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Any requests, suggestions, questions, or reports regarding this service should be directed to:

Editor/Publisher
Kenneth C. Williamson III, Ph.D.
Langford Building A, Room 427
College Station, TX, 77843-3137
Tel: 979.845.7052
E-mail: jce@taz.tamu.edu

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Editorial

Educational Practice Manuscripts

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1522-8150/00/$3.00/General Manuscript

Editorial
Annual *Journal* Entries

Within the following I will provide the reader with an analysis of manuscripts submitted for review and publication. I have attempted to track those issue items that might indicate changes in the ways authors communicate bulk information to their readership. I may not be tracking the right information, in that this is the fifth year of the Journal, I will review the factors that I have been including in the statistics and make changes in the following issues. I have rewritten the programming of the Journal, as proposed earlier, and hope that it finds continued acceptance among the readership and submitting authors.

Vital Statistics

Number of manuscripts accepted vs. rejection. There were twenty-two manuscripts published during the past year. Eight of the publications represent those that were grandfatherd in by the ASC Board of Directors and will not be included in the statistics. A total of the twenty-three manuscripts submitted for review, nine were rejected as not being acceptable for publication. This provides the Journal with a thirty-nine percent rejection rate. This is similar to that reported in previous years (see Figure 1)

Average number of pages per published manuscript. There was a change in the number of pages per manuscript. The average was 11.09, which was a positive change of 0.42 from the previous year.

Average number of images, tables, and appendices. Within this volume images averaged 2.05 images per manuscript that is 0.18 less than that of the prior year. Tables increased 1.07 per manuscript to an average of 1.77. Attachments decreased from .74 per manuscript to 0.45. Figure 2 is a graph of the statistics from 1996 to 1999.

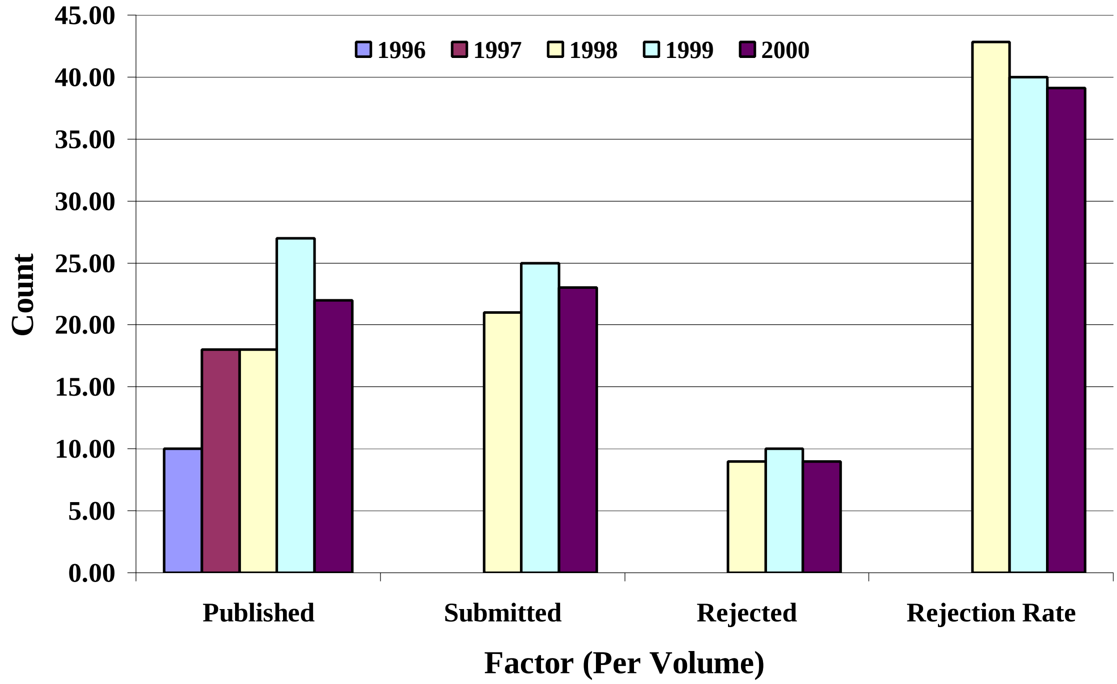

Figure 1. Publication and Submission Data

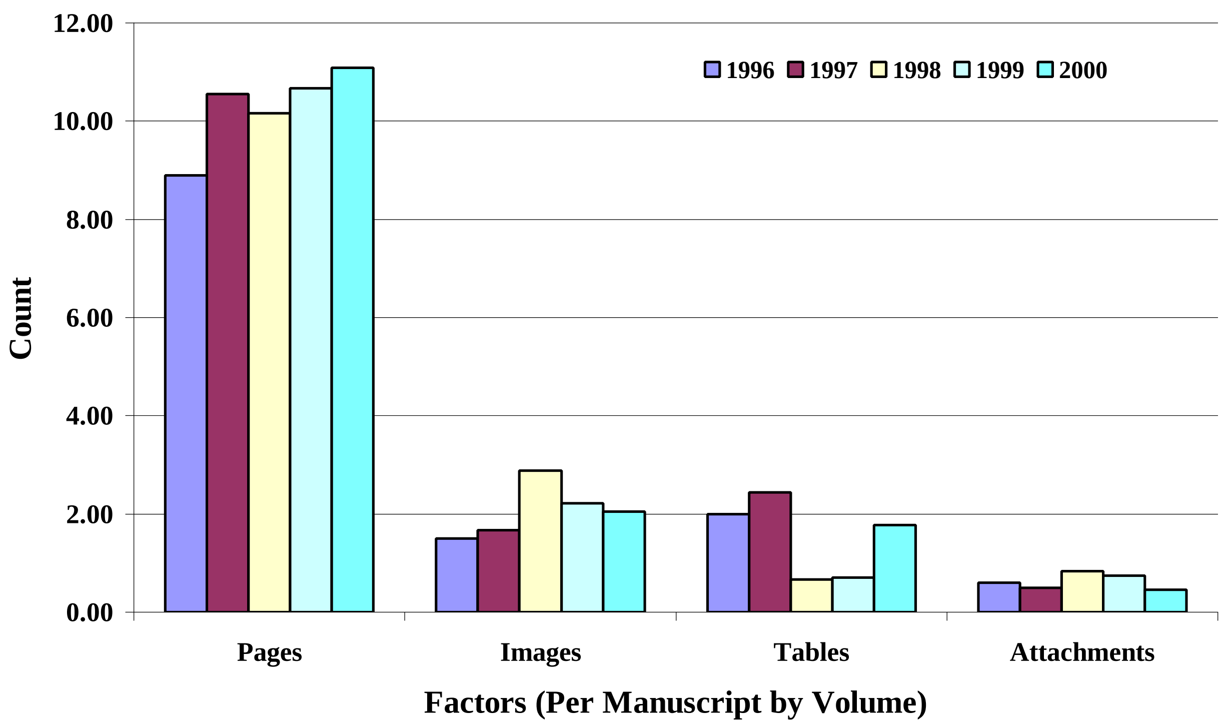

Figure 2. Manuscript Description Data

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1522-8150/00/$3.00/Educational Practice Manuscript

An Evaluation Model for Project Management Training Programs

Gloria J. Auchey
Success Institute of America, Inc.
Blacksburg, VA

Flynn L. Auchey
Virginia Polytechnic Institute and State University
Blacksburg, VA

J. LeRoy Ward
Educational Services International
Blacksburg, VA

Academia can benefit greatly from collaboration with training companies with a proven track record for developing, delivering and evaluating project management training programs. Because corporate clients demand cost effective as well as measurable outcomes, some training companies have developed sophisticated models and tools to assess PM training programs. This unique perspective is important to academic research in the assessment of cost-effective PM education and training practices. Over the past two years, the authors and Educational Services International, Inc. (ESI) have been engaged in assessing ESI's project management core courses, but also in creating process models to provide a framework for project management solutions. As part of one study, two versions of the Learning Outcomes Template (LOT™) were created to validate the learning outcomes of the curriculum, one to assess the outcomes, the other to baseline performance levels. These two tools could then be used to assist clients to customize curriculum as well as evaluate participant performance. The education and training evaluation model (ETEM) presented in this paper incorporates information from these studies and research in current best practices as well as several financial models (BCA, ROI, ROE). In this way, the model provides both quantitative and qualitative assessment tools.

Key Words: Training evaluation models, Project management training models, Course effectiveness, Training assessment, Project management practices model

Introduction

Project Management Core Courses Validation Study

It is instructive for academia to collaborate with, learn and benefit from some of its commercial counterparts who are also trying to accomplish progress toward the application of more effective project management practices. Over the past two years, Educational Services International, Inc. (ESI) has been actively engaged not only in validating and assessing its project management core courses but also in creating process models to provide a framework for project management solutions. In 1998, ESI commissioned the authors to perform a validation study of the Project Management core courses. This study utilized several models, including Anastasi and Kirkpatrick to accomplish the validation. As part of this study, an ESI Learning Outcomes Template (LOT™) for the PM Core Courses was created, which would assist in the evaluation of these courses as well as in the assessment of performance levels achieved in the courses. (Auchey, 1998).

ESI's Project Management Practice Model of Effective Project Management

In addition, early in 1999 a study on Project Management Practice produced a model, which delineates six essential elements of effective project management. The model implementation approach focuses on integrated enhancement of project management capability throughout an organization. The goal of this PM Practice Model is to improve and transfer knowledge and skills, use best industry practices, incorporate current practices and processes, where appropriate, as well as build on current practices, capability, and individual competency. (ESI, 1999). The graphic presentation of this model takes the form of a pyramid, which indicates the importance placed on education and training as the foundation of an effective PM practice model. Figure 1 below depicts the six components of the PM Practice Model of Effective Project Management.

Figure 1. Project Management Practice Model

Each of the elements has specific key factors to assist user clients in the establishment of effective project management practices. Of the six essential elements of this PM Practice Model, the foundation is Education and Training. According to the study, when training is linked to specific business goals, is relevant to the organization and the attendees, has strong sponsorship, offers a variety of training options (including distance and on-line) and is well advertised, the programs are not only more appropriate to adult learners, but also more likely to succeed in the organization. (ESI, 1999) In addition, the participation of related populations (e.g. executives and project team members) can have significant impact on program success.

Table 1 below presents these elements and delineates the key factors to consider in the assessment of that element of the Practice Model.

Table 1

Six Elements of the Project Management Practice Model

ELEMENT	KEY FACTORS
Strategic Oversight	Determines current executive support and corporate policies to support project selection/termination Examines project management in organization Conducts continuous improvement and planning
Center of Competence	Identifies support needs Determines Project Management Office structure, responsibility, staff Establishes Project Management Office capability
Project Execution Support	Identifies resources and team: project mentor support, project needs, project manager placement Manages and controls project management process facilitation
Methodology Deployment	Identifies current state of process, role of PM in organization, interface with current organizational methodologies, PM technique development Develops process to support process, i.e. Rollout Model Monitors implementation, value added, and user feedback
Maturity/Capability Assessments	Evaluates current status of PM Performance, strategic involvement of executive and state of Project Management in organization Baselines for project manager capability Plans short/long term quality improvement
Education and Training	Links training to business goals and client needs Determines level of sponsorship/participation Varies delivery strategies

ESI’s Clientele Input

Over the past several years, many of ESI's key clients, including Novartis Pharmaceuticals, Sprint and its University of Excellence, and Motorola have been engaged in evaluating on-going as well as new training programs. These and other clients can provide important input into the development of an appropriate as well as effective education and training evaluation model for project management programs. This resource is critical in the development and review of the ETEM Model.

Thus, based on these initial studies and resultant models as well as on client needs assessment, it is clear that an Education and Training Evaluation Model to assess present and future training efforts is needed. The proposed model will build on these previous efforts to design an evaluation process as well as develop appropriate tools. The ETEM Model will use the LOT™ to ensure there is a match between the Project Management Core Course learning outcomes and client project manager competencies, roles and responsibilities. In addition, it will integrate with the PM Practice Model to insure fit between program evaluation and key project management capabilities. Further, the ETEM Model will use industrial partners in the development and evaluation phases of the project to ensure industry appropriateness and application. In this way, the ETEM Model, with its flexible process and applicable tools, will help industry address emerging as well as future training issues. (see Figure 2)

Academic Foundation and Approach for Model Development

This section presents the theoretical and practical foundations for the development of the ETEM Model.

Background

Since the early 1970's, industry, government agencies as well as accrediting bodies have been requiring greater accountability for education and training programs in both the private and public sectors. This accountability requirement, in turn, has precipitated research into and development of a reliable means to measure learning outcomes (rather than just learning objectives) as well as evaluate institutional effectiveness (Derlin, Solis, Aragon-Campos, & Montoya, 1996; Julian, Chamberlain, & Seay, 1991; Clark, 1999).

The Kirkpatrick Assessment Model

At present, the most often cited evaluation model used to assess training programs is the Kirkpatrick Model, albeit The Bell System Approach, The Result-Oriented HRD model, the Parker Model and the CIRO models have also been utilized (Phillips, 1991). However, assessment still occurs primarily at Kirkpatrick's Level 1 (Reaction), which is participant assessment based on satisfaction with training, typically done at the end of the course or event. These evaluations usually ask participants to rank or grade the training program, instructor, facilities, etc.

However, most program evaluations are also participant biased and based on several assumptions, including that participants are open and ready to learn, have the proper background or experience to evaluate the effectiveness of the program, have willingly attended the workshop, have personally identified specific needs, are able to assess the practical implications of the training and, finally, can evaluate program effectiveness before testing it personally in their work environments. Also, there is often the assumption made by the learner that the trainer is in the active role and the participant is in the passive (Merwin, 1992).

Given these assumptions, effective evaluation of Level 1 would include pre- and post-tests (diagnostic instrument), participant and trainer self-evaluation, participant and trainer evaluation of each other, content and facilities assessment by participant and trainer, and, finally, follow-up evaluation (Merwin, 1992). The first and last items have significant impact on the actual measurement of learning before, during and after the program. The pre-and post tests can determine individual change and the follow-up evaluation can measure program effectiveness and impact on the job. Employee action plans are an important vehicle for establishing the criteria to measuring training success in the workplace. In this way, data (both quantitative and qualitative) are generated before, during and after training using measurable set criteria.

Level 2 (Learning) is usually accomplished by post-training examinations or evaluation. Using a variety of testing methods is the key to successful evaluation., e.g. tests, portfolios, case study work-ups, reports, checklists or matrices, anecdotal documentation, to name a few. However, it is most important to remember two evaluation concepts: validity and reliability. The former assesses whether the method used actually measures the objective; whereas, the latter addresses consistency over time (Anastasia,1988).

Levels 3 (Behavior) and 4 (Results) are done to a must lesser extent (Parry, 1996; Phillips, 1996). To date, assessment of the impact of training on the job or on organizational objectives rarely occurs (Clark, C. 1996; The Conference Board, 1997). In fact, results based on the examination of the monetary value of the cost of training/learning, although desirable, have been difficult if not impossible to obtain (Parry 1996; Phillips, 1991;Todesco, 1998). In his attempt to address this challenge of monetary evaluation of training, Phillips proffers an additional level to the Kirkpatrick model, i.e. Level 5: Return on Investment, and presents a model for determining ROI.

To summarize the Kirkpatrick Model and its application, Phillips suggests percentages of programs to be evaluated at the different Kirkpatrick Levels:

- Levels 1 (Reaction) and 2 (Learning): Target 100% of the workshops--because it is fairly easy to assess participant reactions and evaluate performance.
- Level 3 (On-The-Job): Target 30-50%--because it involves more time and expense to conduct.
- Level 4 (Business Results) and Level 5 (ROI): Target 5-10%--because these evaluations require significant resources and budgets.

Because of the importance placed on bottom-line profitability, the trend appears to be leading toward some form of monetary measures of training, including Return on Investment (ROI), Benefit Cost Analysis (BCA), and Return on Expectation (ROE), the foci for discussion in the next three sections.

Financial Assessment of Training

Return on Investment (ROI)

As most researchers point out, performance improvements may be linked to training; however, other factors may also be responsible for the changes (Phillips, 1991). Much of the research indicates that the better the planning is up-front, the greater the possibility there is for isolating and measuring some training factors, which can then be used to calculate Return on Investment (ROI) or Benefit Cost Analysis (BCA) (Parry, 1996; Phillips, 1996; Chase, 1999; ASTD, 1997). Phillips places particular importance on the up-front planning required to utilize any monetary measurement and the significance of focusing on the primary goals of any ROI, i.e. to convince the Human Resource staff that the process works and to show senior management that training can make a difference. Indeed, because monetary return on training is so difficult, research supports the use of various methods to evaluate training.

However, most research supports the establishment of a standard methodology for training evaluation that is supported by the organization (Parry, 1996; Phillips1991; Chase 1999; ASTD, 1997). As well, since the methods used to monitor costs vary widely, standard cost data should be established as part of this overall evaluation methodology. This standard evaluation methodology, when supported by statistical analysis, can provide a level of confidence for corporate and senior-level decision-making.

For ROI to be determined, business results need to be converted to monetary benefits. Hard-data items such as productivity and time can be done relatively easily; however, soft items such as customer satisfaction are difficult. Philips suggests using a variety of methods to gather data and prepare the evaluation design, including the following:

- Surveys. Questionnaires and interviews are designed to measure program value by participants and their managers. A comparison of the two entities provides data on the impact of training.
- Control groups. An experimental training design is implemented with one group receiving the training and the other not. After training, a comparison of the two provides performance data.
- Trend-line analysis. A line is drawn from current performance to future performance, assuming that the current trend will continue even without training. After training, the post-training performance is compared to their predicted performance, thereby, attributing any improvements to training.
- Forecasting. More analytical and mathematical than trend-line, forecasting uses a linear equation to calculate a value of the anticipated performance improvement.
- Estimations: Estimations of the impact of the training by various stakeholders, including the participant, supervisor, customer, top level management, and experts, are collected and compared.
- Focus groups: Focus groups are a structured form of interview. Eight to twelve participants in the training are assembled and asked specific questions about the training. Brainstorming and creative thinking among the participants can produce high-quality data, especially for Level 3 evaluations.
- Follow-up sessions: Training participants are reconvened 2-4 months after the training to report on their successes. As well, these sessions can be opportunities to refine new skills.
- Performance tracking: This is a common practice at many companies, and is often considered the most credible post-training evaluation approach. Performance tracking monitors department, work-unit, or individual performance after training in such areas as productivity, quality, cost, time and customer satisfaction.

Other methods to assess training can include follow-up assignments, surveys and questionnaires, interviews, focus groups, observations, and performance tracking (Phillips, 1996; BellSouth, 1997). Indeed, one of the most effective methods to gather data on soft items is the use of employee action plans, with the inclusion of performance contracts and tracking measurements (Parry, 1993; Phillips, 1996).

Once these measures are determined and standard cost data established, statistical analysis is much easier to perform. In fact, research indicates that ROI may be best utilized at the micro-level when the associated costs of training are allocated to specific, and often the most popular, training programs (Parry, 1993; Phillips, 1996). This data, in turn, can provide the foundation for appropriate statistical analysis and subsequent corporate decision-making. However, a word of caution regarding micro-level assessment and statistical methods: if sample sizes are small, statistical results may be insupportable or even misleading.

In short, in order for an evaluation model to be effective, it should be designed as a standard methodology with standard cost data established for the organization and varied in its approach to evaluation, on-going in its assessment process, and appropriate to the needs of the organization. Further, it should incorporate employee action plans as well as updated performance contracts and tracking. As well, if statistical data with monetary assessment is requisite, ROI, BCC or ROE can be useful; however, because of the costs and time associated with ROI measurement, these measures should target 5-10% of the programs (Phillips). In addition, when using ROI, evaluation needs to isolate the effects of training, i.e. control the variables. Therefore, the use of control groups and/or the assessment of training programs at the micro level, perhaps linked to specific projects, may be advisable. Indeed, if resources including training are allocated on a per-project basis, the micro level may be the only option.

Benefit Cost Analysis (BCA)

In his article, "Measuring Training's ROI", Parry considers BCA a subset of ROI; that is "BCA is the most demanding way to calculate ROI, but also the most accurate." (p.75). He also provides a guide to establish the relationship between the costs (one-time, cost per offering, cost per participant) and the benefits (time savings, better quantity, better quality, personnel data). His eight observations, sample applications, and Benefit Cost worksheet provide strong support for the use of BCA in the context of a comparison model.

However, he adds a word of caution: be aware that benefits can accrue long after training. Therefore, human resource managers should calculate costs with benefits calculated by trainees and their managers "after they have had enough experience in the workplace to collect enough data to project the benefits over the playback period." (p.75) Then, the comparison of the total costs to the total benefits yields the ROI (Parry, 1996). Thus, a tool, which compares benefits and costs, may be useful in assisting managers not only in making high-level decisions regarding training but also in establishing appropriate parameters for areas and items requiring further analysis.

Return On Expectation (ROE)

As another subset of ROI, some organizations are measuring results based on Return on Expectation or ROE, which examines the perceived market value of training compared to program costs. This latter method may lend itself well in the initial attempts to evaluate training before, using a Feasibility Analysis, as well as after, using Cost-Benefit Analysis (Parry, 1996). Because the trend is to measure and assess activities, including training, with organizational objectives, organizational fit, accepted standards, competency profiles, learning outcomes, as well as budgetary considerations. ROE may be a better method or strategy to use. According to Todesco, “companies are striving to find simple, affordable, yet reliable ways of measuring the results of their investments.” (p. 2) She deduces that the challenge is to bridge the chasm between “inconsequential reaction data” and “costly and time-consuming outcome data” as well as insure adequate assessment of "soft training/learning" in a corporate climate of "weak management support for evaluation." (p. 2-3) A tool, then, that can organize and present information that is both qualitative and quantitative would be extremely useful.

Current Industry Best Practices

Research indicates that awareness and sharing of the best practices in industry could be beneficial in creating a comprehensive training assessment model, especially since each organization considers different elements as critical to their business performance and practices (Phillips, 1993; Parry, 1996; Todesco, 1999). Keeping a list of 'best practices' by individual companies may provide key assessment elements for a comprehensive as well as flexible training evaluation model.

For example, Table 2 lists a sampling of organizations and their training assessment foci.

Table 2

Organizations and Assessment Foci

Organization	Assessment linked to:
RCMP programs	Performance, organizational competencies and core values rather than training.
Xerox	Standards that employees can upgrade (self-directed competency improvement.
Motorola	Transfer of knowledge and skills to the job.
Ernst and Young, Bell South	ROI carried out based on participant estimates attributed to learning
Imperial Oil (Esso)	Company's strategic focus through competency gap analysis
Bank of Montreal	Learning Action Plans (LAP) and investment in extensive assessment of innovative learning events
(Based on information from Todesco, BellSouth, Parry, Phillips)	

In each of these organizations, the impact the learning would have on the business organization and its employees was determined and then appropriate measures to assess that impact were created. For example, Bell South gathered information through post-program questionnaires, surveys and interviews, analyzed the data statistically and then determined ROI based on estimates attributed to learning.

Table 3, based on the Royal Canadian Mounted Police (RCMP) presentation "Measuring Problem-based Training" (1996), summarizes current, emerging and future assessment practices based on Levels of Assessment, Beneficiaries, Linkages, Focus, Orientation, and Drivers. Noteworthy is the importance placed on Level 3 and 4 assessment as emerging and future practices.

Table 3

Current, Emerging and Future Assessment Practices

	Current	Emerging	Future
Level of Assessment (Kirkpatrick):	Reactions, Some learning (Level 1, 2)	Behavior, On-the-job, Business impact (Level 3,4)	Competency for future requirements (Level 4)
Beneficiaries:	Training Departments	Functional and Senior Project Managers	Diffused in organization
Linkages:	To training course objectives	To business plan	To anticipated future needs
Focus on:	Prescribed needs	Performance and business objectives	Competencies that permit organizational adaptation and change
Orientation:	Process-oriented	Results-oriented	Future-oriented applications
Drivers:	Quality control for training	Improvement of business results	Anticipating future competencies
(Based on RCMP, 1996)			

Summary

There is increasing interest in knowing and assessing the value of training as a strategic investment with benefits for the individual and the organization. Indeed, some researchers contend that, in the very near future, the value of a company's stock may be determined in part by the value of the company's intellectual capital (Conference Board, 1997). At present, most organizations engage in some form of Kirkpatrick's Level 1 (Reaction) and Level 2 (Learning) assessment of training programs; however, the use of pre- and post tests as well as employee actions plans are strongly recommended to establish reliability and validity. Because Levels 3 (Behavior) and 4 (Results) require more resources and time, only 5-10% of the workshops should be measured. If monetary measures of training (ROI, ROE or BCA) are used to quantify outcomes, it may be best to measure against specific projects. That is, when training budgets are allocated on a per project basis, the ROI, ROE or C/B could then be measured against the bottom-line profitability of that specific project (Conference Board, 1997).

Further, research indicates that an effective training assessment model should also:

- use formative as well as summative measures; that is, measure training effectiveness before (feasibility analysis), during (participant assessments) as well as after (Cost/Benefit) the training,
- determine management support for training and assessment as well as an organizational attitude that training is a beneficial investment in intellectual capital (IC),
- use pre- and post tests as well as employee action plans to assist in continual program assessment,
- employ various types of measures, both qualitative and quantitative; that is, focus on intangible (intellectual capital) as well as tangible measures (ROI or BCA),
- provide evidence of monetary impact both real (Benefit/Cost Analysis, ROI) and/or perceived (ROE), if deemed appropriate and feasible,

- assess criteria that are linked to organizational business objectives, established training standards, competency profiles, and employee action plans,
- provide user-friendly assessment tools to facilitate using the model throughout the organization.

In addition, industry partners should be involved in the development and assessment of the evaluation model so that best practices can be incorporated.

The proposed model, the Education and Training Evaluation Model, incorporates these attributes and, thus, provides a flexible yet comprehensive evaluation methodology for project management training programs.

The ETEM Model

Because the ETEM Model is the foundation of the PM Practice model, it will include data generated from initial client needs assessment, including an evaluation of each participant's present level of understanding of project management, as well as information obtained from corporate business objectives and strategic plans. The model will also incorporate current best practices as well as information gleaned from other sources, including training questionnaires, pre-tests, interview questions, and client evaluation criteria. In addition, tools will be designed which can be customized for individual clients, e.g. LOT Comparison Tools (1 & 2) The model itself is a process that begins long before the actual training occurs and continues throughout the life of the training initiative(s).

ETEM Model Graphic

Figure 2 below is a graphic presentation of the ETEM Model:

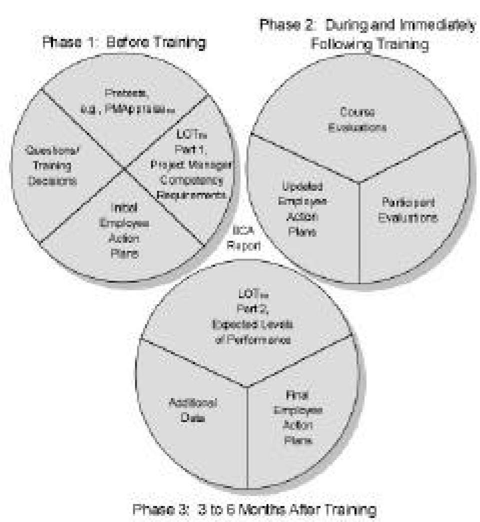

Figure 2: ESI's Training and Education Model - ETEM

Description of the ETEM Model

Phase 1: Before the Training

Before the training occurs, the ETEM Model will assist clients in the identification of training outcomes within the context of the overall PM Practice Model and in conjunction with ESI's PM Core Course Learning Outcomes. The purpose is to match client expectations with training content as well as insure the training program fits with the organization's strategic plan for training.

- Questions. During needs assessment, as client concerns regarding training are communicated, a list of key questions would be posed, including "What part does Project Management play in attaining your company's business goals? How do you presently measure if these goals are being met? What do we, as training providers, need to set up to help you to measure training success?" These questions establish the purpose and the measures to be used to determine program success as determined by the strategic business goals. They are also key to designing an appropriate curriculum for each client.
- Pre-Tests. A project management diagnostic test can be administered to determine general project management skill levels. This test could be used not only as a diagnostic tool for the instructor(s) but also as a basis for statistical analysis of individual learning achievement.
- LOT™ Comparison Tool, Part l--Project Manager Competency Requirements. A key tool in the identification and quantification of training outcomes is the customized LOT™ Comparison Tool, Part l--PM Competency Requirements. This tool compares ESI's PM Core Course Learning Outcomes with client project management requirements, or their equivalent. The tool, a comparison matrix, is completed before training begins and provides the client and the employee with a basis to measure program as well as individual success.
- EAP. The Employee Action Plan would be developed for each participant prior to the onset of training. The EAP will contain the information gathered from all sources during the entire training process.
- BCAR. The information gathered from this phase is organized into a Benefit Cost Analysis Report, which will provide data for subsequent phases.

Phase 2: During and Immediately Following the Training/Workshop

During and immediately after the training, the ETEM will qualify and quantify, where possible, training program effectiveness.

- Course Evaluations. After each course, a course evaluation of content, facilities, and instructor will take place. Evaluations by instructors are to be included.
- Participant Evaluation. At the end of the training session, some form of evaluation of individual performance is needed. These can take various forms including exams,

portfolios, case studies, anecdotal instructor comments, etc. A statistical analysis of this post-test with the participant's pre-test can provide a measure of the learning accomplished (Merwin, 1992).

- EAP. The Employee Action Plan for training should be updated with the information gathered in this Phase.
- BCAR. The information gathered from phase 1 and 2 is organized into a Benefit Cost Analysis Report, which will provide data for the final report after Phase 3.

Phase 3: After the Training

After the training has occurred (anywhere from 3 to 6 months), the ETEM Model would evaluate training courses in the context of client business and training objectives and strategic goals, both qualitatively and quantitatively.

- LOT™ Comparison Tool, Part 2--Expected Levels of Performance. The LOT™ Comparison Tool, Part 2--Expected Levels of Performance compares ESI Expected Levels of Performance with Client Expected Levels of Performance or Participant Achievement, depending on the client needs. Both the participant and his/her manager should complete the instrument after the course to give the client a basis for comparing individual performance or achievement with the anticipated performance levels established by ESI. A comparison of the assessments is done to determine any differences in perceived or actual achievement. An important aspect of the tool pertains to the ability to perform, the opportunity to perform and the reasons for the responses. The tool also addresses the impact in terms of qualitative and quantitative results.
- EAP. A finalized Employee Action Plan for training is completed. This document, now a portfolio, would contain not only information on the training program completed but also plans for the future training and on-the-job applications. In addition, mentorships between new project managers and senior project managers are strongly encouraged to ensure application of the training.
- Other Sources. Additional information gathered from participants and their managers can provide excellent information for determining the benefit cost ratio. Some possible sources include:
    - control groups,
    - trend-line analysis,
    - forecasting,
    - estimations (participant, supervisor, management, experts),
    - input (customer and subordinate),
    - other factors (See Assessment Models Section, Return on Investment).

- BCAR Compilation and Assessment. The data generated from each of the previous phases and housed in the BCAR database is compiled, sorted, and analyzed. An assessment report is produced from this information.

Conclusion

The ETEM is designed to guide management and training managers in the development of appropriate training programs and/or customized training curricula in the context of overall effective project management practices. The tools recommended in this paper can be effectively used in CM education and training not just in post-secondary but also on the job. Further, not only are appropriate measures for evaluation determined early in the process, but budget and resources for training are allocated as well. In fact, the costs associated with training can be allocated on a per project basis, giving the project manager and training manager more control. In addition, assessment of training program effectiveness is on going and cumulative. Most important, however, the entire process would be developed to meet not only specific business goals and objectives for training but also the strategic plan for effective utilization of intellectual capital and long-term profitability (The Conference Board, 1997). In short, the goal of e-valu-ating training programs is to add value to the organization.

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Developing Effective Teams

Janet R. Achor
Purdue University
West Lafayette, Indiana

D. Perry Achor
Purdue University
West Lafayette, Indiana

Attempting to incorporate team projects in a construction class can be frustrating to the students and the instructor. An example illustrating how to successfully establish teams that will motivate members to work together through experiential learning is presented here.

Key Words: Teams, Experiential Learning, Motivation, Human Relation Skills, Team Planning, Production Task, Time Limits, Profitability

Introduction

The majority of construction projects and tasks in the construction management industry are accomplished by teams of employees, both in the home office and in the field. Therefore, it is essential that students in construction management programs are provided the opportunity to learn how to work in teams.

The purpose of teams is to ultimately accomplish a task in a minimum amount of time while using all possible resources available to maximize profitability and aesthetics. This is accomplished by learning and developing each individual team member's assets and pooling their resources to accomplish a task.

Students are taught that a team's purpose is to ultimately accomplish a task, using human relations skills, during a minimum amount of time while using all possible resources available. Each team member's assets are determined and resources are pooled to accomplish a task. Through team development, students learn that construction projects are accomplished through teamwork during planning stages and during actual construction. This exercise will help students to become more familiar with such critical areas as planning, controlling, goals, priorities, and developing programs of action.

Most construction educators have received some experience in attempting to establish successful teams within a classroom environment. Generally discovered in attempts to establish teams are the difficulties inherent in teams such as attempting to reach consensus among strongly held beliefs, and dealing with hostility, anger, frustrations, and team members letting the team down. Discussed here are ways to address such difficulties, using an exercise, The Real Estate Project, so that students can better approach learning, and team projects in their careers.

Before Classroom Teams are Formed

Instructors need to be alert to the pre-team expectations that students tend to develop from past experiences. These expectations or attitudes can create self-fulfilling prophecies of either positive or negative feelings about teams. Instructors should encourage students to enter into the team concept with the expectations of both learning and enjoying working together as a team. When team members enter into a team setting with such expectations, other team members tend to react to these positive expectations in ways that allow the expectations to be fulfilled.

Instructors should encourage students to enter into teams with students they do not know well. The resulting benefits will be:

- Students can learn more from students they do not already know.
- Students can more openly confront non-friends on team task issues.
- Students can compare experiences and progress with friends from other teams.
- Students learn that in the industry, managers are not assigned to teams on the basis of friendship.

During the Team's First Meetings

Instructors can assist the students in developing positive expectations before entering the team situation. Students are advised that there are no second chances in making a first impression. The instructor encourages the students to think about what they desire from the group, what they wish to accomplish, and the role they wish to play in the group. Thus, before entering the team situation, the student is better prepared to be a positive and productive team member.

When students are in the process of forming a new effective team, they will encounter predictable issues, which need to be addressed. Such issues include:

- How do team members relate to each other?
- Who has power and influence?
- What is each member's role?
- How is conflict to be handled?

This is one of several team-building activities that can be helpful in setting the stage for an effective resolution to the above issues. Instructors can encourage team members to engage in the following:

- Doing something which requires self-disclosure (such as the sharing of values or feeling)
- Taking personal risks with each other (confronting, disclosing, sharing)
- Not allowing the task to become more important than managing relationships
- Establishing a few team goals that:
    - satisfy team members' needs for belonging
    - are a minimum 50% achievable
    - are specific and concrete

Engaging the students in such team-building activities at the beginning of their meetings together can better prepare them to accomplish team tasks, and maintenance roles more successfully. Presented here is a Team Planning and Production Task exercise (Pfeiffer, 1985). This exercise can be implemented in the instructor's course, done by the students, as a way to assist in the development of successful teams within the classroom environment.

Applying a Classroom Exercise:

Team Planning and Production Task: The Real Estate Problem

Purpose

- To develop knowledge of the value that plans and objectives have on team productivity.
- To explore the effects of objectives, planning, organizing, directing and controlling have on team productivity and output.
- To examine different factors that may affect profitability and aesthetics.
- Human dynamics! Power - who takes it?

What to Expect

This is a highly involved task and team members always enjoy it. The spirit of "getting into" the exercise is enhanced when a clear climate of inter-group competition is established.

The exercise is especially useful at the beginning of the course when participants may not recognize the importance of setting objectives, planning for profits, or designing an organization structure to enhance task accomplishment. Many teams will treat Step 1, and especially 2, very superficially. This may be frustrating for them later when they begin to build and realize that they have no idea of where they are going or how to get there. Other teams may spend most of their time planning to conserve resources, maximize aesthetic value, or devising elaborate designs for "shockproof' buildings. Often these teams are highly effective at constructing creative buildings, but they may show a very low profit and be one of the least successful groups. Other teams may find that their "plans" did not allow for time contingencies.

Since this is a fairly complex exercise to run, it is very important that you have all materials and physical facilities prepared well in advance. It is useful to obtain extra help and space, especially if the total group is greater than 25 people. Note all "Operating Hints," below, carefully. Also, be sure to have all participants remain through the conclusion. The exercise has a "game-like" quality. Without a good wrap-up, it can be perceived as just that, a game. Through analyzing the experience, however, participants come to several valuable conclusions about their behavior.

Introduction

Most textbooks describe the management process as one that involves four functions: planning, organizing, directing, and controlling. How each of these functions is performed will determine, to a great extent, whether a company is successful or not in meeting its objectives.

Like larger systems, small teams must also consider these functions if they are to be successful. Frequently, team task accomplishment involves interdependencies among members and requires a high degree of coordination.

In both cases, tasks to be accomplished must be analyzed and objectives must be established in advance. Once these objectives are clear, the team can plan how it will organize its members and utilize resources to achieve these objectives. In companies, one of the objectives will involve profitability. Just as companies must plan and organize for production, they also need to plan and organize to ensure that profit objectives are met.

In this exercise, each team will have an opportunity to compete with other teams in constructing a building. The success of the teams will be measured by the profit each team makes in the project. Profit is determined by subtracting costs from the total appraised value of the finished structure. As the teams will see, many factors are involved in determining the appraised value. Therefore, it is essential that the teams analyze this task carefully, set objectives, and plan the best possible organization that will allow each to meet them.

Procedure

STEP 1: Each team should allow itself sufficient time to become familiar with the parameters set forth below in Step 1. Discuss these until everyone understands them, then proceed to Step 2.

> *Task Directions.* Each team will be required to construct a building out of 3" x 5" ruled index cards (to be provided) and to sell the building at the end of the exercise. The sale price will be the total appraised value as determined by the Real Estate Board valuation standards outlined below. The winning team will be the team with the greatest profit, regardless of the appraised value of the building. Teams are instructed to make two sketches, plan A and plan B, before beginning to construct the building.
>
> *Material and Tools.* Each team will have the same raw material and tools available. These are 3" x 5" ruled index cards, one ruler, one pair of scissors, one stapler, and one roll of 1/4" tape. Extra staples and tape will be available upon request without charge. The cost of construction cards (raw materials) is described below. The instructor provides all of the materials and tools.
>
> Cards cost $70 each. At the beginning of the exercise, each team will receive a package of 100 cards and will be charged $7,000 as the initial startup investment. Additional cards may be purchased from the supplier at the regular price. At the end of the exercise, each team may redeem any unused cards for $50 each. To purchase or redeem cards, ONE PERSON only from each team must go to the supply depot to carry out the transaction.

The presenting team leader will designate the supply depot at the beginning of the exercise.

Construction and Delivery Time. At the beginning of the exercise, the team leader will announce the amount of time each team will be allotted to construct the building. No team is allowed to build until the team leader announces BEGIN PRODUCTION. When the time is up, the team leader will announce STOP PRODUCTION. No construction is allowed after this point. Each team will have 30 seconds in which to deliver your completed structure to the Real Estate Board for appraisal. Building received after 30 seconds will not be appraised, and they will be disqualified. No team members are allowed to remain with the building after it is delivered, except for the Real Estate Board members.

Real Estate Board. Each team should designate one member to serve on the Real Estate Board. The board member may help plan your building, but he or she will not be able to actually help during the construction phase. The Board is responsible for appraising each building and assuring that building codes are met. The Board will convene during the construction period to decide upon criteria for the DROP-SHOCK test and quality and aesthetic values. The board must appraise one building before going on to the next. Once a building is appraised, it cannot be reappraised.

Building Code. All buildings must be fully enclosed (sides, floors and roofs). They must have ceilings and be capable of withstanding a DROP-SHOCK test. This test may consist of dropping the building or dropping an object on the building. It will be the Real Estate Board's responsibility to decide which test.

Appraisal Values. Buildings are appraised on the basis of quality and aesthetics. In order to obtain the total appraised value, the total of the quality and aesthetic values is multiplied by the total square inches of floor space in the building.

Quality Valuation. Quality is determined by subjecting the building to the **DROP-SHOCK** test. Various qualities are assigned values as follows:

- Minimal quality: $12.00 per square inch of floor space
- Good quality: $14.00 per square inch of floor space
- Better quality: $16.00 per square inch of floor space
- Top quality: $18.00 per square inch of floor space

Aesthetic Valuation. The Real Estate Board can set an aesthetic value from $0.00 (zero) to $3.00 per square inch.

Other Instructions. Once construction begins, your team will not be allowed to ask the team leaders to clarify any game rules to resolve any team difficulties. You are on your own. Five minutes before construction is to stop, the team leaders will notify the teams of the time remaining. While the Real Estate Board is appraising buildings, each team will be expected to clean up left-over raw materials and return them to the supply depot. All unused cards should be redeemed.

STEP 2: Each team should discuss the task and establish the following:

- What are your team's objectives in this project?
- What plan will your team use to achieve the objectives?
- How will members be organized and coordinated to accomplish the team's task?
- How will your team utilize resources?
- Who will serve on the real estate board?
- How will your team deal with the uncertainties, e.g., unknown time allocation and DROP SHOCK test?

One member of each team should be designated to report on your team's objectives, plan, and organization structure during the discussion at the end of the exercise.

STEP 3: Each team should assemble together at one work place (table or two tables). The team leaders will designate the following: (1) supply depot and supply person(s); (2) delivery station for real estate board; and (3) construction time (20 - 25 minutes). In addition, the team leaders will distribute all materials and tools to the teams. Finally, the people designated to serve on the real estate board will be asked to convene. No one is to use any materials or tools at this point.

STEP 4: When the team leader announces BEGIN PRODUCTION**,** the team may build. When the team leader announces STOP PORDUCTION, the team must deliver the team's building to the real estate board within 30 seconds.

STEP 5: The Real Estate Board appraises the buildings. The teams clean up and return the raw material. The team leaders and supply persons compute total cost and enter figures on board or easel. The Real Estate Board appraises the buildings and enters total value on board or easel (10 minutes).

STEP 6: The team leaders and supply persons compute the profit for each team. The total costs are subtracted from the total appraised value for each building to determine the winning team (i.e., most profitable).

STEP 7: The entire team and the team leader should discuss the results in terms of the objectives, plan, and organization of each team to determine how these factors affect output and profits. Team members should respond to discussion questions for their own teams.

Discussion

After the exercise, the students are required to answer the following questions. The answers are turned in and also used for class discussion analyzing the team efforts.

- What was the primary objective in this task?

- Given this objective, what other objectives did your team set? Did you try to minimize/maximize floor space (profit)? Quality? Resources used? Aesthetic value? Cost?
- Did your team's plan allow for the uncertainty associated with construction time? Did your team establish any contingency plan or alternative for long or short construction periods? Various shock tests?
- Did team members attempt to influence the Real Estate Board either before or during the appraisal?
- What factor in your team's efforts do you think account for its success or failure in this task?
- How did your team's division of labor and coordination of efforts affect your performance?
- What effect has your team's success or failure experience had on: (a) you? (b) your team's cohesion/identity? (c) your attitudes toward other teams and individuals?
- What does this exercise demonstrate about the role of team objectives?
- What is the value of planning, as demonstrated in this exercise?

Conclusion

Establishing teams in the classroom as an important component of academic efforts in a construction program is essential. Incorporating teams within the curricula ensures that students are exposed to the value of team skills. Effective teams must establish high goals and objectives that are accepted by the team members. Effective teams establish high standards of performance, rather than being pressured to perform by the leader. Effective teams allow members to disagree and to determine effective ways to resolve problems and inter-team conflict. Effective teams make decisions by consensus with consideration of alternatives, resulting in a cohesive sense of unity. In addition, students learn that effective teams recognize individual team member contribution.

Instructors who ensure that students receive team development skills within a construction program provide graduates who are better prepared to become productive and successful team workers and managers in the construction industry.

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The Impact of New Surveying Instruments on the Construction Surveying Course of Study

Joseph O. Arumala
University of Maryland Eastern Shore
Princess, Anne, Maryland

Construction Surveying has been highly affected by advances in technology. Technological development has led to new surveying instruments being produced at fairly regular intervals for the construction industry. The new instruments offer many advantages including accuracy, productivity and interconnectivity. Owing to the advantages offered by the instruments, many construction companies readily adopt the use of these instruments in their businesses. Trends in the manufacture of new construction surveying instruments are presented. A study using a questionnaire was done to establish how this developmental trend should be approached in teaching construction surveying to students in the Construction Management Technology programs. This paper also gives the results of the questionnaire sent to all 4-year degree awarding members of the Associated Schools of Construction (ASC), which are accredited by the American Council for Construction Education (ACCE). Fourteen schools responded. The finding of the study is that the schools favor the inclusion of the cutting edge “High Tech” equipment in surveying in the teaching of the course so that students can be better prepared for the workplace. After the students have been taught the use of the basic surveying instruments, it is recommended that the use of the new surveying instruments and their applications in construction should be taught.

Key Words: Electronic, surveying, construction, robotic total station, theodolite, transit, levels, Global Positioning System (GPS), Global Information System (GIS)

Introduction

The use of the principles of surveying is not limited to the professionally registered surveyor and his or her employees. From the initial mapping and selection of a construction site to a final check of the roof slope, nearly everyone involved in the control of a construction project must be aware of a variety of surveying instruments and techniques. Anyone doing surveying work must be able to accurately measure long distances and elevations within hundredths of a foot and angles within fractions of a degree. In addition, this precision must be accomplished efficiently in terms of time and labor (Leica Report 27, 1991).

Construction Surveying is an integral part of the Construction Management Technology program. It serves as an introduction to a variety of surveying equipment and techniques and encompasses the process of gathering information about a proposed job site, laying out the location of structures on the site, checking the dimensions of the structures during construction and documenting the completed work (McCormac, 1991). One of the course objectives is to give students proficiency in the use of surveying instruments. The instruments currently used in teaching the course include measuring tapes, range poles, plumb bobs, levels, theodolites, and traditional total stations.

Electronic distance measuring devices are extensively used in the present construction industry. The electronic distance measurement (EDM), first introduced in the late 1950s has since those early days undergone continual refinement. The early instruments, which were capable of very precise measurement over very long distances, were large, heavy, complicated and expensive. Technological advances have provided lighter, smaller, simpler and less expensive models (Roberts, 1995).

Current EDMs generate and project an electromagnetic beam of either microwaves or infrared (lightwaves) from one end of the line being measured to the other. The beam is received and either retransmitted (as for microwave) or reflected (as for infrared) back to the transmitting instrument (Kissam, 1988). Infrared EDMs come in long range (10-20 km), medium range (3-10 km) and short range (0.5-3 km). EDMs are generally used in conjunction with theodolites; vertical angles must be measured so that the slope distances obtained by the EDM can be reduced to horizontal distances. The electronic digitized theodolite, first introduced in the late 1960s, set the stage for modern field data collection and processing. When the electronic theodolite is used with a built-in EDM, the surveyor has a very powerful instrument. Adding to such instrument an onboard microprocessor that automatically monitors the instrument's operating status, and a data collector that records and processes field data will produce an electronic Tachometer Instrument (ETI) - known as a **Total Station** (Kavanagh, 1992).

Construction Surveying is a specialized course. Owing to advances in technology, new surveying instruments are produced from time to time. These new instruments offer many advantages ranging from cost and time saving features to higher degrees of efficiency. In addition, they are also generally much easier to use. Because of these advantages, construction companies readily adopt the use of these instruments in their businesses. Since students in the Construction Management Technology program are being prepared to enter the construction industry, there is, therefore, a need for the course of study in Construction Surveying to reflect the new methods and instruments used in the dynamic construction industry.

The objective of this paper is to present the trends in the manufacture of new instruments in the construction surveying industry. It also presents the results of a questionnaire administered to determine the need to have the course of study in Construction Surveying to reflect new methods and instruments used in the construction industry.

Current Trends

There has been a quick pace of improvement in the quality of surveying equipment within the past twenty-five years. The most significant areas have been in the development of Auto Focus Levels, Laser Levels, traditional Total Stations and Robotic Total Stations. There has also been much progress made in the introduction of the Geographic Information Systems (GIS) and Global Positioning Systems (GPS). In addition, there has been a corresponding development of new field data collectors and computer software for use with these instruments. These developments have had a great impact on the construction industry. A brief description of each these now follow.

Auto Focus Levels

Auto Focus Levels have seen great improvements since the first auto level appeared in the industry twenty-five years ago. Some of the latest auto levels are the Pentax Auto Focus Levels Series. The Auto Focus Level uses autofocus techniques to automate the troublesome focusing procedure. Pushing the Auto Focus (AF) key will focus the target in an instant to dramatically improve the operational efficiency. The Autofocus function uses the Phase Contrast Method. Automatic and Manual modes are easily changeable so that the two modes can be selected freely. The automatic compensator uses special alloy ribbons so that stable measurement accuracy is obtained even under adverse conditions such as heavy vibration. The level's operational efficiency is dramatically increased by the use of Auto-focus.

Laser Levels

Advancement in laser technology has been utilized to produce surveying instruments that cover a wide range of applications in the construction industry. These instruments produce visible laser light that range from a pencil-thin line of light to a plane of light that covers a whole work site. The instruments consist of the laser beam transmitters and receivers for the infrared ray. The instruments have long range (1000-ft radius). Some of the instruments can be used on grade (slopes) and can be used in conjunction with several excavating equipment. Some are used for both interior (e.g. layout of metal studs for drywalls) and exterior work (e.g. general construction work). Most also establish horizontal and vertical planes to guide workers. An example of a specialized laser instrument is the pipe laying laser level. The Cordless Pipe Laying Laser sets lines and grades. It has a large grade and line display that lets the user see the display outside the trench or in a manhole up to 10 feet away. Dialgrade is cordless with power options and battery life that is very good. It has a wide self-leveling range.

The Laserplane Leveling Systems is one of several laser level products by Spectra Physics. The Laserplane transmitter (operating unmanned) sends a continuous self-leveled 360° reference plane of light covering the work area. This reference can be picked-up by one or more receivers simultaneously which may be hand held or attached to a grade rod or machinery. This is used for all construction applications: setting and adjusting, elevations, marking, excavation cutting depth etc. The transmitter can be mounted on a regular tripod or can be set free standing. The receiver's Liquid Crystal Display visually indicates when high, on-grade, or low, with up to nine channels of grade information. The user may also select distinct audio tones that match the display. The receiver allows the user to locate the level reference to perform all leveling applications. It is used to provide a precise vertical reference plane for faster installation of drywall, layout or other vertical applications. It is also produces a rotating, pencil-thin beam of highly visible red laser light. This beam generates a continuous horizontal reference plane for installing acoustical ceilings, raised computer floors, and sprinkler systems. It is designed for quick, easy setup in either the horizontal or vertical mode. The laser level has assured accuracy. If the unit is knocked out of level, it will automatically shut off until it has re-leveled itself;

hence inaccurate readings cannot be made. The self-leveling feature assures fast, accurate setup and a one-man crew can operate it.

Traditional Total Stations

In the surveying profession today, there is a very strong movement away from theodolite and levels toward the use of electronic total station instruments. With total stations the surveyor can measure slope distances as well as horizontal and vertical angles. Furthermore, these devices have the capacity to compute and display horizontal distances, differences in elevation as well as directions and coordinates. These instruments may also be used with superb results for differential leveling and for stadia readings for topographic work. When total stations are used for topographic maps, readings can be made so quickly that many more points may be sighted than with the old procedures. This is particularly true when one uses an electronic data collector and AutoCAD to plot the needed maps. The use of additional points should result in better maps. Even though chaining techniques with a metal tape are still important in everyday layout and basic surveys, electronic distance measuring devices are the number one method of today's and tomorrow's survey and engineering work. The old fashioned transit with the method of using a magnifying glass to read verniers is not being used in the field as it once was (Kirby, 1992).

Robotic Total Stations

The latest advance in the field of surveying is the Robotic Total Station. A one-man crew can operate this system. The Geodimeter System 4000 is one of several different Robotic Total Stations on the market. The operator can control this fully robotic surveying unit, from as far as 1500 feet away by a Remote Positioning Unit (RPU). Similar to conventional total stations, the Robotic Total Station is positioned over a point (station) and oriented to a back sight station. When the setup and orientation is completed, a button is pushed on the instrument keyboard that allows the instrument to be controlled from the RPU. The RPU is about half the size of the total station and is mounted on a pole similar to a conventional prism pole. From the RPU, the operator can serve as the "Rodman", collect data and control the movement of the total station. All data, which are usually shown on the total station, are shown on the RPU, thereby being at the operator's disposal at all times. After moving to the point, which needs to be surveyed, the operator pushes a button and a signal is transmitted by radio link, to the robot. The robot then begins to search for the retro prism on the RPU (Roundtree, 1998).

Using appropriate computer software programs to accompany the Robotic Total Station cuts down on office work and produces quality reports. The new technology allows for increase in productivity, cuts office time in half, and allows for obtaining of permits in a very short time. The advances in surveying technology have helped companies large and small, to take huge strides in efficiency and customer satisfaction.

The Robotic Total Station can be used in the dark. The system operates both in the unattended robotic mode and in the conventional mode. This innovative technology has caught on with firms of all sizes, making their surveying work easier, faster and thus more efficient.

Geographic Information Systems (GIS) and Global Positioning System (GPS)

Geographic Information System (GIS) is a mapping system that integrates position information of an object with descriptive information about that object. GIS stores and displays both spatial and non-spatial data. For example, the shape, size, and location of a parcel of land constitute spatial data whereas the name of its owner is a non-spatial descriptor.

A GIS is comprised of a database and a map. Coordinate data is retrieved by the database and then displayed (with relation to other objects) using the mapping engine. A major advantage of GIS software is the ability to maintain data associated with different elements in separate layers (or coverages) that are based on the same geographic referencing system which can be superimposed spatially to support data queries and analysis (Hobbs, 1991).

The Global Positioning System (GPS) is a system for providing precise location information. This information is transmitted from a constellation of 24 satellites that continuously orbit the earth at high altitude. This constellation of satellites orbits high enough to avoid the problems associated with land-based systems and yet provides accurate positioning 24 hours a day anywhere in the world. Uncorrected positions determined from GIS satellite signals have accuracy in the range from 50-100 meters. This accuracy may be further refined to less than 2 centimeters using a technique called Differential Correction.

GPS has found its greatest utility in the field of Geographic Information Systems (GIS). By integrating the two technologies, users can now navigate to a position using the output from a GPS device, and then query this location using the GIS application. This query will provide users with all the data related to that location such as the object's attributes.

A large number of engineering and business applications require the tight integration between "real-world" positioning of objects and information related to these objects. The system capable of providing the information above is developed using the marriage of two related technologies, namely a Geographic Information System (GIS) and a Global Positioning System (GPS).

Once GIS and GPS systems are integrated, the possibilities are endless. For example, a utility company may be interested in dispatching a maintenance crew to fix a transformer. A system based on these technologies can lead this crew to the transformer's location; and then supply all the information related to that transformer such as its size, manufacturer, etc. In the highway application, roadway information, alignment, and condition are supplied by the system to engineers to assist them in planning. The railroads can benefit greatly from the integration of GPS to track roadbed information such as tilt, soil stability, or rockslide likelihood (ASCE, 1998).

With a continuous improvement in the quality of GPS and mobile PC devices and a continuing reduction in their costs, such systems are becoming more affordable. There is therefore the need to provide students with an in-depth understanding of GIS and GPS hardware and software, operational concepts, performance characteristics, and engineering and business applications.

Field Data Collectors and Surveying Computer Software

There are currently in the market several data collectors and computer software for use with the electronic surveying instruments. These are flexible and make field data collection, retrieval, and management easy. Some of the data collectors and software available are:

TDS Survey Pro

The **TDS Survey Pro** is a powerful and versatile tool for survey design and layout. The **Survey Pro** card takes the most popular data collector, the TDS 48GX, and adds functionality and ease-of-use enhancements. With its industry standard menu-screen interface and new on-line help screens, **Survey Pro** also has one of the fastest learning curves in data collection software.

TDS Easy Survey Plus

Easy Survey Plus is a Computer Aided Surveying (CAS) program for surveyors who want a flexible, graphic environment to use in computations and plotting. It provides Automated Mapping, Graphical COGO, Road Design, Data Collection and File Transfer. Easy Survey Plus is built around a powerful, 32-bit graphics engine and operates on 386 or better laptop and desktop PC's with VGA compatible graphics Cards. It provides crisp accurate on screen views of field data and accurate plots of finished designs. It is the field to finish solution that saves time and effort. With Easy Survey Plus, contour plots and least squares adjustments are just a few keys away. Automated Mapping provides an instant screen plot of the job, including different symbol and line types, curves and text. All screen plots can easily be output to printers, plotters or DXF and DGN files.

TDS Easy Survey plus w/TFR Software

The TDS Easy Survey plus w/TFR is DOS compatible software that offers automated mapping with user-definable feature codes. Site plans can be viewed or edited on-screen, plotted directly or translated into a DXF file for import into external CAD systems. It has a two-way data transfer with DR-48 data collector.

Carlson Survey Software

Carlson produces the **SurvCADD** and **SurvStar** software for the surveying industry. The latest in the series of this software are:

Standalone COGO-Design Software

This software merges SurvCADD functionality powered by Autodesk Technology into a single standalone product. It has most of the COGO-Design module of the SurvCADD 98 and AutoCAD Release 13. Contouring and volume calculations are also included in Carlson Survey.

SurvStar

This software a complete data collection system for Real Time GPS and Total Stations with in-field coordinate geometry.

GradeStar-GPS Grade Control System

This system allows GPS-guided grading according to a pre-set surface grid. Cut/fill values and cross-section and plan views are updated in real-time. The on-board computer-GPS system provides an operator with all the necessary information about differences between existing and design surfaces. The existing surface is updated automatically as the equipment moves around the site. No other total station, laser or GPS surveying is necessary for precise grading.

MapPlus

This is a collection of enhanced routines and features that takes full advantage of AutoCAD MAP Release 2. Automated database connectivity is among the many improvements of Map Plus. Enhanced features allow the user to edit, create, and manage ODBC compliant database tables, within the AutoCAD MAP environment. Table links are automatically registered with the Map Plus database administrator. Analysis of map features becomes a simple point-and-click process. Map Plus reduces database configuration time, effort, and maintenance.

Other **SurvCADD Software Modules** are: COGO/DESIGN, CONTOUR/DTM, SECTION/PROFILE, HYDROLOGY, MINING and AUTOCAD for GOVERNMENT.

The electronics surveying instrument manufacturers have developed several computer software and data communication links within their instruments. For example, Geotronics uses the Geodimeter software and data communication system in its instruments. The system collects and stores data in both internal and external memory units. There is flexible and well-designed data communication built in with all systems. Other features of the Geodimeter surveying systems are: **UDS** (User Defined Sequences) software which allows the user to set up 20 registration sequences; **Pcod** (Point code) which allows the user to use his own point code list; **View**, which allows one to rapidly retrieve stored data in the instrument's display in order to check its contents; **Edit**, which not only lets the user rapidly seek stored data and see them on the instrument's display (View) but also provides full editing capability; **StnEst**, is a program for station establishment; the **Z/IZ** program, helps the user to determine the absolute elevation of the instrument rapidly; **Angle/Meas**, a program for angle measurement which handles the time-consuming search for different targets when doing a round of angles; **SetOut**, a program designed to set out a point; **RefLine**, a program which allows the user to set out any point along or parallel with a known or unknown reference line; **Area/VolCalc**, a program that calculates surface and volume between points that have been measured; **DistOb**, a program which gives the user rapid and easy to use calculation of distance, height difference and slope in percent between two points where sight between the points is blocked; **Roadline**, a software package with which the user can set out roadlines in a very rational manner. This is a complete program for station establishment in three dimensions, with routines for setting out and collecting data as well as for checking and storing data; and **RoadLine 3D**, an all inclusive program package which gives the user completely new prerequisites when setting out and checking roadlines in three dimensions.

This program contains all the functions of RoadLine but will also furnish the user new productive “tools”.

The Need

A survey of the Construction Management Technology graduates and comments from the Construction Technology Advisory Council of the University of Maryland Eastern Shore revealed that it is increasingly important for the construction graduates to be familiar with electronic surveying instruments.

The feedback from some students who participated in the Construction Management Technology Internship Courses and the current trends in the construction industry indicate the need to use modern electronic surveying equipment in the course on Construction Surveying. The Construction Management Technology Internship courses are designed to provide the students with work experience as interns under the supervision of construction professionals. Some of the student interns have been involved in construction site development and layout projects that included the use of electronic surveying equipment. For these students, the internship experience was the first opportunity to use these instruments. It is believed that if the students have experience in the use of electronic surveying instruments as part of the course on Construction Surveying, this will not only be of good benefit and advantage which may be strengthened during internships but will be a good preparation for them as they graduate and enter the real world of construction. Knowledge of and experience in the use of the electronic surveying instruments will greatly improve the quality of the course on Construction Surveying and provide a good background for future work. This will also be of good advantage to the students as they go on the construction management internship courses.

Furthermore, the students should be taught the use of the electronic measuring instruments and their maintenance and safe use. They should also learn to use the computer software for storing and processing surveying data and should use these to produce survey drawings and reports. It is therefore, very important that a course of study in Construction Surveying should reflect new methods and instruments in the construction industry.

The Questionnaire and Responses

A questionnaire was designed to determine the need to reflect the changes in the development of new instruments in the teaching of construction surveying. The questionnaire was sent to all American Council for Construction Education (ACCE) accredited 4-year universities teaching Construction Surveying requesting course descriptions and other relevant information. A copy of the Questionnaire is shown in the Appendix. Responses were obtained from 14 institutions out of the 40 institutions selected for the study.

Analysis of Responses

The various schools gave different course names to the course. Table 1 shows the different titles given to the course. The popular trend is calling the course Construction Surveying as seen in Table 1.

Table 1

Course Titles

S/No.	Course Title	Number of Universities With This Title
1	Construction Surveying	6
2	Plane Surveying	3
3	Surveying	3
4	Construction Surveying Fundamentals/Construction Layout	1
5	Engineering Measurements	1
6	Engineering Surveying	1

Prerequisite

As a prerequisite to the course in surveying all the colleges required some Mathematics course to have been completed. This is appropriate because some concepts of mathematics especially trigonometry, are required to compute some distances and angles.

Course Description

The description of the course by the various programs included the theory and principles of surveying applied to construction. They also included the use of instruments and field exercises and field note preparation.

Course Objectives

The objectives of the course as recorded by all the institutions are to develop in students the skills and knowledge needed in the accurate use of surveying instruments.

Some institutions offer two courses in surveying e.g., Purdue University offers a Construction Surveying Fundamental and Construction Layout in its Building Construction Management program. Texas A & M University has two courses: Plane Surveying and Surveying in the Civil Engineering program. In some programs, the surveying courses are taken as service courses from other departments like the Department of Civil Engineering.

There is a need to include in the objectives of the course in construction surveying, the introduction of new instruments and systems in the construction industry. The instruments taught should include Auto Focus Levels, Laser Levels, Conventional Total Stations, Robotic Total Stations, Geographic Information Systems (GIS) and Global Positioning systems (GPS). This will make the skills and knowledge the students acquire in college relevant to the work place.

Recommended Text Books

The Text Books used by the various institutions and their authors are shown in Table 2. Textbooks in surveying with construction applications are popular.

Table 2

Recommended Textbooks

Title	Author	No. of Schools
Surveying with Construction Applications	Barry Kavanagh	1
Principles of Surveying	Herobin	1
Construction Surveying and Layout	Wesley Crawford	5
Elementary Surveying	Wolf & Brinker	5
Surveying	Moffit & Bouchard	1
Surveying: Principles & Applications	Kavanagh & Bird	1
Construction Surveying Layout and Dimension Control	Jack Roberts	1

Student Enrollment

The average yearly enrollment of students in the Surveying courses in the Colleges that responded to the Questionnaire is shown in Table 3. All students enrolled in a Construction Management Technology program take a course in Construction Surveying. The course is important to the program.

Table 3

Student Enrollment

Institution	Course Name	Avg. Student Enrollment	Credit Hours
Central State University	Plane Surveying	25	4
Northeast Louisiana University	Construction Surveying	20	3
Georgia Southern University	Construction Surveying	24	5
Purdue University	Construction Surveying Fundamentals	120	3
Purdue University	Construction Layout	120	3
Southern Polytechnic State University	Surveying	20	5*
University of Washington	Plane Surveying	30	4
Bowling Green State University	Construction Surveying	25	3
University of New Mexico	Engineering Measurements	45	2
East Carolina University	Construction Surveying	18	3
Oregon State University	Plane Surveying	67	3
Boise State University	Engineering Surveying	25	3
University of Northern Iowa	Construction Surveying	18	3
Texas A & M University	Surveying	120	4
North Dakota State University	Surveying	100	4
University of MD Eastern Shore	Construction Surveying	18	3

Instruments

Table 4, shows a list of 'major' instruments commonly used in surveying. The Respondents were asked to indicate which of the instruments they used in their programs. The instruction for completing this section of the Questionnaire was: **"Directions:** For each item, circle an appropriate response 'YES' or 'NO''.

Table 4 shows their responses. The "**% YES**" column in the Table is the percentage of schools that use the instrument with respect to the total number of respondents. The instruments widely used are Dumpy Levels (50%), Automatic Levels (86%), Transits (79%), Theodolites (57%) and Total Stations (64%). The least used instrument is the Compass (7%).

Table 4

Instruments Used in Construction Surveying Courses

	Instruments	Yes	% Yes	No
A	Compasses	1	7	9
B	Construction (Dumpy or Wye) Levels	7	50	4
C	Automatic Levels	12	86	0
D	Laser Levels	6	43	6
E	Engineer's Levels	5	36	4
F	Transits	11	79	2
G	Theodolites	8	57	2
H	Electronic Theodolites	5	36	4
I	Total Stations	9	64	0

Other instruments reported being used are: Digital Level, Zenith/Nadir Instrument and GPS Hand-held Receivers.

Rating the Importance of Instruments Used

Note: The Respondents were requested to circle the appropriate response to signify what they perceived to be the level of importance of each of the instruments used in the teaching of construction surveying.

Scale for level of importance

1 = No importance
2 = Little importance
3 = Important
4 = Great importance

Table 5 shows the rating for each instrument. Automatic Levels (90%) and Total Stations (89%) were highly rated. Laser Levels (50%) and Theodolites (78%) had high ratings also. Compasses had the lowest rating (0 %). Automatic Levels, Laser Levels, Theodolites and Total Stations are seen to be quite important to the surveying course.

Table 5

Instrument Rating

Level of Importance	1	2	3	4	*% of* Levels 3 & 4
Compasses	7	3			0
Automatic levels		1		9	90
Engineer's levels	1	3	1	4	56
Laser levels	3	2	3	2	50
Transits	2	3	2	4	55
Theodolites		2	2	5	78
Electronic Theodolites		4	2	3	50
EDMI (Electronic Distance Measuring Instruments)	1	1	3	4	78
Bolt-on Accessory Type EDMI	1	5	2	1	30
Total Stations	1		3	5	89

Cost of Surveying Instruments and Software

Surveying Instruments are quite expensive. For example, the Nikon AZ-2 Automatic level costs $600, the Nikon NE-205 Electric Theodolite, $1, 950; the Top Gun A20LG Total Station, $11, 545; the TOPCON AP-L1A Robotic Total Station, $35, 985; the Dual Frequency Real Time Kinematic GPS System and accessories, $64, 870; and a GIS with accessories, $10, 480. The cost of the SurvCADD COGO/DESIGN, CONTOUR/DTM and SECTION/PROFILE software modules is $800 each; and the TDS Easy Survey Plus w/TFR, is $1, 500. Although educational discounts can be obtained, the cost of procuring these instruments to any construction program is high. On a short-term basis, these instruments can be rented from local vendors for specified period for students' use.

Integrating New Surveying Instruments in the Curriculum

As indicated earlier, all the construction programs have a semester course in construction surveying, in which surveying basics including the use of traditional surveying instruments are taught. These instruments include the dumpy level and the transit/theodolite. These basics are invaluable to the students and must still be taught. However, also recognizing the importance of the new instruments to the construction industry, the course syllabus should be modified to include the use of new instruments. This can be done by either including the use of new instruments in the current one semester course or designing another course that will fully incorporate the use of the new instruments. Owing to the fact that there is a limit to the number of courses that can be added to the program, the first option is favored.

First Option

The first option is to include the teaching of the use of new surveying instruments in the existing semester course. The new instruments may include Auto Focus Levels, Laser Levels, Total Stations, and the use of data collectors, and survey computer software. In particular, emphasis should be placed in the "Field to Finish" process, in which the data collector is seen as an intermediary between the field and office operations that will produce the necessary plots and reports, by using the relevant computer software on the data collected. It has been observed that the students easily learn the use of the new instruments after being taught the use of the traditional instruments. Most of the field exercises can then do done with the new instruments. In the case of tight budget, the desired instruments may be rented for use in the field exercises. The instrument vendors will normally give educational discounts for these rented instruments.

Second Option

There are some programs that have two courses in surveying. This second course can be modified to include the use of new surveying instruments. The course should include Electronic Distance and Angle Measurement Instruments and their application to construction site planning, layout and control. Other areas may include, topographic maps, building foundation and stake-out, road, bridge, dam, and utility construction. These instruments should include the laser level, total station, robotic total station, GIS, GPS, and the use of data collectors and computer surveying software.

Recommendations

While it is important that some of the more traditional surveying instruments like the automatic levels and transits/theodolites should still be taught in the Construction Surveying course, it is important that new instruments, which are being widely used in the construction industry today, should be incorporated into the course. It is recommended that the use of the new instruments be taught. These instruments should include, Auto Focus Levels, Laser Levels, Traditional Total Stations, Robotic Total Stations, Global Positioning Systems (GPS) and Geographic Information System (GIS) and appropriate field data collectors and computer software. This will give students an opportunity to gain proficiency in the use of these instruments. This can be achieved by:

- Incorporating the use of the new instruments in the syllabus of the current semester course in surveying, and/or,
- Teaching the use of the new instruments in a second course. This may be feasible for the programs teaching two semester courses in surveying.

Instruments selected for use, should include the state-of-the-art instruments for electronic surveying, which are being widely used in the construction industry.

Conclusion

The advances in Construction Surveying Technology have made available new surveying instruments and systems that are efficient, easy to use, and affordable. This innovative technology has caught on with firms of all sizes, making their surveying work easier, faster and more efficient. These instruments and systems include Auto Focus Levels, Laser Levels, Traditional Total Stations, Robotic Total Stations and Geographic Information Systems (GIS), Global Positioning Systems (GPS), and the use of field data collectors and computer surveying software. Owing to the wide use of these instruments and systems in the construction industry, there is a need to introduce students in the Construction Management Technology programs to these instruments since they will be the executors of projects in the future. In view of this, the Course Description and Curriculum for Construction Surveying Course of Study should be modified to include the use of new instruments and systems. In particular, the "Field-to-Finish" process should be adopted so that students can learn how to use data collectors in the field, transmit these data to a computer in the office, and by using appropriate software, produce required maps, plots and reports.

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Appendix

QUESTIONNAIRE ON CONSTRUCTION SURVEYING

1. General Information.

2. Please provide the following general information.

Name of Respondent: ____

Name of Institution: ____

Department: ____

Course Name: ____

Average Student Enrollment: _____________Number of credit hours: _______________

Recommended Text:____

____

3. Course Description:
   Please include a catalog description of the course:

4. Course Objectives:
   What are the objectives as listed in your course description?

5. Field Exercises:
   Please list Field Exercises undertaken in the course:

6. INSTRUMENTS

The following list of instruments is commonly used in surveying. Please indicate which of the following instruments you use in your program.

Directions: For each item, circle an appropriate response ‘YES’ or’ NO’.

Compasses	YES	NO
Construction (Dumpy or Wye) Levels	YES	NO
Automatic Levels	YES	NO
Laser Levels	YES	NO

Engineer's Levels		YES	NO
Transits	YES	NO	
Theodolites	YES	NO	
Electronic Theodolites	YES	NO	
Total Stations	YES	NO	

Please list below any other major instrument in use in your program:

7. RATING THE IMPORTANCE OF INSTRUMENTS USED

Direction: Please place a circle around the number of the appropriate response to signify what you perceive to be the level of importance of each of the instruments used in the teaching of construction surveying.
Scale for level of importance

1 = No importance
2 = Little importance
3 = Important
4 = Great importance

	level of importance (Circle one)			
Compasses	1	2	3	4
Automatic levels	1	2	3	4
Engineer's levels	1	2	3	4
Laser levels	1	2	3	4
Transits	1	2	3	4
Theodolites	1	2	3	4
Electronic Theodolites	1	2	3	4
EDMI (Electronic Distance Measuring Instruments)	1	2	3	4
Bolt-on Accessory Type EDMI	1	2	3	4
Total Stations	1	2	3	4

Others:

I will appreciate any general comments you may have concerning this questionnaire:

I appreciate very much your assistance, time and effort in completing this questionnaire.

Please return completed questionnaire to:

Dr. J. O. Arumala,
Department of Technology,
11931 Art Shell Plaza,
University of Maryland Eastern Shore,
Princess Anne, MD 21853-1299

Thanks for your cooperation

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Using the Learning Outcomes Template as an Effective Tool for Evaluation of the Undergraduate Building Construction Program

Flynn L. Auchey, Thomas H. Mills, & Yvan J. Beliveau
Virginia Polytechnic Institute and State University
Blacksburg, Virginia

Gloria J. Auchey
Lambton College
Blacksburg, Virginia

This paper describes the use of The Learning Outcomes Template (LOT) to perform continuous self-evaluation of a construction related academic program. This discussion is provided to help construction educators achieve their vision for their individual programs. Specifically documented is how the *LOT* is used in the horizontal and vertical integration of the Virginia Tech Building Construction curriculum. Learning Outcomes Template *LOT* described in this paper: 1) Provides the platform for a rational, dynamic approach for creating an effective applied academic model, 2) Helps to evaluate the balance between the construction education concepts of practical experience-based knowledge and academic inquiry, 3) Suggests how to integrate people and communication skills with the pragmatic building construction skills, and 4) Assists in assuring a construction program that maintains a strong identity while interfacing with Architecture and Engineering. Strategically, this template acts as a guide to the evolution of our curriculum as we weave vertical and horizontal integration into the curriculum of the Building Construction Department at Virginia Tech Results of the first year's use of the *LOT* are presented along with a description of the process, benefits, evaluation, lessons learned and recommendations for adaptation.

Key Words: Learning Outcomes, Building Construction Curriculum, Vertical Integration, Horizontal Integration, Construction Education, Team Building, Curriculum Development Tools, Curriculum Evaluation

Introduction

A primary goal of the Virginia Tech construction education program is to be a source for dynamic, practical and innovative building construction knowledge. The cornerstone of building a strong construction education curriculum is the balance between practical experience- based knowledge and academic inquiry. To accomplish this goal, construction graduates must possess technical strength combined with the people and communication skills necessary to be successful in the global construction industry of the 21st Century.

At a time when many universities are being asked to do more with less, a challenge has been tendered which forces us to re-evaluate the way we do business. Faculties are smaller, student populations are growing and graduate programs are added without the benefit of added resources. No longer can universities continue with "business as usual." This environment has created an opportunity not only to examine the program's curriculum but also to implement changes that strengthen the educational mission. New methodologies and tools are needed to accomplish this mission. Strategically, this is being accomplished at Virginia Tech by adjusting the current curriculum to provide for vertical and horizontal integration of the learning experiences in all Building Construction student course-work. The Learning Outcomes Template (LOT) is becoming a valuable tool in this process.

The *LOT* is a matrix showing which learning outcomes are addressed in each course; it also indicates the degree of emphasis placed on that particular outcome. The result is a grid showing when the students will acquire specific competencies and skill sets throughout their undergraduate course of study. (See Appendix A)

The *LOT* is being used to help us communicate as a faculty and make informed decisions as we attempt to:

- Develop a dynamic, practical, applied academic model,
- Balance the construction education concepts of practical experience-based knowledge with academic inquiry,
- Integrate people and communication skills with pragmatic building construction skills,
- Maintain a strong identity within the university and the industry.

How the *LOT* Fits in with the National Perspective

The concept of curriculum integration has been talked and written about for numerous years. L.T. Hopkins (193 7) described the concept of curriculum integration as a means of fostering unity between the learning process and the learner. What occurs through "integration" is the melding of the learning process with student behavior. That is, knowledge is enhanced through experience, which, in turn, poses new challenges. These challenges generate further academic inquiry, thus completing a highly integrative cycle. The Virginia Tech Building Construction curriculum evolution process utilizes the *LOT* as a tool in horizontal and vertical integration to assure the fusion of theory and practical application. In so doing, we can plan for this cycle to be self-directing; the learner becomes the teacher in an extended learning environment, i.e. beyond the classroom and independent of the professor. In this way, the essence of construction education, that of self-directed problem solving, can be accomplished.

Educational reform requires that we emphasize "multidisciplinary content, teamwork and communications, hands-on and laboratory experiences, open-ended problem formulation and solving, and examples of 'best practices' from industry" (Synthesis Strategic Plan, 1995). The *LOT* helps us to plan for these emphases.

Construction education and the construction industry may be unique in that the focus has always been pragmatic problem solving in team-oriented situations. Virginia Tech's Building Construction Department has been unifying experience and academic inquiry through its senior capstone course for twenty years. We are now integrating that experience across the curriculum in a vertical sense, i.e. build teams comprised of sophomores, juniors, and seniors.

The philosophical foundation of creative problem solving has aroused National Science Foundation interest and industry support, which led to establishment of the Synthesis Coalition.

(Synthesis Strategic Plan, 1995) It is noteworthy that a major component of the Synthesis Coalition's mission is to develop a multidisciplinary "Bridging the Architectural/Engineering/ Construction Gap" curricular sequence. It can be suggested that the Coalition look at existing construction education models already bridging this "gap" using **vertical** integration. Vertical integration relates to the process of actively involving students, from freshmen to seniors, in an undergraduate capstone project.

Project Succeed, a consortium of nine southeastern universities engineering programs, is also being funded by the National Science Foundation. This funding is directed at developing a "system for creating transparent boundaries and methods for integration between courses, departments, schools, and colleges, and institutions within the academy." (Project Succeed Strategic Plan) This has led to many engineering programs exploring horizontal integration of the curriculum.

The April 1995 Journal of Engineering Education devoted a third of the issue to discussion of curriculum integration. Much of the literature discusses the concept of an integrated senior capstone course stressing participatory learning and creative problem solving. (Lonsdale, Mylrea, and Ostheimer; 1995; Lumsdaine and Lumsdaine 1995; Wilczynski and Douglas). Missing from the literature, however, is an example of integrating students of multiple skill and academic levels in a common capstone experience with a common, open-ended, problem-solving task. Having developed and directed a participatory senior capstone course for twenty years, the Virginia Tech Building Construction Department considered vertical integration of the experience to be the next logical stage of development. We are confident that teams of learners who focus on specific tasks will actually teach each other and, thereby, create a successful, problem-solving learning environment. Indeed, research indicates that cooperative learning increases productivity, fosters complex problem solving, and 'cements' the learning for the individual as well as the group. (Johnson, 1995)

Our philosophy and approach are, thus, consistent with current academic strategies to shift the paradigm of academic thinking in the technical/managerial fields to non-linear right brain pervasiveness. (Lumsdaine and Lumsdaine, 1995) Industry is aware of the need for communicators and creative problem solvers in a long-range global society. The university educational system is responding to this charge by a shift in educational philosophy that prepares students to solve problems successfully with dynamic and less-than-complete information, a strategy construction educators teach and construction professionals apply on a daily basis.

The Use of the *LOT* in the Horizontal and Vertical Integration Process

Continuous quality improvement requires a contemporary Building Construction program to look within both the university and its own program and to the construction industry for mechanisms to achieve its objectives in more efficient ways (Auchey, 1989). The *LOT* provides a blueprint for creating a horizontally and vertically integrated Building Construction Program. In order to comprehend how the *LOT* Matrix works, it is important to understand the concepts of vertical and horizontal integration.

Vertical integration relates to the process of actively involving building construction students, from freshmen to seniors, in an undergraduate capstone project.

To accomplish vertical integration, the Virginia Tech program organized and scheduled theory-based BC core major courses in the fall and then the followed-up with application courses in a common lab experience for all BC students in the spring semester. In this way, first semester students learn concepts they can use in the following semester's integrated lab. In the common lab period, all sophomore and junior students worked in teams directed by a senior working on a capstone project. For this first year of implementation, the freshmen were observers.

Horizontal or cross integration relates to the process of assuring that all information presented in support courses, (engineering, communications, math, business, etc.) relate directly to skills being developed in the BC core major courses. The concept of horizontal integration also uses the larger context of the university to provide BC support courses for undergraduates in other curriculums.

To accomplish horizontal integration, the construction curriculum examined its goals and objectives along with all courses necessary to achieve these goals. Figure 1 provides a flow diagram of the BC curriculum investigation. We then examined the existing curriculum to determine the strengths established in the courses already being taught. (Figure I shows where the *LOT* Matrix comes into play in this process) Indeed, in many cases, it was simply a matter of fine timing existing course content to allow for vertical and horizontal integration. The *LOT* became the common tool to accomplish this tuning process. In a few cases, it helped us to determine that major revisions were required, depending on the program goals and mission.

Our goal at Virginia Tech has been to retain a strong technical emphasis based in engineering skills, balanced by practical business and managerial skills; revisions based on the *LOT* have helped us to keep focused on that goal.

The following diagram shows the Horizontal and Vertical Integration Process using the *LOT* as a self-evaluation tool.

Horizontal integration requires close coordination and acceptance by departments outside the construction core courses. BC core courses are taught by BC faculty, but support or service courses are taught by other departments.

This task was accomplished by working closely with departments teaching support courses, such as Math. We provided appropriate physical examples of abstract concept problems for BC students in these courses. This helped the students to relate to the value of the abstract information being discussed in the support course within the context of its value to them as a building constructor. This collaborative approach to course delivery used facilities and faculty more efficiently, especially since Virginia Tech has strong engineering and business courses.

The acceptance of the concepts of horizontal integration by the support departments has been very positive to date. We have been able to focus student-learning experiences in courses outside

BC. Further, support course faculty have become more familiar with our program and student needs.

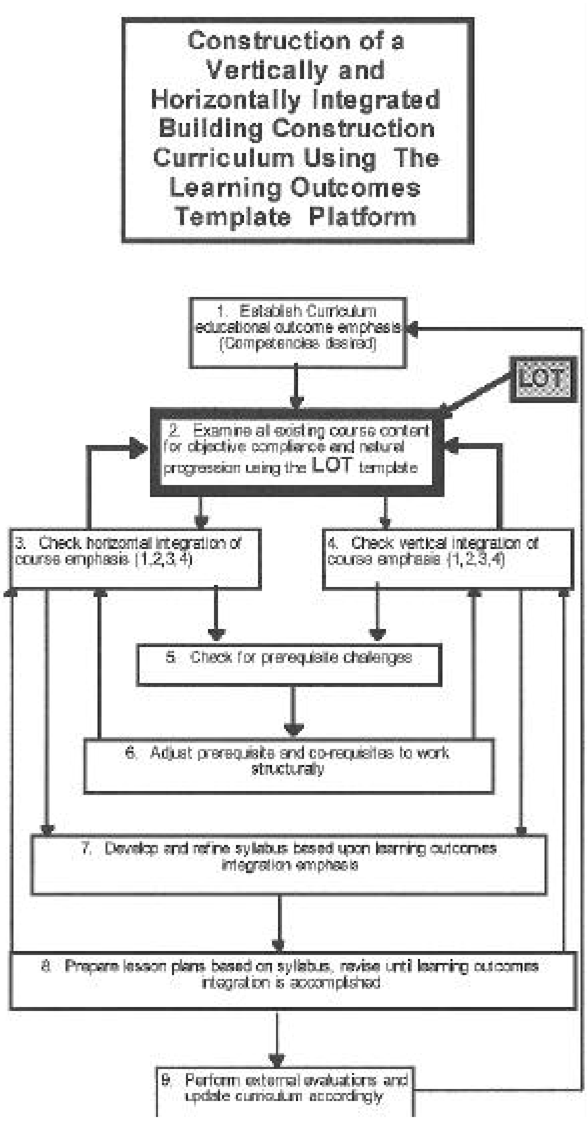

Figure 1. Flow process for implementing the *LOT* in the development of an integrated curriculum.

Vertical integration requires the determination of the learning outcomes expected to be achieved within the BC curriculum core. These competency and skill sets formed the basis for the matrix of the *LOT.* These competencies or outcomes are used to establish course objectives. They are the necessary link between program goals and course objectives.

The re-alignment of BC course emphasis has allowed us to split some of the higher credit courses into lower credit courses. One of the overall effects was a reduction of BC curriculum credit hours from 136 to 134 without a decrease in course content or knowledge transfer.

In addition, the realignment has provided an opportunity for non-BC students to participate in BC core courses, which has increased BC enrollment from non-BC curriculums, including architecture, civil engineering, mechanical engineering, technology education, business management, and interior design. This precipitated the offering of a minor in Building Construction.

Four-Level Progression of Competency Evaluation in the *LOT* Matrix

The *LOT* is used to enhance, coordinate and focus each course and, thereby, ensure each students progress through four levels of skills acquisition: 1. philosophical, 2. competency, 3. proficiency, and 4. mastery. The *LOT* (Appendix A) was prepared for each core course and coordinated as a matrix within the curriculum to confirm, verify and correct course placement, content and focus.

The curriculum competencies were organized in a systematic format that allowed both horizontal and vertical progressions in the student's development toward the mastery level of the professional constructor. Student competencies are achieved by a coordinated progression through all four levels of skills acquisition.

The following presents our approach to the development of this progression in the *LOT* Matrix. Note that the description of each level is based on the type of job this level of student/worker would perform (especially in the integrated capstone lab project). Suggested components are also listed.

Level 1: Philosophical (Preparatory Foundations)

Description

This level establishes a fundamental understanding of the "Why" and "How" aspects of the construction industry.

Components include:

- Attitudes and Ethics
- Educational Background and Assessment of Previous Knowledge (beginning skill sets)
- Personal Background and Evaluation of Commitment
- Foundation Courses in Preparation For a Career in Construction.
- Communication Skills i.e. effective oral and written communication
- Basic Procedures on the Job Site

Level 2: Competency (Construction Course Knowledge Development)

Description

This level emphasizes jobsite skill sets needed by a professional constructor.

Components include:

- Basic Construction Concepts (in and out of construction emphasis)
- Basic Construction Vocabulary (understanding and use)
- Using Problem-Solving (as it relates to industry: beginning case studies)
- Means and Methods of construction
- Basics of communication methods in construction, including oral, written, and graphic formats

Level 3: Proficiency (Practice and Application In- and Out-of- Class)

Description

This level applies the skill sets of a beginning project manager who works with contractors, sub-contractors and owners.

Components include:

- Mentorship Preparation -- Application of Theory -- Case Studies at Site
- Problem-Solving at Applications Level (Construction Case Studies)

Level 4: Mastery (Analysis, Evaluation and Controls)

Description

This level prepares the student with the skills to fully integrate his/her knowledge in a meaningful, real-life situation. These skills will prepare Building Construction graduates to be immediately productive for their employers as project managers or site supervisors. This level also prepares graduates for continuous learning in a changing workplace environment.

Components include:

- Internships or Mentorships--Full Integration of Theory and Practice at the Project Management Level
- Problem-Solving at the Analysis and Evaluation Level
- Control Mechanisms Used by the Construction Project Manager
- Project Team management and evaluation

Implementation Process for the *LOT*

Every Building Construction Curriculum is going to have a personality unique to the educational philosophy of its base institution. The curriculum evolution process, however, has many similarities at all institutions. The *LOT* can be helpful in addressing those similarities. For that reason ' the following process is suggested:

1. Accurately identify and mutually agree upon the Mission and Goals of your curriculum.
2. Review your current course offerings for a natural pattern of competency development both horizontally (between support courses and core) and vertically (within core courses). Place the core courses along the horizontal axis of the *LOT*.
3. Determine the competency and skill sets that are required to be consistent with the mission statement and the goals of the curriculum. Place these along the vertical axis of the *LOT*.
4. Discuss and agree on the meaning and intensity of the levels of skill and competency development, i.e. philosophical, competency, etc. Use descriptors with meanings that describe what you want THE STUDENT to DO in your curriculum.
5. Have each faculty review his/her specific courses; identify the skills and competencies to be addressed in each course and determine to what level each is going to be developed.
6. Put together the composite *LOT* Matrix combining all of the faculty responses on one template. (See Appendix A)
7. When this Matrix is first completed by all faculty, certain discrepancies, omissions, overlaps and misinterpretations will become obvious. The real value of the *LOT* now becomes apparent. It becomes a dynamic, graphic reflection of your faculty's perceptions about the make-up of the current curriculum status. Fine-tuning can be undertaken with a clearer sense of curriculum goals and objectives.
8. Re-evaluate on a regular basis as new insights on course content and structure are discovered. Now is when the real self-evaluation begins.

The Virginia Tech Building Construction department made the following observations during the first year of implementation:

- You may be expecting that certain competency development has been accomplished in prior courses, when, indeed, it has not. That is, students may not have been exposed adequately to the concept in their previous courses.
- On the other hand, you may find that you are, in fact, doubling up on certain competency development when it may not be warranted.
- You may be expecting too high a level of accomplishment in several of the competencies or skill sets. The *LOT* can identify whether the competency was addressed in a previous course to the required level. (All of these conditions are time and quality wasters.)
- You may find that faculty members have a better basis for understanding what is expected to be taught in each course. They will probably find that they have different expectations. This is important for improving not only the inter-university, but also the inter-departmental communications process.
- Discussions between the faculty will slowly bring a better focus to the course content and better compliance with the curriculum goals.
- When there is collective agreement on the exact content and expectations for each course, the individual course syllabus can be re-written incorporating the expected learning outcomes.
- The revised syllabus can then be used to determine the course schedule and specific lesson plans.

This is not a 'one time' exercise; rather, it is a continuous quality improvement process.

Revisions to the BC Curriculum Model resulting from Use of the *LOT*

Motivation to improve Virginia Tech's Building Construction curriculum grew from the fact that BC students took no BC core courses in two of the eight semesters in residence. This caused the student to lose touch with the faculty, student associations, and fellow BC students for 25% of their time in the construction program.

This situation, coupled with our desire to provide the finest full time undergraduate construction program, precipitated the use of the *LOT* in the development of the vertical integration in our undergraduate courses.

Appendix B presents a graphic representation of the present integrated BC curriculum. This chart shows the central curriculum core composed of BC courses supported on one side by science, math and engineering courses and the other side by communication and business courses. Course prerequisites and co-requisites are linked based on competencies. Each of the core courses is designed and developed systematically using the learning outcomes (competencies) as an organizational tool defining content and competency.

The BC core courses are organized to provide BC student contact hours every semester and to provide a combined integrated lab in each spring semester. This lab is intended specifically for BC undergraduates and occurs at a common period to facilitate participation of all BC students. Teams must have representatives from each year, with a senior as a project leader. In this way, a senior facilitates the learning process for lower division students while enhancing his or her own knowledge and management experience.

It should be noted that the present curriculum has decreased the number of credit hours in BC core courses by 2. We were also able to respond to one of the recommendations of a successful re-accreditation summary by decreasing the amount of Math (Differential Equations) by 3 credits and re-assigning those 3 credits as a Directed BC elective.

Opportunities and Benefits Derived from the Use of the *LOT* Matrix

Opportunities and benefits derived from a fully integrated curriculum include, but are not limited to, the following to date:

- Proper competency emphasis is being introduced at the most effective time and place in the overall curriculum
- There is less chance of missing or unintentionally duplicating key concepts in the overall course syllabus.
- Continual evaluation of curriculum relevancy occurs, particularly concerning pre-requisites and co-requisites
- The BC faculty has a common platform upon which to discuss specific course goals and content (While the *LOT* Matrix does not tell everyone specifically what you intend to cover in a course, it does provide the means to highlight specific competencies and skill sets you intend to address)

- Students learn by teaching each other in the team-driven integrated lab.
- Conceptual and philosophical reinforcement of technical knowledge is accomplished.
- BC students improve their leadership and team building skills.
- All faculty and facilities are used more effectively and efficiently
- A higher concentration of student time in Building Construction is placed on skills development to mastery.
- Programs can anticipate and even offset the potential negative effects of forced curriculum hour reduction.

In addition, we have experienced other noteworthy results using the *LOT* Matrix in the integrative approach. We have found that use of the *LOT* can:

- Guide the process of evaluation and change so we do not have change for change sake but true continuous quality curriculum improvement.
- Precipitate the development of progressively more difficult problem solving skills at the appropriate levels of curriculum progression.
- Overcome the "If it ain't broke don't fix it" resistance that some faculty, administration, and alumni might have.
- Recognize and capitalize on increasing skill levels to teach management, leadership, and team building skills.
- Engage the entire BC undergraduate population in an integrated lab in a way that reinforces the skills being acquired at each individual's level of ability.
- Provide a guide for improving the combined effectiveness of faculty team-teaching efforts.
- Help students understand the natural process of information acquisition throughout their academic experience.
- Help students to learn and better retain knowledge by being involved in the teaching process.

The *LOT* as a Continuous Quality Improvement Evaluation Tool

The final aspect necessary to implement a vertically and horizontally integrated curriculum is to create tools and mechanisms for continuous evaluation and feedback. Evaluation at Virginia Tech is intended to occur both internally and externally. To make this work, the faculty will continually be asking each other, "Is it working, and how do we know it is?" The *LOT* is an ideal tool for each faculty member to use as he/she evaluates what should be taught to what degree of intensity in each course. In addition, the *LOT* can provide external entities, including accrediting teams, with an appropriate means of assessment.

Internally, we use the *LOT* as a check on decisions regarding what and how much we should be covering in each course. We can use it to record responses from interviews with our students on how they perceive the value of the course content. Perception of the user is an important component of any evaluation. Using hierarchical levels of skills in the vertically integrated labs will encourage multiple perceptions from both novices and experienced students. One unique component of the evaluation is that it deals with what the student learns as well as with what the student is able to teach.

Externally, we will be soliciting follow up responses from graduates and their construction industry employers relative to the quality of the preparation of the graduate to be successful on the job. The competency and skill levels addressed in the *LOT* make an ideal basis for discussion with employers about what they think the students should be learning while in school. The intensity levels achieved in each course provide a better basis for the employer to understand what a student should be capable of performing upon graduation. Indeed, employers will be able to pick up and continue the development of the graduate from the very onset of employment.

The *LOT* will be an invaluable tool for the ACCE accrediting team to assess comprehensively what, when and how the material is covered. The Matrix shows clearly what competencies are being addressed in each course and to what level of intensity. Further, ACCE feedback will mean more to the faculty as it relates to the modification of specific course content.

Conclusions and Lessons Learned Using the *LOT To* Date

Communication is the key to success in making the changes required for successful vertical and horizontal curriculum integration. The *LOT* Matrix provides an ideal communication platform for making sure all faculty are saying what they mean and understanding the same information about each course. The faculties involved will almost always come to the curriculum-planning table from different perspectives because of their background and differences in personality styles. The tendency is, at first, to try to force everyone into a common mold of curriculum change acceptance. This approach is loaded with negatives, which can and probably will, put valuable minds at odds with each other. It is far better to accept the differences in teaching approaches and styles and capitalize on those differences by approaching the changes on a step-by-step basis, evaluating and adjusting as you go. The *LOT* helps all personality styles understand the content and emphasis in a course using a common communication platform. If your approach is correct and positive results are being experienced, the faculty will probably enter into and continue to support the integration process using the *LOT* with a more constructive spirit. The results of encouraging differences to surface and be tested should prove to be a very positive experience if everyone involved feels that his/her input has been considered honestly and fairly.

Using the *LOT* to discuss the competencies and skills emphasis proposed in each course with the students affected is also paramount. Their feedback is an important part of the communication process. Change in any form is stress producing. Knowledge about the reasoning behind the change is very important for the students affected; they will be better equipped to adapt to and enhance the change. The *LOT* Matrix should help them see the logic of the flow of competency and skill development throughout the curriculum.

Be careful of the amount of change you undertake at any one time. Small steps are better than grand leaps, especially when students are involved. Much valuable information and feedback from the students will occur particularly when difficulties arise or student expectations are at odds with course content. We expect to get even more good feedback as we integrate the juniors into the process. The early responses of the sophomores and seniors ranged from resistance to anger at being used as the 'guinea pigs in this first integrated lab'. Fortunately, because we only involved two of the classes, the magnitude of the change and corresponding stress was manageable to the extent that the students once provided with reasons they could believe in, were very supportive of the changes. The net results were new or renewed energy emanating from the two classes involved, improved support for the program and lab, and increased enrollments from outside related disciplines.

Plans calling for integrating the freshman and Junior classes in 1997 have been modified based on the first semester's trial integration experience. We now plan to actively involve only the juniors and sophomores in the integrated lab; the freshmen class will be involved only as observers to team presentations. This will give them an idea of exactly what a building constructor does prior to their entering the sophomore year; this should help address the challenge of student confusion regarding their chosen profession. Information regarding the reasons and benefits of the integration are already being transmitted to all classes formally in writing and informally by 'word of mouth'.

The restructuring of the BC core courses enabled us to offer a minor in Building Construction; this minor program is now in place and has received candidates from Architecture, Mechanical Engineering, Business Administration and Civil Engineering.

The benefit of splitting large credit hour courses into two courses, one each semester, has improved communications between the classes and the faculty. The students have more contact time with their fellow students, both in class and in extracurricular activities like the Construction Consortium (a composite of memberships in several construction related associations such as AGC, NAHB, ABC, etc.

One of the benefits of the horizontal integration effort has been the development of a process for providing the Math Department with physical examples of construction related problems that demonstrated the application of abstract Math concepts. During this process, the BC faculty concur-red that they were hard pressed to find a valuable application for differential equations theory in the BC Curriculum. This meant one of two things: either there was no need for the Differential Equation competency or we are not expanding the BC skill set sufficiently to be presenting coursework that requires the use of Differential Equations. We decided that there is probably no need for our students to be taking Differential Equations. The ACCE accreditation team came to that same conclusion after reviewing our curriculum mission statement. The net result was that we discontinued the requirement for Differential Equations and created room in our curriculum for another directed elective related to the business of Building Construction. For those programs facing credit hour cutbacks, using the *LOT* to make these hard decisions is a worthwhile exercise.

A vertically integrated capstone lab requires extensive preparation. If your program is considering this type of activity, identify and start preparations for the capstone project as far in advance as possible so that all the necessary documentation, course syllabi and support materials are coordinated and available when needed.

Finally, and most important, *time is of the essence* when making the change to the vertically integrated curriculum. Initially, much more time is required of the faculty and students to accomplish the integration. With additional experience, this initial time investment will be repaid by other economies, such as the time saved by having the students teach and mentor other BC students.

In conclusion, everyone has to be aware of the benefits going into this process. The basic rules still apply:

- People do things for their own reasons, not yours. Therefore, everyone has to buy into this process for his/her reasons. You may have to help your faculty and students find those reasons.
- People do things to avoid pain or to gain pleasure. Therefore, if you are going to be successful in your attempts to integrate your curriculum, you may have to help the people involved find the pleasure and avoid the pain of the process.
- In short, the emphasis in re-engineering a curriculum needs to be placed on building better linkages, rather than on implementing shortsighted cost cutting measures. The *LOT* can be an invaluable tool for improving communications between those linkages.

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Appendix A

Analysis of Competency and Skill Development Emphasis Across Building Construction Program

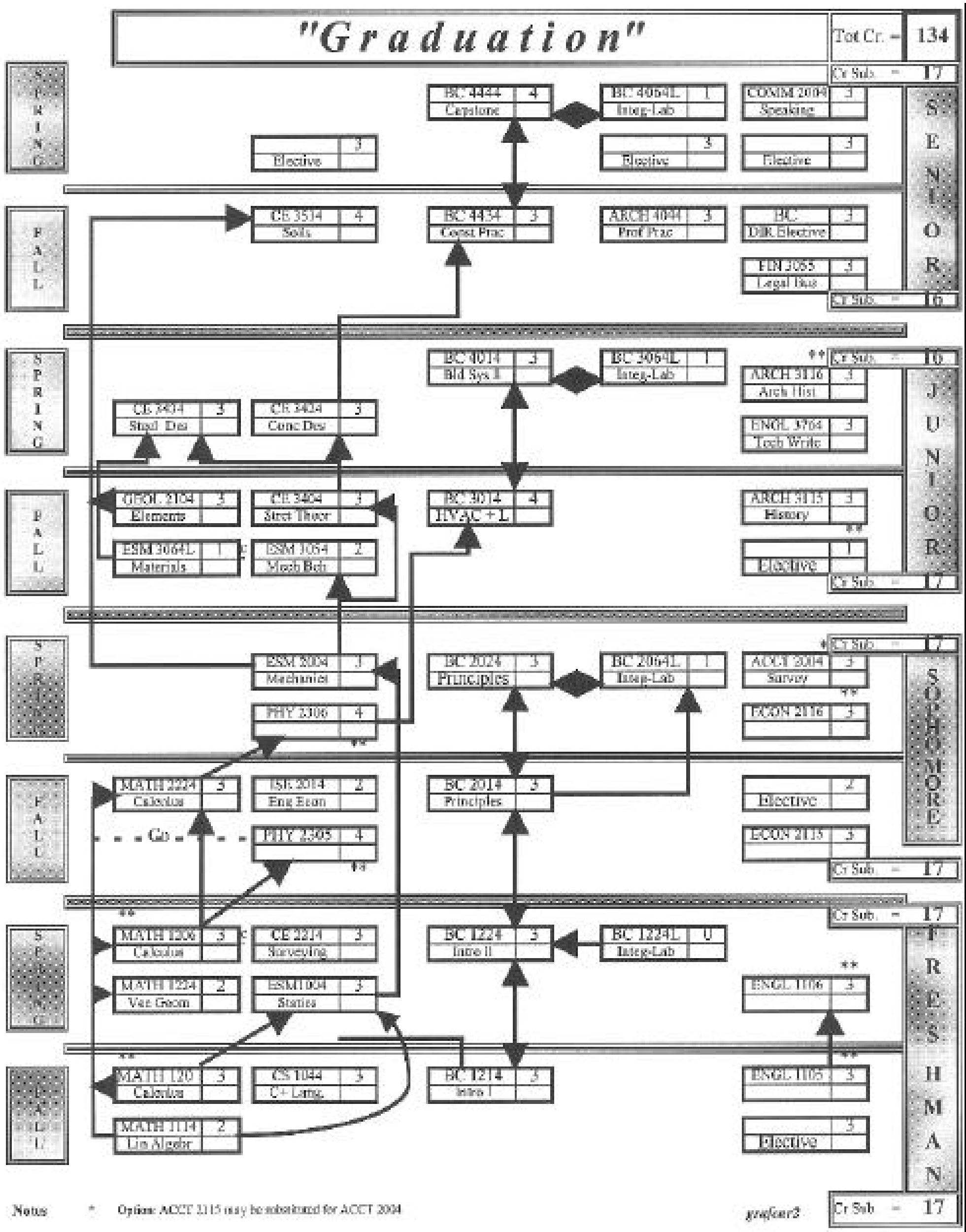
LOT Worksheet	Building Construction Core Curriculum												
Levels of Student Learning Expectations in the course 1. Has attained a Philosophical Foundation 2. Has attained a level of Competency 3. Has attained a level of Proficiency 4. Has attained a level of Mastery	BC 1214 Intro to Bldg Const I	BC 1224 Intro to Bldg Const II	BC 1234 Integrated Lab	BC 2014 Construction Principles I	BC 2024 Construction Principles II	BC 2064 Integrated Lab	BC 3014 HVAC	BC 4014 Building Systems Technology	BC 3064 Integrated Lab	BC 4434 Construction Practice I	BC 4444 Construction Practice II	BC 4064 Integrated Lab	Expectation Level at Graduation
Skills and Competencies													
Building Sciences													
Be Familiar W/ Construction Materials	1	1		2	2	2	2	2	2			3	3
Understand Const. Mech. & Elect Systems				1	2	2	3	3	3			3	3
Design/Analyze Building Structures		1			2	2		2	3			3	3
Understand Influence Of Bldg. Codes		1		1	2	1	2	2	2	2	2	2	2
Means and Methods													
Understand Const. Language & Methods	1	1		2	2	2	2	3	3		4	4	4
Be Able To Select Bldg. Sys. & Comp.		1		1	2	1	2	2	2			3	3
Accurately Interpret Project Specifications	1			1	1	2	2	3	3			3	3
Be familiar with Temporary Structures		1		1	1	1		2	2			2	2
Accurately Interpret Construction Drawings		1		2	2	2	2	3	3			4	4
Project Control													
Structure and Maintain Project Controls			1	1	1	1		2	2	3		3	3
Develop Project Budgets			1	1	1	1		2	2	3	3	3	3
Apply the Process of Project Scheduling		1		1	2	2		2	2	4	3	3	3
Apply the Art of Project Scheduling				1	1	1		1	1	2	2	2	2
Coordinate Overall Project Activities		1				1		1	1	2	2	3	3
Performance Improvement													
Use effective Graphical Communications	1	2		2	2	2		3	3	3	3	3	3
Communicate Well Orally & In Writing		1		1	1	2	2	2	2	3	3	3	3
Implement Continuous Quality Control				1	3	1		2	2	2		2	2
Applying Team Building Principles		1		1	2	2	2	3	3	3		3	3
Apply Decision Making Skills					1	1	1	2	2	3	3	3	3
Apply Value Analysis Concepts (LCC)			1	1	2	2	2	3	3	3	3	3	3
Labor Management													
Understand Principles of Managing People				1	1	2		2	2	2		3	3
Apply Safety and OSHA Requirements		1		1	1		1	1	1	2	2	3	3
Understand What Motivates People				1	1	1		1	1	2		2	2
Field Operations													
Coordinate Project Disciplines				1	1	1	2	2	2	3	3	3	3
Control Material Delivery & Handling			1	1	1	2		2	2	3	3	3	3
Expedite Purchase Orders & Subcontracts			1	1	1	1		2	2	3	3	3	3
Handle Shop Drawing Procedure		1		1	1	2		2	2		3	4	4
Identify Elements of Project Risk		1		1	1	1		2	2			2	2
Comprehend Project Closeout Process			1		1				1	2	2	2	2
Estimating													
Compile Project Information	1			2	2	2		3	3	4	4	4	4
Perform Quantity Take-off	1			2	2	2		2	2		3	3	3
Understand the Art Of Estimating		1		1	1	1		2	2		2	2	2
Assemble and Manage The Bid Process	1		1		1	2		2	3	3	3	3	3
Apply Computerized Estimating				1	2	1		2	2			2	2
Company Operations													
Understand Const. Co. Financial Mgmt.	1	1			1	1		1	1		2	2	2
Coordinate Governmental Reviews		1						1	1	1		1	1
Use Computerized Spreadsheets	1	1		2	2	2	3	3	3	4		4	4
Use Word Processing System	1			2	2	2	3	3	3	3		3	3
Understand Components of Leadership				1	1	1		1	2	2		2	2
Understand Apply Professional Ethics	1			1	1			1	1	2	2	2	2
Understand Construction Contract Law				1	1	1				1	1	1	1
Be Familiar With International BC Issues		1			1			1			1	1	1
Understand Principles of Negotiation				1	1	1		2	2			2	2
Total Emphasis in This Course	11	21	7	43	54	57	31	83	86	70	52	115	115

LOT worksheet

RLA 02/25/97

Appendix B

Building Construction Program of Study for:



Notes

* Option: ACCT 2115 may be substituted for ACCT 2004

** Satisfies university core curriculum requirements

1. 18 credits of electives are included in the 134 total credits required. They are to be selected as follows:

   6 - credits of Free electives (of which 3 cr shall meet Area #7 and 1 cr shall meet Area # 6); see University Core Curriculum Guide.

   9 - credits from Business and Management electives (may not be taken as pass/fail)

   3 - credits of a Directed BC Electives to be selected in conference with your advisor

2. BC students shall meet University progress requirements

3. Core Requirement: Foreign Language: The student shall have earned (2) units of a single foreign or classical language in high school or (6) credit hours of same at the college level, or have passed an equivalency exam (in addition to the total number of credits required for graduation)

Advisor:__________________ 02-25-97

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A Model for a Quality Safety Program

Farzad Shahbodaghlou and Ronald Haven
Bradley University
Peoria, Illinois

The construction industry is one of the largest industries in the world, both in dollar volume and in number of people participating. As a result of the number of participants and due to the inherent danger in the work involved, it is also the industry with the highest accident and injury rate. With rising insurance costs and the increasing threat of injury related lawsuits, many companies find it difficult to compete, or even survive, in this highly competitive industry. The purpose of this research project is to illustrate how basic Total Quality Management principles can be used in developing a health and safety plan that any typical construction company could adopt and implement.

Key Words: Total Quality Management, TQM, Construction Safety, Quality Safety Program

A Model for a Quality Safety Program

Total Quality Management (TQM) is a management tool involving strong commitment to two basic principles: customer satisfaction and continuous improvement.(3) There are a number of elements common to most TQM programs as follows:

- The senior management of the company are strong supporters of TQM and completely understand its functions and values. They are willing to commit resources, especially for training, to implement the program.
- Employees have more say in how work gets done and they are encouraged to participate in the decision-making processes that affect them. They know they are welcomed, even encouraged, to make recommendations and observations at any time. In addition, they are encouraged to question policies and procedures that prohibit them from doing their job properly.
- Employees receive training in quality awareness. Technical training is provided to improve existing skills and develop new ones.
- Middle management understands the value of a well informed, highly competent, trained and motivated work force. They are trained to relinquish some of their power and behave more as coaches or mentors.

The end result from a successfully implemented TQM program within a company is increased customer and employee satisfaction, better relationships with other members of the team, lower cost of doing business, less litigation and a better prospect of being in business in the future.

The same TQM principles can be integrated into a health and safety program regardless of whether a company has implemented an entire TQM program. The most important aspects are for senior management to recognize the need and value of a well-implemented quality safety plan, be a strong advocate of it and sell it to the employees to make them realize the need and value of it. Just as with a TQM program, everybody must constantly strive for improvement. With respect to safety, the goal should not be to have less accidents and injuries than the previous year, but, to have zero accidents and injuries every year. An important feature of a quality safety program is to be proactive in preventing accidents by training employees in safety awareness to identify potential hazards and prevent accidents before they happen.

Quality Safety Program Model

Contained herein is a proposed model for establishing a Quality Safety Program. Figure 1 gives a simple overview of a typical program and the subsequent figures provide greater detail to each section of the program. All the figures will be discussed in detail. Everything discussed throughout this model is recommended or proposed. Any company that chooses to use this model will find items that may not necessarily apply to their company or may determine that some of the items need to be molded to fit their company.

Management takes the lead role in establishing a Quality Safety Program. Notice in Figure I that the first two actions are developing a mission statement and committing resources. By commencing with these two steps, management has already determined its commitment to improvements related to safety performance. The mission statement is created to provide direction for the safety program. It is simply a level of achievement to strive for. It should be a realistic and attainable objective, such as eliminating all lost time accidents and injuries. Even though a desirable goal is to eliminate accidents and injuries altogether, lesser, intermediate benchmarks should be established as a way to measure improvement.

The next step for management is to commit the resources necessary to develop and carry out the Quality Safety Program. The initial commitment should be to name a Company Safety officer and provide him the freedom to set up and administer the entire safety program. Upper management should remain involved in developing and approving the company safety program, but the administration of it should be left to the Company Safety officer. Putting the safety plan into operation is not a quick and cheap endeavor. Depending on the size of the company, it could take a year or more to get the entire staff trained and familiar with the safety program and teach them what is expected of them. With a resource commitment of this magnitude, management's dedication to the Quality Safety Program should become apparent to the employees of the company.

The next step by management is to determine where their most serious problems are. All companies are required by law to maintain OSHA 200 logs that record injuries and accidents that occur during each year. This log can be used to review the company's safety performance on a quarterly basis, as a minimum, and project whether goals will be met by the end of the year. If it appears that the safety objective may be met if the current trends continue, the indications are the safety program is succeeding. If it appears that the safety objectives will not be met, two things must be considered; first, are the objectives of the mission statement realistic, and second, how does the current safety program need to be revised?

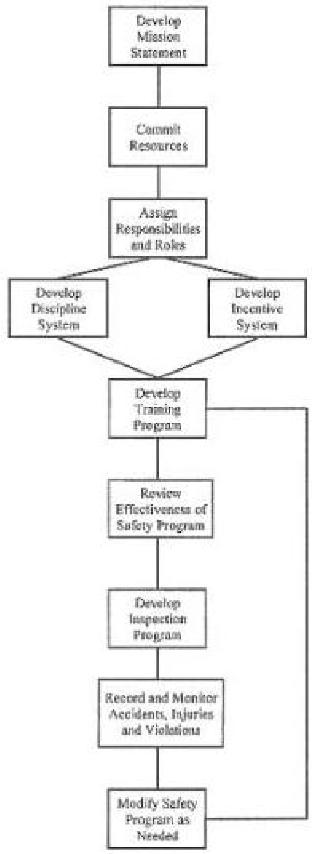

Figure 1. Overview of a typical program.

Information to revise and modify the Quality Safety Program must be compiled continuously, but formal changes to the program should be limited to only once or twice a year. The more frequent the changes, the more confusing the program becomes. The information from the OSHA 200 log can be used to look for trends in the accidents and injuries. Factors such as type of tasks, weather, time of day, time of year and type of equipment used may reveal areas of the safety program to address.

Roles of Management

Referring to Figure 2, additional management functions can be seen. The next step is to assign roles and responsibilities to individuals within the company with their functions stated clearly within the safety program. As was discussed earlier, the most important role is that of Company Safety officer. His/Her primary responsibility is to develop and administer the safety program. It is essential that he/she has the authority to manage safety in the best interest of the company. Other roles and responsibilities are discussed later.

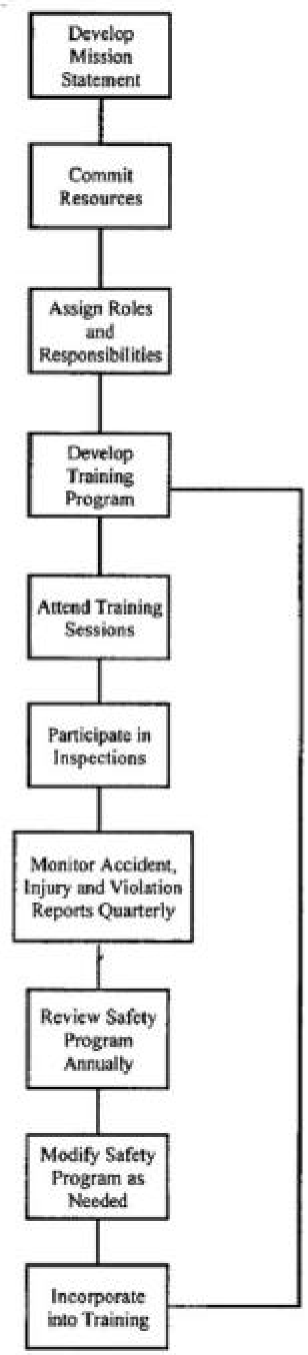

Figure 2: Role of management

The next step, led by the Company Safety officer, is to develop the training program. The training program should consist of a general review of safe work practices, specific training in areas where accidents and injuries historically occur, specific training in unique work activities and regularly scheduled training refresher classes. The training program should follow the guidelines required by OSHA's Occupational Safety and Health Standards for the Construction Industry, 29CFR Part 1926.

The next two steps are management's attendance in the training sessions and management's participation in inspections. These roles are important for two reasons. First, they illustrate their commitment to the safety program by involvement. Second, management receives valuable background information in hazard recognition and abatement and aids in the evolution of the safety program. What follows next is the quarterly review of accident, injury and violation reports and the annual review of the overall effectiveness of the Quality Safety Program. Based on the results of these reviews, the safety program can be modified as needed. Then, as Figure 2 illustrates, any revision to the safety program is incorporated back into the training program.

Assignment of Roles and Responsibilities

Referring back to Figure 1 (and as briefly discussed in Figure 2), the next step is to assign the roles and responsibilities of individuals within the company. This is illustrated by Figure 3. The first and most important role to establish is that of Company Safety officer. His/Her function is to develop and administer the company's safety program. In addition, he/she is involved with the creation of the training program and site inspections.

Next, the company must decide how to divide responsibilities among field personnel. Some companies, especially smaller ones, elect to include the safety duties under the Site Superintendent. Other companies prefer to have a Site Safety officer on site. Together, the Superintendent and the Site Safety officer direct the progress of the project in a safe and efficient manner.

Led by the Company Safety officer, all the individuals involved in some aspect of safety need to provide input into the development of the Quality Safety Program. Whether it is through observations during inspections, accident and injury reports or accident investigations. Historical company records and the wide range of individual experiences and training provide the best sources of information during the formation of the safety program.

Two important elements of the safety program are the development of a discipline plan and a reward plan. The discipline plan is a method for handling those employees who disregard the safety policies and endanger other employees. An example would be a simple write up and hazard abatement on the first violation, a written warning on the second violation, possibly accompanied by an unpaid day off or termination on the third violation. The incentive plan can be used to recognize individuals who demonstrate good safety practices or safely accomplish an extremely difficult task. Incentive could include additional paid vacation, prizes or awards.
Once the safety plan is accepted by management, it is to be incorporated into the training program. In the training sessions, the employees are made familiar with what is expected of them as they perform their jobs from the safety perspective.

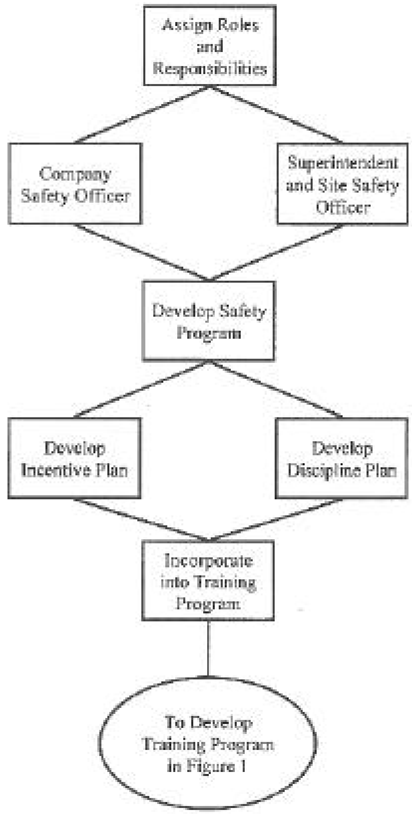

Figure 3. Roles and responsibilities.

Training and Education

The primary training guide to be used is The Occupational Safety and Health Standards for the Construction Industry, 29 CFR Part 1926 manual, which is published by the Occupational Safety and Health Administration.

Employee training is as follows:

- Management receives general, comprehensive training, updated as required.
- Superintendents receive general training, updated as required, and specialized training as specific tasks may require.
- Employees receive general training, updated as required, and specialized training as specific tasks may require.

Most formal training is required to be updated annually or every other year and it is a good idea to conduct a brief refresher at the onset of a risky activity. Usually, weekly "toolbox" safety meetings at the jobsite can serve this purpose.

Periodic monitoring of the OSHA 200 log, as described earlier, is a good indicator of the success of the training program. Reoccurring accidents will point out areas needing more rigorous training. In addition, when there is a particularly dangerous or highly unusual task to perform, a Job Safety Analysis (JSA) is a very helpful training tool. The superintendent or their employees actually performing the work will review the activity by describing in detail each step of the activity and the problems and hazards expected to be encountered. They will then meet with the Project Manager and Safety Coordinator to review the JSA and the entire activity. The discussion will include preparation for the hazards to be encountered, as well as how to deal with various problems they may face. Alternate methods to perform the activity are also investigated.

Referring back to the overview of the safety program in Figure 1, the next action is to develop a training program. Figure 4 illustrates the training in greater detail. As previously discussed under the category of roles and responsibilities, the training program is developed as part of the Quality Safety Program by the Company Safety officer and endorsed by management. Upper management then receives comprehensive training while the Superintendent and the Site Safety officer get an additional specific training pertinent to the activities performed in the field. All the employees receive the same general training and specific training as the Superintendent plus more training for any special or unique task they may be required to perform.

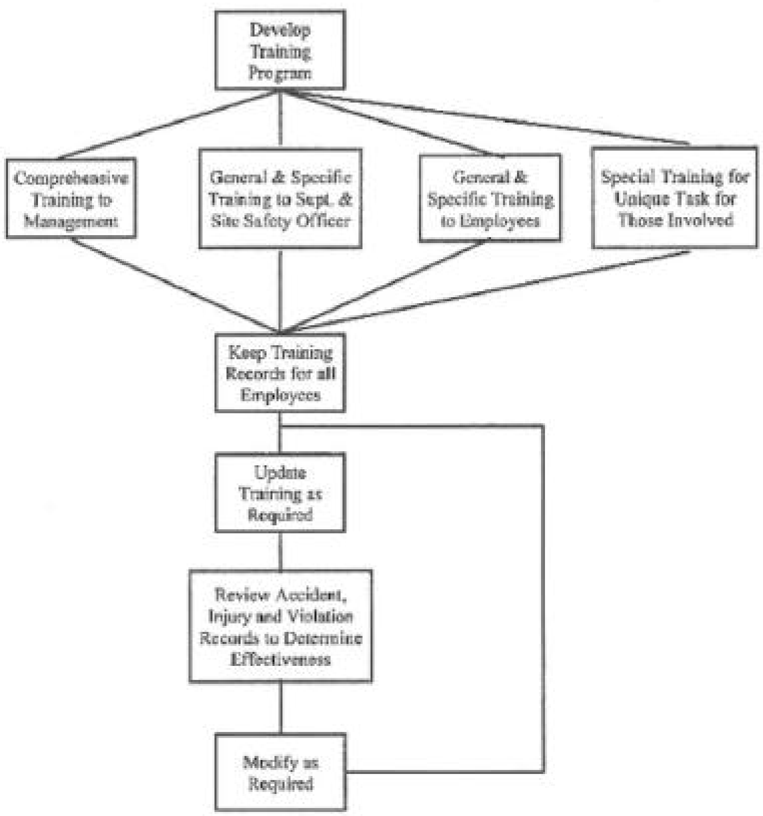

Figure 4: Training program

It is critical that the company keeps accurate records of all training sessions conducted for the employees for several reasons. First, a project may come along, especially a government funded project that requires proof of training for the owner to award a contract. Another example is during an accident investigation by OSHA, the inspector may request training records. Equally as important is to keep the training up to date. Some training require refresher courses annually or every other year. Some may be updated as frequently as every new project or during weekly toolbox safety meetings at the site.

As briefly mentioned under responsibilities, management needs to monitor accident, injury and violation reports quarterly, looking for repeated problems or trends, and determine the effectiveness of the training program. They must judge if the information they wish to impress upon the employees is being effectively communicated. The training program can then be modified accordingly. While planning the modifications can be a continuous process, it is probably best to formally change the program only once a year. Once the changes have been made, the loop returns back up through reviewing records and determining effectiveness.

Inspection Program

Continuing down Figure 1, the next action is to develop an inspection program. This is further illustrated in Figure 5. Part of the inspection program is the establishment of an inspection frequency and assigning of an inspector. One possible scenario is: for the Company Safety officer, monthly; for the Project Manager, weekly; for the Superintendent and Site Safety officer, continuously; for the workers, daily. The purpose of these inspections is to confirm that all the preventative controls are in place and the workers are working safely. They should occur at random, unannounced times. Also, as previously discussed, it is just as important to note conditions that are maintained exceptionally well as opposed to only noting the unsafe ones. Take pictures of both good and bad conditions to use in training sessions and praise those who deserve it.

Regardless of who conducts the inspection, the next step is always the same; correct the violation and eliminate the hazard immediately. If the violation is an isolated occurrence, determine if it should be incorporated into the next revision of the safety program. If it is a reoccurring violation, monitor the activities for a period of time to determine if it is activity related or employee related. If it is activity related, either modify the activities to eliminate the hazard or increase the awareness of the hazard and provide additional precautions to reduce the possibility of injury. If the violation is employee related, discipline the employee as dictated by the disciplinary program. Whatever the root cause of the repeated violation, incorporate it into the next revision of the safety program.

Once the violation has been noted and corrected, record the information on the appropriate form (an example is attached) in a manner that allows data to be compiled and evaluated periodically. Then, as mentioned in each figure, evaluate the effectiveness of the safety program. In addition to monitoring the violations, it is an excellent idea to recognize exceptional examples of safety noted during the inspection. Now, taking into consideration the violations and good practices noted, modify the safety program as deemed appropriate and incorporate the new changes into the training program.

Keeping records of training and tracking hazards and corrective actions are an important activity in the evolution of the Quality Safety Program. It is imperative to keep records of formal, structured employee training at the jobsite (as well as a main file) as a reference to determine personal qualifications for various tasks. It is also necessary to keep records of jobsite toolbox safety meetings both at the jobsite and in a main file. Subjects of toolbox meetings can include a wide range of topics from ladder safety, electrical safety, heat exhaustion to winter driving safety. Other, more involved topics can include information resulting from accident investigation, revisions to the safety program or safety precautions to be taken as new work commences.

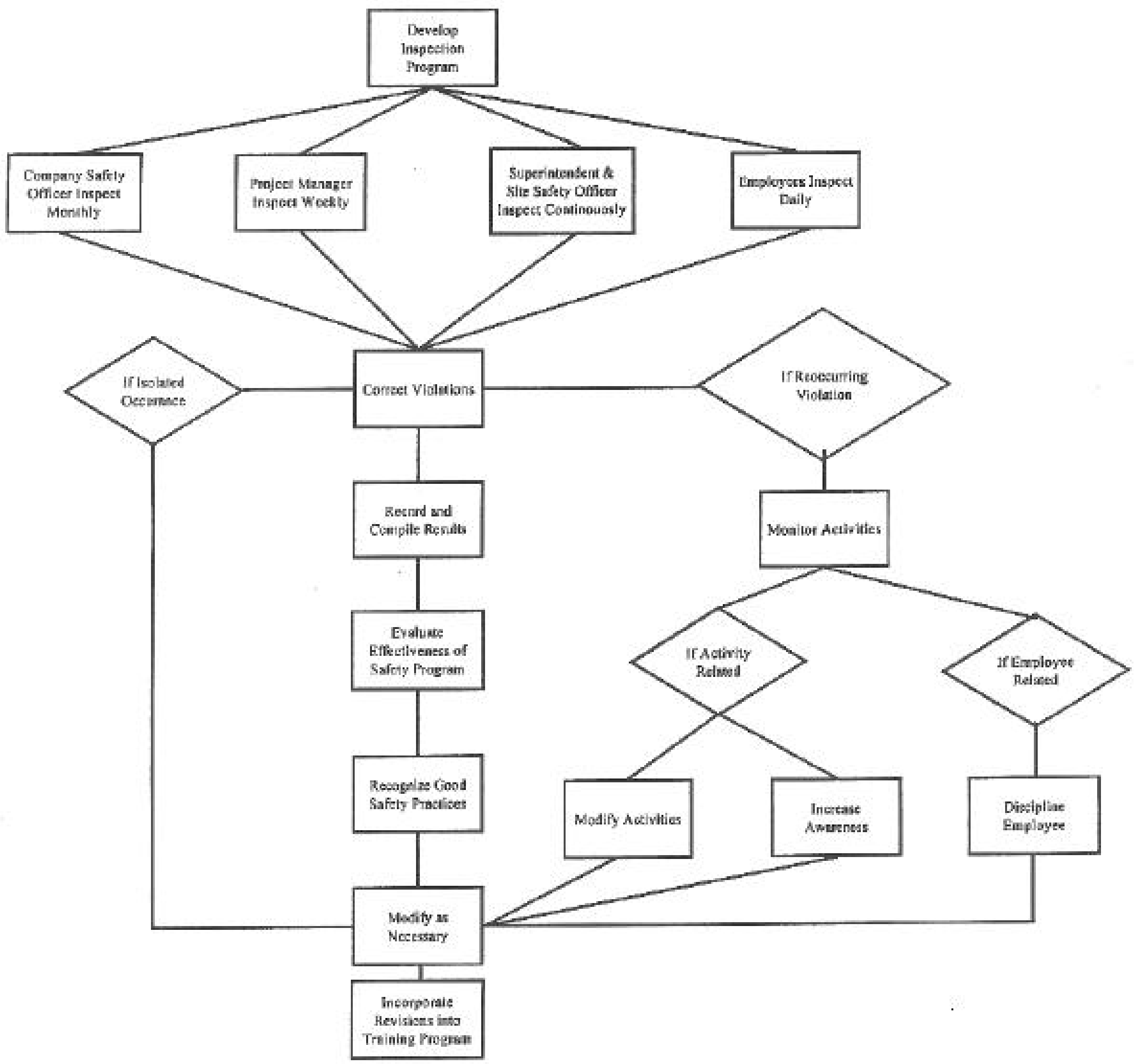

Figure 5. Inspection program.

Returning once more to Figure 1, the final step has been discussed in almost every aspect and is the key to integrating TQM principals into a company Quality Safety Program. In keeping with the idea of continuous improvement, the effectiveness of the safety program is constantly monitored, revised and updated as needed and looped back up to be incorporated into the training program so all the employees become increasingly aware of what is expected of them from a safety standpoint.

Although the ultimate goal is to eliminate accidents, it is unrealistic to believe it can be achieved initially. Therefore, one additional figure, Figure 6, has been included to illustrate the flow of activities if an accident occurs.

Fig. 6: In case of an accident

In Case of an Accident

The first two steps occur immediately following an accident. It must be reported to the Superintendent or Site Safety officer and treatment must be provided to the injured person. If the injury is minor, the employee can be treated at the site and then returned to work. If the accident is serious, the employee should be treated at the hospital.

Regardless of the severity of the injury, the accident is investigated following the treatment of the employee. The investigator, usually the Superintendent or Site Safety officer, visits the scene of the accident, interviews witnesses, inspects tools, equipment or materials involved and determines the cause of the accident. As previously discussed, if the accident is deemed to be an isolated incident, a determination is made to the potential for future accidents. If future accidents seem likely, the situation is corrected. If the accident seems to be a reoccurring problem, the activities need to be monitored to determine if it is activity related or employee related. If the problem is activity related, the activities will be modified to eliminate the danger. If the problem appears to be employee related, those employees who are working unsafely are disciplined as directed by the disciplinary program. Regardless of the cause or source of the accident, the circumstances are discussed with the employees during the weekly toolbox safety meeting so everybody is aware of the hazard and satisfied that corrective action has been taken to make the workplace safe.

Meanwhile, the employee who has been seriously injured is likely to be pursuing a worker's compensation or disability claim. His/Her position will probably be filled until he/she is able to return to work.

The next important element to an accident case is the follow up inspection. This is to assure the situation that caused the accident is not reoccurring. It is also to insure that the modifications made to the safety program to eliminate the hazard are being followed. Once again, management has to evaluate the effectiveness of the safety program and recommend modifications.

Conclusion

It is important to observe that a critical feature of any TQM model is continuous improvement. This is achieved every time the effectiveness of the Quality Safety Program is evaluated. The changes and improvements are always tied back into the training, thereby continuously increasing employee awareness of hazards and teaching them new and better ways to perform their work.

Another key element to the success of the Quality Safety Program is the dedication of upper management. The eagerness and excitement displayed is monumental in terms of employee moral and willingness to accept the program. Once the employees accept the program, implementation becomes much easier.

Reporting incidents, accidents, violations and hazards has been shown to be a valuable tool in assessing the success of the safety program. It is also an extremely important source for determining where unsafe conditions exist and, thus, provides information for structuring training programs.

This Quality Safety Program is intended to be an example for companies to use as a guide to establish and build their own safety program. However, it is also general enough to be adopted in its present form for a company to use as its safety program. It is strongly recommended for any company that wishes to develop a quality safety program to use this as a model to create their own program that is specifically suited to their particular type of work and company structure.

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Impact of Structured Internship Programs on Student Performance in Construction Management Curricula

Allan J. Hauck, Scott Y. Allen and Daniel F. Rondinelli
Colorado State University
Ft. Collins, Colorado

The objective of this study was to explore the effects of a structured internship program, implemented in the Fall of 1997 by the Construction Management Program at Colorado State University, on student perception and performance in subsequent coursework. Because it was recently initiated, not all construction management students participated in the first structured internship session. As a result, many departmental courses during the 1998-1999 academic year had a combination of students; those who experienced the structured internship program and those who had not. The department was in a unique position to compare student perception and performance of these groups. Measures of performance and perception included: 1) Comparison of changes in GPA, 2) Comparison of student course performance, 3) Differences in attitudinal surveys designed to measure the students' perception of the impact of the structured internship program. The results of the research were inconclusive. GPA's of the internship group increased slightly (1.09%). The data supporting this increase did not prove statistically significant. The non-internship data was statistically significant where the non-internship group posted a 4.49% decrease in GPA. As a whole, the internship group outperformed the non-internship group in subsequent academic performance but the difference between groups was not statistically significant. Students' perceptions overall were very positive with regards to the internship experience. Many students found the work fulfilling and beneficial with regards to career growth and grasping of the concepts presented in future coursework.

Key Words: Structured Internship, Experiential Learning, Co-op Programs, Student Performance

Introduction

Structured internships have grown to become an integral part of the academic landscape. Many argue the practical experience gained from a structured internship is an important step to lay the groundwork in preparing students for careers in their chosen field. It is expected that this experience reaps such benefits as: (1) exposure to techniques and problems not encountered in a classroom environment, (2) enhanced understanding of the business world, (3) improved ability to evaluate and assimilate classroom experiences, and (4) increased motivation to master subject material on returning to school (according to The AAA Committee on Internship Programs as cited by Knechel and Snowball, 1987). Other benefits include: (1) opportunities for permanent placement with the sponsoring company, (2) clarifying career choices, and (3) increasing student's self-esteem (Flesher, Leach, and Westphal, 1996).

Besides the potential rewards for the student, the sponsoring company may also realize benefits from participating in a structured internship program. They include filling staffing needs (Rohlk, 1998), recruiting (Buchanan, 1997), contributing to the profession (Crumbly and Summers, 1998), and giving back to the community (Buchanan, 1997). The school implementing such programs benefits as well. It strengthens communication with the industry and supplements academic programs with the practical experience gained by the students.

As a result of these expected outcomes, many academic institutions are convinced the internship experience adds to the student's overall education and award credit to those who take part in the internship program. However, the assumption that structured internships nurture academic learning is arguable. Little empirical evidence is available to sustain this hypothesis (Knechel and Snowball, 1987). This study's purpose was to further explore the assumption that structured internships do have educational merit by testing the hypothesis that students improve academically following a structured internship experience.

In the fall of 1997, the Construction Management Program at Colorado State University followed the trend and initiated a mandatory structured internship program, officially known as the Phelps Internship Placement Program, in which the participating students earn credit. Because it was recently initiated, not all construction management students participated in the first structured internship session, which occurred in the summer of 1998. As a result, many departmental courses during the 1998-1999 academic years had a combination of students; those who experienced the structured internship program and those who had not. The department was in a unique position to compare student performance of these two groups and perceptions of interns. Measures of performance and perception included: (1) comparison of fluctuations in GPA, (2) comparison of student performance in subsequent coursework, and (3) attitudinal surveys across various demographics designed to measure internship students' perceptions and elicit open-ended comments.

Four previous studies explored the effects of structured internship programs on subsequent coursework. The studies conducted by Koehler (1974), Knechel and Snowball (1987), Kwong and Lui (1991), and English and Koeppen (1993) examined accounting students' post-internship scholastic performance. This study builds upon their research but investigates construction management students' performance in subsequent coursework.

Methodology

Research Questions

To address the above areas of concern, the study posed the following research question:

> **Does participation in the Phelps Internship Placement Program improve academic performance within the Colorado State University Construction Management curriculum compared to those who have not participated in the structured internship program?**

This question was addressed with the following sub-questions:

1. What are the GPA changes of those students who had experienced the structured internship program compared to those who had not?
2. How do those students who experienced the structured internship program perform in the same construction management coursework subsequent to the internship compared to those who had not participated in the internship?
3. What are the changes in students' perceptions of the internship regarding career, coursework, internship, and quality of work life?

Subjects

The sample of internship and non-internship students originated from Colorado State University construction management majors. The sample consisted of two groups: Internship (treatment) and Non-internship (control). The pre-selected internship sample consisted of those students who elected to participate in the first structured internship session that occurred in the summer of 1998. The Phelps Internship Placement Program coordinator provided a list of those students participating in this first session. The non-internship group was formed from all other construction management majors in the program who did not elect to participate in the first structured internship session. CM administrators provided class roles to help the researchers identify those students who were construction management majors and were enrolled in at least one upper-division construction management course for the 1998 fall semester. All students who fit the criteria were included into the pre-selected non-intern group. No non-construction management, pre-construction management, construction management minor, second bachelor, or graduate students were included in either group.

Procedure

The methodology of this study built upon the research conducted by Koehler (1974), Knechel and Snowball (1987), Kwong and Lui (1991), and English and Koeppen (1993), but measured construction management students' performance in subsequent coursework and changes in intern perceptions of the internship experience. The methodology of this study relied on three instruments for gathering data. They included pre- and post-internship GPA data, performance measurement in subsequent coursework, and pre- and post-internship questionnaires.

After approval of the appropriate Human Subjects Review Process, the research sub-questions were answered in the following manner:

1. **What are the GPA changes of those students who had experienced the structured internship program compared to those who had not?**

A list of participants was created for the intern and non-intern group. Space was provided to record the term GPA and credit hours of each student for the two pre-internship semesters (1997 Fall, 1998 Spring) and post-internship semester (1998 Fall). Only the 1997 Fall and 1998 Spring semester term GPAs were examined for this study since these represented participants' performance as construction management majors. Prior to these terms, participants may have been in other majors or their academic performance may have been unfocused and possibly influenced by adjusting to college life. The term GPAs represent performance in all classes, including non-construction management courses, for which the student was registered and had completed during that particular semester. The post-internship GPA excluded the grades earned for the internship itself.

Once this data set was assembled for both groups, the two-term pre-internship GPAs for all participants were averaged using the respective credit hours as a basis for weight. The mean two-term pre-internship GPA was compared to the one-term post-internship GPA to observe a possible percent change for each participant. The average was calculated for an overall pre-internship GPA, post-internship GPA, and percent change for both groups.

To test for differences at the .05 level of significance between the intern group and non-intern group, data were entered into the SAS statistical package to perform various analyses. Analysis of variance (ANOVA) was performed between groups on their:

- Term GPAs before treatment,
- Term GPAs after treatment,
- Percent change of GPA.

The ANOVA test was also performed within each group's:

- Percent change of GPA.

The ANOVA test was used because this methodology compares the variance between groups and within groups. The test reveals if there are two means that differ significantly from each other. The ANOVA is more versatile than other inferential statistics because it can test the differences between two or more means (Ary, Jacobs, and Razavieh, 1996).

2. **How do those students who experienced the structured internship program perform in the same construction management coursework subsequent to the internship compared to those who had not participated in the internship?**

For each of the required upper-division construction management classes offered in the 1998 fall semester, lists were generated consisting of the intern and non-intern group enrolled in each class.

Along with the class lists, instructors were provided course performance data sheets on which participants' names were not identified. The instructor recorded course performance data randomly; thus the researchers had no opportunity to link names to this data.

Upon collection of all course performance data, the information was converted into percentages reflecting total points earned versus total points possible for each student to allow for comparisons between groups on their overall performance regarding all 11 courses.

To test for differences at the .05 level of significance between the intern group and non-intern group, an ANOVA from the SAS statistical package was performed between groups on their:

- Overall performance in the 11 courses.
- Performance within each of the 11 courses.

As with the previous research question, the ANOVA test was used because the methodology compares the variance between groups.

3. What are the changes in students' perceptions of the internship experience regarding career, coursework, internship, and quality of work life?

Pre-internship and post-internship questionnaires were developed and administered to the internship group prior to and after their structured internship experiences. Questionnaires were designed utilizing suggestions from Salant and Dillman (1994). The survey consisted of 15 questions inquiring about students' perceptions of their career, the construction industry, and their coursework. The questions were part of four composite groups. Questions 1 and 2 revolved around *career*. Questions 3, 4, and 6 focused on *coursework*. Questions 5 and 15 addressed *internship*. Questions 7, 8, 9, 10, 11, 12, 13, and 14 inquired about *quality of work life*. Additionally, space was provided to allow students to openly express their thoughts regarding the structured internship program and construction industry. The pre-internship questionnaire asked the participants to respond to statements regarding their perceptions that existed prior to their structured internship experience. The post-internship questionnaire asked the participants to respond to the same statements found on the pre-internship survey but inquired about their perceptions that existed after their structured internship experience.

Questions revolving around coursework were significant to this study since they inquired about the internship student's perception of the relationship between the internship experience and academic performance. The other composite questions and the open-ended comment section were primarily intended to provide additional insight about the internship program in general. The dependent variables were developed from literature reviews. Participants were asked to respond to questions using a Likert scale with seven response options. Values 1 to 7 were assigned to the responses from strongly agree to strongly disagree. The lower the response to the item, the stronger the students agreed with the statement. An example of the questionnaire is presented in Appendix A.

Results

Participation Rate

Seventy-eight (78) students participated in the internship program during the summer of 1998 and were ultimately placed with a total of 59 companies. Seventy-five (75) students were pre-selected to be included into the internship group. Three students were excluded because they were not construction management majors at the time of the study or were enrolled in the 24-week internship session, thus not allowing them to return to campus for the 1998 fall semester. After examining the class roles of upper-division construction management courses for the 1998 fall semester, 113 construction management students fit the criteria for the control group and were pre-selected to be included into the non-internship group.

Of the 75 internship students, 60 chose to sign the consent form and were included in the sample making a participation rate of 80 percent. Of the 113 non-internship students, 89 elected to sign the consent form making a participation rate of 79 percent.

Student demographics are presented in Table 1. Only four members of the internship group were female (6.7%) while nine members of the non-internship group were female (10%). During the 1998 fall semester, the internship group consisted of two sophomores (3.3%), 21 juniors (35%), and 37 seniors (61.7%). The non-internship group consisted of three sophomores (3.4%), 29 juniors (32.6%), and 57 seniors (64%). Although unintended by the researchers, the distribution of student's class standing was similar between groups. During the two semesters prior to the internship, the mean credit hours earned by the interns were 28.03. The non-interns earned 25.79 credit hours. The semester following the internship, the mean credit hours for which the interns registered was 14.75 while the non-interns registered for 14.37 credit hours.

Table 1

Student Demographics

Category	**Internship N = 60**		**Non-internship n = 89**	
	N	**Percentage**	**n**	**Percentage**
Female	4	6.7	9	10.1
Male	56	93.3	80	89.9
Sophomores	2	3.3	3	3.4
Juniors	21	35.0	29	32.6
Seniors	37	61.7	57	64.0

GPA Performance

Pre-internship GPA Performance

Pre-internship and post-internship GPAs were amassed for both groups. Overall GPA performance is presented in Table 2. The GPA earned by the non-internship group (2.9827) was higher than the GPA earned by the internship group (2.9047) prior to treatment. However, the ANOVA performed on the difference between the two groups was not statistically significant. This demonstrated the equivalence of groups making them initially comparable and strengthened the internal validity of the study.

Table 2

Overall GPA Performance

Category	Internship		Non-internship		Significance Level* (p)
	Mean	**S.D.**	**Mean**	**S.D.**	
Pre-internship Term GPA	2.9047	.5166	2.9827	.5555	.3889
Post-internship Term GPA	2.9050	.5931	2.8285	.6512	.4674
Percent Change In GPA	1.09%	.1821	(4.59%)	.1738	.0571
Significance Level Change In GPA**	.6345		.0157***		

* Significance levels between groups.
** Significance levels within groups.
*** Significant at the .05 level.

Post-internship GPA Performance

Table 2 also illustrates that post-internship academic performance by the two groups was distinct. The internship group earned a term GPA of 2.9050, an increase of 1.09% from their pre-internship GPA. The non-internship group earned a term GPA of 2.8285, a decrease of 4.59% from their pre-internship GPA. In spite of this, the ANOVA performed on the difference between groups with respect to their post-internship term GPAs and percent change in GPA was not statistically significant. Nor did the internship group achieve an increase in GPA that was statistically significant. However, the decrease in GPA by the non-internship group was statistically significant. A graph depicting the pre- and post-internship performance is presented in Figure 1.

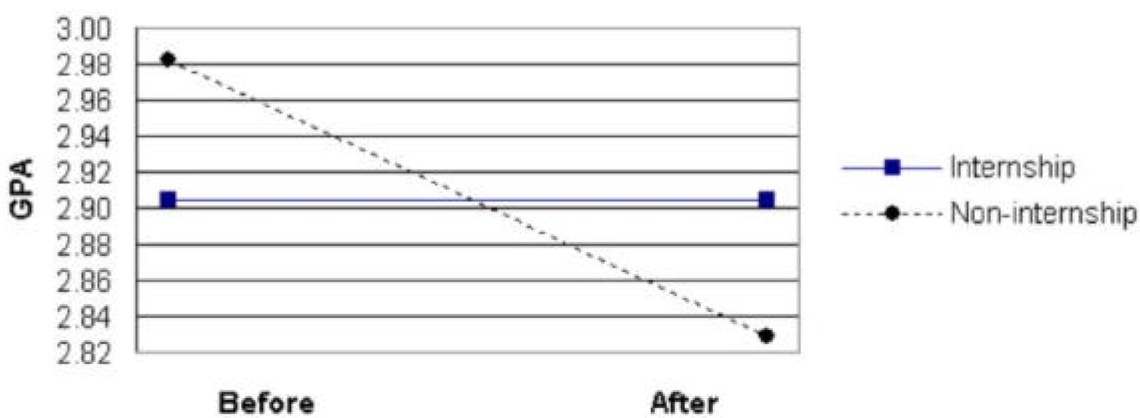

Figure 1. Pre- and Post-internship Performance

Subsequent Course Performance

Course Profile

To segregate the effect of the internship on academic performance, the 11 upper-division construction management courses offered following the internship were examined to compare performance between groups. The total number of students in all 11 classes for each group (137 and 214) exceeds the sample number for each group (60 and 89). This was due to enrollment in multiple classes by students from each group during the 1998 fall semester. Course performance is presented in Table 3.

Course Performance

As a whole, the internship group outperformed the non-internship group in subsequent academic performance but the difference between groups was not statistically significant. Performance in specific subject areas varied. The internship group earned higher grades in MC 261, MC 361, MC 362, MC 363, MC 364, and MC 366. The non-internship group performed better in MC 232, MC 317, MC 365, MC 461, and MC 464. However, these grade differences between groups in each class were not statistically significant.

Table 3

Course Performance Data

Course No.	**Course Name**	**Internship**		**Non-internship**		**Significance Level (p)**
		Mean	**S.D.**	**Mean**	**S.D.**	
MC 232	Arch. & Const. Planning	87.27	9.37	88.57	7.43	.6451
MC 261	Const. Surveying	86.05	7.08	83.54	7.20	.4012
MC 317	Safety Management	92.20	5.30	93.03	3.54	.7270
MC 361	Mechanical Building Systems	84.80	6.40	81.25	13.03	.1000
MC 362	Const. Contracts	78.48	7.19	74.17	11.37	.1363
MC 363	Quantity Surveying	87.28	4.76	85.68	7.02	.5631
MC 364	Advanced Const. Systems	85.82	4.89	82.42	6.98	.2113
MC 365	Const. Estimating	87.78	6.32	88.00	4.50	.9272
MC 366	Const. Eqpt. & Methods	88.11	3.34	85.72	7.03	.4704
MC 461	Const. Sched. & Cost Control	87.25	2.58	92.18	3.92	.1392
MC 464	Const. Project Administration	87.47	5.34	88.11	7.01	.8272
Overall		86.77	6.78	85.68	9.37	.5354

Intern Perceptions

Response Rates

A pre-internship and post-internship questionnaire was developed to measure the internship group's perceptions regarding career, coursework, internship experience, and quality of work life. The pre-internship questionnaire was given immediately before the internship. The post-internship questionnaire was administered near the end of the 1998 fall semester. Of the 75 participants, 65 returned a pre-internship questionnaire making a response rate of just under 87 percent. Forty-four (44) returned a post-internship questionnaire making a response rate of just under 59 percent.

Internship Demographics

Internship participant demographics are presented in Table 4. Of the internship participants surveyed, five females responded to the pre-internship questionnaire (7.7%), while four females responded to the post-internship questionnaire (9.1%). At the time of the internship, two sophomores (3.2%), 28 juniors (44.4%), and 33 seniors (52.4%) responded to the pre-internship questionnaire (63 had reported their class level). One sophomore (2.3%), 13 juniors (29.5%), and 30 seniors (68.2 %) responded to the post-internship questionnaire.

More than 83 percent of the interns indicated that they had construction experience prior to the internship. Nearly 75 percent of the interns had at least one year of construction experience. Eighty-seven (87) percent reported they worked as a laborer at some point. More than 59 percent had field supervision experience and almost 30 percent indicated they performed administrative duties during their construction experience. Finally, approximately 24 percent reported they were involved with managerial responsibilities.

Table 4

Internship Participant Demographics

Category	***<u>Pre</u>-internship Questionnaire n = 65***		***<u>Post</u>-internship Questionnaire n = 44***	
	N	***Percentage***	***N***	***Percentage***
Gender				
Female	5	7.7	4	9.1
Male	60	92.3	40	90.9
Class Level				
Sophomore	2	3.2	1	2.3
Junior	28	44.4	13	29.5
Senior	33	52.4	30	68.2
Experience				
Yes	54	83.1	NA	
No	11	16.9	NA	
Time				
3 Months or Less	3	5.5	NA	
3 to 6 Months	6	10.9	NA	
6 to 9 Months	5	9.1	NA	
1 Year or Greater	41	74.5	NA	
Responsibility (check all that apply question)				
Laborer	47	87.0	NA	
Field Supervision	32	59.3	NA	
Administrative	16	29.6	NA	
Management	13	24.1	NA	

Initially, the most striking results of the questionnaire originated not from the measurement scale, but from the demographics section. Of the 65 interns surveyed, more than 83 percent had previous construction experience. Nearly 75 percent of these interns had at least one year of experience in the construction industry. Almost 60 percent indicated they had experience in field supervision, administrative duties, management responsibilities or some combination of the three. The researchers could only speculate on the magnitude of experience the non-interns possessed. Upon reflection, this should not have been an overwhelming surprise. More than 50 percent of the intern participants were seniors. However, this pre-existing construction experience base possibly negated the effects of the questionnaires with regard to certain questions. The subsequent lack of significant results on the questionnaires may have substantiated this hypothesis.

Implications

The purpose of this study was to investigate whether participation in the Phelps Internship Placement Program helped improve academic performance compared to those who had not participated in the formal internship program. The results suggested that participation will likely lead to an increase in scholastic performance, but this is a fragile assumption. The demographics show a tendency for construction management students to possess relevant work experience before the internship. The nature of the experience is unknown, but it has the potential for wiping out the positive effects of an internship with respect to subsequent academic performance.

The implications of this study have a significant impact on the role internship plays within an academic program. At the development stage, educators must clearly identify the purpose of the internship and the level of resources they wish to commit. If the purpose is to augment the curriculum, enhance academic learning, and increase the stature of the academic program with the commitment of minimal resources, implementing an internship program may not deliver the desired results and will not be the best use of those resources. If the primary goal is to ensure all construction management students gain interview experience, work with a quality company, are exposed to the industry, and are assigned challenging tasks, internships have been demonstrated to be worthwhile for the students.

If the latter is the predominant objective, this study has presented some implications, both general and specific, for administering such internship programs. It’s clear that construction management students probably have some level of experience under their belt before the internship. In an attempt to differentiate the internship experience, educators must establish procedures to increase the likelihood that students will receive stimulating assignments. These procedures may include aggressively recruiting companies that will adhere to the ideals of providing students with a variety of opportunities. Vigorously maintain record keeping policies via student assignments or periodic telephone calls so as to monitor their experiences and determine if sponsor companies are providing the appropriate level of opportunities for the students. This also implies that construction management departments must commit the necessary resources to suitably perform such monitoring. Failing to do so would possibly result in an internship program becoming irrelevant.

Since the internship program at CSU was recently initiated, it will require time to mature and gradually provide students with a valuable experience they will cherish. Perhaps academic performance will proportionally improve as well. This study only scratched the surface of this topic and the results lead to additional research. These additional areas of research are presented in the next section.

Conclusions

Based on the outcome of this research, it is initially difficult to conclude whether participation in Colorado State University's construction management internship program enhances academic performance. The results from the two primary indicators of performance, overall GPA and subsequent course performance, contradicted each other. The decline in GPA experienced by the non-interns was statistically significant. The variation in subsequent course performance between groups, although hard to ignore, was not statistically significant. The fact that the internship group's marginal increase in agreement with the statement saying the internship helped their performance in subsequent coursework upon returning to the classroom was not statistically significant does not lend credence to the hypothesis that the internship enhances academic performance. Perhaps the primary reason for the inconsistent results lies within the previous work experience an overwhelming number of interns, and possibly the non-interns, had prior to the internship. The internship could have been nothing more than a continuation of previous work. As a result, both groups may have had a good understanding of the intricacies of the industry thus minimizing or even negating the effects of the internship on academic performance. Two students' comments in the open-ended section were particularly enlightening.

- "The only thing I don't like about the internship program is I worked for my company before I was a student at CSU and going to continue working for them after graduation. So the only thing I got from the internship program was a tuition bill that I had to pay and homework after working for 10 hours. I also didn't like the fact that my boss has to be burdened with extra paperwork for me."
- "I do agree with the internship program but not fully. The company I'm doing my internship with I already worked for the past two summers. Now to graduate, I have to pay out-of-state tuition plus the company has to pay to have me back."

Another reason for the inconsistent results may have to do with duration. Conceivably, 12 weeks may not have been enough time to fully grasp the prerequisite skills needed to succeed in the industry resulting in the interns not taking full advantage of the classroom experience.

Regardless of the performance in subsequent coursework and questionnaire results, the fact that the interns maintained their GPA while the non-interns did not suggests the internship probably had a positive affect on academic performance. The reasons for this relationship are hard to pinpoint. Possibly due to the urging of internship coordinators and the record keeping responsibilities required by the program, host companies may have felt compelled to provide students with a variety of challenging tasks; tasks which may not have been ordinarily assigned if the position was a standard "summer job." One student noted the following in the comments section:

- “Since I have had previous field experience in the past, I had a good idea of what goes on at the job site. However, I have received much more responsibilities with the internship which requires different skills than I have used in the past.”

As a result, intern students may have gained a more sophisticated outlook of the industry thus enhancing their motivation to perform well academically or at least negate the effects of “senioritis” (Dorrance, 1979).

With respect to subsequent coursework, the interns earned an overall average of 86.77%. In the six classes in which the interns outperformed the non-interns, the average difference in grades was 2.96 points. In the five classes in which their non-intern counterparts surpassed them, the average difference in grades was 1.58 points. The point here is how much better do the interns have to perform? Their average score is comparatively high which illustrates that they have a firm comprehension of the subject material. This is also true of the non-interns. Construction management students often have a solid fundamental knowledge of the techniques employed by their craft when they reach the second half of their academic careers. In a study by Jackson (1998), a survey was administered to 340 construction management seniors from six different universities regarding ethics. Of the 285 responses, more than 65 percent indicated they had 1.5 years of experience and almost 40 percent reported they had an immediate family member involved in the construction business. One member of the internship group of this study noted the following in the open-ended section of the questionnaire:

- “I have lived in the house of a senior superintendent (Dad) all my life so there are no real ‘shockers’. I’m just learning more and more about *why* [emphasis added] things are done the way they are.”

It would be expected that construction management students as a whole will perform moderately well in courses related to their chosen field of study, even without the benefit of participating in an internship.

The answer may lie with courses taken outside the construction management curriculum. Classes such as soils in construction, elementary structural design, or labor relations, may be the real test of whether the internship has a positive affect on academic performance. These subjects are on the fringe of the core construction knowledge base and would be a key indicator in determining if a student was motivated to learn as a result of the internship. This study did not incorporate performance data from these types of classes, but, judging from the performance in overall GPA of both groups, this may be the area in which the interns differentiated themselves from the non-interns.

Clearly, the benefits of an internship program are numerous. Students have the opportunity to observe first-hand the skills and knowledge needed to succeed and enhance their understanding of the industry. To reinforce this statement, students have noted the following in the open-ended section of the questionnaires:

- “I don’t know where my interests lie. However, the internship helped narrow the field.”

- "The learning experience of the internship program is very beneficial. There is the potential of gaining an entire years worth of coursework in a single semester of internship."
- "The internship that I did was extremely beneficial to me. I learned a lot and I feel that if I didn't do an internship, I wouldn't have the job that I have today."
- " My perceptions of commercial construction have changed the most. Before my internship with a commercial GC, I did not like it. After, I was confident that I wanted to pursue this as a career."
- "It is very important that you have good communication skills. Telephone conversations are a daily activity."

Conversely, the internship proved to be an eye-opener for some students:

- "Surprised at the level of politics involved in the construction industry."
- "I did not expect the role that the social/political relationships play in the industry. If it were just building buildings, the job would be perfect. Instead, you have to shuffle paperwork, and deal with owners and architects."

The results of the study suggest that participation in a formal internship program will probably have a positive affect on academic performance. However, the effects of construction management internships may not have the same magnitude of influence as compared to other pre-professional internship programs. This is due in part to the characteristics of the construction management field. Many students already have extensive construction experience before they even begin their internship thus possibly dulling the enlightenment the internship is intended to provide.

Recommendations for Future Research

The findings of this study lead to the following recommendations for future research:

1. The current study included students from only one institution. It would be beneficial to replicate this study at another institution offering a comparable construction management internship program to observe and establish any subsequent trends regarding academic learning.
2. As previously noted, this study did not capture the grades from courses outside the core construction management courses. Examining this indicator of performance may provide additional insight whether participation in a formal internship programs will enhance academic learning.
3. The current study only examined performance in subsequent courses that occurred during the 1998 fall semester. Expanding the methodology to include courses following the 1998 fall semester will help establish long-term trends and improve the reliability of the study.
4. The current study suggested participation in the internship program enhanced academic performance. A possible benefit of this outcome is the cure for "senioritis". It would be an interesting study to examine student performance over a 10-year period to determine if "senioritis" does exist.

5. To assess the impact previous work experience has on the internship and subsequent academic performance, a study that would incorporate a more detailed examination of work histories of each group would be useful in further understanding the academic benefits of the internship program.

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Appendix A

Internship Questionnaire

STUDENT PERCEPTIONS OF THE CONSTRUCTION INDUSTRY

Please respond to the following statements regarding your perceptions of the construction industry that exist prior to your internship experience. **All return forms will be kept confidential and your anonymity will be maintained. All results will be released in the aggregate. Individual responses will not be identified**. Clearly circle the response that best represents the extent to which you agree or disagree with each of the following statements by using the scale below:

SA = Strongly Agree, **A** = Agree, **MA** = Mildly Agree, **U** = Unsure, **MD** = Mildly Disagree, **D** = Disagree, **SD** = Strongly Disagree.

Prior to the start of your internship experience:

1. You knew your specific career path within the construction industry (e.g. estimating, field engineering, planning & scheduling, etc.). SA A MA U MD D SD

2. You had a clear understanding of which area of construction in which you wish to be involved (e.g. residential, commercial, heavy highway, utility, etc.). SA A MA U MD D SD

3. You believed your coursework would prepare you for the internship program. SA A MA U MD D SD

4. You believed your coursework would be beneficial in preparing you for a career in the construction industry. SA A MA U MD D SD

5. You felt confident that the internship program would be beneficial in preparing you for a career in the construction industry. SA A MA U MD D SD

6. You believed the internship program would help your performance in remaining coursework at CSU. SA A MA U MD D SD

7. You felt the construction industry generally provided safe working conditions. SA A MA U MD D SD

8. You believed the construction industry provided fair wages for *management* personnel. SA A MA U MD D SD

9. You believed the construction industry provided fair wages for *field*

supervisory personnel. SA A MA U MD D SD

10. You felt the members of the construction industry are ethical. SA A MA U MD D SD

11. You trusted that your immediate supervisors of the sponsoring company would treat you fairly. SA A MA U MD D SD

12. You believed that the field employees ("craftworkers") of the sponsoring company would treat you fairly. SA A MA U MD D SD

13. You felt confident that the responsibilities assigned to you would be meaningful. SA A MA U MD D SD

14. You believed your efforts would make a worthy contribution to the sponsoring company. SA A MA U MD D SD

15. You would have not participate in the internship program if it were not required. SA A MA U MD D SD

STUDENT INFORMATION

Gender: ____ Male ____ Female

Your class level following the internship program: ____ Sophomore ____ Junior ____Senior

Do you have previous experience in the construction industry (do not include time spent with present internship company)?
____ No (Stop)
____ Yes. If yes please answer the following:

Time spent working in the construction industry:
____ 3 months or less.
____ 3 to 6 months.
____ 6 to 9 months.
____ Approx. 1 year or greater.

Primary nature of responsibilities (Check all that apply):
____ Laborer
____ Field Supervision
____ Administrative
____ Management

Your comments below relative to your perceptions of the construction industry are appreciated.

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