ISSN: 1545-679X

Information Systems Education Journal

Volume 4, Number 23 http://isedj.org/4/23/ April 14, 2006

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Recommended Citation: Scott (2006). Systems Development Group Project: A Real-World Experience. *Information Systems Education Journal, 4* (23). http://isedj.org/4/23/. ISSN: 1545-679X. (Earlier version appears in *The Proceedings of ISECON 2004:* §4134. ISSN: 1542-7382.)

This issue is on the Internet at **http://isedj.org/4/23/**

The **Information Systems Education Journal** (ISEDJ) is a peer-reviewed academic journal published by the Education Special Interest Group (EDSIG) of the Association of Information Technology Professionals (AITP, Chicago, Illinois). • ISSN: 1545-679X. • First issue: 8 Sep 2003. • Title: Information Systems Education Journal. Variants: IS Education Journal; ISEDJ. • Physical format: online. • Publishing frequency: irregular; as each article is approved, it is published immediately and constitutes a complete separate issue of the current volume. • Single issue price: free. • Subscription address: subscribe@isedj.org. • Subscription price: free. • Electronic access: http://isedj.org/ • Contact person: Don Colton (editor@isedj.org)

EDSIG activities include the publication of ISEDJ, the organization and execution of the annual ISECON conference held each fall, the publication of the Journal of Information Systems Education (JISE), and the designation and honoring of an IS Educator of the Year. • The Foundation for Information Technology Education has been the key sponsor of ISECON over the years. • The Association for Information Technology Professionals (AITP) provides the corporate umbrella under which EDSIG operates.

Systems Development Group Project: A Real-World Experience

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Abstract

The Group Systems Development Project course of the Information Systems major at the University of Cape Town is a practical course designed to integrate the body of knowledge obtained in other undergraduate theoretical courses. The main objective of the course is to give students a real world experience of the diverse and complex nature of the Information Systems profession and provide them with adequate skills for the global marketplace. This paper describes the objectives as well as the deliverables and the administration of the course. The basic course content is outlined, and the various stakeholders and their roles are identified. Some discussion is provided regarding the comprehensive set of assessment strategies that has been implemented as well as a number of critical issues that have emerged. Brief summaries of past projects are provided, including feedback from project sponsors. Finally, the need for ongoing research in this area is addressed.

Keywords: systems development group project, capstone course, skills, problem-solving, object-oriented paradigm

1. INTRODUCTION

Information Systems (IS) professionals are required to function in a complex organizational and dynamic software development environment (McGuire and Randall 1998). At the University of Cape Town, the Group Systems Development Project is an integrated capstone course that attempts to develop a diverse set of competencies that will equip students to face the challenges of the workplace more effectively.

One of the main objectives of the group projects is to provide students, working in teams of 4 or 5 members, with a unique opportunity to experience the convergence of multiple disciplines that is characteristic of the day-to-day experience of an Information Technology/ Information Systems (IT/IS) specialist in industry. This course has been developed and refined over a period of four years to integrate and permeate the most important characteristics of the IS profession as described in the IS2002 Curriculum Update (IS2002).

2. BACKGROUND

Educating undergraduate students to be capable IT professionals poses several significant problems (Dawson & Newman 2002).

According to McGuire and Randall (1998) the growing global economy for software products and services has caused a shift which increasingly necessitates the effective use of information technology. This includes amongst others, communication technology as well as organizing, accessing and generating information. Software professionals are thus confronted with the dynamic, sometimes unstable and complex nature of software development environments and must be able to rise to the challenge of dealing effectively with these situations.

Several authors (Dawson and Newman 2002; Noll and Wilkens 2002; Tuttle 200; Kussmaul 2000) agree that the revolutionary and rapidly changing field of Information Systems places stringent demands on IT/IS educators, who must continually revise and change programs and curricula in an attempt to better equip students for the marketplace. Phukan (2001) is of the opinion that determining the exact content required by these curricula is a real problem. Enormous technological advances have brought the global marketplace within reach of even small organizations, creating both enormous opportunities as well as threats to these organizations. To effectively operate in a global environment and escape its negative effects, personnel need to be equipped with a comprehensive array of skills. A further implication is that IS education across the world needs to provide a 'base foundation' of skills and knowledge that will emphasize effective delivery of information and prepare future IS professionals (Phukan 2001).

Dawson and Newman (2002) adopted a strategy of empowerment by utilizing experiential learning. They created a project environment to motivate and challenge

students to take an active part in their own learning experience. At the same time students were monitored, supported and provided with the necessary skills to avoid unproductive experimentation.

Based on a review of previous research, job announcements, advertisements and IS literature, Noll and Wilkens (2002) developed a questionnaire to determine what employers perceived as the most critical areas of knowledge and skills for IS professionals within the next three years. This research verified the need for IS curricula to accommodate the diverse job market and proposed a model curriculum matrix including a common core, three concentrations and electives. It confirmed the increasing importance of the so called "soft skills" like writing, working in teams, delivering presentations, and developing interpersonal relationships. The research further emphasized that web-based programming languages were becoming more important than structural languages and that students need to be more adequately prepared to advance to systems analysts jobs (Noll & Wilkens 2002).

3. THE PROJECT COURSE

According to IS2002: An Update of the Information Systems Model Curriculum (IS2002), the characteristics of an IS professional evolves around three major areas namely:

- a broad business and real world perspective.
- strong analytical and critical thinking skills.
- strong interpersonal communication and team skills.

To fully reflect these major areas, the systems development project course is designed to give students first hand experience of the management issues and complexities of running a real-world systems development project. Students experience the subtleties and complexities of interacting with actual users in real organizations, some of whom may have had no prior exposure to computer technology and applications in business. An important added benefit is that students gain experience of working in teams and realize the challenges that this entails.

Systems development is fundamentally a problem solving activity. The complexity of systems development is two-fold and requires expertise in the area of the problem to be solved (application domain) and the area of constructing a software solution (systems and software development) (Vessey and Glass 2003). In line with this approach the course further equips students with:

- crucial problem-solving abilities using object-oriented techniques
- business process re-engineering skills.
- the insight and understanding required to capture business processes programmatically

Course Objectives

The Group Systems Development Project has the following objectives:

- consolidate knowledge and skills in systems development and extend the use of object-oriented techniques and business process re-engineering
- prepare students for the corporate computing environment
- allow practice of formal project management and the concepts of systems engineering
- extend exposure to working in teams and "soft" IS issues, such as motivation and ethics
- provide a solid foundation for those students continuing to postgraduate IS study
- expose students to the challenges, advantages and problems of working with real-world users.

Course deliverables

The main deliverable for this course is a comprehensive web-based management system with a concise and clear business focus. This system must include both a web component and a Visual Basic.Net back-end; the importance and scope of each one of these parts depends on the specific business problem to be solved. An object-oriented approach is followed throughout the System Development Life Cycle. At the beginning of every year the students are provided with a generic business problem, detailed specifications and functionality guidelines. These specifications are then used to find a "best fit", i.e. an appropriate business problem and sponsor in industry. Students are encouraged to use a technology platform similar to what is currently used in their computer labs. Groups with excellent skills in other programming languages who wish to use alternative development environments may motivate this in writing and submit their request to the course coordinator. The object oriented paradigm must however be used for the development of all systems and no other environment, not fully supporting this, would be acceptable.

The project has been sub-divided into clear phases, each with well-defined interim deliverables. Deliverables in the systems development course refer to all marked assignments, including written documents and source code, as well as project management and design diagrams. For each phase (see Table 1) the applicable system development deliverables, project management deliverables as well as quality control procedures are specified, culminating in a milestone deliverable (Scott and van der Merwe 2003).

Through the deliverables of the project, students are forced to:

- identify the business problem and the alternative solutions to solve it.
- cope with the difficulties of obtaining user requirements and the changing nature thereof.

- evaluate the alternative solutions and come up with a recommended solution.
- apply their prior knowledge (theoretical, as well as practical).
- acquire new specialised skills to solve their specific business problem.
- deal with and manage customer expectations and scope creep.
- work efficiently as individuals in a team.
- analyse, design and build the proposed system.
- deliver a shrink wrapped product at a non-negotiable deadline.

Table 1: Project phases and corresponding milestone deliverables

Phase	Milestone deliverable
Project definition	Business Case
System analysis	User requirement specification
System design	System specification
System Build and Testing	Shrink wrapped product

The course terminates with a live project presentation as well as a code review for each group. The project presentation is expected to be highly professional and is evaluated by a panel of three examiners. It commences with a brief discussion of the business problem, the analysis and solution thereof. This is followed by a live demonstration of the system to a panel of three examiners using previously documented and submitted test cases to extensively illustrate the capabilities and functions of the system. The code presentation is conducted on a separate occasion and is evaluated by the course coordinator. An EXPO is hosted to showcase the projects to industry representatives, as well as to school representatives (teachers and learners). The aims of the EXPO are to promote the students to the local IT Industry as potential employees, as well as to promote Information Systems as a career choice and field of study at UCT.

Course Skills
To adequately prepare students to complete the project successfully, it is necessary to equip students with the most prominent specific skills and technologies that the industry requires. Through formal lectures, as well as through information sessions with the sponsor and facilitation by faculty members, broad business and real world perspectives are enhanced. The project management sections of the IT Management course running in parallel with the project course during the first semester has been tailored to assist students to complete the project management deliverables of the course more effectively. Analytical, technical and critical thinking skills are improved by weekly workshops conducted in a computer laboratory environment. During these workshops students are guided to build a pilot system, empowering them for the development of their own system.

4. COURSE ADMINISTRATION

The systems development group project is resource and labor intensive (Novitzki 2001; Ludi 1998) as outlined below:

Course schedule
The systems development group project course runs over three terms, from February until September. The course commences with the introduction of the generic project brief and the presentation of a relevant case study by a guest lecturer from industry. Due to the large class size, students are encouraged to self-select teams of 5 members. Group formation is concluded during a session with the assistance of a facilitator. As soon as the groups are formed and the students have obtained the project brief they are ready to search for an appropriate sponsor in industry whose business problem best exhibits the given functional specifications.

Formal lectures and workshops are conducted during the first two terms to empower students with vital and appropriate skills and competencies. A diverse range of topics are discussed during the two weekly lectures to adequate address the body of knowledge (BOK). This includes lectures or discussions of group dynamics, time management, testing and deliverables. Technical topics like advanced object-oriented principles, ASP.NET, database access and XML are also covered. Nine three-hour workshops are used to provide the students with a working prototype, exhibiting advanced programming principles and enabling groups to complete the project in a .NET environment.

In the second part of the course, groups allocate most of their time to build their systems using Visual Basic.NET and ASP.NET. During this time representatives of each group meet the course coordinator for a weekly group-wellness check. Microsoft (MS) Project Server 2003 is used with Microsoft Project 2003 to serve as the technology platform for the project teams. Through its MS Project Web Access Interface, MS Project Server makes it easy for team members and stakeholders to collaborate and access project information using only a Web Browser. MS Project Server stores project and resource information in a central database, thereby enabling standardized and consistent planning and reporting even though team members reside at different physical locations.

The eight intermediate deliverables during the lifecycle of the project contribute towards four milestone deliverables that represent the different phases of the project as shown in table 1.

Stakeholders
Due to student numbers (ranging from 115 to 200) and the inter-disciplinary nature of the course, several stakeholders play a role in the administration of the course. These are the students, course coordinator, course assistant, course secretary, faculty members acting as project managers, the sponsors and tutors.

Students: Students are encouraged to form groups with 5 team members each. Although team members are mostly self selected, a formal group session is conducted to finalize the team formation and incorporate those students not yet allocated to teams. Each team has a team leader to co-ordinate team activities; assign roles to the rest of the team and to act as liaison between the course-administrator or faculty member, acting as project manager, and the team.

Coordinator and Course assistant: The course coordinator oversees all procedures of the course, facilitates and conducts lectures, prepares and conducts workshops, produces course readers and acts as project manager of at least three groups. With the assistance of the course assistant, the course coordinator prepares templates for deliverables, schedules the project presentations and organizes the EXPO event at the end of the year. The assistant is also responsible for some lectures as well as maintaining the website. During the build phase of the project, technical assistance as well as encouragement and support form a vital and time-consuming part of the guidance.

Project managers: In a commercial development environment a project team will normally report to a systems manager or development manager. This person will provide guidance to the project team from the perspective of their experience, as well as checking that they are making satisfactory progress and that the scope of the project is in accordance with the project specifications. The faculty member acting as Project Manager (PM) needs to play this role for his / her assigned groups. Project teams must manage their own work, but are expected to contact the PM on a regular basis, as deliverable review points approach, and set up review meetings at the PM's convenience. Where possible, these should occur within the week when the deliverables are due. Project managers keep a record of these meetings and also assist in the assessing of

- the deliverables that will contribute to the final documentation of the project.
- team synergy (e.g. equal distribution of workload; general co-operation between team-members) and report any problems to the course coordinator.
- a preliminary presentation of the project two weeks before the final hand-in date.

Tutors: The tutors are 4th year and masters students with the necessary technical skills whose main responsibilities are to:

- provide technical assistance during the workshops, repeated twice a week. The tutors also assisted with the building of the prototype.
- man the hot seat in the second part of the course to assist with technical problems, which could either be analysis and design problems or programming problems. Additional tutors with specialized skills might also be needed for the hot seat duties.
- mark the first two milestone deliverables for each one of the systems.

Sponsors: Sponsors are representatives of businesses that have a business problem matching the generic specifications given in the project brief, and as such epitomize the real world users. A sponsor's main responsibilities are to:

- meet with the team to assist them in gaining an understanding of the company's business rules. The information obtained is used to establish the Project Requirements and Scope Definition.
- have follow-up meetings with the group to monitor the project progress.
- complete two formal evaluation sessions at given deadlines.

Two short evaluation templates are provided for this purpose and can be submitted as a hard copy or via email.

Assessment strategy and instruments
Shepard (2000) argues that assessment should not merely act as a measure of teaching, but should contribute to and support the learning process. Due to the diverse nature of the course and the several deliverables it entails, the author agrees with Pellegrino et al (2001) who state that learning is enhanced by assessment that provides feedback to students about the quality of their work and what they can do to improve their understanding. In addition to this, assessment should also enhance and encourage what Entwistle (2000) describes as a deep approach to learning. A deep learning approach centers around the understanding the material, whereas a surface learning approach mostly involves recall and reproduction. Students have to take ownership of their system and become actively involved and interested in the course and its content. Encouraging students to think for themselves, presents a challenge to the lecturer to design teaching and assessment material that will engage the students in deep learning. According to Biggs (2000) assessment should be closely linked with learning objectives by moving away from quantitative measurement orientated assessment models to qualitative standards orientated assessment models.

To comprehensively assess a diverse range of abilities, the assessment strategy implemented for this course is in line with that suggested by Shepard (2000). It includes dynamic assessment, assessment of prior knowledge, feedback, teaching for transfer, student self-assessment, and evaluation of teaching. Table 2, as used by Scott

and van der Merwe (2003), depicts the implementation of the assessment strategy for every component of the course. Different assessment instruments are used to incorporate the three elements of assessments as shown in Table 3.

The reader can obtain examples of these instruments by emailing his/her request to the author, see the supplied email address on the first page.

Table 2: Assessment Strategy

Component	Occurrence	Key assessment strategy (Shepard)	Group / Individual	Contribute to final mark
Mid-year exam	Once - 3hr exam	Prior Knowledge	Individual	Yes
Interim deliverables	8 - approx every 2 weeks	Dynamic Feedback Explicit Criteria	Group	Yes
Milestone deliverables	3 - approx every 6 weeks	Dynamic Feedback Explicit Criteria	Group	Yes
Technical workshops	Weekly – first 10 weeks	Prior Knowledge Teaching for transfer	Individual	Yes
Weekly reports	Weekly	Feedback Student self-assessment Evaluation of teaching	Group	No
Weekly project management meeting	Bi-weekly	Feedback	Group	No
Sponsor meetings	When required	Feedback	Group	No
Sponsor evaluations	Twice	Dynamic Feedback	Group	Yes
Course evaluation	Twice	Evaluation of teaching	Individual	No
Peer- and self evaluations	When required and once as part of final assessment	Student self-assessment	Individual and Group	Yes (Final assessment)
"Mock" presentation	Once	Dynamic Feedback Explicit Criteria	Group	Yes
Final presentation	Once – 2hrs	Explicit Criteria	Group	Yes
Code review	Once	Explicit Criteria	Group	Yes

Table 3: Assessment instruments

Element of Assessment	Course component	Instrument
Formal summative assessment	Tests, Exams, Presentations, sponsor evaluations	Tests, exams, scoring rubrics
Formal continuous assessment	Interim deliverables, workshops and milestones	Mark sheets
Informal formative assessment	Self-assessment, peer evaluation, course evaluation	Questionnaires, checklists

Scoring rubrics is the most fundamental assessment instrument used in the course and is a movement towards qualitative standards orientated assessment (Scott and van der Merwe 2003).

Scoring rubrics provide clear and concise guidelines of the standards against which students will be measured. It also limits bias and ensures effective and consistent assessment. In this course the rubrics (or mark sheets and other assessment instruments used) are published well in advance to inform students of the criteria and associated standards that will be used. It also encourages them to perform self assessment and prepare themselves accordingly.

5. PAST PROJECTS

Every year students choose problems representing a diverse range of industries. In 2001 and 2002 the business problem was a comprehensive web-based management system performing generalized administrative and scheduling functions. It was required that efficient and advanced scheduling algorithms were implemented for the various applications. Proof of these algorithms had to be documented in the technical specifications and the logic had to be tested thoroughly.

Of the 42 projects in 2002, 7 projects were developed for non-profit organizations, 2 of which were developed for the society of the blind. The one system was developed for The Western Province Sport Association for the Physical Disabled to streamline the efficiency of the society. The other one was developed for the Lighthouse Association for the blind and visually impaired with the main aim to improve efficiency by computerizing all the records and allowing for easy access of necessary information.

The top project was a multi-platform web-based management system to provide an operational pilot of an all encompassing web-based, medical transcription and operation solution using cutting edge hardware and software technology. The system needed to capture medical data and manage the transcription services located in India and South Africa. Some of the other systems were:

- a reliable aircraft maintenance and flight management system with web-enabled facilities and functions to reduce inefficiencies and to facilitate planning.
- a general management system in the motor industry to facilitate the efficient managing of customer and staff details, used equipment, office assets, the car hiring and parts library.
- a SLYCards computerized distribution management and reporting system to ensure greater efficiency, effectiveness and profitability.
- a Fitness club management system, Bodies under Construction (BUC), to allow for easy management of bookings of equipment and rooms, schedules for personal trainers and payroll process.

The motivational keywords to project the spirit of the project and provide a theme for the EXPO were: Projects - Presentations - Planning - Perseverance - Passion and Perfection.

In 2003 and 2004 the business problem was a comprehensive web-based tracking system. This could typically be implemented in an organization which will provide any form of support service to clients that involves the tracking of resources. Similar to the previous years it was required that student document advanced tracking algorithms.

The top project out of 37 projects in 2003 was an Online Media Exchange system encompassing web-based rich-media content delivery. In addition the system included project management, project collaboration and decision support functionalities. It was designed to use open source tools and was tailored to be user friendly and platform independent.

Some of the other projects were:

- a Life-Source system to automate and standardize the current manual processes at Western Province Blood Transfusion Services. The system recorded all donation information, including blood processing and tracking, order fulfillment and donor management.
- a membership tracking system for Pedal Power Association (PPA). This included basic accounting features, specialized e-mail and short messaging (SMS) facilities, allowing PPA to contact their members based on certain search criteria. In addition, the existing website was updated with additional features added to it.
- a customer software licensing procurement environment with distributed web-based clients. It consisted of a pricing and selection tool, with order placement, manual order acceptance, electronic notification of order placement and order tracking functionality. The system also reported on license consumption and tracking.
- a competent and efficient donor tracking system to improve communication between SHAWCO (Students' Health and Welfare Centres Organisation) at UCT and their respective donors.
- an efficient information management system for Shack/Slum Dweller International (SDI) to provide a credible basis for SDI to gain funding, influence government policies and uplift impoverished communities internationally.

In 2003 students were faced with the challenge to change from Visual Basic 6 to Visual Basic .Net, supporting a true object-oriented environment. The motivational keywords thus chosen to depict the theme for the year and the EXPO were: Dedication, Determination and Discovery.

6. SPONSOR FEEDBACK

In addition to the usual sponsor evaluations, the only formal follow up procedure conducted on past sponsors was in the form of an empirical research study (section 8, Related Research). Despite the occasional exception where sponsor requirements were not met or unacceptable student conduct was experienced, sponsor feedback was mostly positive during past years.

During the lifetime of the project students are constantly cautioned to act professionally when communicating with sponsors. Before signing a commitment form,

sponsors, on the other hand, are informed of the degree of risk that exists when taking part in student projects.

In 2003, 24 sponsors out of the 37 sponsors provided overwhelming positive feedback. A satisfied sponsor of a leading company in the motor industry acted as a sponsor for two consecutive years. In contrast to this, two groups had severe problems to consolidate their systems on time. This was mostly due to inefficient time management and underestimating the complexity of the product. One of the sponsors also had reservations about his group's communication skills.

A successful industrial effluent sample tracking and reporting system developed for City of Cape Town by a team in 2003 initiated a collaboration action between the university and the City of Cape Town in 2004. Sixteen 4th year students assisted in the re-development of legacy systems, written in Clipper. They completed the business analysis as well as the functional and technical specifications for these systems. It was also decided that they would assist in tutoring specially trained interns designated to build these systems.

7. CRITICAL ISSUES

As only 20% of the total marks for the course comprise of individual contribution, there is reason for concern that the performance of individuals is not tested adequately throughout this course. Cases do occur where team members do not contribute equally to the project. To encourage full participation and ensure fair assessment a peer review process is implemented where students perform a self assessment as well as peer assessments. In cases of significant variances from a mean value, a penalty deduction will be applied to the specific student's mark. A departmental decision was made to incorporate a part of the theoretical project management course into the project course in 2005 to eliminate this imbalance.

According to Redmond (2001) the formation of groups is an important issue in successful group work. He argues that the formation of groups via self-selection is not conducive to group work. Students tend to choose friends as team members, instead of those with specific competencies and skills. Large numbers, a very diverse population of students and the importance that most students attach to the success of the project, have lead to allowing students to choose their own team members as far as possible. This approach is not always a true reflection of the real world and runs the risk that super groups or very weak groups are formed. An empirical study to investigate possibilities of changing the way in which groups are formed is currently in progress.

Sponsors are often concerned about their intellectual property when communicating information to students. For this reason a commitment was made by the university that any proprietary information and intellectual property belonging to the user (sponsor), and passed on to the students and the University for the purpose of completing the projects, will remain the property of the user (sponsor). Neither the students nor the university will have any right to make further use of this intellectual property without the prior written consent of the user (sponsor).

8. RELATED RESEARCH

The technical and other challenges that have emerged during the development and management of these projects provide a diverse and rich field of study.

As software testing is an integral part of the software development lifecycle, empirical research (ER) was done on "The Alignment of Software Testing Skills and Procedures of the Information Systems Students at UCT with that of Industry Standards in South Africa" in 2002. The research on testing was continued during 2003 and another empirical research project, "The status of Software Testing in South Africa" resulted from this. As part of this investigation, the standard of the software testing process in South Africa was compared to benchmarks for Alberta, Canada and the rest of the world, based on the findings of a similar study conducted in Alberta.

Two studies are currently conducted, the first of which is entitled: "An investigation into the extent to which skills learnt during the systems development project has been applied in industry". This study is a follow up on two previous ER studies in 2001, 2002 addressing the Skills Gap. The second study: "An investigation into a model which will assist in the formation of a group structure in order to optimise the effectiveness of the systems development group projects", is conducted to provide guidance in the group forming exercise of the third year systems development project.

9. CONCLUSION

The systems development group project has developed into the flagship of the Information Systems majors over the past four years. It is a challenging course where students are highly motivated, passionate and proud of "their system" and determined to complete it successfully within the given deadlines. The competitiveness of project teams promotes creative solutions. This necessitates students to acquire advanced technical skills and forces them to keep up with the most recent technologies.

In addition to this exposure to real-world projects is vital for the development of the students into marketable IT/IS professionals. Students experience deep learning and both their technical and interpersonal skills are enhanced through project management, the systems development and build process, team work and communication with real world users. However, ongoing research into the content, management and assessment of this type of project is essential if our graduates are to keep

abreast of the demands presented by a constantly changing technological environment.

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