Developing Examination Management System: Senior Capstone Project, a Case Study

S. Vasupongayya, W. Noodam, and P. Kongyong

Abstract—This paper presents the result of three senior capstone projects at the Department of Computer Engineering, Prince of Songkla University, Thailand. These projects focus on developing an examination management system for the Faculty of Engineering in order to manage the examination both the examination room assignments and the examination proctor assignments in each room. The current version of the software is a web-based application. The developed software allows the examination proctors to select their scheduled time online while each subject is assigned to each available examination room according to its type and the room capacity. The developed system is evaluated using real data by prospective users of the system. Several suggestions for further improvements are given by the testers. Even though the features of the developed software are not superior, the developing process can be a case study for a project-based teaching style. Furthermore, the process of developing this software can show several issues in developing an educational support application.

Keywords—Scheduling, Web-based, Greedy Algorithm, Engineering Education.

I. INTRODUCTION

EXAMINATION is a basic requirement of an educational system at any level. The examination questions are usually receiving the major focus in any examination. However, a lot of tasks are required in order to organize an examination from the institution such as assigning each subject to a room, assigning a set of proctors to each examination room, and assigning a seating layout for each examination room. These tasks usually involve a lot of data from many sources. For example, the registration information provides the list of subjects, the list of students in each subject, the list of instructors in each subject, and the examination schedule (i.e., date and time). Furthermore, each proctor may not be available during the examination period. In addition, the available rooms to be assigned as examination rooms are limited. Thus, the examination schedule of each subject and the list of examination proctors for each subject must consider such constraints. This leads to an idea of developing an application to create a suitable examination schedule.

Prince of Songkla University—the case study institution in this study—uses a semester system [1]. Each academic year contains two semesters. The first semester starts in June and ends in September, while the second semester starts in November and ends in February. The institute has a two-examination policy. That is, each semester will have two institutional examination periods which are the midterm and the final examinations. All subjects are required to participate in these two examinations. Exceptions are given to special teaching style subjects such as design, extra curriculum or project-based subjects. Thus, all students will have their examinations during this period. Typically, the examination schedule should be based on the class time such as those in many institutions [2], [3], [4]. However, some subjects may be offered in several sections and at different class time. Thus, assigning the examination schedule based on the class time or the classroom will not be suitable in this case.

In the past, the Faculty of Engineering uses a manual method to organize the examination schedules both the examination room assignment and the examination proctor assignment. The examination date and time of each subject is assigned by the university registration office [5]. However, the examination rooms and the proctors of each room must be assigned by each associated school. However, as a faculty member of the Department of Computer Engineering, there is a senior capstone project available to be utilized for such task. The senior capstone project consists of three semesters from the second semester in the junior year until the last semester in the senior year. Thus, the amount of time and the skills of these students could be utilized. By assigning the real educational related support system as a senior capstone project, the students can get a real problem to practice while the institution can receive the final product at minimal cost.

As a result, the examination room and proctor assignment project is assigned as a senior capstone project for three students. The first student is an alumnus of the Department of Computer Engineering class of 2010. The final product from this student is a prototype of the examination room assignment and seating layout using Microsoft Visual Basic Express edition to develop [6]. Later, two students from class of 2012 are assigned to develop a web-based application. Both students must design the database of the system together while each student will develop a different part of the application. The first student is developing the room assignment and the seating layout while the second student is developing the examination proctor assignment.

The remaining of this paper is organized as follow. Section II presents overview of the examination management process. Section III outlines the software architecture design and algorithms. Section IV provides the experimental results and setting. Section V discusses issues discovered from the senior

S. Vasupongayya is Assistant Professor at the Department of Computer Engineering, Faculty of Engineering, Prince of Songkla Unviersity, Hat Yai, Songkhla, 90110, Thailand (corresponding author; phone: 66-7428-7075; fax: 66-7428-7076; e-mail: sangsuree.v@psu.ac.th).

W. Noodam and P. Kongyong are alumni of the Department of Computer Engineering, Faculty of Engineering, Prince of Songkla University, Hat Yai, Songkhla, 90110, Thailand.

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capstone project adviser point of view. Section VI gives the final conclusion of this work.

II. EXAMINATION MANAGEMENT PROCESS

The examination management process at Prince of Songkla University starts when the university registration office announces the examination schedule including the date and time of the midterm and final examinations of each subject offered. Typically, this event happens during the student registration period which is approximately two months before the semester starts. The students are not allowed to register for classes if they have a conflict examination schedule. However, the students can fill the exception request form in order to register for these classes. Thus, the university registration office will use this information to arrange a few examination schedules in order to reduce the conflicts as much as possible. The answer to the question why the examination schedule is different from the class time is that many classes are offered in a small class size due to the limited number of equipments. Thus, the students do not take the class at the same time. To organize the examination during the class time will require the instructor to create several versions of the examination questions.

After the second week of each semester, the Faculty of Engineering will open the online examination information system [7] for each instructor to fill in information regarding their subjects such as the specific examination room request, the specific answer sheets, and the open/closed book examination style. The staff will use this information in order to assign rooms or to prepare specific answer sheets. Furthermore, the proctors must fill in the request of absents if they are not available during a certain period of the examination. Again, the staff will use this information in order to assign the proctors to each subject. Last week of classes before the examination starts, the examination proctor assignment is announced. Then, the seating layout of each examination room must be produced. During the examination period, the information of the absent or late report time of each assigned proctor is recorded. This information will be used later to hand out the punishment for these proctors. For example, the proctor who is late will be given an extra assignment in the upcoming examination while the proctor who is absent will be given two extra assignments. The information of the student activities during the examination period is collected in order to improve the examination management process. Furthermore, the proctors who proc the examination during the weekend will get paid overtime. Thus, the proctor assignment must consider the weekend and the weekday assignment differently.

As can be seen that there is a lot of information to be collected and some information is required for assigning examination rooms and proctors. Currently, data is collected in several formats such as a spreadsheet format for the overtime payment, the paper format for late or absent proctors, and the stand-alone (Microsoft Visual Basic) room and proctor assignment application. Furthermore, the paper-based final examination schedule (i.e., date and time) and the actual instructor(s) of each subject are sent to each school approximately 4 weeks before the examination period. From these limitations, the examination management process involves and requires attentions from several staffs from several units in the Faculty of Engineering. Several tasks are done manually. As a result, mistakes and delays are observed frequently.

To solve such problems, the capstone project for room assignment and seating layout was given to a student in the 2009-2010 academic year. However, the result was still in a stand-alone application with an additional database to collect related information [6]. Unfortunately, this version of the software was not really to be used because it does not produce the proctor assignments. Thus, the responsible staff does not want to learn the system since it does not complete the whole process.

III. ARCHITECTURE DESIGN AND ALGORITHMS

To complete the project, two senior capstone projects are assigned to the students of 2011-2012 academic year. Both students must work together in designing the database but each student works separately to complete a different module. The first student must complete the room assignment and the seating layout while the second student must complete the proctor assignment module. Each module and the database design are explained in the next sections.

A. Examination Room Assignment and Seating Layout

The examination room assignment and seating layout project is developed by following the idea of the previous project [6]. The goal of this work is to develop the database and to implement the module as a web-based application. The main goal is to choose the room for each subject according to the examination style, the room capacity, the relationship among subjects in the same room and the availability of the room. The examination style is the closed/open book types. That is, the open book examination should not be in the room with the closed book examination. The room capacity is the maximum number of students per subject that can be filled in the room such that the students from the same subject should not be seated next to each other. The relationship among subjects in the same room is that some subjects are related but they have different course id. That is, these classes must be considered the same subject. Thus, the students from these classes cannot be seated next to each other in the examination room as well. The room availability must be considered because each room may be scheduled for other events during the examination period.

The algorithm to be used in this module is the greedy algorithm [8] with a simple priority function. The priority function is based on [6]. That is, all subjects are sorted according to the number of students in the subject from large class size to small class size. The algorithm will assign rooms for each day by separating morning section and afternoon section. At each section of each day, all subjects of that time are sorted according to their class size from large to small size. The available rooms of that time are also sorted according to

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their capacity from large room to small room. The algorithm then maps the large subjects to the large room. However, the whole subject might not fit in one room because some seats must be assigned to other subjects. The algorithm will search and assign the next subject to the room until the room is filled. Then, the algorithm moves to the next room and performs the same steps. The algorithm stops when there is no subject left to be assigned or there is no seat available. Either case, the algorithm will report to the user. Once, the room assignment is done the seating layout of each room must be produced. All results are stored in the database so that they can be edited or retrieved later by the authorized users.

B. Examination Proctor Assignment

The goal of the examination proctor assignment module is to design and develop the proctor assignment interactive module as a web-based application. The main goal of this module is to allow the proctors to login to the system and select their assignments from the list of available examination rooms resulting from the examination room and seating layout module. Furthermore, the module must provide a random proctor assignment so that the administrator can assign the available proctors to each available examination room randomly. The constraints of assigning the proctor to the examination room include (1) each proctor should receive at least one weekend assignment, (2) each examination in the computer laboratory must be assigned the computer unit staff as one of the proctors, (3) the administrative staffs (at least an associate dean level) are allowed to proc the examination only once, (4) the instructor of each subject should assign to proc his/her subject (if possible), and (5) each proctor should not proc the examination all day.

The algorithm in this module can be separated into two sets. The first set is focusing on the proctor self-assignment which will allow each proctor to select his/her schedule from the available list. The second set is focusing on the automatic proctor assignment which will be used after the proctor self-assignment period. The proctor self-assignment part allows each proctor to login to the system and select his/her assignment from the list of available examination room and time. Each proctor can select up to two assignments. However, the system does not allow each proctor to select the assignment on the same date and at the same time. If more than two proctors are selecting the same examination room simultaneously, the proctor of the request that reaches the server first will be given the assignment, while the other proctor will receive the message that the selected slot is already taken.

The algorithm to be used in the automatic proctor assignment is the greedy algorithm with a simple three-level priority function. That is, the algorithm will assign the proctors in three main steps. The first step is focusing on assigning the proctors in all the computer laboratory rooms. At this step, a computer unit staff is assigned to each laboratory examination room. Then, the instructor of the subject is assigned to each laboratory examination room. However, if the instructor is not able to proc the examination, a proctor is

drawn randomly from the staffs of the same department. The second step is focusing on the proctor assignment during the weekend. The proctors are randomly sorted however the administrative staffs are given a higher priority than others because the administrative staffs must be assigned the weekend. During the weekday, the administrative staffs are usually not available due to several administrative meetings. The last step is focusing on the remaining assignments. During this step, the remaining proctors are sorted randomly however the proctors with the least number of assignments are given a higher priority. The results are stored in the database to be used for averaging the number of tasks so that each proctor receives approximately similar number of assignments for one academic year.

C. Database and Related Information

The input to the developed system is flowed from various organizations. The main examination schedule that is what examination is scheduled (i.e., date and time), is flowed from the university registration office. Currently the most-up-to-date information will be sent as a hard-copy to each related school approximately four weeks before the examination period. However, the Faculty of Engineering maintains the backup database of the registration office. Thus, the developed system can import the data from this backup system. The flaw at this point is that the staff must evaluate the data from the backup system and the hard-copy version before the scheduling can be done. The room availability, the proctor availability, the proctor penalty and the list of administrative staffs are collected by the Faculty of Engineering staff. This set of information is in a hard-copy format. Thus, the students must first design an overall database to be used. Fig. 1 shows the flow of input data to be used in the system.

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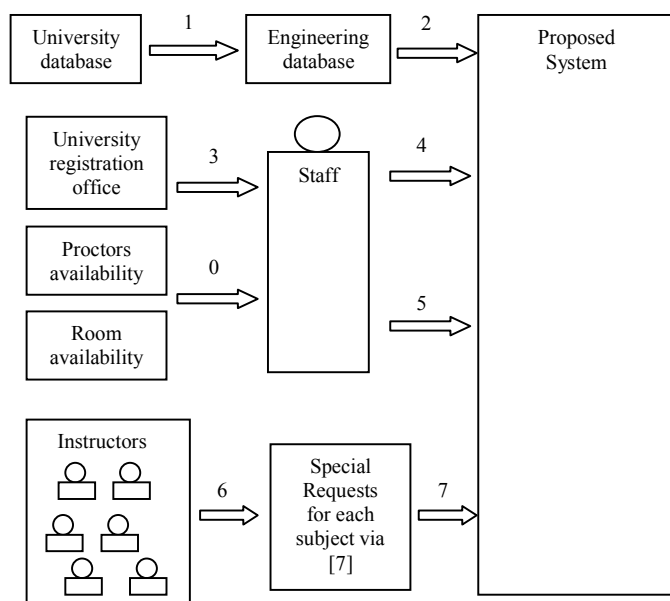Vol:7, No:7, 2013

Fig. 1 Flow of input data to be used in the system

According to Fig. 1, there are several parties involving in supplying the input data to the proposed system. First of all the lecturers are requested to fill in the basic and special request at the examination management system [7] (denoted as 6 in Fig. 1). The information from the examination management system is then exported to our proposed system (denoted as 7 in Fig. 1). For example, the instructor can specify the examination type (i.e., open, close or laboratory) and any special request such as a specific examination room. The examination time and date of each subject is downloaded from the university main database to the backup database at the faculty of engineering (denoted as 1 in Fig. 1) before exporting to the proposed system (denoted as 2 in Fig. 1). However, this data must be verified by the staff against the hard-copy from the university registration office (denoted as 3 and 4 in Fig. 1). Furthermore, the staffs must conduct a survey on the proctor and room availabilities (denoted as 0 in Fig. 1) and enter the information into the proposed system (denoted as 5 in Fig. 1).

IV. EXPERIMENTAL RESULTS AND SETTINGS

After each module is completely developed, it is scheduled to be tested by the prospective users of each module. That is, the examination room assignment and seating layout is tested by the Faculty of Engineering staff responsible for the task. While, the examination proctor assignment is tested by the faculty and the staff members who are on the proctor duty list. The input data is collected from the real data during each examination of Academic year 2011-2012.

A. Examination Room Assignment and Seating Layout

At the end of the academic year, the first student delivers her project both the source code and the project report which includes the testing results, discussions and the user manual. At the end, this part of the system is able to assign all the subjects to available examination rooms according to several constraints which include the seating limit in each room, the maximum number of subjects in each room, and the order of the examination rooms. The final program also allows the authorized user to edit the information by moving a subject to a different examination room or deleting a subject out of an examination room, or adding a subject to an existing schedule on available examination room. Furthermore, the seating layout of each subject in an examination room is also provided graphically as shown in Fig. 2. The S817 room is a flip-L-shape room which can contain a maximum of 90 students. In this example (Fig. 2), there are two subjects in the room and the seating layout show the seating of each subject with a different sign (i.e., X's and O's).

The examination assignment and seating layout part of this system is not quite completed according to the requirements when the student delivers her final project because the student takes up too much time to implement her program. At the end, the student does not have enough time to conduct the evaluation by the faculty of engineering staff who will use this system. Thus, all tests performed on this part are only conducted by the student herself. Since this first part of the system is not completed, the integrating process of the first part and the second part cannot be conducted. Discussions from the senior project advisor are given in Section V.

Fig. 2 Result of S817 room on March 1, 2012

B. Examination Proctor Assignment

The second student also delivers his project at the end of the academic year. However, this student is good at maintaining his work schedule resulting in a more completed project result. The examination proctor assignment part of the system allows all the proctors to login to the system and test the system for a week in order to collect comments and issues from the system perspective users. Each proctor can select any available proctor slot on the system. Fig. 3 shows the user interface of the system for selecting the proctor slot. However, the actual view of the record is in one row. Thus, the record is broken into two rows as shown in Fig. 3 for a larger view of the picture. Each proctor can select the date, time and room to see the examination information including the list of subjects and the proctors already assigned to the room. According to the sample shown in Fig. 3, the proctor can click the select button

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to select S817 room as the third proctor of that room. Or, the proctor can select the random mode to allow the automatic proctor assignment module to randomly assign the slot. In the case that some proctors do not wish to select their assignments, this part of the system is able to automatically assign each available proctor to an examination room according to the defined priority.

As mention earlier, this part of the system is tested by the perspective users. The evaluation process starts from an email sent by the student and the advisor containing information regarding how to access the system to all perspective users at Faculty of Engineering, Prince of Songkla University in order to request for their supports in testing the system. The system is located at a commercial hosting service. All the users must register and select their passwords in order to test the system. There are more than 200 perspective users. However, only 11 users evaluate the system. All 11 users provide good comments and suggestions. Table I gives a summary of comments and suggestions from these users.

TABLE I
COMMENTS AND SUGGESTIONS ON PROCTOR ASSIGNMENT

Topic	Details
Format	1. adding the day of the week into the date for the proctor to easily select the proctor slot 2. adding the current status of the selecting to tell the users whether they have selected enough proctor slots 3. reducing the size of the figures used as the command buttons so that the loading time will be reduced 4. using different colors to separate each record displayed on the screen 5. displaying the section information of each subject on the record
Platform	1. the user interface is a fixed width thus the user with Chrome on iPad has a problem scrolling left and right to see the whole page
Procedure	1. When a user wants to change the current selection to another available slot, the user must first delete one of his/her current assignment to make a space, then the user can select the new assignment. However, another proctor may have selected that particular slot. The suggestion is to allow the user to select any number of assignments without any limit. 2. Displaying the user manual or the user tips on each command buttons
Other	1. The system should provide a method to exchange the proctor assignment after the assignments are scheduled and announced. Even though this event may not occur often but it always comes as an emergency case. Therefore, to find a person that is available and willing to exchange the duty will be difficult. Thus, the system should open a communication channel among users for such purposes. 2. Several perspective users are not agreed to evaluate the system due to their security concerns since the system is holding on a commercial site. Furthermore, the users are verified by their national ID number from the university database. Thus, it is another issue for some users.

Fig. 3 The user interface for selecting the proctor slots

The comments and suggestions can be grouped into four topics including format, platform, procedure and others. There are five comments and suggestions on the format related topics mostly to the graphic user interface and word choices. This is a typical comment from the perspective users of any system because the requirements and the details during the initial process usually are not quite clear. The language or word choice is another typical issue with the perspective users. Typically, the programmer is not using the system and the users are not writing the program. Thus, the word choices on the interface must be cleared during the requirements. There is one good comment/suggestion on the design regarding the multiple platform issue. One of our perspective users uses an Apple-iPad to access the developed system via Chrome browser and several comments are reported back. There are two comments/suggestions regarding the procedure of the system. Two comments and suggestions are on another topic related to the proposed system.

V. DISCUSSIONS

This section provides the advisor of the senior capstone project point of view because this course is an example of a project-based class in the curriculum. As shown in the previous section, some parts of the proposed system are not completed at the end of the academic year due to several reasons. The discussion on the issues and solutions is given in order to share the experience in teaching a project-based class.

First of all, the advisor must understand his/her student ability and how to guide them. This is a very sensitive issue. In this work, both students have problems with the database design. With a limited time in the curriculum, the students have learned the database concept without having to design a database for a real world application. Thus, the database has to be redesigned several times during the first four months. To help ease this process, the students are suggested by their advisor to consider the graphic user interface of the system at each step in order to collect the data required. In addition, the students will see the relationship between the input data and the output data. This suggestion turns out to help the students in designing the database. However, the story is not ended at

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this point because the students must present their progress to the project committee. These project committees want the students to start from the database design not the graphic user interface design. Thus, the students do receive a lot of complaint and comments from the committee on their processes. This event points to an issue in conducting and/or organizing a project-based class. In other words, the role of each party in the class must be clear to all parties. From the advisor point of view, the committees only interact with the students twice a semester during the progress report, while the advisor has regular weekly meeting with the students. Thus, the committee should use an outcome-based approach. The process should be left to the project advisor.

Second, the limitation of the service or data provided to the students during their project. In other words, the students are considered untrustworthy to handle data of the university. Thus, the students can only use the old data in order to test their system. Furthermore, the students are not allowed to access the authentication server of the university. Using the old data set to evaluate or test the system is still acceptable during the developing phase. However, the students cannot evaluate the authentication process of the system because they are not allowed to access the server. In addition, the students have to use an external hosting service in order to perform the final test from the perspective users. As a result, several perspective users are not comfortable to test the system because of the external hosting service. This issue will not occur if the system is developed by one of the staff members. Thus, the institute and the department must consider resolving this issue together. One possible solution to solve this problem from an advisor point of view is to simulate the real system in order for the students to learn/develop/test their systems. This idea can be used as a backup system as well as the learning ground for students. Furthermore, the system can be evaluated by several people for security.

Lastly, the understanding of the students on the differences between the class assignment and the project must be done early because the project means developing a good application within 1.5 year. The first semester is designed for a proposal development period. During this period, the students must understand and collect all requirements of their applications. The next two semesters are designed for developing, testing and writing the project report. However, the students are struggling with the project progress presentation such as producing good presentation slides, preparing a good oral presentation, and writing a proposal. Most students do not allow enough time to study the requirement of the application and the advantage and disadvantage of tools or algorithms to be selected. Usually, the students follow their project advisors in selecting the tools and algorithms and collecting the application requirements. As a result, the students will struggle during the implementation period. The class schedule is also another issue for students. Most students still take a lot of classes during their senior capstone projects. As a result, the students do not have enough time for their capstone projects during the implementation period. An example problem is that the integration of both parts in this project cannot be completed because one of the students cannot complete her project by the end of the academic year. One solution to this problem is limiting the students who can take the project during each semester. This solution must be implemented in two phases. The first phase is to allow only students with enough skills and knowledge to take the class. The second phase is to allow only students with good progress to advance to the next project class in the series. The process can ensure that the students who can advance to the next level in the project series are ready.

In conclusion, the project-based class is a good method to educate computer engineering students because the project requires the students to develop a real software application as shown in several studies [9]-[11]. The students will have a chance to utilize their knowledge in the field to solve a simple and small project. Several processes in the institution can be fasten/improved by an information technology. These processed can be given as a real world problem for a project-based class. However, the success of such class depends on all parties involved (i.e., the students, the instructors and the curriculum).

VI. CONCLUSION

This paper presents a story of a senior capstone project both success and failure sides. The challenges, the features and the limitations of the application in this project are given. The student products at the end of the academic year are presented. The discussions from the advisor point of view on the issues and solutions to the problem of supervising a problem-based class are also given. The experiences from this work suggest that a real world application around the institution may be used as a real world question for a senior capstone project because it will be easy to collect the requirements and test cases. However, the outcomes of the work may not be accepted as a real product to be used in the workplace due to the user viewpoint of the developing process and the ability of the students. In addition, the students are not taken the project as their works. Thus, they are not serious about the outcomes of their products at the end of the year.

With limitations of the number of credits in the current curriculum rules [12], a project-based class will be another method to enhance the student skills for job markets. Furthermore, there is a need for educational supporting system in several areas at each institution. These systems can be costly. Thus, the senior capstone projects in the computer engineering, computer science or information technology can help reducing these costs. However, all parties must arrange the project and make a common understanding of what to expect from each party at each step. A well arrangement can lead to even a larger project which can lead to a commercial product in the future.

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S. Vasupongayya is currently an assistant professor of the Department of Computer Engineering at Prince of Songkla University, Hat Yai, Thailand. Dr. Vasupongayya received a Ph.D. in computer science from Portland State University, Oregon, USA. Dr. Vasupongayya's research interests include computer security, scheduling and engineering education.

W. Noodam is a newly graduated from Prince of Songkla Unviersity, Hat Yai, Thailand. She received her bachelor of engineering degree in computer engineering majoring in information system in March 2013.

P. Kongyong is a newly graduated from Prince of Songkla Unviersity, Hat Yai, Thailand. He received his bachelor of engineering degree in computer engineering majoring in computer network in March 2013.