describes a model for providing this kind of culture wherein students are randomly assembled into teams and given a poorly-defined task to complete within a ten-week period. The students are given little technical guidance and are required to deliver a working prototype of a software-based project.

In the course, students deal with "customers" through weekly meetings with the instructor who poses as an employee from a fictitious company. At those meetings, the students learn how to develop solutions to problems and also discover an important lesson in corporate culture: They quickly find out that corporations may understand their own missions, but do not understand how to complete the missions. At the end of the course, students submit a working prototype and a presentation to the faculty who pose as the corporation. The results of these efforts were enlightening and educational at the same

time. This paper discusses a typical project—one of many—in which students had to design software for a courier service. This project is representative of ten different projects that were assigned to different student teams and the results were typical. In this project, students had to design software to help a courier service keep track of pickup and delivery information, optimize routing of drivers and improve the general business framework for the company.

Rationale

The requirements for graduating students who enter the technology industry are rapidly expanding. Entrants must bring with them a complete toolbox of knowledge coupled with the highest possible levels of skills and experience. These skills include problem dissection, problem solving, communications, teamwork and the motivation to complete the most tedious tasks within a set time frame. While university curricula effectively prepare students technically, they fall short in delivering these additional skills.

At Northeastern University, students are given a limited opportunity to gain real world experience while still in college through a co-operative education program. The coop experience reinforces the learning experience and allows the student to focus on non-classroom aspects of a potential permanent career. The cooperative education program also gives students an opportunity to expand education through an experience in a real company. The co-op student is treated like a member of the staff and although involvement with key company decisions and actions varies by company, the experience usually includes a healthy mix of tasks. Although this is a valuable learning experience, it lacks depth, is limited in responsibility and generally uses the student in only a limited capacity.

The skills developed in the co-op experience still need to be fine tuned and developed if the student is to succeed after graduation. Additional skills must somehow be made part of the classroom requirement and to achieve this, the classroom must be transformed into an environment where these skills can be further improved. This concept of the classroom is the focus of a course offered at Northeastern University entitled "Software Engineering." Beneath the title, the class teaches all of the necessary "tools" beyond technology that allow the student to be successful in a real-world design project.

The remainder of this paper will describe the objectives, methods and results when the real-world requirements of industry are blended with course work in the classroom. It describes the course objectives, how the students reacted, the results they achieved and the details of one of the completed projects.

Objectives

In addition to technical course work, industry demands skills in problem dissection, problem solving, communications, teamwork and motivation. Due to the nature of the

technology world and its rapid changes, companies need employees who have the ability to interpret, critically analyze and solve problems, work effectively in teams and be able to communicate across various segments of a business. To effectively teach students these skills, the classroom needs to be transformed into an industry setting.

Within the workplace, it is common to operate in teams. These teams, incorporating individuals from varying backgrounds, are charged with the completion of a common goal. Rarely do employees have a say about placement on a team and, in most cases, the team members do not know one another personally prior to the team experience.

For the classroom project, this concept was mimicked by having the instructor select teams. Team selection matched skill levels, backgrounds, expertise and personalities in order to make each team as well balanced as possible. As in the corporate world, the class was composed of students with different majors and skill sets. Each team, composed of six full-time undergraduate students, had no prior experience working together, and for the most part, the project provided the first opportunity for any of them to associate with one another outside of the classroom.

Communications as the First Barrier

Communications between team members was the first and most difficult challenge. To be successful, the project required communications between team members and communications between the team and the fictitious client (the instructor). Both types of communications were equally important and both were equally problematic. The instructor's self-imposed mission was to provide as little information as possible (and often to provide inaccurate information). The team's mission was to discover as much as possible about the problem from their "client" and to divide the problem amongst themselves based on individual skills. For the first time, the team experienced the need to interpret and potentially disregard their instructor's advice. In addition, the instructor formally mandated that each team had to operate as a single functional unit and members of the team were required to rely only on one another. Complicating the communications task was the varying backgrounds and skill sets of the individual team members. As a result, communications within the team required some internal management and patience from all team members.

The communications between the student teams and their client was the first unexpected obstacle. The client claimed only limited knowledge and was not willing to provide the teams with sufficient or additional information about the details or implementation of the project. Each team had to determine a method of interfacing with the client in an appropriate and meaningful way to gather the necessary information about the project that they were required to complete. They quickly discovered that the more questions they asked, the more convoluted the answers became. Their only solution was to sit down as a team and analyze what they had heard. By having multiple sets of minds analyzing the same response, the teams found that they could effectively understand the client response and the teams that discovered this early were able to move forward quickly.

Course Methodology

This course was structured differently than most other college courses because class time was spent in a totally different manner. Students did not show up to class, sit through a lecture and take notes anxiously awaiting the professor's next words. The focus of this class was to provide hands-on experience with the real business world. As such, lectures were brief and very informal. Some class meetings were dedicated exclusively to client-company meetings and some were used for inter and intra-company discussions allowing the students to ask questions about how to gather information from a client who was unwilling or unable to provide data.

During the first week of class, the class was divided into teams of six students. Each team was required to create a company name and assign job titles simulating a real company. Each team was given the task of designing and building a prototype product for a fictitious client. After the teams were created, they had to unite and choose one of ten proposed projects. Class time was spent on meetings with the client to discuss ideas and plans.

During each client meeting, there were no student/professor conversations. The professor played the role of a fictitious client who deliberately lacked specific knowledge about the project or how it needed to be implemented. The teams were forced to probe in many dimensions in order to obtain valuable information from the client just as it might be in real life. During formal class sessions, the teams were told that they should expect this kind of situation and were coached about how to glean information from an uncooperative client. It was further explained that if the client actually understood how to solve the problem himself, he would not need the assistance of the teams. This explanation invigorated the students and they were able to approach their client with must greater confidence.

The teams were subjected to real problems and real situations, and they learned many things about themselves that could never be taught in a classic college class.

Class Structure

Unlike most other college courses based solely on classic lectures and examinations, this class was equally divided between lectures and team operations. Part of each class was spent discussing and learning the steps a company would take when creating a concise requirements document for producing a new product and a working prototype. The instructor described the steps that teams could implement to move their projects forward while also demonstrating why such activities, documents and structures were important.

The remaining class time was available for teams to meet with their client. During these meetings, teams could update the status of their projects or ask questions about project

requirements that were unclear. Meetings varied in length and the client (instructor) frequently (and deliberately) had prior "engagements" to attend or might skip the meeting entirely without notice. This was part of the industry simulation. Students learned that client meetings don't always go as planned and often interruptions prevent companies from being successful. The student teams had to learn how to deal with this problem. Nonetheless, this format gave the students a good mixture of lecture and industry simulation.

Guidelines for Success

Rather than having a template, the development of each product was left solely to the individual teams. The project software could be custom-written in any programming language or could be extracted from an existing "off-the-shelf" product. Evaluation of the best solution was a team decision. All product requirements required a signed agreement from the client and the client could and often did change the requirements if the group failed to get a signed agreement (and often tried to change requirements even if there was a signed agreement). Completion required a formal presentation and working demo as well as additional detailed documentation.

The client was intentionally vague about project details or specifications, always preferring to "get back to you on that" and rarely ever doing so. This forced the teams to do enough research to allow them to make intelligent decisions without client input. They discovered that often the client lacks depth or perception of the range of technologies available to solve a problem. They also discovered that an important part of solving technology problems required gaining customer confidence.

Results

From the instructor's point of view, the students eventually succeeded. Although there was an acclimation period during which the students needed to internalize the fact that this course was distinctly different from previous ones, collaboration between the teams eventually solved the problem. This course was different because there was no formal schedule to follow. There was traditional coursework and the usual reading/examination schedules, but this comprised only half of the actual course content. The rest of the course involved getting the teams to understand just what was expected and then having then figure out how to achieve the expectations.

For team creation, the only formal direction given from the instructor was that each team had to create a formal structure, pick a company name and assign responsibilities. No additional guidelines of any sort were provided. The teams needed to rely on their understanding of how companies work and on their co-op experiences. Because teams were mixed relative to skill level and major, the shared experiences of the individuals was an important part of solving this problem and deciding exactly who would take which responsibilities.

As evidenced in the appendix containing a summarized version of a specific project, the students all rose to the occasion. The need to operate as teams, the need to communicate both internally and externally, the need to establish and work toward goals was eventually learned. Although a few of the teams required a degree of "off-line" guidance and encouragement from the instructor, the majority of the students did well and solved problems in a surprisingly professional manner.

Some Student Observations

Prior to meeting the client, each team's first task was to form a company, develop a company logo and determine each member's function within the team. For the specific project described in this paper, the team chose the name "WareSoft Technology Corp." with a company slogan "Reversing your problems through software." The selection of team positions was difficult due to controversy between team members, but the team quickly decided who would take charge and lead the group.

Over the course of the 10 week project, the team encountered many obstacles and problems; however, the overall project was successfully completed on time. Below are accounts from some of the students involved in the project and their views of the problems and obstacles. It should be pointed out that these responses and observations were typical of what most teams encountered.

Teamwork & Motivation

"Each student brings with him or her a different perspective on learning and life to the classroom, and what drives them to achieve their goals also varies. Some students walk into the classroom nervous and concerned. "Can I really do this stuff?" "Will I pass?" At the same time, other students are willing to work extensive hours and do whatever it might take to be the best. In team settings, these two extremes clash and the differences could be seen from day one although they eventually dissipated just in time for the presentation."

"The work ethic from the beginning was very lax and, as commonly occurs in the rapid moving quarter system at Northeastern, the company fell behind quickly. It can't really be determined what pushed the team onto the track in the beginning, however the push didn't affect the whole group until the deadlines were eminent."

One of the greatest problems for WareSoft Technology was dividing the work as well as getting the appropriate personal to complete their assignments. The different backgrounds of the students was the first obstacle the team encountered, while lack of experience with the platform being used was a close second. The company president had the dubious task of determining what task to give to whom, and as recounted by him:

"It was very hard in the beginning and quite discouraging when I could not get the entire group on the same page to meet deadlines or to just seem interested in the project. I knew some of the tasks were not as interesting as others, but all were at one point or another relevant and important. Other issues I encountered were getting those whom I knew were capable and could handle the technical items to actually complete them, and at the same time find a task for someone who lacked the necessary technical background to complete those level tasks. It was definitely something I discovered to be very difficult and it also began to hit home when I finally was able to see, first hand, what my real-life boss has to deal with daily between those who are from very different backgrounds or utilize opposite styles (e.g. Windows vs. Unix)."

Nevertheless, WareSoft ultimately completed the task at hand in time, barely, but effectively. On the day of the presentation, the product prototype was presented to the client, and everything seemed to come together to give the company the added push needed to sell its product to the client.

Communications

From the beginning, the communications skills of the team were questionable, and many times incurred overhead and wasted time creating further frustration. The first hint of this potential problem came during the first meeting as a company and later on during the first meeting with the client as well.

During the meeting in which the company was formed, it was obvious to the company president that things would be rough. According to him, "I remember sitting around a table in the library staring at blank faces, and knowing my own self-drive and determination was not shared by the rest of my team. I was concerned about what I would need to do to motivate them and get things started. Furthermore, it was difficult to get the team of students, who had little to no previous interaction, to mesh well and complete such a task within the confined time limits."

Further communications difficulties were demonstrated when meeting with the client, especially in the beginning. Even though the company had discussed its plan of attack with the client prior to each client meeting, the team communication skills began to break down. "People would begin to get off the current topic and flood the client with questions that were too in-depth and irrelevant at the time," according to one team member. In the end, things did turn around for the group during the final weeks of the project.

A lesson was learned from the project about communications skills that are beneficial not only in the classroom, but in the workplace as well. Over the course of the quarter, the company was able to form working relationships with one another, good communications amongst themselves, and develop a coherent plan of execution when questioning the client as well as reporting back to him.

Time Management

The effective and proper management of time is something that evades everyone including professionals. Many supervisors and managers are forced to assume tasks that are outside of their areas of expertise. Therefore, time management is paramount for managers, employees and definitely students.

The project was not taken seriously at first and this was the beginning of significant trouble. Coupled with communications and teamwork obstacles, the time management problem created a major issue.

According to one team member, "Before we knew it, deadlines were creeping up on us one after another, and we as a team were not able to manage. I remember when we scheduled meetings, there would be shoddy attendance and even when the majority of members did show up, they rarely were productive 100% of the time. With all of these factors, I realized that there was no way we could continue, let alone complete a successful project till I took matters into my own hands. The idea of time management hit home after a two and half day sleepless period where I went to classes and spent the remainder of each day working to prepare the program, presentation, and documentation. I definitely learned my lesson, something I have since carried with me to my co-op job and all my subsequent assignments in school."

Results

In the end, each team was required to present their project to a panel of faculty posing as the board of directors of the client company. This was the final chance for the teams to demonstrate their product based upon the wants and needs of the client as determined through the weekly meetings. At the presentation, each group was required to produce a working prototype and a PowerPoint presentation to describe what their company was trying to accomplish.

Presentation day for WareSoft Technology went well and was a excellent conclusion to an extremely tedious and challenging project. A portfolio containing business cards, demo software and product instructions preceded the demonstration. Afterwards, each team member spoke briefly about his involvement in the project and the presentation concluded with a demonstration of the product designed.

The teams were able to accomplish the course goals of learning about the challenges of operating in an industrial setting from within the classroom. They learned about developing a product specification and a product without significant input from a client. They learned that communications within the team was one of the most valuable skills and they learned to do communicate effectively. In an industrial setting, information is not always available and is often incomplete. The teams learned this and had an opportunity to deal with it in a project-based setting. These are the kinds of skills that

should prove invaluable to them when they graduate and have to actually cope with these kinds of limitations in a true industrial setting.

Conclusions

Students learned the rudiments of how companies actually produce products. With the goals of higher education and this particular college experience demonstrating these trial and error situations, each student eventually realized that the skills developed in this course will be of great benefit to them. They now understand that problems can be solved when multiple mindsets more accurately assist in the dissection of a problem.

The reaction from most students was that the class gave them "their money's worth." The students learned that meshing of business and engineering students in a team environment helped them to learn new concepts and ideas about the workplace that they will carry with them after graduation. One student summed it up quite clearly. "If I keep getting 'tools' like this class, I am going to need a bigger tool box."

Bibliography

Pfleeger, Shari Lawrence. <u>Software Engineering: Theory and Practice</u>. New Jersey: Prentice Hall, 2001.

Hammer, Michael & Champy James<u>. Reengineering the Corporation.</u> Harper Business.

Weinstein, Joel. <u>Simulating Industry in the Classroom</u>, ASEE Conference Proceedings 2000.

JOEL WEINSTEIN

Joel Weinstein is the Program Coordinator for the Computer Technology curriculum at Northeastern University's School of Engineering Technology and Lowell Institute School. He has been a member of the faculty for over twenty years and has many years of service with a wide range of industrial firms.

ANDREW GILCHRIST IV

Andrew Gilchrist IV is a junior undergraduate at Northeastern University's School of Engineering Technology, majoring in Computer Technology with a minor in Business Administration. Throughout his tenure at Northeastern, Andrew has worked for the Charles Stark Draper Laboratory in Cambridge Massachusetts. There, he worked on various network infrastructure projects that aided in the lab's many improvements. During his free time, Mr. Gilchrist enjoys playing hockey, reading, and furthering his knowledge in various computer areas. Andrew will be receiving his B.S. in Computer Technology in June of 2003. After graduation, he plans to attend graduate school and obtain his MBA.

KYLE HEBSCH

Kyle Hebsch is an undergraduate of Engineering Technology majoring in Computer Technology at Northeastern University. Mr. Hebsch has been employed at Dynisco and the Taunton Municipal Light Plant as part of the university's Cooperative Education program. When away from class and work, Kyle enjoys playing intramural basketball and soccer at the university. Mr. Hebsch will receive a B.S. degree in Computer Technology from Northeastern University in the spring of 2003.

JEFFEREY STEVENS

Jefferey Stevens is an undergraduate student attending Northeastern University who recently switched majors from Criminal Justice to Computer Technology. Mr. Stevens sought a more interesting major while trying to determine his personal strengths. With this decision, Jefferey can fine tune and increase his vast knowledge within the computer field. Mr. Stevens is looking to graduate by 2004 with a Bachelors degree in Computer Engineering Technology.

Appendix I: Key Parts of the Final Documentation for WareSoft Technology

Section	
1	**Company Information and Organization**

WareSoft Technology is a small company based out of Jamaica Plains, Massachusetts. Our mission is to provide our customers with a cost effective, technologically advanced software solution in a timely manner. Our services include software development and integration, training and support for all of our products, and private consulting services.

The six‑member team that comprises WareSoft Technology Corp. are all members of the academic population of Northeastern University and are enrolled in classes through the School of Engineering Technology, thus qualifying them for each of there designated positions. Two members of the team also have outside backgrounds in business and finance, as well as law.

Company Members:

> Andrew Gilchrist IV – President, CEO
> Roger Holeczy – VP of Sales & Marketing
> Jefferey Stevens – Director of R & D
> Tom Baratta – Assistant Director of R & D
> Peter Wong – Engineer
> Kyle Hebsch – Engineer

Section	
2	**Existing System Information and Purpose**

General System Purpose
- ?? Current business process involves keeping track of pickups and deliveries using a shoebox containing all paperwork
- ?? There is no automatic system for keeping track of customers or for scheduling pickups and deliveries.

Operation Practices & Limitations
- ?? Hours of operation are 6am – 10pm, special deliveries possible
- ?? Customers pay by check or credit card
- ?? There is a minimum cost of $25.00 and $.50 a mile there after
- ?? Packages over 50 pounds, there is a $10.00 surcharge.

Available Resources & Employees
- ?? Four (4) automobiles, sedans; 1 being a Ford Pinto that is not at risk of being stolen.
- ?? Two (2) Ford Rangers that are only used for larger packages and cannot be used in the rain because they do not have caps.
- ?? Six (6) full-time drivers and four (4) part-time drivers who are not the most reliable.
- ?? One (1) secretary and three (3) office workers are employed as office staff.

Regular Pick-Ups
- ?? Worcester to Mass General Tues. and Thurs. at 4:00 p.m.
- ?? Springfield to Bank Boston Wed. in the afternoon
- ?? Some pick-ups to locations just within the borders of New Hampshire and Providence.

Location & Environment
- ?? The current system is used within the courier's main office located in the Prudential Building of downtown Massachusetts.
- ?? The size of Lou's office space is a 400 square foot room.
- ?? The temperature and environment of the office is under the appropriate conditions to maintain an even temperature at all times.

Interfaces
- ?? The information is written down on vouchers by one of the office staff that is taking calls from customers.
- ?? The information is inputted through the system by the office staff.
- ?? The output of the information is a voucher that the driver brings with him or her on the delivery for proof of service.

System Functionality
- ?? All data is recorded by the office staff and given directly to an available driver for pick-up and delivery.
- ?? The system does NOT provide for report tabulation or statistic gathering in an effective, timely fashion.
- ?? The system creates a lot of paper work and additional labor in order to complete everyday business practices.

System Data
- ?? The data is received from customers the same day the package is to be delivered.
- ?? All data from the customer is assumed to be accurate and straightforward.
- ?? The information is kept on the slips of paper within a shoe-box and stored for a given amount of time (for example 1 year).

Section	
3	**Proposed Solution**

Location & Environment
- ?? The new proposed system will be implemented in the main office of Lou's Courier Service, which is located in the Prudential Building.
- ?? The office size will not change, remaining at 400 square feet
- ?? The temperature and environment of the office will remain under appropriate conditions to maintain even temperature and ensure the safety of the equipment.

Interfaces
- ?? The information gathered from a customer's phone call will be inputted into the system built on Microsoft Access 2000®.
- ?? The information will be inputted into the system by one of Lou's office staff.
- ?? Output of the information will be sent to the screen for visual recognition and printouts will also be available to keep a paper copy or to hand to a driver waiting in the office.
- ?? Output will include customer's name and pick-up address, destination address and recipient name, phone numbers for both locations, desired time of pick-up, approx package weight, package class (different sized envelopes – boxes), billing information, and customer number

System Users
- ?? Only the authorized users as designated by Lou will have access to the system.
- ?? Regardless of previous skill, the office employees will be required to attend training sessions to increase basic computer knowledge as well as knowledge of the system.
- ?? WareSoft Technology Corp. will provide training for up to 6 employees and such charges will be included in the price

System Functionality
- ?? The system will present customer information and the corresponding delivery information for each individual pickup as entered by one of the office staff.
- ?? If the customer is a repeat user, entering his or her name or the customer id will automatically bring up their location, telephone number(s), and billing information (credit card, etc.).
- ?? Data can be entered at any time of the day as well as be outputted any time of day on either the screen or to the printer.
- ?? The organization of data is a vast improvement over the existing system.
- ?? The program will provide detailed reporting of the customer base at different intervals and real-time. These reports can be run by any user accessing the system
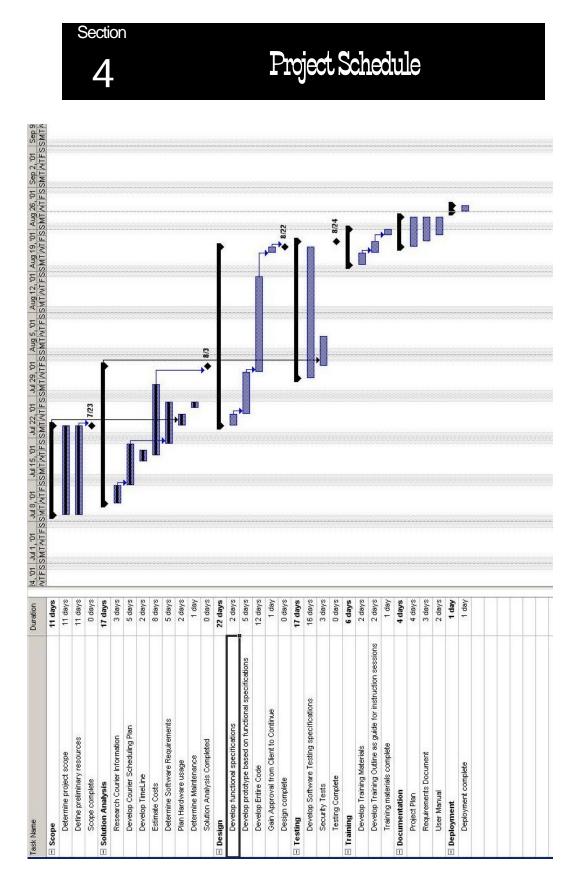
Resources

?? Electricity, a minimum of two Computers, and the minimum of 3 telephones will all be needed to complete the system. The computers must be outfitted with Windows 2000 or ME and all run Access 2000.

?? Eight (8) Nextel Telephones with direct connect plus unlimited to provide direct communication access from the main office and drive regardless of the driver's location. The price of the phones and one-year service contracts for each phone will be include in the overall price. Continuing the contracts past the first year is the sole responsibility of Lou's Courier Service as the phone will be in his name.

?? The system will require less upkeep and organization physically than the current paper and shoebox method.

?? The environment must remain at a steady level that is conducive to keeping the computers in good working order. This will require the correct amount of air conditioning in the hot season and heat in the cooler ones.

Documentation & Maintenance

?? WareSoft Technology Corp. will supply brief instruction sets to be kept with the system at all times.

?? A designated 2-3 training course, as mention previously, will be held for a maximum of 6 office employees, picked at Lou's discretion.

?? Support for the courier system will be provided on a 12 x 5 basis for the first year.

?? All system bugs and hot fixes designed within 3 years of the system delivery date are included in the cost. This covers design faults by Engineers at WareSoft Technology Corp, and are separate from major upgrades to the system.

?? Lou's Courier Service can suggest upgrades to the designed courier system after the delivery date of the initial system. The cost of each additional upgrade is subject to the changing price rates within the remainder of the industry.

Cost

?? The system will be developed and delivered no later than August 31, 2001.

?? The cost of the system must remain under $72,500.

?? The cost includes budgeted amounts for labor, equipment needed, training, and support. Depending on the exact amount of hardware needed, the cost can be considerably lowered by the system delivery date, however regardless it will not exceed this figure.

Section 4 — Project Schedule

Task Name	Duration
Scope	**11 days**
Determine project scope	11 days
Define preliminary resources	11 days
Scope complete	0 days
Solution Analysis	**17 days**
Research Courier Information	3 days
Develop Courier Scheduling Plan	5 days
Develop TimeLine	2 days
Estimate Costs	8 days
Determine Software Requirements	5 days
Plan Hardware usage	2 days
Determine Maintenance	1 day
Solution Analysis Completed	0 days
Design	**22 days**
Develop functional specifications	2 days
Develop prototype based on functional specifications	5 days
Develop Entire Code	12 days
Gain Approval from Client to Continue	1 day
Design complete	0 days
Testing	**17 days**
Develop Software Testing specifications	16 days
Security Tests	3 days
Testing Complete	0 days
Training	**6 days**
Develop Training Materials	2 days
Develop Training Outline as guide for instruction sessions	2 days
Training materials complete	1 day
Documentation	**4 days**
Project Plan	4 days
Requirements Document	3 days
User Manual	2 days
Deployment	**1 day**
Deployment complete	1 day