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# Utilizing Multimedia Case Studies to Teach the Professional Side of Project Management

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# Utilizing Multimedia Case Studies to Teach the Professional Side of Project Management

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## Introduction

Engineering students studying project management generally become skilled at carrying out the various activities connected with a project, such as using project task networks and evaluating resources to determine if a specific project is likely to meet its budget. These skills are important in their later careers, both as members of project teams and, eventually, as project managers. However, their career progress in the project management area is likely to depend just as much on their skills at communication, especially at communication with supervisors, project sponsors, and other project stakeholders. Multimedia case studies, such as those offered by the Laboratory for Innovative Technology and Engineering Education (LITEE), are being implemented in educational settings to help students learn these skills.

The *Introduction to Project Management* course taught in the Engineering Management and Systems Engineering Department at Missouri University of Science and Technology (Missouri S&T) tries to provide a mix of theory and reality, including a significant effort to ensure that skills in communication and teamwork are improved along with technical skills in management of projects. Particular emphasis is given to evaluating the students' work, ability to write about their work, and the growing pains of learning how to get a project funded. The undergraduate students are told that it is important to learn how to think like a project manager. They learn how to set goals, line out the steps of a project, assess risk, and accomplish the goals and objectives of the project, but they also learn how to communicate goals and objectives of potential projects to project sponsors and stakeholders, as well as to team members on the project. Implementation of a LITEE multimedia case study in the classroom aids in the understanding of important project management principles during their class project. In order to bring more reality into the classroom, the class at Missouri S&T uses their skills to assist local municipalities in project prioritization and selection. They interact directly with potential project sponsors to help these municipalities fulfill an important need -- that of economic development.

To help students prepare for this interaction with community officials, a case study was used to provide insight into the practical aspects that were likely to develop in real world situations. There are a variety of sources for case studies, for this course, the Laboratory for Innovative Technology and Engineering Education at Auburn University, established by Raju and Shankar [1] provided an appropriate case study. The students studied the case study as part of their coursework; they later applied all the coursework (including the case study) to evaluate and advocate various projects to the aldermen of a small municipality. The students were surveyed twice (pre-case study and post-case study) about their views. The aldermen were surveyed after the project presentations to obtain a view of the value they felt had been obtained from the student work. This last survey might be considered to be an overall evaluation of using a case study. The aldermen were very positive about the student accomplishments, and the aid provided toward the community's economic development.

## Literature Review

Economic development activities are essential for the survival of both large and small municipalities in the United States. Economic growth and maintenance often brings new capital into municipalities by increasing the tax base, thus allowing for further development and quality of life improvements. Without a sustaining level of economic growth and activity, municipalities may not be able to support the needs of an evolving community, resulting in population loss and economic distress. As an example, in a recent six-year period, in the State of Missouri, 43% of municipalities with a population of less than 3,000 had a negative population growth. The average decrease in population of these municipalities was 3.7% [2]. In order for these smaller municipalities to survive, they must develop strategic plans designed to maintain their current populace and infrastructure by promoting healthy and sustainable economic activity.

## Abstract

**This research was conducted to evaluate the effectiveness of using a LITEE multimedia case study to teaching concepts in engineering courses. The LITEE Superstar case study was implemented in an engineering Project Management course. Numerous surveys regarding student expectations, outcomes, and attitudes were collected and results are presented herein. Overall, the study provided evidence that the students felt that the LITEE case study added value to the course via the different methods of teaching material, aided in the understanding of the project selection process, and ultimately helped them be successful in their course project which was conducted for a real rural Missouri city. The data was unable to be tracked on a per student basis; this yields areas for future research to track individual student improvement and attitudes. This research provides evidence that using multimedia case studies, such as the case studies published by LITEE, are effective and well received by engineering students in their coursework.**

### Keywords

**Engineering education; Multimedia case studies; Laboratory for Innovative Teaching and Engineering Education; Student learning; Case reports**

Strategic planning plays a vital role in the future success of any organization by establishing the mission, objectives, goals, and strategies for an organization's direction into the future [3]. The strategic planning process is made up of four sequential activities: reviewing and defining organizational mission, setting long term goals and objectives, analyzing and formulating strategies to reach the objectives, and implementing strategies through projects [4]. Gray and Larson [4] provide an accepted definition for a project, "A project is a complex, non-routine, one-time effort limited by time, budget, resources, and performance specifications." They also state that there are five main characteristics of a project: (1) an established objective, (2) a defined life-span with a beginning and an end, (3) the involvement of several departments and professionals, (4) doing something that has never been done before, and (5) specific time, cost, and performance requirements.

### *Implementing Strategic Management*

Many communities have developed mission statements and have set long term goals for the community, but fall short of reaching their goals because they fail to complete the final two activities in the strategic planning process: development of strategies and implementation of these strategies through projects. Even if communities develop strategies that will help them meet their objectives, they often do not implement those strategies through projects, due to a variety of capacity limitations. This shortcoming is not only inherent in communities; businesses also find the final stage of the strategic planning process to be the most difficult step [4]. As Gray and Larson [4] stated, "the key is selecting from the many proposals those projects that make the largest and most balanced contribution to the objectives and strategies of the organization." They suggest using a project portfolio system to select proposals. In such a project portfolio system, projects are prioritized so the organization's resources are assigned to projects that will best help the organization implement its strategies.

In many communities and in some organizations as well evaluation of the project portfolio is difficult and organization politics sometimes enter into the process to make it non-optimal [4]. Students in project management courses rarely have an opportunity to experience the practical aspects of project selection. In the course at Missouri S&T, students are involved with a local community in identifying, evaluating, and selecting projects. This practical activity gives them a better understanding of the importance of communication skills and helps them realize that a successful project manager must be able to deal with people at several levels, in addition to understanding the mechanics of carrying out projects.

### *Project Selection Process*

Processes for selection of projects have been extensively studied, often in connection with the strategic planning operations of organizations. Gray and Larson [4] suggested using a project portfolio system to make the selections, using priorities. John M. Lang [5] developed a strategic planning model for implementing community development block grant programs from his research experience working with the city of St. Joseph, Missouri. The model consisted of a five stage process that was used to develop a strategic plan for the community. The stages of Lang's model included Community Commitment, Needs Identification, Program Development, Management System Design, and Application Process. Although not all five stages are relevant to project portfolio selection and economic development, the first two stages, Community Commitment and Needs Identification, are important factors in any community project. According to Lang, there are three separate groups from which to gain Community Commitment: political and administrative, city taskforce, and citizens' organization. Once the community is committed, the next stage in Lang's model is Needs Identification. This stage consists of four steps: preliminary identification of needs, input on needs, public hearing on needs, and refining and adopting needs. Lang notes that it is important to express the needs in "broad and sweeping concepts, covering general areas rather than specific things."

Alpaugh, Murray, Burgher, and Flachsbart [6] dealt with community projects and illustrated a nine-step process to select projects. Sun, Ma, Fan, and Wang [7] dealt with reviews of R&D projects and advocated assigning expert reviewers to rank proposed projects. Eilat, Golany, and Shtub [8] developed an extension of a balanced scorecard approach, integrating it with a data development analysis framework. Other approaches with more mathematical approaches for project selection were developed by Liesiö, Mild, and Salo [9, 10]. Bitman and Sharif [11] reviewed eight previously developed project selection techniques for R&D projects. Except for the process outlined by Alpaugh, Murray, Burgher, and Flachsbart [6], these processes

generally involved techniques that would be costly for project selection in small communities. Even in the case described by Alpaugh, Murray, Burgher, and Flachsbart [6], external assistance was provided for community project selection. Sullivan, Wicks, and Luxhoj [12] defined public projects as projects that are authorized, financed, and operated by federal, state, or local government agencies to protect health, protect lives and property, provide not-for-profit services, and provide jobs. These public projects are funded through taxes, loans, bonds, and subsidies and their project life is relatively long (20-60 years).

Sullivan, Wicks, and Luxhoj [12] noted that they are often difficult to analyze because the nature of their benefits are often nonmonetary, difficult to quantify, and difficult to equate to monetary terms. Because many public projects rely on taxpayer's money for funding, the taxpayers are the owners of the project. After ownership is determined, the project's benefits and costs must be determined. Project benefits are defined as favorable consequences of the project for the public, while project costs represent the monetary disbursement required by the government to complete the project. Projects often have negative consequences that affect a segment of the public. Because these negative consequences are borne by only a segment of the public, they cannot be considered either a benefit or a cost. Sullivan, Wicks, and Luxhoj [12] refer to a project's negative consequences for the public as disbenefits.

Determining the benefits, costs, and disbenefits of a pubic project is often difficult. In Figure 1,

1 There is no profit standard to be used as a measure of financial effectiveness. Most public projects are intended to be nonprofit.
2 The monetary impact of many benefits of public projects is difficult to quantify.
3 There may be little or no connection between the project and the public, which is the owner of the project.
4 There is often strong poltical influence whenever public funds are used. When deci sions regarding public projects are made by elected officials who will soon be seeking reelection, the immediate benefits are stressed, often with little or no consideration for the more important long-term consequences.
5 The usual profit motive as a stimulus to promote effective operation is absent, which is not intended to imply that all public projects are ineffective or that managers and employees are not attempting to do their jobs efficiently. But the direct profit stimuli present in privately owned firms are considered to have a favorable impact on project effectiveness in the private sector.
6 Public projects are usually much more subject to legal restriction than are private projects. For example, the area of operations for a municipally owned power company may be restricted such that the power can be sold only within the city limits, regardless of whether a market for and excess capacity exist outside the city.
7 The ability of governmental bodies to obtain capital is much more restricted that that of private enterprises.
8 The appropriate interest rate for discounting the benefits and cost of public projects is often controversial and politically sensitive. Clearly, lower interest rates favor long-term projects having major social or monetary benefits in the future whereas higher interest rates promote a short-term outlook whereby decisions are based mostly on initial investments and immediate benefits.

**Figure 1. Difficulties in Evaluating Public Projects**

Sullivan, Wicks, and Luxhoj [12] describe the eight main difficulties inherent in public projects.

In the nine-step methodology described by Alpaugh, Murray, Burgher, and Flachsbart [6], project selection is a part of the interaction between officials and it depends on presentations about project benefits and costs. Weighting is used to determine prioritization, but the weighting is also subject to discussion and "give and take." This concept of discussing weighting and coming to an agreement on it in order to prioritize projects became part of the class effort described in this paper. It has been difficult to convey the challenges in these political negotiations to an undergraduate engineering class using traditional instructional methods.

### *Using Multimedia Case Studies to Aid Effective Learning*

The use of case studies to aid students in learning and applying material has been well-established in management courses for a long

period of time. The Harvard Business School Case Studies for MBA students are used extensively, for example, to add a real-life perspective for students. A National Center for Case Study Teaching in Science exists at the University of Buffalo, part of the State University of New York [13]. The center at the University of Buffalo also provides lists of locations for case studies in other areas.

In engineering and related areas, case studies have also been used in many ways. Raju and Shankar established a Laboratory for Innovative Technology and Engineering Education (LITEE) at Auburn University to promote the use of case studies in engineering education [1]. Cobb [14] described one of the early workshops sponsored by LITEE and related the advantages of case studies that had been shown at that time. The LITEE website provides lists of publications about case studies in engineering [15]. Sankar and Raju [16] have been working in this area since the late 1990s; one of their early papers provided a "kit" for instructors to aid development of case studies. Raju and Shankar [17, 18] provided a motivation for and a description of the case study method of instruction in 1999. Halpin, Halpin, Raju, Sankar, and Belliston [19] described the progress and successes of case studies as of 2004. Investigations of the advantages of case studies has continued, with Buchanan, Brown, Stokes, Morris, and Beales [20] preparing a description of potential changes in British practices.

## Methods Used to Evaluate the Effectiveness of a Multimedia Case Study

A valuable way to evaluate a teaching method or a teaching instrument's effectiveness is by evaluating the effect it has on student learning and student perception of learning. The purpose of this research was to evaluate before and after engineering students' perceptions and feelings about engineering courses and to assess how the implementation of a multimedia case study could aid student learning and foster a positive impact on student perceptions and actual results. This research addresses two main objectives: 1) Did students perceive that they learned more during an engineering course after the use of a multimedia case study and 2) Did the multimedia case study tool help the students to understand the "big picture" beyond the daily tasks of individual assignment for a specific engineering course. Questionnaire instruments provided by the LITEE multimedia case study authors were implemented as well as unique instruments developed by the research team to evaluate these objectives.

### *Participants and Procedures*

Undergraduate students enrolled in the project management course were tasked with completing project planning for a rural Missouri city. The city had limited resources and a great need for many projects. The students were asked to prepare proposals and presentations as a final class product to present to the aldermen of the city. The city provided a list of project descriptions that were in need of analysis by the students. The students were divided into "divisions," or student teams for each potential project provided by the city. The students were to aid the city in the project selection process (decision making) by applying the topics they were learning in class to the city's project list. Bias and bargaining are key topics that the student teams must address in order to take into consideration the natural bias that occurs when one has a vested interest in a project or development. The students learned to bargain and "pitch" winning and losing points to gain favor for their division and/or project. Criteria were developed by each division for their particular project and then all divisions came together to select criteria pertinent to the majority of the projects posed by the city so that they could be evaluated on a "level playing field." Each of the final, cumulative criteria was assigned weights and rankings to determine which should be given utmost preference in the project selection process. The LITEE case was presented to the students as a tool to help them learn the criterion assignment aspects of project selection so that they could apply the principles learned to their project with the city. The LITEE case study was used as a supplement to the textbook materials presented in class by Mantel, Meredith, Shafer, and Sutton, *Core Concepts of Project Management* [21].

Student perceptions were collected throughout the semester via several questionnaires. The intent was to assess changes in student perceptions about engineering courses, knowledge of project selection principles, and the effectiveness of the LITEE case study as a learning aide. Data was collected via "pre-case study" and "post-case study" surveys of students' feelings about engineering classes, frustrations with learning engineering topics, and related issues. The "pre-case study" and "post-case study" questionnaires were provided by the LITEE case team to all parties implementing their various cases. This questionnaire was

administered in an effort to measure student perceptions regarding whether the case was a good teaching tool for project selection topics and if students' feelings or frustrations toward engineering courses were influenced by using the case. Another questionnaire was developed by the research team; this evaluated the case's ease of use and students' views about its effectiveness. The final questionnaire was also developed by the research team and was given to the city "customers" of the students' project analysis. This questionnaire addressed items such as whether the students criteria selection made sense in regard to the city, whether the customers felt that the students presented their proposals in a reasonable manner, and overall, whether the students had helped the city's decision making process regarding resource allocation. All of the questionnaires utilized a 5-point Likert scale with "A" being "strongly disagree" and "E" being "Strongly Agree."

### *Course Description/Course Map*

The LITEE case study was implemented in the Engineering Management 254, *Introduction to Project Management*, class at Missouri S&T. The class met once per week for two and a half hours each session during the Spring 2009 semester. The course description and concepts are outlined below in Figure 2.

Figure 3 outlines the "course map" used in implementing the LITEE case study in the project management course. The LITEE case study was used as a complementary instructional tool to the textbook to demonstrate "real activity" in decision making and the project selection process in project management.

### *LITEE Case Study Implemented*

The Institute for STEM Education and Research disseminates innovative case studies developed by the Laboratory for Innovative Technology and Engineering Education [15]. These case studies help introduce engineering students to the complexity of real-world problems and demonstrate how engineering companies work in the information age. The case studies attempt to bring real-world issues alive in undergraduate classrooms, ensuring that students explicitly see the connections between the theory they have learned in the classroom and its practical applications. The case studies utilize multimedia tools, including audio and video clips and photos, to offer students a chance to interact with the material in a more hands-on way. During the cases, students have opportunities to interact with each other in a productive environment, developing team work, problem-solving, and decision-making skills while learning from their peers.

"Introduction to Project Management 254 - This class will be a mix of theory and reality. We will also learn the rudiments of Microsoft Office's Project Management Software develop a "White Paper," Work-Plan, & Budget. While you may or may not use MS Project out into the future, it is important to learn to think like a project manager - how to set goals, plan steps, determine sequences, and generally be able to internalize the process for accomplishing goals and objectives and assess risk. Project managers must deliver projects "On time and on budget" with high quality, or at least the quality level deemed successful.

Key Concepts –

1. Understand basic theory and application of PM
2. Writing project proposals and "white papers"
3. Writing a work plan using Work Breakdown Structures
4. Using PM tools (i.e. MS Project) to track projects
5. Presentation and strategies ("Selling your project" Skills)

**Figure 2: EMGT 254 Course Description**

### *LITEE Superstar Case Study Learning Goals*

The initial goals of the case study include:

1. Discuss how companies make choices among multiple projects due to limited resources and the need to prioritize among them.
2. Understand the relationship between companywide critical success factors, their relative importance, and how these are used in prioritizing among projects.
3. Analyze multiple R&D projects using the Business/Project analysis tool.
4. Communicate recommendations, negotiate with others, and develop a final list of prioritized projects that best ensure business success.

*LITEE Superstar Case Study Problem Statement*

In the LITEE Superstar Case Study, Mr. Sanjeev Kumar, CEO of Superstar Specialties, has limited funds that can be used for research and production projects. There is a dilemma as to how to allocate his $4.91 million budget among the fifteen proposed projects that required financial resources of $7.37 million. His budget allocations have to ensure the goal of achieving 25% gross profit over the next three years for the company. Sanjeev had to decide which projects to fund that will give him a high probability of meeting the profit goals. Also, he had to decide if any or all of the segments were achieving their profit goals and how to categorize these segments into "grow," "maintain," or "harvest" categories. He had to choose a few highly rated projects from fifteen projects, to keep his company growing [15].

*LITEE Superstar Case Introduction & Class Structure*

The LITEE Superstar case study was implemented in the Engineering Management 254 class in the manner described below:

The instructor gave the following introduction to the students:

> This class works with communities on engineering projects for economic and socioeconomic community development. The course teaches students project management processes and skills that can be utilized to aid these communities. We do this in communities with limited resources to help them with infrastructure, service, and organization. Since the Spring of 2007, this course, along with a complementary graduate class, has been in five communities performing over 45 projects with an estimated value exceeding $450,000. Projects often involve construction, design, and process projects. Students are divided into teams of 1-3 people dependent of the level of the work effort involved with the community project(s). I and typically the mayor of the particular community act as the Program Managers, the Students are the Project Managers, and each student team has a senior project manager. The community is the client – there is one point person in the community that is in charge and my contact, typically the mayor – that person has a number of champions to act as points/leads for each student group. The student teams work with the community lead in working through the project. I and the community lead ensure timeliness, cooperation, and success. Each week we have project meetings where we update and talk about work effort (as one would in a project management group). Deliverables by each team include a "White Paper," Presentation of the White Paper for midterm review – additional project definition/selection (at Classroom), a subsequent Work Plan, and Presentation of the Work Plans at a Community Meeting (in Community), and often a Potluck Dinner.

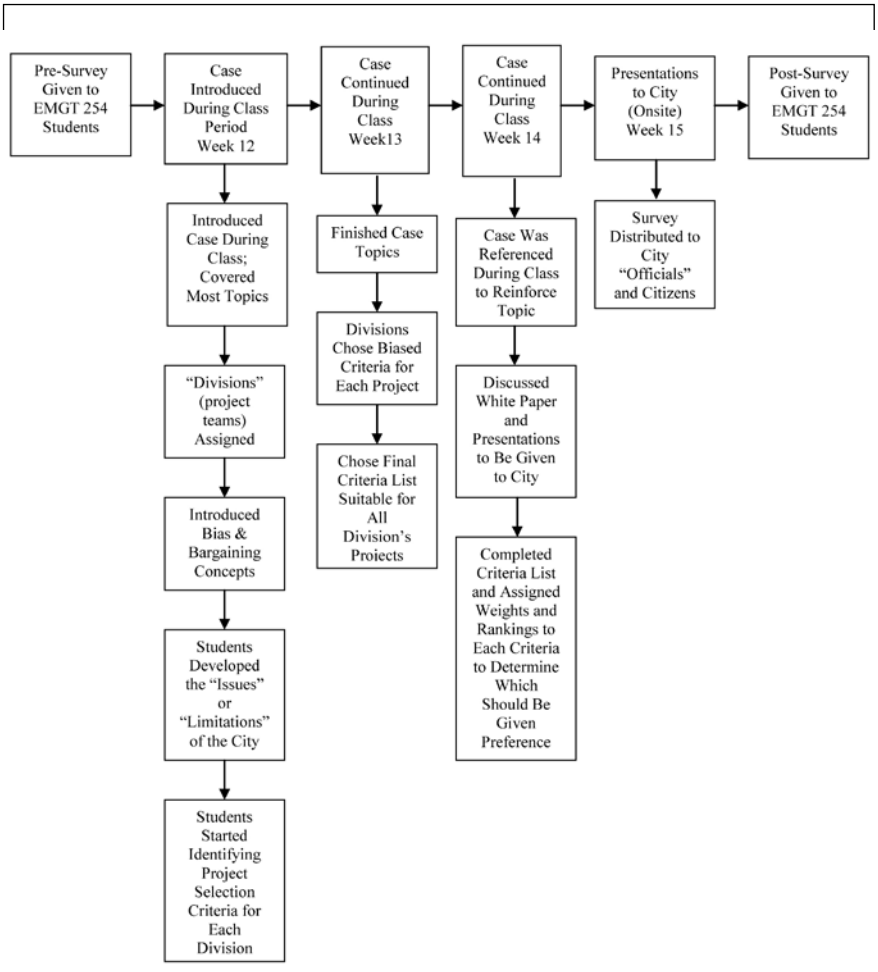


**Figure 3: LITEE Case Study Course Map**

## Questionnaire Analysis and Results

Questionnaire items were used to draw insight into whether or not the multimedia case study aided student learning of engineering course material. Quantitative questions were used to assess whether or not the students gained "big picture" knowledge of project man-

agement and working with clients through the use of the LITEE multimedia case study (See Figure 4 below). Figure 4 also displays the "pre-case study" and "post-case study" survey means for each questionnaire item which were self-reported from the 36 students enrolled in EMGT 254.

An ANOVA analysis was performed to compare the difference in means for each of these questionnaire items (see Figure 5). It was determined that only two of the difference in means was statistically different. (See Figure 4 for item number and item language correlation.) Item #7 had a statistically significant difference in the "pre-case study" and "post-case study" means with an F statistic equal to 6.120. Item #9 also had a statistically significant difference in "pre-case study" and "post-case study" means with an F statistic equal to 6.458. All other questionnaire items included in this study had no statistically significant difference in means. Item #9, however, did show a negative change in means between the "pre-case study" and "post-case study" survey data (see Figure 4). Intuitively, this would indicate that the students felt that they did not improve their problem solving skills as a result of the course and teaching materials. Item #7 also indicated a negative change in means, indicating a lack of gain in confidence as a result of the course and teaching materials. Based on the statistical test, these decreases were not statically significant. An effect that can possibly be occurring is one in which the novice overstates his or her abilities and, as the novice learns the material, their confidence decreases [22].

The "post" LITEE case study surveys included qualitative, or open ended, questions. Clear cut analysis of this type of questions is difficult, but the answers to them do provide an avenue of collecting unbiased "kneejerk" responses from participants. One question asked "How beneficial would you rate the use of the multi-media case studies in your learning the material presented in this course?" The following are excerpts from student responses to this questionnaire item:

- "The case study added a new element/layer of depth in seeing what happens to the projects after the research is complete."
- "In most cases beneficial."
- "There is nothing non-beneficial about the use of multimedia case studies."
- "Beneficial, taught us how to rank projects."
- "Multimedia case studies get the whole

| | | Sum of Squares | df | Mean Square | F | Sig. |
|---|---|---|---|---|---|---|
| Item 5 | Between Groups | 1.389 | 1 | 1.389 | 1.617 | .208 |
| | Within Groups | 60.111 | 70 | .859 | | |
| | Total | 61.500 | 71 | | | |
| Item 6 | Between Groups | 2.722 | 1 | 2.722 | 3.301 | .074 |
| | Within Groups | 57.722 | 70 | .825 | | |
| | Total | 60.444 | 71 | | | |
| Item 7 | Between Groups | 8.000 | 1 | 8.000 | 6.120 | .016 |
| | Within Groups | 91.500 | 70 | 1.307 | | |
| | Total | 99.500 | 71 | | | |
| Item 8 | Between Groups | .727 | 1 | .727 | .966 | .329 |
| | Within Groups | 51.893 | 69 | .752 | | |
| | Total | 52.620 | 70 | | | |
| Item 9 | Between Groups | 7.347 | 1 | 7.347 | 6.458 | .013 |
| | Within Groups | 79.639 | 70 | 1.138 | | |
| | Total | 86.986 | 71 | | | |
| Item 11 | Between Groups | .000 | 1 | .000 | .000 | 1.000 |
| | Within Groups | 63.778 | 70 | .911 | | |
| | Total | 63.778 | 71 | | | |
| Item 22 | Between Groups | .125 | 1 | .125 | .137 | .712 |
| | Within Groups | 63.750 | 70 | .911 | | |
| | Total | 63.875 | 71 | | | |

**Figure 5: Analysis of Variance**

| Research Objective | Item # | Item Language | "Pre-" Mean | "Post-" Mean | Statistically significant difference? |
|---|---|---|---|---|---|
| 1 | 5 | I expect to learn how to inter-relate important topics and ideas using the instructional materials. | 4.06 | 3.78 | NO |
| 1 | 6 | I expect to learn how to identify various alternatives/solutions to a problem using the instructional materials. | 3.97 | 3.58 | NO |
| 1 | 8 | I expect to learn how to sort relevant from irrelevant facts using the instructional materials. | 3.92 | 3.71 | NO |
| 1 | 9 | I expect my confidence in applying Engineering concepts to real situations to improve as a result of this Engineering course. | 4.33 | 3.69 | YES |
| 1 | 22 | I expect my presentation skills to improve as a result of this Engineering course. | 4.08 | 4.17 | NO |
| | | | | | |
| 2 | 7 | I expect to improve my problem solving skills using the instructional materials. | 4.08 | 3.42 | YES |
| 2 | 11 | I believe that an interdisciplinary focus is important in Engineering. | 4.03 | 4.06 | NO |

**Figure 4. Questionnaire Item Analysis Summary**

| Question #: | Question Language |
|---|---|
| 1 | The Superstar case we studied was easy to use. |
| 2 | I see a connection between the Superstar case study and the City portfolio selection process. |
| 3 | The Superstar case we studied helped me in stating appropriate criteria for the City to select projects. |
| 4 | Due to the Superstar case study, I was better able to apply project selection criteria to the City projects. |
| 5 | The process of selecting criteria for ranking projects worked out well. |
| 6 | Use of the Superstar case helped me understand project management principles. |
| 7 | The case study was an effective way of teaching project selection. |
| 8 | I learned more from examining the case study than from other material presented in the lectures. |

**Figure 6: Student Superstar Case Questionnaire Items**

class talking about one common interactive topic."

These comments were very positive indicators that the LITEE case study aided student learning of class material.

Another question asked "What part of this course did you find to be most helpful to you in learning the material?" The following are excerpts from student responses to this item:

- "Writing the white paper and work plan and the accompanying research."
- "Actually making a work plan to be presented at a town."
- "Writing reports and presenting."
- "Peer to peer interaction and problem solving."

The students also indicated they felt benefit from the professor's experiences that were shared, working with a real project, and watching Web videos during class to reinforce topics and give examples. These responses indicate that despite the negative change in means in the quantitative questions in the "pre-case study" and "post-case study" survey, the students did have a sense of value and accomplishment from the course and instructional materials used.

Further data collection was completed by the research team regarding the students' thoughts and perceptions of the LITEE case study itself, and also how the city officials felt about the quality of the final product presented to them. Undergraduate students often miss the value gain from an experience due to the stress and "real time" work involved in a project and reap the benefits at a later date. Questions on the survey included "the Superstar case we studied was easy to use," "I see a connection between the Superstar case study and the city portfolio selection process," "the Superstar case we studied helped in stating appropriate criteria for the city to select projects," and "due to the Superstar case study, I was better able to apply project selection criteria to the city projects." See complete listing of questionnaire items in Figure 6. Figure 7 displays the overall means on a 5 point Likert scale to this questionnaire analysis.

Overall, each question asked received a self reported above average (3.0) mean from the student users. In particular, Item Q7 asked "the case study was an effective way of teaching project selection"; the students rated this as a 3.81 on a scale of 1 to 5, indicating that the case study was a very effective teaching tool (see Figure 7). The results of this questionnaire also indicate that despite the negative change in means from the "pre-case study"" and "post-

| | N | Minimum | Maximum | Mean | Std. Deviation |
|---|---|---|---|---|---|
| Q1 | 36 | 2.00 | 5.00 | 3.6944 | .92023 |
| Q2 | 36 | 2.00 | 5.00 | 4.0833 | .84092 |
| Q3 | 36 | 2.00 | 5.00 | 3.9444 | .75383 |
| Q4 | 36 | 2.00 | 5.00 | 3.9444 | .79082 |
| Q5 | 36 | 1.00 | 5.00 | 4.0000 | .75593 |
| Q6 | 36 | 2.00 | 5.00 | 3.7500 | .90633 |
| Q7 | 36 | 2.00 | 5.00 | 3.8056 | .88864 |
| Q8 | 36 | 1.00 | 5.00 | 3.1667 | 1.20712 |
| Valid N | 36 | | | | |

**Figure 7: Student Case Study Questionnaire Mean Responses**

| Question #: | Question Language |
|---|---|
| 1 | The criteria the students used for evaluating projects made sense. |
| 2 | I felt the way the students presented their decisions was valid. |
| 3 | The student prioritization of projects fit my views of the projects. |
| 4 | I thought the criteria the students used were good. |
| 5 | Selecting projects with student involvement was much better than we would have done without that involvement. |

Figure 8: City Official/Citizen Questionnaire Items

case study"" questionnaires (see Figure 4), the students did find the LITEE Superstar case study useful and it aided them in learning engineering course topics and overall aided the success of their city project.

The questionnaire given to the city officials consisted of questions such as "the criteria the students used for evaluating projects made sense," "I thought the criteria the students used were good," and "selecting projects with student involvement was much better than we would have done without that involvement." The questionnaire was given to nine city officials and to five other involved citizens who attended the students' presentations. Figure 8 shows the results of the five questions asked. See Figure 8 for complete questionnaire item listing.

Overall, the City "Officials" (who were effectively the "champions" for the projects) rated the students' contributions lower than the "Citizens," which would be expected for a City Official of a successful project. Overall means ranged from 4.14 to 4.79 over the 5 questionnaire items (see Figure 9). But, in particular, Item Q5, which stated "selecting projects with student involvement was much better than we would have done without that involvement," received a very high overall rating from the Officials and Citizens and overall. This indicates that the students got a "big picture" lesson in assigning criteria for project selection, making decisions, assembling and giving professional presentations, and the experience of writing professional reports.

## Discussion and Conclusions

In a business environment, one important aspect of judging an organization's success is to measure customer satisfaction. In this effort, the goal was to improve student learning, but also to provide practical project selections to aid a rural community in their economic development. The LITEE case study not only aided student learning to apply to a real world project, it also opened their eyes to politics and how to work within them (through videos and data provided with the case) to get a project funded, and then through to the final stages. The "customers" for the rural community were clearly very satisfied -- their strong agreement overall (4.78 of 5) to the question "Selecting projects with student involvement was much better than we would have done without that involvement" makes that clear. The success of the student learning was harder to interpret, with little change between pre- and post-survey responses. However, the follow-up survey of additional questions indicated that the students (as customers) were also very satisfied and believed that the case study was an effective teaching tool (3.81 of 5). Student responses to the open-ended questions appeared to confirm this satisfaction.

One possible limitation to this study is the self reported data provided on the questionnaires by the students. As mentioned earlier, literature shows that often times students over estimate their abilities or perceptions of an issue [22]. For this study, this may have skewed the results

| Group Responding to Item: | | Q1 | Q2 | Q3 | Q4 | Q5 |
|---|---|---|---|---|---|---|
| City Officials | Mean | 4.4444 | 4.3333 | 4.0000 | 4.5556 | 4.7778 |
| | N | 9 | 9 | 9 | 9 | 9 |
| | Std. Deviation | .72648 | .70711 | 1.00000 | .52705 | .44096 |
| Citizen | Mean | 4.8000 | 4.8000 | 4.4000 | 4.8000 | 4.8000 |
| | N | 5 | 5 | 5 | 5 | 5 |
| | Std. Deviation | .44721 | .44721 | .54772 | .44721 | .44721 |
| Total | Mean | 4.5714 | 4.5000 | 4.1429 | 4.6429 | 4.7857 |
| | N | 14 | 14 | 14 | 14 | 14 |
| | Std. Deviation | .64621 | .65044 | .86444 | .49725 | .42582 |

Figure 9: City Official/Citizen Questionnaire Mean Responses

from the pre-survey data. The surveys were not tracked on an individual student basis for this research. This provides areas of interesting future work; if the student responses could be tracked on an individual student basis, the pre- and post- responses could be compared to student grades and other indicators of success.

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## References

1. P. K. Raju & C.S. Sanka. Laboratory for Innovative Technology and Engineering Education (LITEE). http://www.litee.org/site/ (2009).

2. Population Division, U.S. Census Bureau. Annual estimates of the population for incorporated places in Missouri, listed alphabetically: April 1, 2000 to July 1, 2006 (SUB-EST2006-4) [Table]. Retrieved February 15, 2008, from http://www.censu.gov/popest/cities/SUB-EST2006-4.html (2007).

3. D. I. Cleland. Projects and strategic planning. In L.S. Hager & S.M. Smith (Eds.), *Project management: strategic design and implementation* (3rd ed., pp. 69-70). New York: McGraw-Hill (1999).

4. C. F. Gray & E. W. Larson. Organization strategy and project selection. In B. Gordon, S. Isenberg, & W.J. Zeman (Eds.), *Project management: the managerial process* (3rd ed., pp 21-59). New York: McGraw-Hill (2006).

5. J. M. Lang. A strategic planning model for implementing community block grant programs. *Unpublished master's thesis, University of Missouri-Rolla (now Missouri University of Science and Technology)*. (1975).

6. A. Alpaugh, S. Murray, K. Burgher, & B. Flachsbart. Systematic Approach to Project Portfolio Selection for Economic Development in Smaller Municipalities. Submitted and Under Review: *Project Management Journal* (2008).

7. Y. Sun, J. Ma, Z. Fan, & J. Wang. A hybrid knowledge and model approach for reviewer assignment. *Expert Systems with Applications*, 34(2), 817-824 (2008).

8. H. Eilat, B. Golany, & A. Shtub. R&D project evaluation: An integrated DEA balanced scorecard approach. *Omega, 36(5)*, 895-912 (2008).

9. J. Liesiö, P. Mild, & A. Salo. Preference programming for robust portfolio modeling and project selection. *European Journal of Operational Research*, 181, 1488-1505 (2007).

10 J. Liesiö, P. Mild, & A. Salo. Robust portfolio modeling with incomplete cost information and project interdependencies. *European Journal of Operational Research*, 190(3), 679-695 (2008).

11. W. Bitman & N. Shari. A conceptual framework for ranking R&D projects. *IEEE Transactions on Engineering Management 55(2)*, 267-278 (2008).

12. W. G. Sullivan, E. M. Wicks, & J. T. Luxhoj. Evaluating projects with the benefit-cost ration method. In M. Horton, E. Svendsen, D. Bernhard, V. O'Brien, D. George, & C. Little (Eds.), *Engineering economy* (13th ed., pp. 465-498). Upper Saddle River, NJ: Pearson Education Inc (2006).

13. C. F. Herreid & N. A. Schiller. National Center for Case Study Teaching In Science. http://ublib.buffalo.edu/libraries/projects/cases/case.html and http://ublib.buffalo.edu/libraries/projects/cases/webcase.htm (2009).

14. C. Cobb. Bringing LITEE to the Classroom. *Journal of STEM Education: Innovations and Research 3(3)*, 36-38 (2002).

15. LITEE Publications. www.litee.org (2009).

16. C. S. Sankar & P. K. Raju. An Instructor's Kit to Aid Development of Case Studies in Engineering and Technical Disciplines. *Proceedings of the 1996 North American Case Research Association* (1996).

17. P. K. Raju & C. S. Sankar. Case Study Method of Instruction in Engineering Classrooms. Invited paper, *1999 South East Advanced Technological Education Consortium* (1999).

18. P. K. Raju & C. S. Sankar. Teaching Real-World Issues Through Case Studies. *Journal of Engineering Education*, 88(4): 501-508 (1999b).

19. G. Halpin, G. Halpin, P. K. Raju, C. S. Sankar, & L. Belliston. Real-World Problems in the Classroom: Vital in Engineering Education. *34th ASEE/IEEE Frontier in Education Conference T2F-13* (2004).

20. R. A. Buchanan, D. K. Brown, P. R. Stokes, P. R. Morris, & K. Beales. Case Studies in *Engineering Training and Professional Education, Engineering History and Heritage 162(1)*, 29-37 (2009).

21. S. Mantel, J. Meredith, S. Shafer, & M. Sutton. *Core Concepts in Project Management*, John Wiley & Sons (2006).

22. P. Mabe & S. West. Validity of Self-Evaluation of Ability: A Review and Meta-Analysis. *Journal of Applied Psychology*, 67(3): 280-296 (1982).

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