A Student-Designed Computer System to Aid ABET Assessment

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Abstract – The amount of paperwork typically provided to an ABET accreditation visitor for a single academic program may easily reach thousands of pages. In spring 2008, the University of Tennessee at Chattanooga used the required student capstone design to address this issue, by assigning senior Computer Science students the project of designing a system to assist in ABET assessments. The project addressed three areas of ABET reporting: the design and implementation of a software/hardware system that allowed the professor to scan a document, associate ABET outcomes with the document, and have the document automatically stored in such a way that the stored documents can be retrieved by ABET outcome, class number, or other ad hoc criteria selected by the system user; storage, access and editing of faculty related information; and electronic survey of alumni, students, and industrial partners.

Keywords: ABET assessment, documentation, automated document storage

THE MOTIVATION

In the years since the Engineering Accreditation Commission of ABET adopted the EC2000 criteria, assessment of both outcomes and objectives has become increasingly important. Many courses and workshops have been held, many papers have been published, and many programs have hired consultants to define what constitutes acceptable assessment, and what level of documentation is necessary to enable this assessment. Although assessment has been important in every year since EC2000 was adopted, the 2008-2009 accreditation cycle is the first in which Continuous Improvement, for which assessment is a *sin qua non*, has become a separate criterion for accreditation, on par with such items as Students, Faculty, and Curriculum. [1] This change does not apply to engineering programs alone. The accreditation criteria for computing programs, governed by the Computing Accreditation Commission of ABET, which were previously significantly different from those for engineering, have been altered to become extremely similar to those for engineering. The computing criteria are embodied in the New Criteria, optional for the 2008-2009 accreditation cycle, but mandatory for evaluations after that point, which include Outcomes, Objectives, a-k, and other elements and requirements very familiar to those who have dealt with EC 2000. [2] These new criteria also include Continuous Improvement as a separate criterion, as shown below:

> **Criterion 4. Continuous Improvement** The program uses a documented process incorporating relevant data to regularly assess its program educational objectives and program outcomes, and to evaluate the extent to which they are being met. The results of the evaluations are documented and used to effect continuous improvement of the program through a documented plan. [2]

When the amount of paperwork typically provided to an ABET accreditation visitor for a single academic program, perhaps thousands of pages for a single academic year, is multiplied by a number of academic years and a number of programs at an institution, the burden of collecting the information and physically storing it can quickly become unmanageable. In addition, some ABET team-chairs and evaluators are increasingly expecting "paperless" visits,

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even though this is not an actual ABET requirement. In spring 2008, the CSE department at UTC used the required student capstone design to address these issues.

CAPSTONE COURSE REQUIREMENTS

While the new computing criteria do not have an explicit requirement for a "capstone," Criterion 3c does require, "An ability to design, implement, and evaluate a computer-based system, process, component, or program to meet desired needs." [2] To insure that all students meet this requirement, the Computer Science and Engineering Department at UTC requires a two-course sequence, with the courses as described in the language below from the UTC Catalog [3]:

450 Software Engineering (3) Study of techniques used in the definition, specification, design, implementation and testing of large software systems. The course will include team efforts to identify and define the requirements of a large software product. The development of this product will continue in CPSC 490.

490r Senior Capstone Project (3) Continuation of the group design effort started in CPSC 450. Implementation of a Computer Science project. Oral and written presentation of progress and final results required.

The capstone course provides each student the opportunity to work as part of a team within a group committed to the successful completion of a semester length project. The goal of this course is to give the students as real a work experience as possible. To facilitate a real work experience, the class becomes a consulting firm. Student teams operate as a team of consultants with the professor acting as a manager. Last year the class was divided into two teams of four students. Each team was given the same charge: to create an automated ABET system.

To accomplish the class requirements, each team was expected to take the project from concept to reality, with professors on the department ABET Assessment Committee acting as "customers" for the projects. The goal was to produce a working ABET system. Exactly how much of the ABET report should be automated was left to each team to determine through interviews and discussions with their customers. In addition, each system had to be functional and well documented. The students were required to make oral presentations of their work at mid-term and the end of the semester. The design, implementation, and documentation served as the primary evaluation tools. An additional grading aspect of the course was the ability of the group to function as a team. Each individual student was graded by his or her peers on factors such as team participation, overall effectiveness, productivity, cooperativeness, timeliness and quality. Teams were also evaluated by their customers, by factors such as overall performance, meeting the needs of the customer, professionalism, punctuality to meetings and team participation.

ABET Project

The project addressed three areas of ABET reporting: the design and implementation of a software/hardware system that allowed the professor to scan a document, associate ABET outcomes with the document, and have the document automatically stored in such a way that the stored documents can be retrieved by ABET outcome, class number, or other ad hoc criteria selected by the system user; storage, access and editing of faculty related information; and electronic survey of alumni, students, and industrial partners.

Technical Specifications of the Project

The students chose to implement the project using the C# programming language. It provides good development tools and is becoming an industry standard. C# is platform independent, and this feature provided students with the ability to develop their portions of the project on differing machines and effectively integrate them into a comprehensive system. The students chose a multi-page feed scanner for entering the documents and developed an SQL database for housing the data resulting from the project.

Students began the project in the second half of the first semester of the two-semester capstone sequence. The first half was dedicated to learning tools and techniques for managing and implementing a large scale project. As a result, the students had approximately five months to complete the project. While the project seemed very doable within the given time frame, students found the time constraints to be very challenging. One of their biggest challenges proved to be time management.

Two team approach

For this particular project, two teams were created to address the same project. The teams were given an overview of the project and the ABET website address as a starting point. Faculty acted as customers. More specifically, the department ABET assessment committee acted as primary customers, with additional faculty serving the role of secondary customers. Using this structure, each team was required to determine the precise tasks to be accomplished, design a solution, and implement the solution. In addition, the teams are required to identify any hardware and /or software necessary, produce a set of specification for those products and provide cost estimates. The teams were required to self-organize, and to produce a work plan flow and a set of requirements. Both teams had the same set of customers and the same requirements. Several deadlines and project reporting deadlines were established at the beginning of the project in an attempt to assure the students were successful in completing the capstone project. Given the above-mentioned factors, the products should have been very similar but were, in reality, very different. One team, Team Awesome, was very successful. The A Team had much more difficulty with the project.

Approach to the problem

The two teams differed in their approaches to the problem from the beginning. Each team approached the organizational aspect differently. Team Awesome choose one of the weaker team members as the leader. As it became apparent that the leadership was weak, other members stepped forward and filled the leadership role. The team functioned well together and developed good lines of communication. They established roles that drew upon the strengths of the individual team members. On the other hand, the A Team never really established any clear leadership. The team floundered much of the semester, blaming one another for failures despite intervention on the part of the professor. Aside from leadership, one of the big obstacles facing the teams was a division of duties. For accountability purposes, the teams were required to define responsibilities and a project timeline. As will be discussed in the next paragraph, their initial approach to defining the project requirements lead to the success and failure in this area. For Team Awesome this went smoothly. They were able to identify the task and assign individual responsibilities by matching the strengths of the team member with the required tasks. Because the A Team never developed as a cohesive unit and lacked the necessary organization, they were not really successful in either of these areas. The underlying difference was the approach to solving the problem. These approaches will be compared below.

Requirements

The initial step in any project is developing a set of requirements. At the outset of the project, it was noted that a total ABET reporting system was not feasible within the time constraints. It was the responsibility of the teams to define what should and should not be accomplished at project completion. Again, the approaches of the two teams were very different. Team Awesome began their process by interviewing each customer for system requirements and functionality. The team developed a set of standard questions and performed face to face interviews. They asked which requirement was most important to each customer and the answers formed the basis of the overall requirements of the project. In contrast, the A team began with a set of written questions they gave to each customer. While this seemed a good idea, it was not successful. The team requested a very short turnaround time at a very work-intensive time, approximately two days in the last two weeks of the fall semester. They did not receive a good response and unfortunately did not follow up when responses were not received. In addition, their questions did not include any prioritization. Unfortunately, the team also made the assumption that if the customers did not respond, the team would simply take the responses received (only one or two) and use those as specifications for the system. They made no attempt at follow up. It was at the first reporting deadline that difficulties with their approach and the lack of customer input to the project specifications were discovered.

Teams were asked to categorize the input into functional and non-functional requirements. Functional requirements were defined as the functionality directly related to the system, such as the ability to store a scanned document. Non-functional requirements were defined as functionality required by the system but not directly related to the system. An example of a functional requirement would be the ability to operate on a Windows-based personal computer, while an example of a non-functional requirement would be the language to be used in coding. After

categorizing the requirements, the teams prioritized the requirements. As noted in the Two Team Approach Section, the entire ABET reporting system was not feasible within the given timeframe.

Design

Based on the requirements, the teams were required to create a high-level design which would define at a very conceptual level, how the system would be designed, including any interfaces and dependencies. Team Awesome originally broke the problem domain into four distinct units which they called the ABET Document and Data Assistance Tool (ADDAT), the ABET Course and Professor Assistance Tool (ACPAT), and ABET Online Survey System and the Database. Each of these distinct units addressed a specific scope of the problem. The ADDAT allowed for the input and retrieval of documents. The ACPAT was responsible for input of course information, description of the included courses, and input of faculty vitae. The third unit, the ABET Online Survey System, contained the input and reporting functionality for online surveys. Functionality of each subsystem resided within the individual unit. As more detailed design began, the team realized they had a need for a Management unit to take care of activities such as establishing new users with passwords, handling large course and course description loads, and general database administration. The underlying database for the entire system was designed as a separate unit. The interface for the system was also designed within the Management unit. Figure 1 depicts this high-level design.
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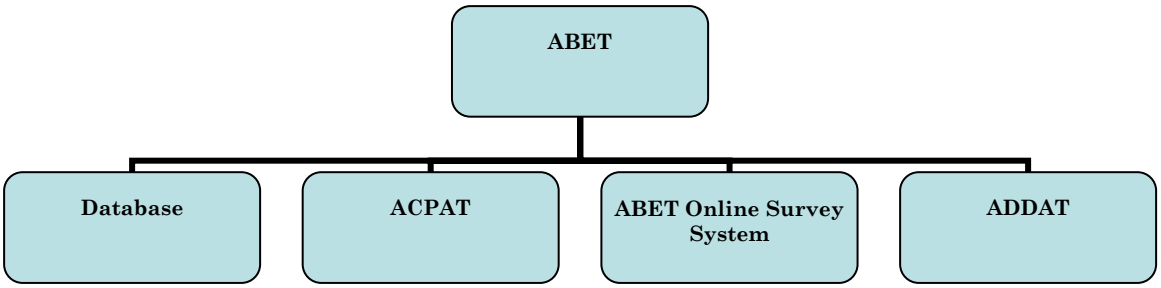

Figure 1: Team Awesome High-Level Design

The A team took a different approach. Their original high-level design called for a client system to be the center of the system and act as a controlling unit. Figure 2 depicts this design.

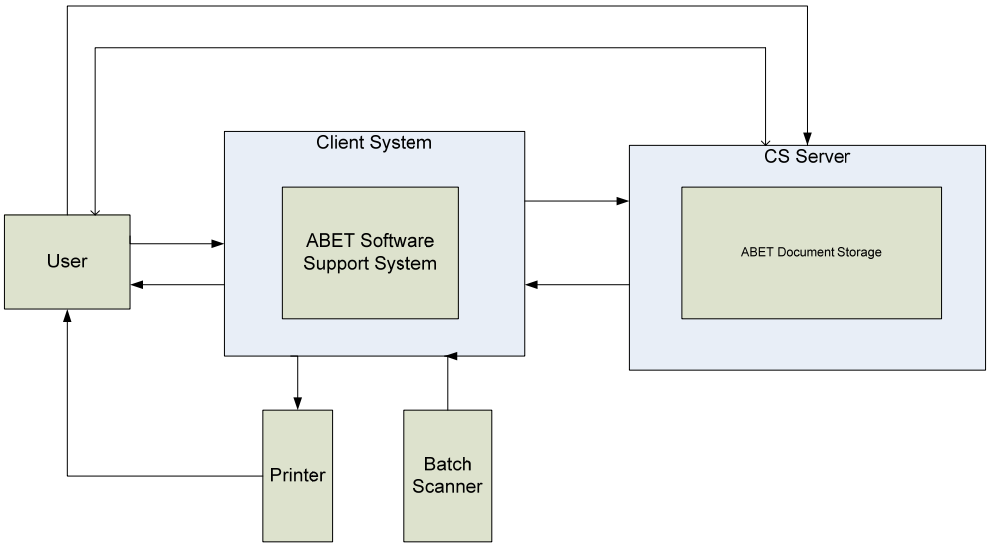

Figure 2: A Team High-Level Design

As can be seen in Figure 2, the A team designs called for each activity to interface through the ABET Software System Support Program within a Client System. Also worth noting is that there is no database identified in the design. Team Awesome began with a straight-forward, easily understood design. The A Team chose a more complex initial design, which resulted in difficulties in further design and implementation.

From the high-level design, a more detailed design of each system was developed for each unit. Team Awesome further modularized their design into manageable pieces and begin coding of the system. For example, Figure 3 provides a more detailed design of ADDAT, the ABET Document and Data Assistance Tool. In turn, a more detailed design was established for each of the subunits of ADDAT until a thorough understanding of the design was reached.

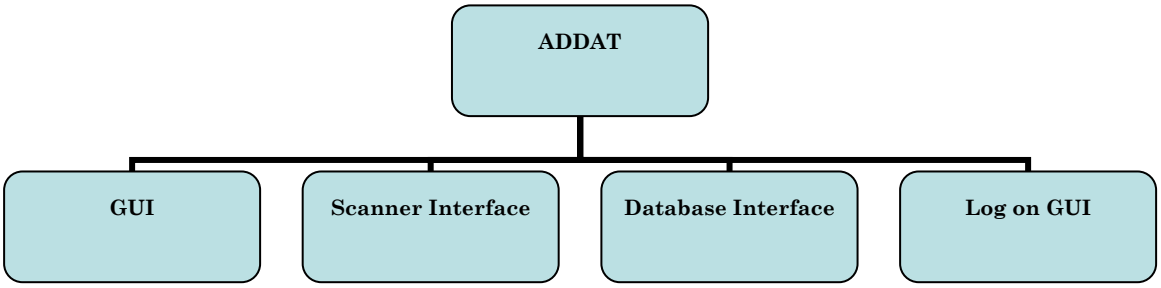

Figure 3: Team Awesome Detail Design of ADDAT

Unfortunately for the A Team, instead of their design becoming simpler and increasing the understanding of the project, it became more complex and increasingly more difficult to conceptualize and implement. Figure 4 shows the A Team design for the Client System.

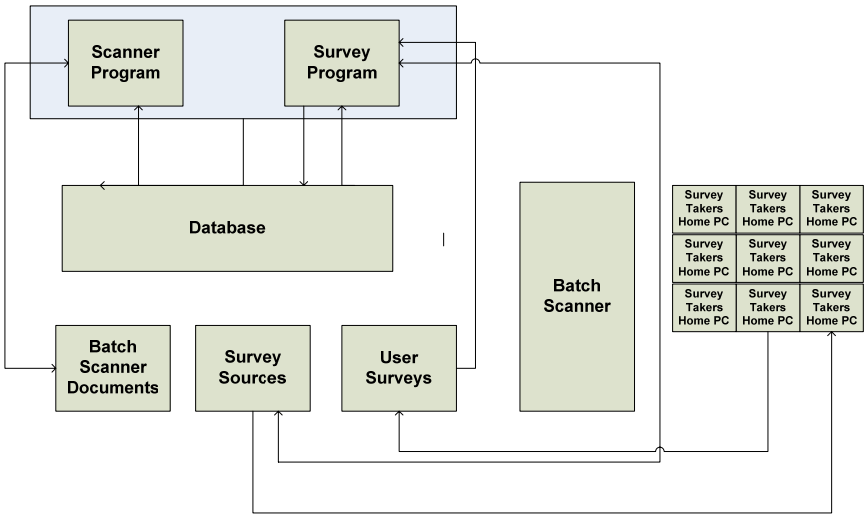

Figure 4: A Team Detail Design of Client System

As one can tell from a comparison of the two designs depicted in figures 2 and 4, the A Team system was not simplifying its design; rather the complexity was increasing. It was in this more detailed design area that real problems began to emerge for the A Team. Because of the design complexities, the A Team had a difficulty in assigning individual responsibility for any one unit and later in the implementation of each unit of the system. It should be noted that this design was not discussed with, nor shown to, the professor until the design phase was completed. It was the opinion of the course professor that the team did not do the actual design work until very near

the due date. Therefore, bi-weekly progress reports and weakly team meetings failed to identify the potential problems.

Implementation

Both teams chose to implement their designs in C# using an SQL database. Both teams also chose to store their databases on the department server, but it was at that point that the similarities of the two systems ended. Perhaps the most critical component to the success of the project was the design of the database. Because of the initial high-level and subsequent detailed design of the project, database design for Team Awesome was very straightforward. The tables and interactions simply became the implementation of the design. In contrast, the A Team created a complex database that eventually became the ultimate downfall of the team. Of some note in the database design was the way in which each team chose to store each scanned document. Team Awesome provided an entity within the database for a BLOB (Binary Large Object). Using this approach, the scanned document is stored in binary form and can be retrieved and viewed in its original file format, such as a Word document or Excel spreadsheet. The A Team wanted to store the scanned document on the server and then store the location, or URL, for the document in the database. This approach had several disadvantages; primarily, any change in indexing of the storage drive could result in lost documents. An additional problem for the A Team was that they chose to create a database that had tremendous flexibility, but that very flexibility made queries and retrieval of data extremely complex, with ad hoc queries and reporting virtually impossible.

RESULTS

Team Awesome was tremendously successful with this project. The product produced was beyond expectations in both in its professionalism and its functionality. The system as produced by Team Awesome allowed for the user to enter the system through a login. The login had full functionality. Login passwords were encrypted prior to storage. If a password was forgotten, the team had two responses: one, a hint button was provided to assist the user in remembering the password, or two, the password could be reset through administrator functions. Each user was assigned an access control level. This level determined the features available. For example, only a professor would be given access to the vita subsystem. A user with access to respond to an alumni survey would not have access to the ADDAT system. Access control was determined through the use of this feature. The functionality of the ADDAT, ACPAT and ABET Online Survey System will be discussed individually.

ADDAT: This component of the system used a graphical user interface to upload documents and data into a database. The document could either be scanned or uploaded from an external file. An interface was developed which allowed for the document to be converted from the native scanner format to a standard .pdf format. Each document could be tagged with department, course, section number, professor, term, year, document type, optional description, assignment number, grade and ABET outcome or objective met. There was a cross reference between the department, course, section number, professor, term and year in the ADDAT and ACPAT. Each of these tags was accessible through pull-down menus. In addition, a retrieval system was created which allowed for the retrieval of an individual document or a series of documents based any of the above-mentioned tags. If an error was found in the coding, a document could be modified or deleted.

ACPAT: This component of the system allowed the user to create a digital personal vita, which was divided into professional experience, publications, and society memberships. For each of these divisions, the user was able to enter, update or delete the information supplied. The professional experience sections included Institutions, Positions Held, Courses Taught, and Responsibilities. The Publications Section included for each publication, as appropriate, Title, Publication Date, Type of Publication, Publisher, ISBN, and Authors. The society membership section allowed for the entry of Society Memberships, Responsibilities Held and Years Held. Upon completion of entry of the data, a paper copy of the vita could be printed.

ABET Online Survey System: Online surveys were created for students, alumni, and industrial partners. Appropriate questions were developed by the department ABET Assessment Committee and provided to the students for their use. The constituent would access the survey through Internet Explorer or Firefox. Results of the surveys were stored in a database for archival and retrieval. Users of the survey results were presented with a series

of options to allow them to retrieve the data in the desired format. For example, the user might only be interested in student surveys or alumni surveys.

The A Team's project was never fully functional. The team was able to enter, store, classify, and retrieve a document. However, the survey system did not work. Also, as discussed earlier, the design of the database created difficulties that the team was not able to overcome.

CONCLUSIONS

As fulfillment of the department's required capstone for Computer Science majors, UTC students produced a surprisingly sophisticated and successful system to aid in ABET assessment, including the ability to conduct and organize on-line constituent surveys, ability to generate faculty vitae in a standardized ABET format, and the ability to scan, store and organize ABET documentary evidence, as well as to retrieve information organized by course or by ABET outcome. While some work remains to be done, for example including ability to easily alter course outcomes and to include separate sets of outcomes for different programs such as Computer Science and Computer Engineering for a single scanned document, the system produced by Team Awesome is already capable of being used for our current ABET needs. After refining the product, the department will consider making this software available to other programs concerned about rapidly growing documentary requirements of ABET accreditation.

REFERENCES

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