# Business Process Elicitation, Modeling, and Reengineering: Teaching and Learning with Simulated Environments

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**ABSTRACT**

The design of enterprise information systems requires students to master technical skills for elicitation, modeling, and reengineering business processes as well as soft skills for information gathering and communication. These tacit skills and behaviors cannot be effectively taught students but rather experienced and learned by students. This requires a pedagogical shift from teacher-centered teaching approaches towards learner-centered teaching approaches that invite students to more actively participate in the learning experience, and to acquire and enhance such technical and soft skills. This paper introduces "simulated environment" – a combination of role-playing activities to simulate organizational activities and several skills development activities to hone technical and soft skills – as a pedagogical tool in the learner-centered teaching paradigm that immerses students in a controlled learning environment which enables them to more clearly appreciate various aspects related to systems design, business processes, and information sharing, and to acquire and develop the necessary skills.

**Keywords**: Simulated Environments, Enterprise Systems, Business Process, Elicitation, Modeling, Reengineering.

## 1. INTRODUCTION

Enterprise information systems are a class of information systems used to integrate business processes and data across the various departments within an organization and with its external organizations such as suppliers and customers (McGauhey and Gunasekaran 2007). Contrary to functional silo systems that cater to activities (e.g., payroll) within specific departments (e.g., accounting), enterprise information systems enable business processes (e.g., order fulfillment) that cut across various departments (e.g., sales, warehouse, production, and accounting) such that the focus is on the end-to-end business process. Enterprise systems packages such as SAP, Oracle, and Microsoft comprise several modules such as human resources, financials, human resources, productions management, and project management (Strong et al. 2006) as opposed to functional silo systems that may be developed or sourced according to specifications.

The philosophy of enterprise information systems imposes certain approaches to the design of enterprise information systems. First, the emphasis of enterprise systems is on business processes, which are essentially "horizontal" activities spanning multiple departments within organizations such that multiple stakeholders lay claim to those activities (Barua, Ravindran, and Whinston 2007). Students need to develop skills for tracing business processes across various departments and stakeholders within organizations rather than focus on activities within specific departments. Second, enterprise systems are used to integrate and standardize business processes and data within organizations that hitherto were organized as silos with little cross-functional synergies and typically familiar to only the relevant stakeholders (Fuβ et al. 2007). Students need to learn how to elicit knowledge of activities and data from multiple stakeholders contributing to any business process to truly understand the entire scope of business processes. Finally, the implementation of enterprise systems often involves changes to existing business processes within organizations to accommodate the native processes built into enterprise systems packages (Shang and Seddon 2007). Students should develop appropriate skills to elucidate and map the roles, responsibilities, and activities within existing business processes, identify information-related and process-related problems underlying the existing business processes, and reengineer the existing business processes by excluding, including, or synthesizing roles, responsibilities, and activities.

To successfully design enterprise information systems then, students would need to master a unique set of technical and soft skills (e.g., Davis and Woodward 2006).

- Technical skills include the ability to recognize and trace business processes that are horizontally embedded and across departments within organizations, identify activities and data isolated within different departments and determine how they are related to business processes, document and map the "as is" (i.e., current or existing) business processes, determine the information- and process- related problems underlying the existing business processes, reengineer existing business

processes such that the information- and process-related problems are addressed, and design an integrated and centralized data model that can support the "to be" (i.e., new or reengineered) business processes.

- Soft skills may be viewed as the communication and interpersonal skills required to elicit the activities performed by different stakeholders in support of the business process, verify the process models with stakeholders, and determine any problems with the process experienced by stakeholders – all of which need to be accomplished through dialogue with stakeholders through mechanisms such as interviews, presentations, panels, focus groups, and observation.

The challenge for teachers is to set up learning modules that will allow students to develop and hone their technical and soft skills to tackle the "open-ended" problems related to enterprise information systems design.

These technical and soft skills may be considered as "tacit" knowledge and behavior that cannot be imparted effectively using traditional teacher-centered teaching approaches (that typically rely on passive learning methods such as lectures and presentations). Tacit knowledge and behavior cannot be codified effectively; moreover, they rely considerably on experiential learning, which is difficult to accomplish with traditional teaching methods. For meaningful transfer of tacit knowledge and behavior related to enterprise systems to students, pedagogical shifts to learner-centered teaching approaches (that allow a more active and participatory role for students) need to be adopted for the delivery of course content dealing with enterprise systems.

The learner-centered teaching paradigm (Weimer 2002) serves as a powerful mechanism by which to enable students to pick up and hone the technical and soft skills for enterprise systems design. Learner-centered teaching approaches have been proposed as alternatives to teacher-centered teaching approaches which have long remained the predominant method of instruction. The learner-centered teaching approach has been used previously in the context of information systems education (e.g., Saulnier et al. 2008).

While the learner-centered paradigm offers several prescriptions (and recommends that such prescriptions be applied simultaneously) on imparting learning to students, a key principle is that students take responsibility for learning and be more in control of their own learning. This principle is particularly appealing in the context of enterprise information systems design since students need to develop technical and soft skills rather than just mastery of the content introduced in readings. The development of skills can be enabled by immersing students in learning environments that exhibit characteristics of experiential learning (Kolb 1984), problem-based learning (Schmidt 1993), and active learning (Bonwell and Sutherland 1996).

A "simulated environment" is considered to be one of the immersive learning mechanisms for students to acquire and hone technical and soft skills described earlier. Specifically, the simulated environment described in this paper is a combination of role-playing activities to simulate organizational activities followed by several skills development activities that allow students to acquire and develop technical and soft skills. Although the content and context of simulated environments may differ, they often convey "reality" more eloquently and tellingly than traditional instructional methods (Smith-Daniels and Smith-Daniels 2008). Simulated environments encourage students to actually participate in the learning process and take on a more active role in learning. Since simulated environments are closed-form representations of reality, students also have the opportunity to visualize and experience that reality more completely.

## 2. DESCRIPTION OF THE "SIMULATED ENVIRONMENT"

The simulated environment was situated in an advanced undergraduate course on systems design and development typically taken by information systems juniors and seniors. The course introduces students to the principles of the design, development, and implementation of information systems (specifically, enterprise information systems). The objectives of the course are to equip students with the skills to elicit business processes and their activities, model the "as is" business processes, identify problems with the existing business processes, reengineer business processes resulting in the "to be" processes, develop metrics for evaluating the existing and new business processes, construct development and implementation plans, and work effectively in project teams.

Coming into this course on systems design, students have had some prior experience with coding given requirements but have limited exposure to enterprise information systems or to gathering business process requirements on their own for designing such complex information systems. Further, their coding endeavors (e.g., payroll) are generally isolated to activities undertaken by a specific department (e.g., accounting) such that they are not exposed to the complexities of end-to-end business processes that cut across multiple departments.

The simulated environment dealt with one specific business process typically found in a manufacturing operation, specifically, the "order fulfillment" process. Three major entities were represented: the manufacturing organization (the focal point of the environment), the supplier organization (that provided raw materials for the manufacturing organization), and the customer organization (that ordered finished goods from the manufacturing organization). The manufacturing organization consisted of six departments: sales, warehouse, shipping, production, purchasing, and accounting.

Figure 1 depicts the various activities that comprise the simulated environment. The activities may be broadly divided into two phases: preparation phase and skills development phase. The preparation phase comprises the "set up" for and "enactment" of activities at a simulated organization. The skills development phase contains six different activities that are organized around the major themes relating to enterprise systems: elicitation, modeling, and reengineering of business processes within organizations. It must be noted that activities in the skills development phase were conducted in the order from #1 to #6 for pedagogical reasons (such as logical flow of activities in actual system development projects, ease of recall and transition to different activities for students, and highlight the

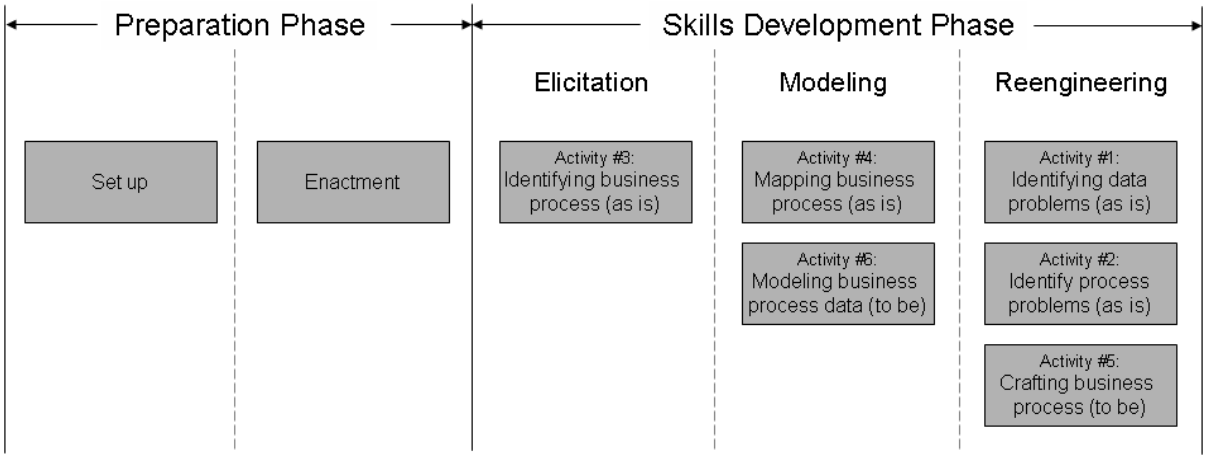


**Figure 1. Structure of the Simulated Environment**

pitfalls and issues in eliciting business processes) but are organized according to the major themes of the simulated environment for the purposes of presentation.

**2.1 Preparation Phase**

The goal of the preparation phase was to enable students to experience organizational activities in a controlled environment and gain an understanding of the variety of issues that need attention in the design of enterprise systems. To enable this, students were split into eight teams – one each representing the six departments in the manufacturing organization, one representing the supplier organization, and the last representing the customer organization, consistent with the stakeholders involved in the order fulfillment process. Each student team was allowed to assume the role of one of the stakeholders and carry out the relevant activities.

**2.1.1 Set up:** Before students experienced the activities of the order fulfillment process, the characteristics of the manufacturing organization (for the simulated environment) were formalized in consultation with the students. For instance, students decided after discussion that the manufacturing organization would be in the business of producing computers, the organization would predominantly follow a "ship-from-stock" model but allow for "build-to-order" requests if necessary, and the supplier and customer organizations would be treated as regular partners. This is consistent with the principles of learner-centered teaching approaches, which allow students to be more actively participate in the learning process while still being faithful to the major content areas covered in the course.

Each team was given a specific set of instructions that constituted the "activities" related to the order fulfillment process for that department or organization. In other words, the "complete" operations of the organization were not revealed to the students. This ensured that students on any team were aware of only those activities that related to their department; they did not share common knowledge about the order fulfillment process that cut across departmental boundaries. This arrangement also ensured that the simulated environment was controlled and manageable within the available time in class. The teams were only allowed to perform the activities as specified in the description – they were not allowed to create "new" activities on their own. For instance, the warehouse department (team) was responsible for taking orders from the customer organization (team) and routing the orders to the warehouse department (team). See Appendix A for a description of the organizational activities considered.

**2.1.2 Enactment:** The organizational activities for order fulfillment were "enacted" by students for about 60 to 75 minutes during regular class time. That is, student teams engaged in "role play" such that they acted out the organizational activities assigned to them. For the purposes of the simulated activities, a "day" in the life of the manufacturing organization was considered to be about three minutes. The customer organization was encouraged to place an order with the sales department of the manufacturing organization approximately every three minutes or so of actual time – which resulted in approximately one "order" every day of the simulated activity.

Since there were multiple students on each team, the teams were strongly encouraged to keep a "log" of observations relating to the information underlying the order fulfillment process as well as the process itself. Teams approached this request in different ways – some teams designated one person to take notes while other teams had each take notes of their experiences. These logs were useful in debriefing sessions following every activity in the simulated environment as well as for the skills development activities #1 and #2.

Figure 2 shows a swimlane diagram (e.g., Rummler and Brache 1990) of the "order fulfillment" business process (specified in Appendix A). The process begins when the manufacturing organization receives an order for products from the customer. The process can end in one of two ways depending on the capability of the manufacturing organization: a) fulfill the order, and b) cancel the order. There are several intermediate activities between the starting and ending points of the process such as the verification for inventory on hand, production of new items to satisfy the order, purchase of raw materials should production need them, picking up the required items from the warehouse, and packing the items to ship to customer.

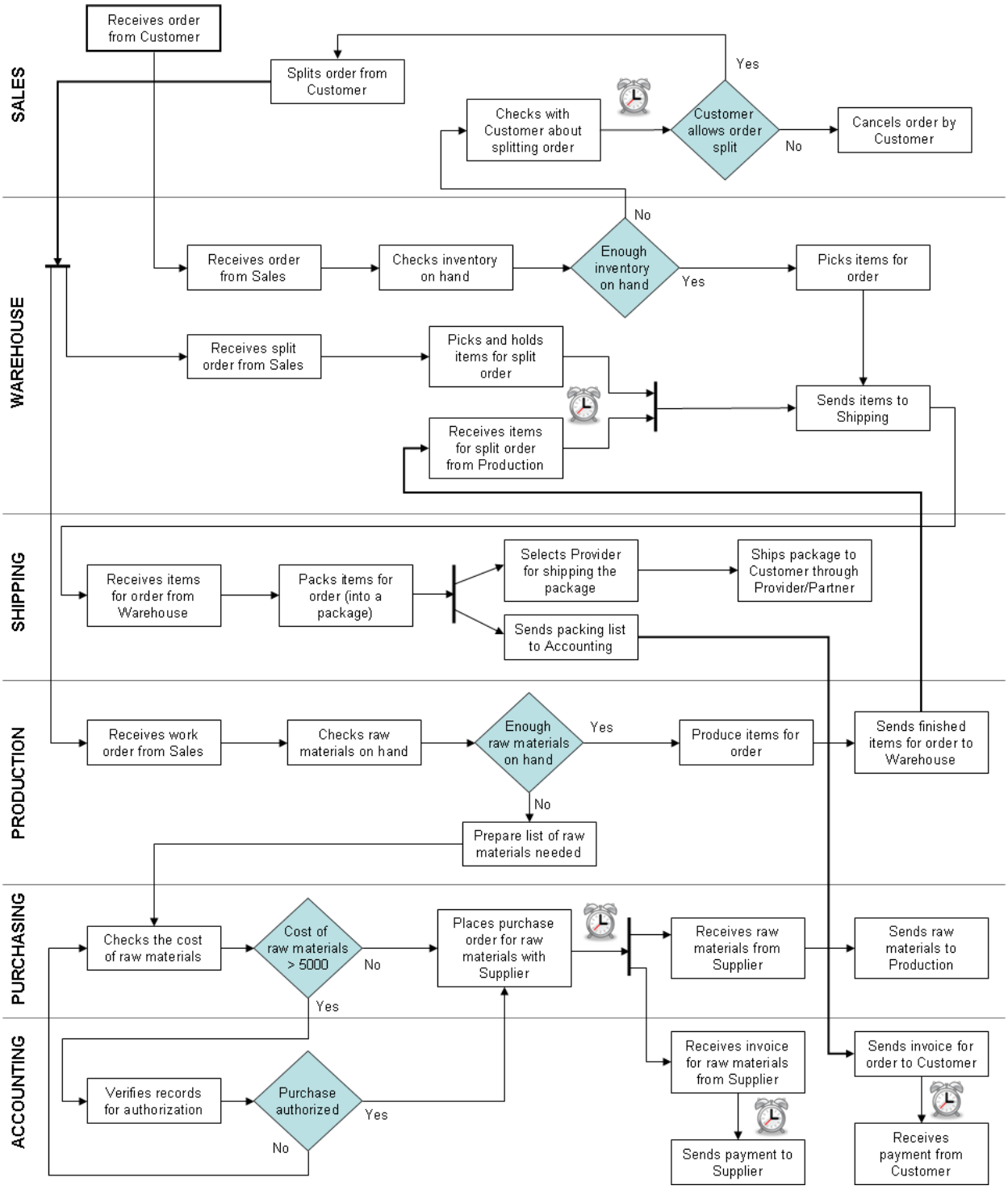


**Figure 2. Order Fulfillment Business Process in the Simulated Environment**

The order fulfillment process described here is a combination of sequential and parallel activities. For instance, when the customer allows the order to be split when there is not enough inventory on hand at the organization, the sales department splits the order and sends it to two other departments: warehouse and production. This is an example of parallel activities in that the warehouse department can pick and hold items for part of the split order that can be fulfilled while the production department can manufacture items for the other part of the split order that cannot be immediately fulfilled. On the other hand, sending picked items to shipping department and packing items for

shipping are sequential activities that are completed in that order. The diagram also uses the "clock" symbol to depict the time lapse between activities that are typically not within the control of the organization. For instance, there may be a time lapse between when the accounting department sends an invoice to the customer organization and when it receives payment.

**2.2 Skills Development Phase**

At the end of the preparation phase, a series of skills development activities were required of the student teams. Each activity lasted between 60 and 75 minutes, typically broken up into one session where students actually completed the requirements of the activity followed by a session of discussion and reflection. These skills development activities were carried out over five different class sessions since they focused on different aspects relating to business processes and enterprise information systems. These activities required students to assume different roles and allowed students to gain an in-depth understanding of business processes and enterprise systems from different perspectives. The descriptions of these activities are available in Appendix B.

**2.2.1 Elicitation:** The elicitation of business processes was explicitly handled in skills development activity #3. To complete this activity, students needed to know the "complete" business process. That is, student teams were required to be knowledgeable on all the activities of the order fulfillment process, including those activities they performed themselves and those activities performed by other student teams during the preparation phase. This necessitated the information gathering phase during which each student team "gathered" information from other teams on their activities in the order fulfillment process as a precursor to mapping the entire business process.

A variety of information gathering methods such as observations, interviews, focus groups, panels, and presentations have been outlined in prior literature (e.g. Hoffer et al. 2008). During different offerings of the simulated environment to different student groups in different semesters, the information gathering activity has been accomplished differently. Interviews were used during one offering, in which each team was allowed to interview every other team. Presentations were used during another offering, in which each team was invited to present their "story" for every other team to listen. This strategy allows for some flexibility to accommodate different information gathering methods in the course and enables students to apply different techniques.

**2.2.2 Modeling:** The simulated environment provided multiple opportunities for students to become familiar with business processes modeling. Specifically, skills development activities #3, #4, and #5 required students to engage in business process modeling, although activity #4 had the most exhaustive focus on this particular topic. In activity #3, student teams were required to develop an "as is" business process diagram of the order fulfillment process based on their own information gathering efforts on the various activities underlying the business process, the sequencing of those activities, and the stakeholders responsible for those activities. In activity #4, student teams developed another "as is" business process diagram of the same order fulfillment process but based on the entire specification of organizational activities (Appendix A) rather than on their information gathering efforts. In activity #5, student teams were required to develop a final diagram of the "reengineered" business process, also known as the "to be" business process. Student teams were allowed discretion over the specific diagramming notation for representing the business process. They had been introduced to different schemes such as flowcharts, hierarchical flowcharts, swimlane diagrams, event sequence diagrams, and activity diagrams (e.g., Monk and Wagner 2008) in the regular course and were allowed to use any scheme that was most comfortable for them.

The simulated environment also provided an opportunity for student teams to engage in modeling the data underlying the business process. This was accomplished during activity #6, in which student teams were required to develop "data models" that could support the "to be" business process completed earlier. In other words, students were expected to consolidate the data underlying the order fulfillment process resident with the various departments and construct a graphical representation of the entities and relationships in the consolidated data. Student teams were encouraged to use entity-relationship diagrams (Chen 1976) for this purpose.

**2.2.3 Reengineering:** Business process reengineering was handled through a combination of different skills development activities. In #1 and #2, student teams were required to identify the problems related to data underlying the business process and the business process respectively as experienced during the preparation phase. Specifically, students were asked to reflect on the business process activities enacted during the preparation phase and identify the problems with information and data sharing between the various departments and with the partner organizations. Student teams were also required to consider the business process itself and report the communication and coordination problems between departments and the partners.

In activity #5, student teams were required to develop a "reengineered" process that will serve as the "to be" process for the enterprise system implementation for the order fulfillment process experienced in the preparation phase. Specifically, this activity called the students to figure out ways in which the order fulfillment process enacted during the preparation phase can be "improved". The business process (Appendix A) given to students does not make any claims that it is efficient or optimal. For instance, the sales department is positioned as the central unit that is responsible for interacting with the customer, warehouse, and production, which need not be done. The sales department can potentially route the order to the warehouse and let the warehouse deal with production if there is not enough inventory on hand. Such "deficiencies" in the order fulfillment process are introduced in the simulated environment to enable student learning as it may relate to business process reengineering. To accomplish the objectives of reengineering, student teams started off with the "as is" diagrams they constructed in activity #4, and using insights on problems related to information and business process they

identified in activities #1 and #2, developed representations of the "to be" process. Student teams were then given opportunities to explain their reasoning for the reengineering efforts and justify the changes they implemented in the "to be" process.

## 3. STUDENT LEARNING AND SKILLS DEVELOPMENT

The simulated environment enabled the students to gain insights on several aspects of business processes and information systems. Students experienced how information silos became common within organizations, how departments became more focused on their own activities rather than the end-to-end business processes, how challenging it is to elicit reality regarding business processes from multiple stakeholders in organizations, how even the best explanations of reality by stakeholders may still not mirror reality and pose problems for business process mapping, how reality can get lost in translation, how to actually map existing business processes for modeling and verification, how to identify information- and process-related problems in the existing business processes, how to reengineer existing processes and design streamlined processes, how to model an integrated and centralized database, and how enterprise systems need to be designed to enable business processes.

During the preparation phase, students learned the challenges when dealing with enterprise systems in organizations. First, students experienced how various departments may end up focusing on their own activities rather than the order fulfillment process as a whole. Since students were not made privy to the complete details of the order fulfillment process, they worked to ensure that their activities were completed and did not really worry about the other stakeholders. Such asymmetries in their understanding of the order fulfillment process resulted in an imperfect execution of the process. Second, students had their own codes and rules for maintaining data underlying the order fulfillment process, resulting in non-standard schema within the organization. Teams used index cards to maintain data about their orders, production, and inventory relating to the order fulfillment process. Consequently, data shared by the student teams were not compatible showing how "information silos" become common within organizations over time. Finally, students experienced the problems arising due to the lack of communication, the lack of information sharing, and the lack of shared knowledge about the process between departments and with partner organizations. This experience enabled students to more clearly appreciate the intricacies of various aspects related to the design of enterprise information systems.

The skills development activities enabled students to gain insights into eliciting, modeling, and reengineering business processes. For activities #1 and #2, students recounted a variety of problems as highlighted in the descriptions below. These comments demonstrated that students appreciated the variety of problems that could arise in organizations as they engage in business processes, including incompleteness or irrelevancy of data, lack of communication, and information isolation within departments.

> "One problem was the lack of a proper list of items for customers to order. Customers would order highly customized products only to find out later they could not be built." (David, Production)
>
> "Each department had its own method of tracking and processing the information. A request to approve raw materials looked different each time it came in." (Jackie, Accounting)
>
> "Another problem was loss of data. Orders we would send to warehouse would disappear within the system with no way of finding out where they were lost or how to restart that order." (Craig, Sales)
>
> "Another problem that we faced was that the order cards weren't detailed enough to actually ship the order. We had to go back to the sales department to find out what the cost was for each computer so we could calculate shipping costs." (Andrew, Shipping)
>
> "Another problem was the lack of communication between Warehousing and Production; Warehousing was frustrated because they were forced to communicate back to Sales that some items Production wanted to build could not be built by the company." (David, Production)

The simulated environment also enabled students to appreciate the problems that arise with information gathering for eliciting business processes. In activity #3, students were required to "map" the order fulfillment business process in the simulated environment. That is, students were asked to create a diagram of the order fulfillment process that depicted the various stakeholders, the activities performed by the stakeholders, and the sequence of those activities. Students had considerable latitude over the specific diagramming tools or notations they wanted to use as long as they depicted the business process. Since students were aware of only those activities for which their team was responsible for, they were unable to develop the diagram on their own. As a result, student teams engaged in information gathering efforts to more completely understand the activities of the business process that spanned multiple departments (teams).

Information gathering methods employed by student teams involved presentations by teams or interviews of teams (in different semesters). Both information gathering methods had their advantages and disadvantages; however, the presentation method was slightly more efficient in terms of managing time taken for the activity. For instance, the interviews required students of each team to ask questions of students on other teams, which meant that students had to first prepare a set of questions to ask, follow up with probe questions during the actual interviews to elicit the required answers, and strive to complete the interviews within the allotted time. This posed several problems: a) not all student teams ended up with the same information from other teams since their starting points (because they belonged to different teams and had access to varying information) and questions were different, b) student teams obtained information with varying levels of detail due to inappropriate probe questions that did not elicit the required details, and c) student teams ran out of time and were not able to complete the interviews either due to runaway explanations by students on other teams or due to too many questions. Not surprisingly, the "reality" was quite subjective for the different student teams.

However, the presentations enabled all student teams to obtain the same information (with the same details) from other teams with no need for the preparation of interview questions. With the interviews, student teams had the ability to obtain "richer" explanations of the process through the various probe questions, which may not be possible with the presentations.

In skills development activity #4, students were given the complete description of organizational activities (as shown on Appendix A) and then required to develop a new business process diagram. This activity was very similar to the previous activity but with one important difference – students now had access to the set of all activities in the organization and did not have to engage in information gathering efforts. Thus, students had access to the "same" information as everyone else; in other words, the reality was quite objective for the different student teams. Much like the skills development activity #3, students had discretion over the types of diagrams they can use for the graphical representation. During the debriefing session, it was determined that student teams generally used the same type of diagram in both of these activities.

At the completion of this activity, students were given an opportunity to compare the two diagrams they developed: the first, for skills development activity #3, based on their information gathering efforts, which may be viewed as the "subjective reality" and the second, for skills development #4, based on the complete description of organizational activities, which may be viewed as the "objective reality". Students were subsequently requested to share the similarities and differences between the two diagrams; students reported some similarities (largely in mapping the stakeholders and some general responsibilities of those stakeholders) as well as considerable differences (primarily in mapping the activities and their sequence) between the two diagrams. Students were encouraged to reflect on how information gathering efforts can lead to "distorted reality". During this discussion, students recounted the importance of gathering information from multiple stakeholders, taking field notes wherever necessary, verifying their representations with stakeholders, and identifying problems faced by stakeholders.

The complexities of business process reengineering were introduced to students through the combination of several skills development activities. In skills development activity #5, student teams engaged in reengineering the business process modeled based on objective reality in activity #4. The reengineering effort was aided by insights students gained from activities #1 and #2 since the focus of this activity was to make the order fulfillment process more efficient and effective.

During the course of this skills development activity, students pointed out the importance of centralized data, standardized data sharing mechanisms, data access, and information availability that were found lacking in the order fulfillment process. Students highlighted how the different departments ended up creating and recreating data and extracting information for their own purposes rather than having a centralized repository that can benefit all departments. Further, students uncovered data anomalies and inaccuracies (due to, for instance, the changes in order quantities to customer orders being captured by the warehouse department but not the accounting department) that created additional problems for stakeholders in the business process.

Students also reflected on the roles and responsibilities of the stakeholders and attempted to determine if they were well-defined. They considered ways in which certain stakeholders may be eliminated and their responsibilities assigned to other stakeholders, while being focused on improvements in productivity and efficiency. This discussion also touched on various issues related to change management that may be crucial in making such changes effective. For instance, students reflected on the extent to which changes to the job description of the different stakeholders in the business process may be well received by such stakeholders and considered ways in which they may portray such changes to stakeholders. Similarly, students pondered over the challenges in convincing organizations and stakeholders to incorporate changes to their operations due to the reengineered business process, and considered strategies by which they can motivate or champion such changes within organization. Further, students analyzed the activities of the business process and suggested some changes that may improve the efficiency of the process and improve overall satisfaction.

In addition, students were encouraged to develop appropriate metrics for evaluating the business process so as to facilitate a comparison between the "as is" and "to be" business processes and determining the specific ways in which the reengineered process was more efficient and effective relative to the current process. Students constructed different types of metrics for efficiency (e.g., turnaround time of a customer order) and effectiveness (e.g., accuracy of a filled customer order) during the course of this skills development activity.

Finally, student teams actually dealt with the data model for supporting the reengineered business process in skills development activity #6. This activity enabled students to reflect and work on data and information related issues that are instrumental for the successful implementation of enterprise systems. Students viewed the end-to-end business process and isolated entities and attributes that would need to be captured. They also viewed the particular data requirements of the various stakeholders and determined the "views" that may be most relevant for those stakeholders. This resulted in a more holistic understanding of data modeling and its importance in enterprise systems design for students.

Students experienced learning beyond the requirements of the simulated environment. This is consistent with the tenets of learner-centered teaching which move students to engage in critical thinking and reflection. For instance, students related insights gained from the simulated activities to actual real-world business operations.

> "It seems like the sales department had to know much of the inner workings within the organization. Alerting us of backorders in the warehouse and knowing when orders are fulfilled would have been nice to know. Reports on the progress of raw materials turning into inventory, current inventory, and fulfilled orders would have been nice to see periodically." (Craig, Sales)
>
> "Production would often sit and wait for days until they received the supplies they needed to build products.

> This inefficiency would be very costly for a real company and it would anger customers to have to wait that long to get their finished products." (David, Production)
>
> "Customers being billed for wrong quantities and for product they have yet to receive are symptoms of a flawed business process within the company. All of this not only costs the company and its partners time and money, but it also can lead to a loss of customers and other businesses willing to do business with the company. And that can lead to the end of a company." (Nicole, Sales)

Although the simulated environment was restricted to the order fulfillment process (and excluded potentially crucial activities for a manufacturing organization such as demand planning and production scheduling), students demonstrated considerable knowledge of the complexities of enterprise information systems from the perspective of business processes and information sharing that may be drawn upon when exploring various other processes within organizations.

## 4. OVERALL USEFULNESS AND OUTCOMES

Students had opportunities to acquire and develop technical and soft skills through the duration of the simulated environment. Technical skills for eliciting, modeling, and reengineering business processes were spread over various activities of the simulated environment. During the enactment activity, students worked in teams and engaged in communication and collaboration with each other. The elicitation activity allowed the students to practice their communication and interaction skills even more. Further, students were engaged in some level of team activity through the various other activities during the skills development phase.

Students were requested to provide feedback on the activities in the simulated environment related to the order fulfillment process. The survey consisted of two major types of feedback: a) rating different components of the preparation and skills development activities using a 4-point Guttman scale, and b) descriptive comments on the different components. The survey was completed by 19 students in one class. Although these activities have been conducted in multiple classes over time, the survey to assess the usefulness of the simulated environment was done during the latest offering to these 19 students.

The 4-point Guttman scale was set up with the following anchors – 1: not helpful, 2: somewhat helpful, 3: very helpful, and 4: extremely helpful. The Guttman scale was preferred over a Likert scale since it is a cumulative scale that allows students to indicate whether or not the activities in the simulated environment were indeed helpful for learning as well as the extent to which they were helpful. An analysis of the ratings provided by students revealed that they found the preparation and skills development activities to be generally "very helpful". The survey elicited only a few descriptive comments from students. The few comments were generally positive of the simulated environment and highlighted the positive learning experience that contributed to a clearer understanding of various issues related to the design of enterprise information systems. Together, the ratings and the comments showed that the simulated environments could be a valuable pedagogical tool for imparting information systems design to students and to enable students to effectively develop those technical and soft skills crucial for enterprise information systems design.

The simulated environment helped address several objectives of the course. Among the several objectives for the course, the simulated environment and its activities enabled students to acquire and develop skills for eliciting business processes and their activities, modeling "as is" business processes, identifying problems with the existing processes, reengineering business processes (based on information- and process- related problems identified with the existing processes), and working effectively in project teams. Students indicated that the simulated environment was very helpful in understanding business processes. Several aspects of the simulated environment such as understanding business processes, information- and process-related problems, and information gathering were rated more than "very helpful". For instance, the average ratings by students for different components were: understanding business processes (3.2), understanding information gathering (3.1), identifying information-related problems (3.1), identifying process-related problems (3.2), modeling existing business processes (3.1), and reengineering business processes (2.9).

There are some possible extensions to the simulated environment based on other objectives for the course. For instance, one of the course objectives was to enable students to acquire skills for developing metrics that may be used to evaluate the effectiveness of the reengineered business process relative to the existing business process. This involves the identification of the different entities, activities, or stakeholders that need to be evaluated and the development of metrics that are specific, measurable, actionable, relevant, and timely (e.g., Balasubramanian and Gupta 2005). The simulated environment could be expanded with another skills development activity that specifically requires students to work on metrics. Another possibility is to extend the skills development activity #6 (or set up a separate activity) to also include the concept of "views" to customize the data model for the different stakeholders involved in the order fulfillment process. This activity would enable students to understand how to provide the most relevant data to the stakeholders for decision making.

While students indicated that the simulated environment was very helpful in understanding business processes and various issues related to enterprise systems design, it must be noted that this study does not evaluate the effectiveness of this learning-centered approach relative to traditional teaching-centered approaches. The simulated environment was developed with the intent to enable learning for all students and not as an experiment for a comparative evaluation of learning- and teaching- centered approaches in system design. Such an experimental study may be a rich avenue for future research that can potentially inform teaching and learning strategies for the classroom.

## 5. CONCLUSIONS

The design of enterprise information systems requires students to master a variety of technical and soft skills that

can be effectively imparted through learner-centered teaching approaches which are quite different from the traditional teacher-centered teaching approaches. This paper described a simulated environment, which appeals to learner-centered teaching techniques, designed to enable students understand business processes, information elicitation, and enterprise information systems was found to be a very useful method for students to acquire and hone technical and soft skills for enterprise systems design. The simulated environment enabled students to appreciate various aspects related to enterprise systems including silos; business processes and activities; business process mapping, modeling, and reengineering; information gathering and potential problems and mitigation strategies; and data modeling and may serve as a valuable pedagogical tool in the instruction on enterprise systems design.

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**APPENDIX - A**

Description of the Organizational Activities for the Order Fulfillment Process

This exercise is aimed at "simulating" the "order fulfillment process" that may be encountered in a real-world manufacturing organization interacting with a supplier organization and a customer organization. The manufacturing organization has six departments that participate in the order fulfillment process. The goal of the manufacturing organization is to maximize earnings [i.e., sales – expenses] for the organization.

Students are split into eight teams that will "mimic" the operations of the six departments within the manufacturing organization, the supplier organization, and the customer organization. Each student team is expected to follow specific rules while participating in this simulation as explained below. [Note: Student teams are given only those instructions that are relevant for their activities and not those of other teams.]

**Customer Organization** (external to the manufacturing organization):
Negotiates prices with the Sales team
- Attempts to get discounts on bulk orders
- Attempts to get discounts in shipping charges
- Attempts to get discounts for loyalty

Places orders with the Sales team (at reasonable intervals, say, every 3 minutes)
Receives shipments
Makes payments to the Accounting team
Answers queries from Sales team about splitting orders (yes or no, randomly)
Cancels order if resolution not possible

**Sales Department** (internal to the manufacturing organization):
Negotiates prices with the Customer team
- Allows 5% discount on bulk orders (with quantity exceeding 100)
- Allows 5% discount on orders from loyal customer (at least 20 previous orders)
- Allows 10% discount on shipping charges occasionally

Takes orders from the Customer team
Routes orders to the Warehouse team
Checks with the Production team about making the items, if the Warehouse team sends a reply
Checks with the Customer team about split orders (due to inventory limits)
Splits and re-routes orders to the Warehouse team

**Warehouse Department** (internal to the manufacturing organization):
Receives orders from the Sales team
Performs one of the following (randomly, for the simulation) based on an inventory check:
- Replies back to the Sales team that only certain items of the order can be fulfilled
- Replies back to the Sales team that only limited quantities of the items can be fulfilled

Picks items for the order and routes it to the Shipping team

**Shipping Department** (internal to the manufacturing organization):
Packs items identified by the Warehouse team for shipment
Performs one of the following (randomly, for the simulation) based on logistics check:
- Ships through the preferred logistics partner (shipping expense is 1% of order)
- Ships through another contracted logistics provider (shipping expense is 2% of order)
- Ships through a third-party provider (shipping expense is 4% of order)

Prepares/routes packing lists to the Accounting team

**Production Department** (internal to the manufacturing organization):
Answers one of the following (randomly, for the simulation) to queries by the Sales team:
- Items can be made in 24 hours
- Items can be made in 3 days (since production schedules have to be changed)
- Items can be made in 7 days (since raw materials have to be ordered)

Places orders for raw materials with the Purchasing team
Receives raw materials from the Purchasing team

**Purchasing Department** (internal to the manufacturing organization):
Receives orders for raw materials with the Purchasing team
Negotiates prices with the Supplier team
Routes orders for raw materials to the Accounting team for authorization

- Authorization not required if prices charged by the Supplier team is less than $5,000
- Authorization required if prices charged by the Supplier team is at least $5,000

Sends orders for raw materials to the Supplier team
Receives raw materials from the Supplier team

**Accounting Department** (internal to the manufacturing organization):
Receives payments from the Customer team

- Allows 2% discount on payments received within 10 days
- Charges 2% additional fee if payments not received within 25 days

Prepares/sends invoices to the Customer team based on packing lists from the Shipping team
Routes orders for raw materials back to the Purchasing team after approval

- Approvals may be completed in different time intervals (randomly, 1 day, 2 days, etc.)

Receives invoices for raw materials from the Supplier team
Sends payments for raw materials to the Supplier team

**Supplier Organization** (external to the manufacturing organization):
Negotiates prices with the Purchasing team

- Allows 2% discount on orders for repeat customer (at least 5 previous orders)
- Allows 5% discount on orders for regular customer (at least 10 previous orders)
- Allows 10% discount on orders for loyal customer (at least 20 previous orders)

Receives orders for raw materials from the Purchasing team
Receives payments for raw materials from the Accounting team
Ships raw materials to the Purchasing team
Changes the prices of raw materials periodically (demand, seasons, etc.)

**APPENDIX - B**

Description of the Skills Development Activities

**Activity #1**

Your task is to complete the following activities based on the in-class simulation of the "order fulfillment" process.

a) Identify the problems related to data or information sharing between the various "departments" within the organization.
b) Identify the problems related to data or information sharing between the organization and its "partners" (i.e. customer and supplier).

**Activity #2**

Your task is to complete the following activities based on the in-class simulation of the "order fulfillment" process.

a) Identify the problems related to the business process as it was enacted between the various departments the organization.
b) Identify the problems related to the business process as it was enacted between the organization and its partners.

**Activity #3**

Your task is to develop a diagram of the "as is" (i.e., current) business process as experienced in the simulation. You may elicit activities of the "as is" business process by conducting "interviews" with individuals in the various "departments".
Each team is divided into two sub-groups, with distinct responsibilities for the purposes of this exercise:

a) The first sub-group comprises one or two individuals and serves as "subject matter experts" of their respective activities on the simulation. These individuals will act as "interviewees" for members of *any* team. These individuals may answer any question posed by "consultants" from other teams (described below).
b) The second sub-group comprises the one or two individuals and serves as the "project team" in charge of developing the "as is" diagram of the business process. These individuals act as "consultants" who "interview" the subject matter experts and gather information to develop the "as is" diagram of the business process.

**Activity #4**

Your task is to develop a diagram of the "as is" (i.e., "current") business process as explained in the complete simulation description, which may be treated as the "objective reality".

a) Compare your "as is" process diagram with the "as is" process diagram you created based on information gathered through interviews.
b) What would you have done differently if you are given another opportunity to conduct the interviews?

**Activity #5**

Your task is to develop a "to be" (i.e., reengineered) business process for the "order fulfillment" process you experienced in the simulation.

a) Compare your "to be" process diagram with the "as is" process diagram you developed based on the complete simulation description.
b) Identify the extent to which your diagram solved the information sharing and business process problems you identified earlier.

**Activity #6**

Your task is to complete the following activities based on the in-class simulation of the "order fulfillment" process.

a) Develop of a diagram of the "data model" to enable the "to be" business process for your proposed ERP system.
b) Develop the relevant "data views" for the various stakeholders in the "to be" business process for your proposed ERP system.


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