Business Process Reengineering (BPR) for Engineering Management (EM) Majors: Industry Perspective and Students’ Feedback

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Abstract
Business Process Reengineering (BPR) is designed to address the BPR concepts, the technologies and the strategies for implementing business transformation and best practices by emphasizing the role of BPR in managing technology and the engineering functions. BPR was first introduced to the senior year engineering students in 2006. The course was then redesigned in 2007 to improve student learning and also prepare the students to address the tasks and challenges related to BPR in their early industry career. This paper discusses the improvements that were made to the course based on an industry survey, student feedback, and performance. The authors believe that these discussions will help the academic community to design better courses related to BPR.

1. Introduction
The curriculum of Engineering Management (EM) program at Stevens Institute of Technology aims to provide the students with the knowledge and skills which are necessary to work effectively at the interface between technology, management, and engineering. The Business Process Reengineering course (EM435) was recently added to the EM program’s curriculum to support the need for providing the bridge between the engineering of systems and business operations. The EM435 course was offered the first time in the fall semester of 2006 to the senior year Engineering Management students.

The EM435 course content was carefully selected based on an extensive literature review in the business process reengineering (BPR) field. The course was designed to provide knowledge of BPR and its main concepts; the technologies and the strategies for implementing business transformation; and best BPR practices by emphasizing the role of BPR in managing technology and the engineering functions. The EM435 course is a senior year course, and one of its main objectives is to prepare the students for their professional lives. Since it was a new course, improvements and modifications were planned to be adapted in the course content to increase the course effectiveness to meet its objectives.

Our primary approach to redesigning the course was to make modifications and improvements in the course content to address the comments, concerns, feedback from the last year’s students who took the course, and inputs provided by the hiring companies of EM majors. Our own experiences and lessons-learned from the first time teaching were also incorporated into the course modifications. We also made modifications and
improvements in the course content to better accommodate the need and expectations of the potential employers of our EM program graduates. A formal industry survey was designed to understand employers’ need for business process reengineering related skills and knowledge. The paper describes our experience of teaching it the first time, students’ experience, performance, and feedback, the reasons and basis for modifying the course, and the process of implementing the changes. The paper also describes the response of the students’ to the new and improved course, their course evaluation, and the impact of the course redesign on their performance.

2. Business Process Reengineering
BPR is a systematic approach to helping an organization analyze and improve its processes. This provides an opportunity to view the organization-wide processes from a systems perspective. A systems perspective focuses on looking at a set of problems as a whole and the context that creates the holistic view rather than looking at a set of problems as individually isolated events [1]. All systems are designed, developed and engineered to support the business processes within an organization. Therefore, an understanding of the business processes is crucial for engineering students for making decisions on designing, building, and managing systems.

BPR was first introduced as a concept for getting radical improvements and better business results by Michael Hammer in 1990 [2, 3, 4] followed by James Champy, Thomas Davenport and several others in the literature [5, 6, 7, 8]. BPR was widely used and accepted from 1993 to 1997. There is a re-emergence of interest in the topic since 2002, and as of 2004, BPR became as popular as in mid 1990s [9].

The practitioners who have applied BPR programs revisited the subject and evaluated the claims which appeared in the earlier publications. [6, 10, 11] This second generation literature discussed the pros and cons of BPR concepts, provided insights for success and failure factors and most importantly revealed the unrealistic expectations and misconceptions from the concept admitting what was missing in the earlier literature.

3. Developing and Redesigning a Course on BPR
The authors have been interested and committed to developing a course on BPR which addresses the employers’ relevant needs from the current perspective of BPR. In order to address this objective the authors piloted a course on the topic in the Fall 2006 [1] and further refined it based on the employers’ and students’ survey for Fall 2007. The major learning objectives/outcomes of the course are to understand the importance of processes and BPR, and appreciate how BPR bridges the business operations and engineering of systems (14P1); to understand how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes (7P1); to identify business processes that are candidates for improvement (4P1); to model current business processes and to diagnose problems (3P1); to model and develop improved business processes that require IT and organizational redesign (2P1); and to develop measures and benchmarks for business processes (5P1). The numbers in the parenthesis are the mapping to the overall objectives of the engineering curriculum [12]. These outcomes were used to evaluate the
course. The student performance and their feedback were tracked across these course outcomes.

The BPR course was evaluated after teaching it the first time in Fall 2006. The evaluation was based on the primary author’s own experience of teaching the course, the formal and informal feedback of the students, and students’ performance on each of the course objectives, student grades on the individual assignments as well as the mid-term and the final project. The instructor also took into account the level of difficulty that the students had in understanding a concept and then relating it to a real process example. The course was redesigned during the summer of 2007, and the revised version of the course was taught in the Fall of 2007.

4. Instructor Experience and Students’ Feedback

While analyzing the students’ performance assessment data of the BPR course from Fall 2006, it became evident that the following two outcomes were not achieved to our satisfaction.

- Understand how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes
- Identify business processes that are candidates for improvement

The authors analyzed possible reasons for the unsatisfactory performance of the students on the above two learning objectives and tried correlating it to the instructor’s observation from the class.

Based on the student feedback and instructor’s observations from the previous year the following changes were made to improve these two outcomes and also provide the students more hands-on experience through modeling and case analysis.

1. A capstone team lab exercise (X-ray process) was provided to the students. Each week each step of BPR for the X-ray process was discussed and worked on in class as teams.
2. Extend, BPR modeling and simulation software, was introduced early on in the course. This was also used significantly in the capstone project. The modeling and simulation helped student understand the steps in BPR through hands on experience.
3. Instead of students trying to find a BPR project and collect data for their final project, Harvard Business Case Studies were provided. In the previous year students exhibited difficulty in getting corporate BPR cases and the data and metrics required for reengineering. To overcome this challenge and provide all the teams similar cases a set of BPR case studies were provided to students for case analysis as a team.
4. In the previous year two text books were used and the students felt it was challenging to cover both the books within the semester. Hence this year only one text book was used. This also resulted in removing the lectures “Redesigning Processes for Online Businesses” and “Future of Computer Based Tools for Process Analysis and Improvement”. This lecture time was used for capstone exercise and these chapters were listed as suggested readings for the students.
5. Industry Needs for BPR Skill Sets

The authors approached redesigning the course from two perspectives, one to improve student learning based on the experience of teaching the course and student feedback and the other by focusing and updating the core concepts based on the industry needs. The authors believe that an engineering course such as BPR should be taught in the context of current practices and application. The course along with providing student learning should also prepare the students for their career in the industries. Hence, a survey on industry expectations from an entry-level applicant for BPR related roles was designed and implemented. The employers’ survey included an assessment of the current relevance of business process design and reengineering for their operations. The authors investigated the understanding of the scope of BPR in its current form for these employers. The results and findings of this survey provided guidelines on which topical areas and topics within the course should be strengthened through lectures, discussions, and hands-on projects and assignments.

5. 1. Industry Survey

Survey research was used to understand the importance of the BPR topics covered in the course to the industry and also to obtain student feedback. A formal industry survey was designed to assess the level of importance of the topics covered in the BPR course to the industry when hiring an entry-level applicant. The respondents were asked to provide their responses in terms of the importance of the topic for their organization when they were considering a potential employee for an entry-level position requiring BPR skills and knowledge.

The survey had a total of 33 questions, 11 of them belonged to Part-1 where we collected information on the respondent and, 22 of them belonged to Part-2. In Part-2, the questions were related to the potential employees’ understanding of BPR and related concepts and its importance, and their ability to demonstrate hands-on skills necessary for BPR. The respondents were asked to rate the topic or skill using a five point scale: (1) Not important, (2) Somewhat important, (3) Important, (4) Very important, and (5) Extremely important. The topics that were covered in the survey are listed in Table 2 in the appendix.

5. 2. Importance for the industry of the BPR topics covered in the course

The analysis of the responses is discussed in the following sections. The survey was organized around 19 BPR topics and respondents were asked to rate them by importance on a 5-point scale. Considering each topic to be an item and then counting the responses for each item the percentage of responses across the 5-point scale was calculated. Figure 1 shows the percentages across the 5-point scale. This analysis shows that overall most of the topics were rated as at least very important (63%). Also, there are no topics covered in the course that are not important for the industry. This is an indicator of how relevant are the topics covered in the course to the industries’ expectations. Based on this result, it is safe to assume that the BPR course provides the learning, knowledge, and skill sets that
an industry requires from a new college recruit.

The average and standard deviation of responses on all BPR topics is shown in Figure 2. The overall average score on all the responses across all respondents was 2.78 on a weighted scale of 0 to 4 translating to very important with a relatively low standard deviation of 0.79. This indicates that on an average all the BPR topics listed in the survey are very important to the industry. An entry-level applicant for a BPR related job should possess adequate knowledge on these topics. A lower overall standard deviation also supports this statement. The lowest level of importance is given to the topic, Ability to create a BPR project plan with an average importance of 1.8 on a 5-point scale. This result further validates that all BPR topics are important to be learned at an undergraduate senior level. The reason for lower importance level for BPR project planning ability may
be because project planning is not just related to BPR effort in an organization and also it is an activity performed at a managerial-level rather than at an entry-level.

The BPR topics that are most important are Ability to research and collect process related data (3.8), and Ability to use graphical methods to map the current or reengineered processes (3.5). This is a reflection of the roles and responsibilities of an entry-level position. At this level the BPR effort requires the person to perform research on the processes and develop a process map.

The survey respondents varied by at least 1 standard deviation (>0.99) in three BPR topics namely, Ability to use a ‘modeling and simulation’ software (i.e. Extend, Arena, etc.), Ability to create an implementation plan for the reengineered process discussing the implementation issues such as cost, time, improvement potential, likelihood of success, and Understanding of the importance of processes, process management and improvement tools and techniques. Respondents varied in these three topics mainly because only a few companies use modeling and simulation software and a role of an entry-level applicant does not include planning and management in most of the companies.

The trend observed from this analysis is that companies rank a BPR topic to be important if that topic addresses identification of value adding processes as candidates for BPR. The level of importance varies to the extent a BPR topic address this aspect. In other words, the industries expect the entry-level applicants to analyze the current processes and identify candidates for improvement. But does not expect them to implement and measure the BPR effort. This trend is also supported by the topical area analysis. Planning and process optimization and measurement are rated the lowest among the five areas.

Table 1 BPR topics that are extremely important and very important to the industry

<table>
<thead>
<tr>
<th>Categories</th>
<th>BPR Topics</th>
<th>% of respondents ranked this topic to be very and extremely important</th>
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<tbody>
<tr>
<td>More than 90% of the respondents ranked this topic to be very and extremely important</td>
<td>9. Ability to research and collect process related data (Researching and reviewing available data; collecting data by conducting one-on-one or group interviews, etc.)</td>
<td>100%</td>
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<td></td>
<td>11. Ability to prioritize potential improvements by identifying: Redundant and unnecessary activities; inefficient process layouts; rework process steps; recurring delays; and major checkpoints which create major delays</td>
<td>92%</td>
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<tr>
<td></td>
<td>10. Ability to analyze process related data.</td>
<td>92%</td>
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<tr>
<td></td>
<td>8. Ability to use graphical methods to map the current or reengineered processes. Process boundary, inputs and outputs; main activities; business rules and decision points; activity/process owners; applications and technology infrastructure.</td>
<td>92%</td>
</tr>
<tr>
<td>More than 70% of the respondents ranked this</td>
<td>6. Ability to diagnose problems, select processes to be reengineered and justify the selection.</td>
<td>75%</td>
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</table>
6. Improvements in Student Learning

The BPR course was redesigned in 2007 based on the student feedback, performance, and teaching experience. The focus on the contents of the course was also varied based on the industry survey on expectations from an entry level candidate. More focus was given on topics that teach students how to analyze the current processes and identify candidates for improvement. The following discussion addresses such significant improvement and highlights the change in student performance across the course outcomes that were discussed earlier in section designing and redesigning a course on BPR.

6.1 Inclusion of capstone team lab exercise (X-ray process): An inefficient X-ray process case as it exists currently with its process sequences, descriptions, parameters, and resources was provided to the students. The students were required to perform AS-IS process mapping and model it in Extend. The simulation results showed the areas of
problems and process inefficiencies. The students were then asked to reengineer this process by applying the framework and concepts taught in the class. They were asked to perform TO-BE process mapping and model the improved design in Extend. The students were also asked to identify metrics for performance and resource allocation. By simulating the new process and comparing the results with the old process and with industry benchmarks the students were asked to document the resulting radical improvements and reiterate for better results. The course outcomes 3P1, 4P1, 5P1, 6P1, and 10P1 are related to this capstone exercise. The student performance improvements by 15% over the previous year on these outcomes are indicative of the impact of introducing the capstone lab. This provided students better learning across all concepts of BPR due to hands on exercises and practical application.

6.2. Early introduction of Extend, BPR modeling and simulation software:
Understanding the importance of the role of tools in BPR and based on student feedback, Extend was introduced early on in the course and was applied to the capstone team exercise over the course period. The students modeled the current and the improved processes and were able to compare the process performances and resources constraints by simulating these process models. The course outcomes 3P1 and 6P1 are related to this change. Early introduction of the Extend tools resulted in an average improvement in student performance of 12% on these two outcomes over the previous year. This helps students in mapping and understanding the current process and identifying the weak areas.

6.3. Final project Harvard Business Case Studies: Based on the students’ feedback and also understanding their difficulties associated with getting access to real BPR project or process related information, a set of Harvard business cases on BPR was selected and given to the teams. The final project was changed from the students having to reengineer a process to analyzing the success or failure of the given case by applying the concepts and principles discussed in the course. The experience of having to reengineer a process was very comprehensively addressed in the capstone lab exercise. All of the course outcomes The final project relates to the entire course outcomes. Based on analyzing the student performances on these course outcomes we can say that this change in course is one of the reasons for an average improvement of 15% over the previous year. This change also helps student understand the importance of identifying the right candidate for the improvements and how to map and analyze the current process.

6.4. Reduction of text books: This change has provided the instructor more time to spend on the lectures and discussions. This reduction in workload for the students could also be a factor for significant improvements in course outcomes. The choice of the text book was also supported by the industry needs. The topics that are covered in the additional reading books focus more on tools, implementation, and metrics.

6.5 Teaching Pedagogy: Effective Learning For Students: A study was performed to understand which mode of learning was more efficient to students. The students were asked to rate the six ways of learning on a 5-point scale. These were case studies – team assignments, individual assignments, final project, capstone project, individual reading
assignments, and class discussions. The rating of over 50% shows that the modes or ways of learning used in the course were effective. The case study approach was rated the highest. The redesigned course uses case study for assignments, exams, and projects. The authors would focus on making the capstone project and the reading assignments more effective for future course improvements.

7. Conclusion
The success of the course redesign could be measured through the significant improvements in student performance and feedback across the course outcomes. To further validate these improvements and also to provide an iterative improvement to the course, a pre and a post survey on student learning across the topics covered in the class was provided to the students in 2007. An overall analysis of the results of the survey supports the increase in student learning across the topics that teach students how to analyze the current processes and identify candidates for improvement. This was also the major thrust area that the industry was expecting from an entry level person. The results of this pre and post survey are currently being documented. The authors plan to perform these student surveys in each instance of the course for constant feedback and improvement.

8. References
11. Hammer, M.; (2005). CIO Evolution: To avoid extinction, CIOs must move from an orientation that revolves around technology to one centered on business processes; CIO; Aug 1, 2005.Vol.18, Iss. 20; pg. 1.

9. Appendix
Table 2 BPR Related Knowledge and Skills

<table>
<thead>
<tr>
<th>BPR Topics</th>
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<tbody>
<tr>
<td>1. Understanding of the importance of processes, process management and improvement tools and techniques.</td>
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<td>2. Understanding of the difference between various process improvement and management techniques (such as TQM, BPR, Six Sigma, and etc.).</td>
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<td>3. Understanding of what BPR can do for organizations</td>
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<td>BPR Topics</td>
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<tr>
<td>4. Understanding of how business processes can be radically improved, dramatically reducing process cycle time and cost, and improving the quality of the process products or outcomes.</td>
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<td>5. Ability to create a BPR project plan.</td>
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<td>6. Ability to diagnose problems, select processes to be reengineered and justify the selection.</td>
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<td>7. Ability to define and document current and reengineered processes by identifying the following: Process boundary, inputs and outputs; main activities; business rules and decision points; activity/process owners; applications and technology infrastructure.</td>
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<tr>
<td>8. Ability to use graphical methods to map the current or reengineered processes. Process boundary, inputs and outputs; main activities; business rules and decision points; activity/process owners; applications and technology infrastructure require.</td>
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<tr>
<td>9. Ability to research and collect process related data (Researching and reviewing available data; collecting data by conducting one-on-one or group interviews, etc.).</td>
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<td>10. Ability to analyze process related data.</td>
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<td>11. Ability to prioritize potential improvements by identifying: Redundant and unnecessary activities; inefficient process layouts; rework process steps; recurring delays; and major checkpoints which create major delays.</td>
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<td>12. Ability to develop measures and benchmarks for business processes.</td>
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<tr>
<td>13. Ability to redesign/reengineer the current process by: Eliminating non-value added activities; reducing cycle time; improving service and product quality; minimizing inefficiencies; balancing flow and capacity, etc.</td>
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<tr>
<td>14. Ability to define metrics to measure the current and reengineered process and evaluate the improvement potential as a result of reengineering of the process.</td>
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<td>15. Ability to model current and reengineered business processes to diagnose problems using modeling and simulation techniques.</td>
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<tr>
<td>16. Ability to create an implementation plan for the reengineered process discussing the implementation issues such as cost, time, improvement potential, likelihood of success.</td>
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<tr>
<td>17. Understanding of the factors that lead to the success and failure of BPR initiatives.</td>
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<tr>
<td>18. Ability to use a 'process mapping' software (i.e. Visio).</td>
</tr>
<tr>
<td>19. Ability to use a 'modeling and simulation' software (i.e. Extend, Arena, etc.).</td>
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