A Cross-Functional Systems Project in an IS Capstone Course

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ABSTRACT

Information systems (IS) practitioners must regularly work cross-functionally with business users when implementing enterprise systems. However, most IS higher education is not truly cross-functional in nature with students typically relying on instructors or even themselves to represent user requirements. To address this gap, we describe an ambitious multi-course project that paired students from an operations management class as business users with students from an undergraduate IS capstone course as systems developers to build an enterprise resource planning (ERP) application. In doing so, we attempted to emulate the critical success factors typically encountered in realistic cross-functional systems projects as identified in existing literature, including top management support, team interaction, communication, project management, and training. We analyze post-project debriefings combined with structural modeling of student survey data to reveal moderate realization of these success factors. We also highlight opportunities for replicating and improving the project as well as review important feedback for our entire IS program.

Keywords: Enterprise resource planning (ERP), experiential learning, instructional pedagogy, team projects

1. INTRODUCTION

Information systems (IS) practitioners must regularly work cross-functionally with business users when implementing enterprise systems. As such, systems implementations require a breadth of both functional and qualitative skills (Mabert et al., 2003; Ngai et al., 2008; Stratman and Roth, 2002). Many of the functional skills can be taught within an information systems (IS) degree program, culminating in a capstone course to integrate and advance the concepts (Gupta and Wachter, 1998; Steiger, 2009). Given that most IS course projects rely on homogeneous, IS-only teams however (Kruck and Teer, 2009), the qualitative skills can be difficult to teach.

With this challenge, we coordinated a multi-course systems development project to emulate realistic obstacles of working cross-functionally with business users. The project paired 56 "users" from an undergraduate operations management (OM) class, who defined the business requirements of the system, with 40 "developers" from an undergraduate IS capstone class, tasked with scoping project requirements and building a new solution. The subsequent primary objectives of the research include:

1. Emulate the critical success factors of a cross-functional IS project in an academic setting.
2. Assess opportunities for improvement and replication of the project, including enhancing IS student cross-functional interaction.

We address the first objective through qualitative analysis of student feedback informed by statistical assessment of student survey responses. The results reveal moderate actualization of the success factors and subsequent replication of a realistic IS project. However, the students still did not fully appreciate important cross-functional factors such as teaming and communication. So, we review student debriefings and our own reflections to support the second objective of project improvement and replication.

2. LITERATURE REVIEW

We focus the literature review on enterprise resource planning (ERP) systems due to the richness of the literature base and similarity to the application used in our project. In linking data and processes across departments, ERP requires cross-disciplinary thinking and integration of business processes (Cronan et al., 2011; Pellerin and Hadaya, 2008; Rienzo and Han, 2011). With such complexity, ERP implementations are generally long and costly (Mabert et al., 2003) and are also frequently unsuccessful (Kanaracus, 2010; Momoh et al., 2010).

Table 1 summarizes the most frequently-cited critical success factors for ERP implementation. First, *top management support* involves leadership communication, commitment, resource allocation, and conflict resolution (Finney and Corbett, 2007; Ke and Wei, 2008; Stratman and Roth, 2002). Next, *team interaction* must be cross-functional across technical resources and business users (Finney and Corbett, 2007; Rothenberger et al., 2010), thus requiring a broad set of interpersonal skills (Boyle and Strong, 2006; Hignite et al., 2002). *Communication* within the cross-functional team is also critical (Finney and Corbett, 2007; Wickramasinghe and Gunawardena, 2010) as is strong *project management* skills such as project planning, task assignments, and progress monitoring (Chen et al., 2009; Dey et al., 2010). *Training* refers to teaching users how to use the ERP system (Finney and Corbett, 2007; Schmidt et al., 2001; Stratman and Roth, 2002). Finally, *change management* entails overcoming internal resistance to adapt to the new system and associated processes (Finney and Corbett, 2007; Stratman and Roth, 2002).

Applying this literature to our project, we hypothesize that higher levels of top management support (H1), team interaction (H2), communication (H3), project management (H4), and training (H5) each increase cross-functional IS project success. We omit change management due to the lack of a formal user implementation stage in our project. Each of these hypotheses represents a path in the research model to predict project success (Figure 1).

3. INNOVATION

With the breadth and complexity of these success factors, some academics consider ERP to be too complex to learn by traditional lectures alone (Davis and Comeau, 2004). Subsequently, researchers highlight the need for experiential learning (Chen et al., 2011), ideally across multiple courses (Swanson and Hepner, 2011). One typical approach involves ERP simulations and games, which research has shown to enhance ERP knowledge retention (Cronan et al., 2011; Leger, 2006; Seethamraju, 2011). Additionally, educational offerings from ERP software vendors (Antonucci et al., 2004) allow students to obtain direct, hands-on ERP experience.

Still, typical IS projects in practice "are often staffed by interdisciplinary teams, not necessarily in the same location, working together to solve complex tasks" (Kruck and Teer, 2009, pp. 326). Yet, conventional IS courses only involve IS students without business user representation (Kruck and Teer, 2009), thus not imparting the cross-functional, team-based success factors identified above. We argue that the IS capstone class requires further innovation to represent cross-functional skills required in practice. With this need, the cross-course basis of our project thus provides an important contribution to the IS pedagogy literature by extending the "threshold" (Meyer and Land, 2003) of the typical IS capstone class to promote student comprehension of critical IS skills at a higher level of complexity and integration.

4. IMPLEMENTATION

The "system" of study was eOps, an existing web-based teaching simulation that highlights interactions between core business functions. In eOps, business users produce and sell computers, managing *purchasing* of components, *production planning*, and *sales* of finished units. eOps generates a performance rating derived from accounting output of profitability relative to utilized resources. The goal is to achieve a high rating by optimizing purchase prices and sales revenue while maintaining high manufacturing plant utilization.

Citation	Top Mgt Support	Team Interaction	Communication	Project Mgt	Training	Change Mgt	Other Example Critical Success Factors	Methods
Akkermans and van Helden (2002)	X	X	X	X			Integration, clear goals	Case
Al-Mudimigh et al. (2001)	X		X	X	X	X	Business case	Lit review
Dezdar (2011)	X		X		X			Survey
Dezdar and Sulaiman (2009)	X	X	X	X	X	X	Process re-engineering, minimal customization, vision, culture	Lit review
Finney and Corbett (2007)	X	X	X		X	X	Software, strategy, consultants	Lit review
Huang et al. (2004)	X	X	X		X		Processes, supplier support, data	Lit review, case
Li and Seddon (2009)	X	X	X	X	X	X	Process reengineering, ERP selection	User presentations
Mabert et al. (2003)	X	X	X	X	X	X	Performance measures, minimal customization	Case studies, survey
Momoh et al. (2010)	X				X	X	Customization, business requirements, data quality	Lit review
Nah and Delgado (2006)	X	X	X	X		X	Business plan	Case study
Nah et al. (2007)	X	X	X	X			Culture	Survey
Ngai et al. (2008)	X	X	X	X	X	X	Software, strategy, processes	Lit review
Noudoostbeni et al. (2010)	X	X	X	X			Goals, integration, decisions	Case study
Plant and Willcocks (2007)	X	X	X	X	X	X	Goals, integration, expectations	Case study
Somers and Nelson (2001)	X	X	X	X	X	X	Integration, goals expectations	Meta-analysis
Stratman and Roth (2002)	X		X	X	X	X	Strategy, business process skills	Survey, interviews
Wickramasinghe and Gunawardena (2010)	X	X	X	X		X	Strategy, control	Survey, lit review

Table 1: Summary of ERP success factor literature

	Hypothesis
H1	Higher levels of **top management support** increase **IS project success**
H2	Higher levels of **team interaction** increase **IS project success**
H3	Higher levels of **communication** increase **IS project success**
H4	Higher levels of **project management** increase **IS project success**
H5	Higher levels of **training** increase **IS project success**

Table 2: Research Hypotheses

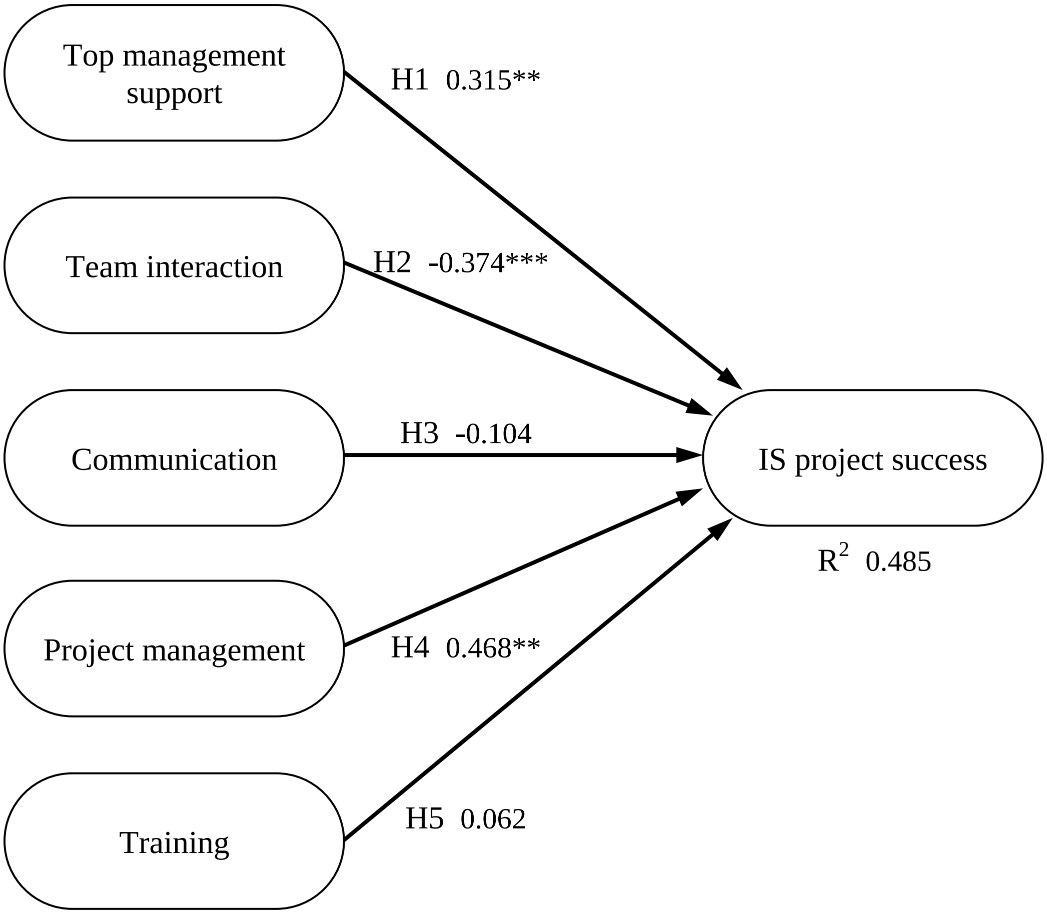

Figure 1: Research model of student perceptions of key success factors
Notes: ***p < .01; **p < .05; *p < .1 (one-tailed test)

Despite the educational value of eOps as an operations instructional tool, the system is over 10 years old, and technical improvements could significantly improve its stability and functionality. The project thus centered on building a new, improved eOps application. The project was executed at a large state university located in the southeast United States. The undergraduate OM class of 56 students served as business users with content expertise to set the business requirements. The undergraduate information systems (IS) class of 40 students filled the developer role of building the system to these requirements. The OM class is required for all undergraduate business students, typically taken in the junior or senior year. The 40 "developers" were graduating seniors enrolled in the capstone course of the Information Systems program. As graduating seniors, developers had completed the entire curriculum including system analysis and design, database, IT infrastructure, and introductory programming courses. Of the 40 developers, 32% were female and 20% international. Approximately 20% of the developers were non-traditional students in the age range of 30-40 years.

Phase 1 of the project entailed individual (OM) users competitively playing the existing eOps to attain deep understanding of the tool as if they utilized it in daily work responsibilities like a typical ERP system. This phase ensured strong awareness of the business requirements of the system. Developers did not participate in this phase. Users' final eOps performance ratings relative to one another served as the sole basis for Phase 1 grading. We held a debrief session with the users shortly after Phase 1 to review lessons learned and reinforce understanding of eOps business requirements. As part of Phase 1, we also tasked users with assessing potential improvements to the eOps tool. Opportunities included correcting existing problems as well as extending eOps functionality to improve both ease-of-play and learning of operations concepts. We then grouped users into teams of four to five to coordinate these improvements and ultimately retain responsibility for "as is" and "to be" eOps business requirements.

Phase 2 then paired OM user and IS developer teams to re-build eOps to "to be" user requirements following tools and processes that the IS students had learned throughout their academic program. Each combined team retained about eight students, typically including three developers. Phase 2 represented 55% of the IS developer student final grade though only 15% of the OM user student final grade. This realistically mimicked the relative workload of the developers (i.e., main responsibility to build the system) versus the users (i.e., main responsibility to continue their daily jobs while also supporting systems development as an ancillary responsibility).

Phase 2 instructions (Appendix) led the user-developer teams through the systems development lifecycle (Grenci and Hull, 2004), including construction of critical documents (e.g., project planning, business and technical requirements, use case diagrams, site maps, etc.), coding, and testing. Students were required to follow the Traditional Project Management approach (Wysocki, 2009) with the waterfall SDLC methodology (Royce, 1970). Both users and developers were involved in creating documentation, though final responsibility rested with the developers. Templates were provided as guidelines for content and consistency.

We provided feedback on these deliverables as the project progressed and scheduled several drop-in help sessions throughout the semester (beyond office hours) for additional help. This approach created a "pull" orientation to fill knowledge and skill gaps (McLaren et al., 2007), letting "students learn from their mistakes" while providing "good customer support" (Fedorowicz et al., 2004). Furthermore, we generally avoided specifying expectations of the final eOps system in order to encourage student critical thought and ownership in the learning process (Umble et al., 2008) as "active constructor, discoverer, and transformer of their own knowledge" (Fellers, 1996, pp. 45). This and other aspects of the project followed Knowles' approach to adult learning (Knowles, 1975, 1984).

5. EFFECTIVENESS

Teams presented their final projects, including a system walk-through, to the instructors at the end of the semester. We also conducted qualitative project debriefings during these presentations and later reviewed team diaries. To promote knowledge sharing, teams also presented solution overviews and lessons learned in a class meeting. Additionally, we administered a survey to the IS students to measure the effectiveness of the project in emulating the critical success factors of a cross-functional IS project (Objective 1) that were presented above as research hypotheses (Table 2) and associated research model (Figure 1). The discussion below uses the statistical analysis of the survey responses to verify and supplement the qualitative feedback. We first describe the statistical results then the qualitative observations.

5.1 Survey

We adapted the survey instrument (Table 3) from industry-focused ERP literature (Nah and Delgado, 2006; Nah et al., 2007; Stratman and Roth, 2002) to our pedagogical context. This literature does not perfectly align with our project, mainly due to the lack of a formal implementation phase, but does provide a practical foundation for studying success factors of cross-functional systems projects. For instance, we applied *team interaction*, *communication*, and *project management* directly as the same constructs from the practitioner literature. We modified *top management support* as instructor support. Similarly, we adapted *training*, depicted in existing literature as user training, to represent developer technical skills imparted in prior coursework and access to supplemental instructional resources. Additional self-report items measured student perceptions of *project success*, *learning*, *difficulty*, and *realism*.

We administered the survey to the developers at the end of the project but before grading with a response rate of 90% (36 observations). Table 3 displays the average responses for the survey items, including statistical significance from the scale medians of 4 ("neither agree nor disagree" or "somewhat certain" as indicated in the footnotes). Most success factor items were significant in a positive direction

Construct		Survey Item	Mean (p-value)
Top Mgt Support[a]	TM 1	Instructors clearly defined eOps Phase 2 project objectives.	5.49 (.000)[c]
	TM 2	Instructors were committed to this project.	5.84 (.000) [c]
Team Interaction[a]	TI 1	User and developer sides of the team worked well together.	4.92 (.001) [c]
	TI 2	We had an open dialogue with the users during the project.	5.14 (.000) [c]
Commun-ication[a]	C 1	It was easy to communicate within the entire project team.	4.89 (.006) [c]
	C 2	Team members used the right communication media (e.g., discussion boards, e-mail, face-to-face meetings, etc.).	4.78 (.021) [c]
Project Mgt[a]	PM 1	We followed a documented project plan to guide our work.	5.68 (.000) [c]
	PM 2	Specific project tasks were clearly assigned to team members.	5.77 (.000) [c]
Training[a]	TR 1	We had skills necessary to successfully complete this project	4.57 (.107) [c]
	TR 2	We could always successfully obtain answers to technical questions from available resources (e.g., class, Internet, etc.).	4.86 (.007) [c]
Project Success[a]	S 1	Our final eOps submission is strong.	5.19 (.000) [c]
	S 2	Our submission is likely better than most others in the class.	5.08 (.001) [c]
	S 3	We will receive a good grade on this project.	5.94 (.000) [c]
Other Student Feedback[b]	A 1	I learned a lot from this project.	6.19 (.000) [d]
	A 2	Project expanded my thinking and skills.	6.03 (.000) [d]
	A 3	Project required different skills than projects in other classes.	6.44 (.000) [d]
	A 4	Project was realistic.	5.17 (.001) [d]

Table 3: Survey items with means and significance

Notes: [a] *scales from 1 (strongly disagree) through 4 (neither agree nor disagree) to 7 (strongly agree).*
[b] *scales from 1 (highly uncertain) through 4 (somewhat certain) to 7 (highly certain)*
[c] *p-value represents Ha: Item mean is significantly greater than 4 ("neither agree nor disagree")*
[d] *p-value represents Ha: Item mean is significantly greater than 4 ("somewhat certain")*

(i.e., greater than 4), indicating student perceptions of strong levels of top management support, team interaction, communication, and project management. However, TR 1 ("skills necessary to complete the project") was not significant, suggesting that developers felt technically unprepared for the project. Team debriefings highlighted specific concerns with programming and database skills, which we will discuss later. Still, respondents indicated a relatively high level of overall *project success* (S 1-3). The additional items addressing level of learning (A 1), expansion of thinking (A 2), difficulty (A 3), and realism (A 4) were also significantly positive from the scale medians, indicating student agreement.

5.2 Partial Least Squares (PLS) Analysis

The model (Figure 1) representing the research hypotheses (Table 2) of the IS project critical success factors were statistically tested with partial least squares structural equation modeling (PLS-SEM) (Hulland, 1999; Wold, 1975). Compared to covariance-based structural equation modeling (Joreskog, 1978, 1993), PLS-SEM is suitable for smaller sample sizes (Hair et al., 2011). Carlson and O'Cass (2010) suggest 30 as the minimum sample size to apply PLS-SEM, and Barclay et al. (1995) recommends a sample of at least ten times the maximum number of indicators for the independent variables or paths to the dependent variable (50 in our case). Given our usable sample, the research model complies with the prior guideline but falls somewhat short of the second guideline. However, Goodhue et al. (2012) indicate that the sample size of 36 should provide reasonable approximation of the model paths.

PLS-SEM is applied with a two-stage approach, first evaluating the measurement model then the structural model (Hair et al., 2011). First, the *measurement model* (Table 4) incorporates model reliability and validity. Reliability refers to survey items in terms of their consistency and repeatability (i.e., in other survey applications) to represent the underlying designated construct (Nunnally and Bernstein, 1978). Validity assesses item similarities (convergent validity as items measuring the intended construct) and differences (discriminant validity as items not measuring other constructs) (Fornell and Larcker, 1981). Sufficient reliability was establish with construct composite reliabilities all exceeding recommended 0.70 levels (Hulland, 1999). Convergent validity was verified with the latent variables each explaining more than half of each indicator variance (Fornell and Larcker, 1981), though the team interaction construct was marginal at .50. Examining discriminant validity, the average variance extracted for each construct exceeded all squared correlations with other constructs, and item loadings for each designated construct exceeded all loadings for other constructs (Hair et al., 2011). Multicollinearity, which causes estimating difficulties due to high variable correlation (Silvey, 1969), was not a concern given variance inflation factors (VIF) and tolerances for independent variables within acceptable ranges of 5 or less and greater than .2 respectively (Hair et al., 2011; Menard, 2002). We verified indicator significance for all items at a .01 level.

The second PLS-SEM step involves evaluation of the structural model, including the statistical significance of the model paths and associated hypotheses. The R2 model significance of 0.485 is considered moderate (Hair et al., 2011). Assessing the predictive relevance of the structural model, Q2 scores for six of seven iterations acceptably exceeded zero (ranging from -.0435 to .5470) (Hair et al., 2011). We tested the estimated path coefficients for significance using the nonparametric bootstrapping process in PLS-SEM (Henseler et al., 2009). Table 5 summarizes the hypotheses outcomes. The paths for top management support and project management were significant at □ = .5, thus supporting H1 and H4. However, paths for communication (H3) and training (H5) were not significant. Moreover, the team interaction path (H2) was significant but in a negative direction. We discuss these results in greater detail below

Construct	Item	Factor Loadings	Composite Reliability	Ave Var Extracted
Top Mgt Support	TM 1	0.964	0.901	0.820
	TM 2	0.844		
Team Interaction	TI 1	0.957	0.914	0.843
	TI 2	0.877		
Communication	C 1	0.938	0.907	0.830
	C 2	0.883		
Project Mgt	PM 1	0.952	0.927	0.865
	PM 2	0.908		
Training	TR 1	0.958	0.950	0.905
	TR 2	0.944		
Project Success	S 1	0.744	0.904	0.760
	S 2	0.957		
	S 3	0.900		

Table 4: Measurement model results

	Hypothesis/Path	Path Coefficient	Hypothesis Result
H1	Higher levels of **top management support** increase **IS project success**	0.315**	Moderate support
H2	Higher levels of **team interaction** increase **IS project success**	-0.374	No support
H3	Higher levels of **communication** increase **IS project success**	-0.104	No support
H4	Higher levels of **project management** increase **IS project success**	0.468**	Moderate support
H5	Higher levels of **training** increase **IS project success**	0.062	No support

Table 5: Hypotheses results Notes: ***p < .01; **p < .05; *p < .1 (one-tailed test)

5.3 Discussion

The structural model results reveal moderate success in accomplishing the first research objective of emulating the critical success factors of a cross-functional IS project. On one hand, the students realized the importance of project management (H4) to project success, which follows training from prior IS coursework. Furthermore, students recognized top management (i.e., instructor) support (H1) as an important project enabler.

On the other hand, training (H5) was not significant, suggesting that the IS students felt that their skills did not impact the success of the project. In other words, they did not feel adequately prepared. The instructors had originally determined that the developers had appropriate technical training given previous coursework. Additionally, we not only carefully laid out deliverables with due dates (including sample documents) but also held many open help sessions beyond normal office hours (also supporting H4). However, detailed review of team diaries as well as post-project debriefings revealed that the eOps technical requirements, particularly programming and database interactions, overwhelmed many students. This aligns with the lack of significance of survey item TR 1 shown in Table 2. Developers consistently reported insufficient time to learn needed programming skills. Moreover, successful teams seemed to rely on one student who already retained superior programming skills from professional experience or personal interests.

Continuing with the structural model results, communication (H3) was not significant, and team interaction (H2) was actually significant in a negative direction. So, the IS students perceived that communication was ineffective and that collaboration within the cross-functional team actually worked against project success. Again, the diaries and post-project debriefings revealed several explanations. First, the IS students questioned user abilities to effectively fulfill their role of producing functional business requirements, which is typical in such real-world projects. More prominently, the aforementioned technical challenges with the project caused many developers to abandon interaction with the users in order to concentrate on programming. In such cases, the developers viewed extended team interaction and communication as delaying and weakening project success. This became evident during the final presentations wherein many users had not yet tested the developers' solutions and even had little knowledge of developer progress. Student feedback verified the cause of this as insufficient time. So in retrospect, a lack of perceived training and technical skills likely detrimentally impacted other critical success factors. This represents a potential opportunity for future research.

Despite the limited success in imparting communication and teaming, project debriefs and diaries revealed that most developers still seemed to grasp the high-level understanding that the project effectively mirrored the challenges of a realistic cross-functional IS implementation. In fact, they clearly recognized the importance of the project deliverables as well as interaction with the user team. Nevertheless, they felt that they had no choice but to revert to a "no time to follow the rules," "do whatever it takes" mindset to produce a solution, regardless if that solution did not reflect the overall "corporate" (i.e., user) objectives of improving eOps.

6. PROJECT REPLICATION AND IMPROVEMENT

The moderate success from the outcomes above points to the need for thorough assessment of opportunities for project improvement and replication (second research objective). We start with the technical difficulty of the project, revealed as the most significant hindrance to promoting cross-functional critical success factors. As former practitioners, the instructors can attest that IS resources often severely underestimate the technical complexities of system implementations. The students also appreciated this aspect of the project as true-to-life. Despite this reality, the eOps project was probably too technically complex given the limited timeframe of a 15-week semester and subsequently instigated abandonment of cross-functional teaming. A less-complicated "system" would have allowed the developers to focus on refining cross-functional interaction and communication skills. Still, a simple project may marginalize the importance and impact of the user role. As an alternate approach, conducting the project across two semesters would allow use of a realistic and complex system to emphasize both the cross-functional and technical skills needed in practice.

6.1 Student Mindsets

The technical challenges of the project also highlighted student autonomy and dependence as important considerations for replication. Several developer teams lacked creativity and assertiveness in attempting to overcome technical difficulties. For instance, while students generally agreed to a high-level of top management (instructor) support, few teams consistently took advantage of instructor availability and willingness to help. In the same vein, students were frequently tentative in exploring external help sources such as on-line tutorials and even other instructors. Similarly, some students lapsed into a learned helplessness attitude, blaming the users, the instructors, and/or prior courses rather than accepting accountability for overcoming skill gaps. Likewise, some teams justified underperformance with one another (i.e., "we're not doing well but no one else seems to be either"), which in some cases perpetuated lack of progress and low performance.

To better guide student perceptions of performance expectations, instructors can better promote the accomplishments of higher performing teams as benchmarks for the entire class throughout the project. As another consideration, organizing specific external training sources may help alleviate student skill deficiencies but could also further foster student dependence. Ideally, we found it most effective to interact with individual teams and direct them to additional resources only when absolutely necessary. With this, we advocate structuring multiple required cross-functional team meetings with the instructors to help identify skill gaps as well as provide coaching and encouragement. We also urge an anonymous, mid-project survey as another line of communication. Finally, the lack of an actual implementation stage of eOps may have created a myopic view among students to deliver a reasonably acceptable solution (i.e., good enough to pass the class) rather than an effective long-term solution. This emphasizes the need for stringent grading expectations and again promotes a multiple semester project. For instance, part of the second semester could be used for a third phase in which users compete (like phase 1) using the new, updated eOps developed in phase 2.

6.2 Cross-Functional Team Interactions

Continuing with improvement and replication, we next discuss the challenges associated with cross-functional student interactions, many (if not all) of which are highly representative of actual IS development projects. Most prominently, the developer and user sides each maintained a self-centered view of the project, framing deliverables and workload primarily in their own terms. While students were considerate of one another, neither side seemed to understand or necessarily respect the other's workload, skill sets, and time commitments. For instance, developers became frustrated with delayed input from users, not appreciating the lower importance of the project for users given other course obligations like exams. On the other hand, users did not fully grasp the technical difficulty of the project and were sometimes slow to complete deliverables. As another example, users assumed that developers had significant business knowledge and tended to omit seemingly obvious requirements (e.g., profit calculation). Conversely, developers grew frustrated with some reaching or cosmetic user requirements that, in some ways, originated from user lack of technical awareness.

The on-line, digital nature of the project work heightened these challenges. Specifically, teams overcame scheduling conflicts through asynchronous interactions such as discussions boards and net meetings. Most teams struggled for effective cross-functional leadership as students were too timid and inexperienced to fulfill the leadership role required to bridge the user and developer sides. For instance, there was often a lack of clarity as to which side could better lead a particular deliverable, which occasionally caused neither side to take control.

Overall, we underestimated the ability of both sides to bridge team integration challenges. We thus recommend obliging the two sides to interact on a face-to-face basis frequently and early in the project, ideally in the presence of the instructors on occasion. Likewise, we advocate highly-specific user or developer ownership of deliverables. Additionally, cross-instructor class interactions (i.e., instructor visits to the other's class) and advanced team-based learning pedagogical approaches (Reinig et al., 2011) could enhance cross-functional learning. As a final consideration, using an MBA-level class as users may support a more mature, experienced benchmark for the IS students to overcome cross-functional challenges.

6.3 Project Execution

We next highlight specific execution challenges for such a complex, cross-functional project. First, instructors must set detailed deliverable expectations and an associated timeline at the project start then strictly enforce deadlines. We recommend grading at each stage in combination with end project evaluation (which could be used another dependent variable in future replications of the project). This requires detailed and immediate instructor feedback (i.e., within one to two days) but prevents timeline slippage, enhances accountability, and quickly identifies skill gaps. Providing sample deliverables for each step is important, though examples may stifle creativity as students simply replicate the given format and detail. As another project execution consideration, instructors should set up a combined class in the school's course management system to support communication and team work. When possible, instructors could loosely monitor discussions and chats in the course management system to identify critical problems that students may not elevate to the instructors.

Instructors also need to encourage active diary updates on both developer and user sides, including instructor reviews at relatively frequent periods. This again allows for active recognition and hurdling of skill set deficiencies, passive student mindsets, and team interaction concerns described previously. Related to documentation, the combined team sizes (averaging eight students) caused some inertia in developing initial deliverable drafts as students would wait for input from all team members. To overcome this, we recommend somewhat smaller teams where possible on the user side. Instructors should also coach teams to have individual team leads develop initial drafts well before the due date then request feedback from the team.

One particular problem with our project was the timing of the actual classes, which met on the same day but at extremely different times. This caused a face time problem between the developer and user sides. Moreover, the time difference also meant that one class drew traditional full-time students (users) while the other primarily drew part-time, working students (developers). This difference further aggravated face time difficulties. As a final project execution concern, we encouraged teams to self-manage under-contributing members but also set clear guidelines and meaningful consequences for loafing through post-project peer evaluations linked to individual final project grades (Jassawalla et al., 2008).

6.4 IS Program Learnings

We close with important project lessons that highlighted potential improvements within our entire IS degree program. For example, we found that the developers were not necessarily used to working with external, inflexible user requirements found in typical IS implementations. In previous coursework, developers had often fulfilled the user role, so they could change project requirements at convenience. This finding highlighted consideration of redesigning coursework in the entire IS program to abide by firmer and more realistic requirements. Such a change would also foster student autonomy in overcoming technical skill gaps discussed above.

Next, several students noted that most if not all prior IS courses required major group projects. This mirrors industry and allows students to learn from one another, yet overreliance on others can also allow students to avoid learning some skills. In the case of our project, many students had apparently eluded programming in prior projects, which rendered them ineffective on a large scale project such as ours wherein teams needed multiple coders. A subset of developer students who already retained a wealth of IS skills based on professional experience exacerbated this problem. Specifically, students who were already capable in the taught skill sets may have skewed assessment of learning effectiveness of prior coursework. Relating these two ideas, some IS students may have deferred difficult project tasks in prior coursework to others without achieving sufficient learning. Again, this is an important lesson-learned for our IS program that may have gone unnoticed without the difficulty and scale of our project.

7. CONCLUSION

Typical IS academic projects do not simulate true cross-functional interactions experienced in realistic systems development initiatives. With this gap, this paper describes an ambitious multi-class IS project that sought to impart the challenges and critical success factors of a true cross-functional IS project. The project provided students with a lifelike replication of what they can expect as systems analysts in the professional world. In fact, we contend that the project was about as realistic as possible in a purely academic setting. As a secondary and unexpected benefit, the complexity of the project illuminated potential gaps in our IS program that would likely have gone unfounded with traditional, easier projects.

The emergence of the capstone class was an important development in IS pedagogy, yet we assert that our cross-functional project approach represents the next generation of capstone course design. As insinuated above, the project generated an extremely heavy instructor workload, and in hindsight, our efforts were still insufficient. Likewise, student work and stress levels were high. So, we recommend that instructors looking to replicate the project reduce other research and teaching responsibilities as much as possible. Still, we found the project to be impactful, and most students did appreciate the benefits. We thus recommend the project for dedicated educators who are looking to push pedagogical boundaries and enhance IS student learning. They can use the recommendations and findings herein to increase the effectiveness of instructor effort as well as improve on project outcomes.

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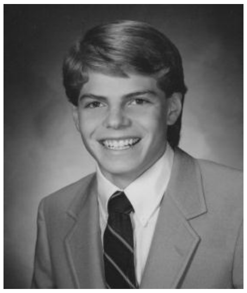

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APPENDIX – Phase 2 Project Instructions (Developers)

Project Requirements

1. Use CSIS 3600/IS 2060/IS 3060; Systems Analysis & Design style
2. Use any software to simplify your work load: Visual Studio 2010, MS Word, Excel, Access, SQL Server, Visio, Project Manager 2010 or later. This is not an inclusive or exclusive list.

Due Date: December 1st. Late projects will not be accepted.

Objective

eOps has served as a valued learning tool for students worldwide. However, improvements are needed to enhance the simulation. **Users** (Mgt 3200 student teams) will help **developers** (IS 4880 student teams) build a **To Be eOps simulation** based on new technology**.**

Your new simulation will at least match As Is eOps functionality with new technology. Ideally, your new eOps will **significantly improve** functionality and usability. You might derive improvements from your own eOps experiences, brainstorming, and course concepts.

As Is eOps Functionality

- Interactive sales, manufacturing, and procurement functionality
- Dynamic pricing for purchasing (parts) and sales (finished computers)
- Performance tracking (e.g., balance sheet, operating statement, inventory, and events)

Examples of Possible Improvements

- Advanced performance rewards/penalties (i.e., backorders, inventory, plant utilization, etc.)
- Advanced purchasing options, advanced sales options
- Multiple user options

Project Details

The heart of this course is a semester-long group project, in which each group will define the user requirements, document, design, and implement the eOps application. Each group will work with the users of the application to define the user requirements and functionality of the application. The users in this case are students registered in the operation management (MGT 3200) course. Since the SDLC process in this case will be highly interactive involving users and project managers, you may have to have to undergo much iteration of the various deliverables of the SDLC to create a successfully working prototype.

Project teams may consist of 3 developers and 3-5 users. In addition, there will be one team lead from the developers' side and one team lead from the users' side. The users and developers will work together to develop some of the deliverables. The developers team will primarily be formed based on the results on the first brainstorming exercise and in-class discussion. Ensure that at least one person on your team has solid programming skills. One member of the team should set up a team web page on which you will post the results of team assignments. Ensure the names and email addresses of the team members are at the top of the page and post it to a server. Organize the page so the instructors can quickly find your assignments.

Your project should be fully implementable by the end of the semester. Each group will present the product to the users and instructors. Groups will compete with one another.

Deliverables, Milestones, Diary

Users and developers team leads are responsible for assembling the deliverables below. Additionally, team leads will each maintain a detailed **weekly diary** of project progress. Users and developers will get together for minimum 2 sets of **mandatory testing** of the application.

Deliverable	Description	Due	Users	Developers
Business Proposal **Business Case**	One page description of application functionality, technology to be used, and how application will be developed Cost-benefit analysis of alternatives (e.g., keep As Is, improve As Is, or develop from scratch).	9/15	X	X
Task Planning (Gantt Charts) **Task Planning (Risk Analysis)** **Project Charter**	MS Project schedule used to manage resources and track deliverables Table with possible project implementation risks, including a risk versus probability matrix. Contract between team members regarding the plan for the project.	9/22	X	X
Requirements - As Is System (Document)	Documents functional, database, back end, and front end requirements of the current (As Is) system.	10/6	X	X
Requirements - As Is System (UML)	Diagrammatic representation of the functionalities of the As Is system.	10/6		X
Requirements – To Be System (UML, E-R)	Written and diagrammatic representation of the functionalities and data expected in the To Be system.	10/6	X	X
Design (site map, story book)	Site map lists web pages of To Be system, including links to one other. Story board is a series of rough sketches describing each web page.	10/20		X
Testing	Users test application and offer feedback on fixes and improvements	11/3	X	X
Testing **User Documentation**	Additional user testing Step by step instructions on operating the application.	11/17	X	X
Finished Project, Documentation	All application development and documentation completed, submitted.	12/1	X	X

Grading

Each combined user/developer team will submit **one completed simulation with documentation** (describing use, functions, and help/FAQs) by Dec 1. Users and developers are **equally responsible** for the submitted simulation. Grading is competitive and will include functionality, quality, and creativity elements.

Your finished project should be fully implementable. Each team will present their completed project to the instructors and other teams. Late projects may not be accepted.

User and developer **peers** will evaluate individual student participation on the project. The instructor may **significantly reduce the final project grade** for those receiving poor peer evaluations.

Description of Functionality, Quality	Grade
Simulation is fully functional and significantly improves upon the As Is eOps (i.e., “wow” factors). Documentation is thorough and professional.	A
Simulation is fully functional and offers moderate improvements over the As Is eOps. Documentation is mostly thorough and professional.	B
Simulation is mostly functional and/or essentially mirrors the As Is eOps. Documentation may be basic with some gaps and/or organization issues.	C
Simulation is not completely functional. Documentation may be minimal.	D
No submission or submission has significantly functionality issues.	F

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