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The Scholarly Pursuit of Construction Knowledge

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Opening comments at the April 2002 Associated Schools of Construction 38th conference.

Key Words: Teaching, Scholarship, Community, Academic Mission

Yvan Beliveau's Comments

Welcome – to Southwest Virginia to Roanoke, Virginia – and to the Blacksburg area later tonight. I hope you find our little bit of the world as beautiful and exciting as most of us who share our homes here.

It is with great pride and a pleasure for Virginia Tech to host the yearly ASC conference.

I would like to introduce Paul Knox, Dean of the College of Architecture and Urban Studies. After Paul has given his comments, I will present some additional thoughts and pose some question to consider during this conference.

Paul Knox's Comments

Welcome to this year's meeting of the Associated Schools of Construction. It's both a privilege and a pleasure to have you here, and I hope that you will have a rewarding experience.

This year's theme - "The Scholarly Pursuit of Construction Knowledge" - is very appropriate to our time. Most people would agree that one of our principal responsibilities in the schools is to act as pathfinders, through basic and applied research, to ways in which the construction profession can become more effective.

Your meeting here is especially timely for us: those of us from Virginia Tech will be listening carefully to every word, since our President has recently announced ambitious new goals in terms of research productivity for the whole university.

Every few decades a group of new technologies comes along and disrupts the old order. I'm personally very interested in how each new technology system undermines the established order of things and creates a new geography, with new winners and new losers in terms of economic growth and development. Each new technology system also presents unprecedented new opportunities for research and practice in almost every field.

1790 - 1840: Early mechanization based on waterpower and steam engines, the development of cotton textiles and iron working, and the development of river transport systems, canals, and turnpike roads.

1840 - 1890: The exploitation of coal-powered steam engines, steel products, railroads, world shipping, and machine tools.

1890 - 1950: The exploitation of the internal combustion engine, oil and plastics, electrical and heavy engineering, aircraft, radio and telecommunications.

1950 - 1990: The exploitation of nuclear power, aerospace industries, and electronics and petrochemicals; and the development of limited-access highways and global air routes.

The latest clutch of disruptive technologies emerged circa 1990 - the exploitation of solar energy, robotics, microelectronics, biotechnology, advanced materials, and information technology. New information technologies have helped create a frenetic international financial system, while transnational corporations are now able to transfer their production activities from one region of the world to another in response to changing market conditions. Construction, like law, accounting, advertising and other professions, have become global in scope, and are in the process of being organized around radically new business practices. Products, markets, and organizations are both spread and linked across the globe. Governments, in their attempts to adjust to this new situation, have had to seek new ways of dealing with the consequences of globalization, including new international political and economic alliances.

My point here is that this new technology system also offers the possibility of re-casting both our disciplines and the associated professions.

At almost all good research universities, faculty are already tunneling out under the old disciplinary and institutional walls to form new relationships. We need to open the gates and let them build highways. We need to cultivate strategic alliances. It will be difficult but it will likely turn out to revitalize university research rather than damage it.

Currently, about 80 percent of all basic research and about 17 percent of all R&D faculty in universities undertakes work in the United States.

Over the past 20 years, overall industry funding for academic research has expanded at an annual rate of greater than 8 percent.

I don’t have the data, but I suspect that in Construction the figure is much lower.

Worse still, governments and businesses don’t allocate very much at all for research in our field. Yet constructing the built environment accounts for more than 8 percent of Virginia’s economy - more than agriculture, more than health, and more than the military.

It’s up to us, of course, to persuade government and industry that they need to fund our research.

That's the first step. But as we then ratchet up our research efforts, there are some important issues that we shall have to confront.

In relation to research training:

- What are the keystones of research competency in Construction?
- How can we attract more of the top students into research tracks in Construction?

There are, though, some much broader questions that we shall soon have to confront. Much of higher education has come to operate on a sort of instrumental individualism. Many academic fields have come to accent the marketability of their technical skills while de-emphasizing their contribution to society and civic life. There has been a great deal written over the past few years about The University Inc.: universities as knowledge factories; and the consequent undermining of universities' independence.

One important question, therefore, is: Can we use and channel our research in Construction to help reinterpret the sense of public purpose for our time and to initiate a recovery of the university's identity in the mind of the public?

These are all issues for the near future. Meanwhile, it is clear that research is already of fundamental importance to our health and well-being as academic institutions. Research propagates an atmosphere of innovation and risk-taking, and the results of research generate new knowledge that sustains the development of our academic disciplines. Basic research also provides the foundation for outreach programs and the catalyst for learning environments that are enriched and enlivened by faculty who are engaged in cutting-edge intellectual inquiry.

The greater the reputation of our schools in terms of research output, the more competitive we can be in attracting the best faculty and, in turn, the best students. A benign, cumulative, spiral results: having the best possible faculty and students not only enhances our reputation but also results in more sponsored research; which in turn helps to fund equipment and infrastructure; which attracts the best faculty and students.

Yvan Beliveau's Comments

I will talk a little on background issues for the conference. Then I will present some thoughts on myself. Then I will pose some questions, which I hope will spark some discussion among you. I hope that this is the reason you came to critically discuss issues of relevance.

As a land-grant university, this is a place to meet other people with interest in educating future builders. It is the place to discuss issues on how to do that better. It is a place to meet good old boys/girls of our club and to form new clubs among ourselves as we look to improve and engage in intellectual dialog.

The theme of the conference this year is “The Scholarly Pursuit of Construction Knowledge”. I particularly would like to look at the three cornerstones of Education: Teaching, Scholarship, and Community. Here at Virginia Tech most people call it teaching, research, and outreach, as we follow our land-grant university mission.

We look at education in these three cornerstones as our focus as we hope that this event will provide critical dialog to this holistic educational ideal. These three areas are in fact all a part of the whole.

Now a Look At Why I Am in Academia

I love building buildings. Even today, I engage in conceptualizing, dreaming, and building these ideas. It is in my blood - it may always have been there.

I moved from industry to academia because I felt that little improvement or change was happening in the world in which I was engaged. I felt that things were done poorly and always the same. I was always running too hard with little time to reflect and effect change. I wanted to be part of beneficial change and I launched into an academic career.

The first issue I faced when I moved to academia was the lack of credit for industrial experience in the academic world. No matter where you have been, in academics, degree rules. A 24-year-old Ph.D. equals a 36 year-old practitioner/Ph.D. Same salary except the 36 year-old practitioner/Ph.D. can hardly stand the slowness of the academic pace. He or she has had no time to reflect in the past; therefore, does not know how. But in time as this 36 year-old practitioner/Ph.D, I learned to appreciate the academic world, but I would never exclude the practitioner world - they are both needed to produce the next generation of builders. Working together with mutual respect for one another and giving value to one another, we can tackle the overall issues of education, teaching, scholarship, and community. I hope we do not go the way of engineering and move to islands of specialization with no one to understand how it all works. However, the opportunity to work together can engage and expand both the practitioner and theorist.

Now I have a list of questions that cause me concern as I look at the future of this organization and my role in academia. I hope to pose several of these questions here. I will not provide answers; however, you will no doubt see biases in the formulation of these questions. My hope is to create dialog which if successful might lead to change.

1. How do we advance this discipline of construction at the academic table? How can we be viewed as an equal member at the academic table?

2. How can we improve the construction industry through the scholarly pursuit of construction knowledge?

3. How can we best educate future builders with inquisitive minds? And how can we work with industry to help the practice through scholarship and community.

4. Are we going to educate or are we going to train?

5. What are the challenges of the construction industry of the future?

6. What is ASC's role in scholarship and community? Will we let engineering, architecture play with academic pursuits and we will only train our students? Or will we create practitioner / theorist teams of players and give it a "go and have some of the fun?"

7. Will we let design-build (the process/design immersion) become a scholarship arena that we have little say in? Will we let Engineering/Architecture do the scholarly pursuit and have all the fun?

8. Will we let industrialization (IT, hard tools, process) become a scholarship area that we have little say in?

9. Will we adopt the concept of to schedule, rather than the concept of to plan – the planning process that outputs a schedule?

10. Will we adopt the concept of estimating with other people's unit prices? Or will we adopt the concept of process design to determine how it should be done better and then apply cost?

11. Will we rush to preach Construction Certification, statutory protection, and push for professional status? Or will we look to maintain our value added status rather than hourly fees with no risk? Will the world accept a no risk contracting system?

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Integrating Relational Database Technology into the Construction Management Curriculum

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Students in construction management programs often lack a solid knowledge about databases and database design. In addition to reasons why students should learn about database applications, the authors provide an introduction to relational database nomenclature and examples on how database technology could be incorporated into construction management course work. A road map through some of the issues related to integrating database applications and design in construction management will be provided including basic concepts of Entity Relationship Modeling (ERM) and Data Flow Modeling (DFM).

Key words: Relational Databases, Database design, Teamwork

Introduction

Understanding the application and design of databases is important for the modern construction manager. The current curricula of construction management (CM) programs provide little instruction about databases. During the past year, the researchers reviewed the college catalogs of 38 different accredited four-year programs in construction management. Information about construction management programs was obtained from the college catalogs of programs accredited by the American Council for Construction Education (ACCE) that were posted on the World Wide Web. The ACCE publishes an annual list of all accredited two-year and four-year construction management programs in the United States. For purposes of this investigation, only accredited four-year programs that posted their college catalogs to the World Wide Web were examined. There are 47 accredited programs out of the approximately 100 four-year colleges that offer construction management and related programs in the United States. Programs listed as being in accreditation candidacy were not included in the survey. A total of 23 out of 38 of the curricula reviewed did not contain any courses that include database management. The researchers concluded that databases are not taught as a regular part of these programs. This causes a hardship to CM students because they miss out on the significant benefits advanced database software applications provide.

The benefits of understanding modern database management features include extending the use of scheduling, document management and estimating software programs commonly used in industry. Learning about database design and how to manipulate databases is becoming an integral part of construction companies' overall management needs (Construction Financial Management Association, 2000). However, current programs do not capture these benefits because they fail to teach database technology and how they relate to company management.

Why Study Databases

First, most software programs used in CM include databases as an integral part of their system. Examples include scheduling software (e.g., Primavera Project Planner) and document management software (e.g., Primavera Expedition). Estimating software such as Timberline Precision Estimating, HeavyBid, and WinEst also rely on database technology.

Second, the significant increase in construction volume coupled with sophisticated building products has forced construction firms to embrace new technologies for estimating, scheduling, and project management (Construction Financial Management Association, 2000). Construction firms that do not have specialty programs for estimating or scheduling often rely on generic relational database management system software such as Microsoft Access or FoxPro or try to use the limited database capabilities of electronic spreadsheet programs. These companies are seeking CM graduates that have appropriate software knowledge.

Third, students apply management principles regarding quality planning and analysis they have learned in other classes by using a problem-centered, activity-based approach to solve real world problems. Students learn the importance and roles that business rules play in the company organization by documenting work processes.

Fourth, CM students sharpen their analytical skills by applying data modeling techniques to relational database system design and implementation. Students learn the importance of careful, advance planning and project analysis by considering factors such as: What are the attributes of the data to be collected and stored; how is it related; and how will it be entered, verified, and reported?

One way to communicate these factors to students is to introduce relational database concepts into multiple courses across the construction management curriculum. The following section will introduce relational database terminology to provide a baseline of knowledge on which to build course modules.

Relational Database Terminology

A database is a collection of tables, queries, forms, and reports. The fundamental element of a relational database is a table, or *data file*, similar to a spreadsheet (Thierauf, 1989). A *table* is composed of *columns* and *rows*. The intersection of a column and a row is called a database *field*. Multiple horizontal fields make up a record as shown in Figure 1. Records in one table have similar characteristics or properties (e.g., automobile has color, Vehicle Identification Number, model year, and assembly date).

tblEmployees : Table

EmployeeID	Employee Name	Address	City	State
A100	John Smith	200 South Blvd	Chicago	IL
A101	Mary Miller	100 East Blvd	Chicago	IL
A102	Jeff Johnson	302 South Drive	South Bend	IN
A103	Linda Jefferson	340 East Blvd	South Bend	IN
A104	Jason Kline	200 South Park	Chicago	IL

Figure 1: Sample database table for employees

There are various types of database systems of which the relational database has become the most popular. A relational database is made up of a number of tables that contain raw data and share a commonality. For example, as shown in Figure 2, a construction firm's relational database could consist of two tables. The Employee Information Table (Table 1) contains employee information such as Social Security number, Address, Name, Phone Number etc. The Project Information Table (Table 2) contains records about the company's projects such as Project Identification number, Location, Type of Work, Size of Job, and Employees Assigned (by Social Security number). Both tables contain a field called Social Security number. The Social Security number in Table 1 is a unique *identifier* for each employee. This identifier, called the *primary key*, is used to link tables within the same database or to tables within other databases (Hernandez, 1997). The Social Security numbers in Table 2 are used to identify which projects an employee is assigned to. Since employees can be assigned to multiple projects, the Social Security number cannot serve as the primary key for this table. A meaningful primary key for Table 2 would be the Project Identification Number since each project will have a unique ID number.

There are several ways of linking tables in a database management system, depending upon the type of relationship that has been established. In the example above, the Social Security number field of Table 1 can be linked to the Social Security number field in Table 2. Since the Social Security number field in Table 1 is a primary key, but can occur multiple times in table 2, we speak of a *one-to-many* relationship.

Another common type of relationship is the *one-to-one* relationship where a primary key field in one table is related to a primary key field in a second table. An example of this type of relationship would be a table with Social Security number and a second table containing Drivers License Numbers associated with Social Security numbers. Since only one Social Security number can be linked with one Drivers License number, we speak of a one-to-one relationship.

The third type of relationship is known as a *many-to-many* relationship. In this type of relationship one or more of one type of data can be associated with one or more of another data types. An example for a many-to-many relationship is a firm's database that contains 3 tables. Table 1 contains employee information using the Social Security number as primary key. Table 2 contains the firm's Construction equipment with the Vehicle Identification number (VIN) as the primary key. Table 1 and 2 do not contain a common field. Table 3 is the Work Orders Table (e.g., oil change). As construction equipment requires maintenance, work order information about the employee (Social Security number) and the vehicle (VIN) is entered into the Work

Orders Table. Therefore the orders table must be linked to tables 1 and 2. Both Tables 1 and 2 will have a one-to-many relationship with the Orders Table, creating a many-to-many relationship between the Employees and Equipment Tables.

tblEmployees : Table

EmployeeID	Employee Name	Address	City	State
A100	John Smith	200 South Blvd	Chicago	IL
A101	Mary Miller	100 East Blvd	Chicago	IL
A102	Jeff Johnson	302 South Drive	South Bend	IN
A103	Linda Jefferson	340 East Blvd	South Bend	IN
A104	Jason Kline	200 South Park	Chicago	IL

Primary Key

tblProjects : Table

ProjectID	EmployeeID Assignment	Project Start Date	Anticipated End Date
2000-1-12	A100	1/15/2000	4/15/2000
2000-2-18	A100	2/15/2000	4/25/2000
2000-2-19	A101	2/20/2000	6/30/2000
2000-3-10	A101	3/1/2000	6/15/2000
2000-6-01	A102	6/1/2000	9/15/2000
2000-9-04	A102	9/20/2000	1/15/2001
2001-10-10	A103	10/1/2001	1/15/2002
2001-1-12	A103	1/1/2001	6/30/2001
2001-12-1	A104	12/1/2001	3/1/2002
2001-5-14	A103	5/15/2001	9/20/2001
2001-9-10	A100	9/1/2001	3/1/2002
2002-1-1	A104	1/1/2002	1/30/2002

Figure 2: Sample database Table for Employees

Queries

Once the tables have been established, the raw data stored in those tables can be selected and manipulated using a wide array of queries. The most common type of query is the Select query (Figure 3). The Select query filters information from one or more linked tables to produce a particular set of records. Depending on the particular Relational Database Management Systems (RDBMS) program used, queries can produce reports, create graphs, choose records, sort records or do calculations (Prague and Irwin, 1997). In addition to select queries there are Action Queries and Cross-Tab queries.

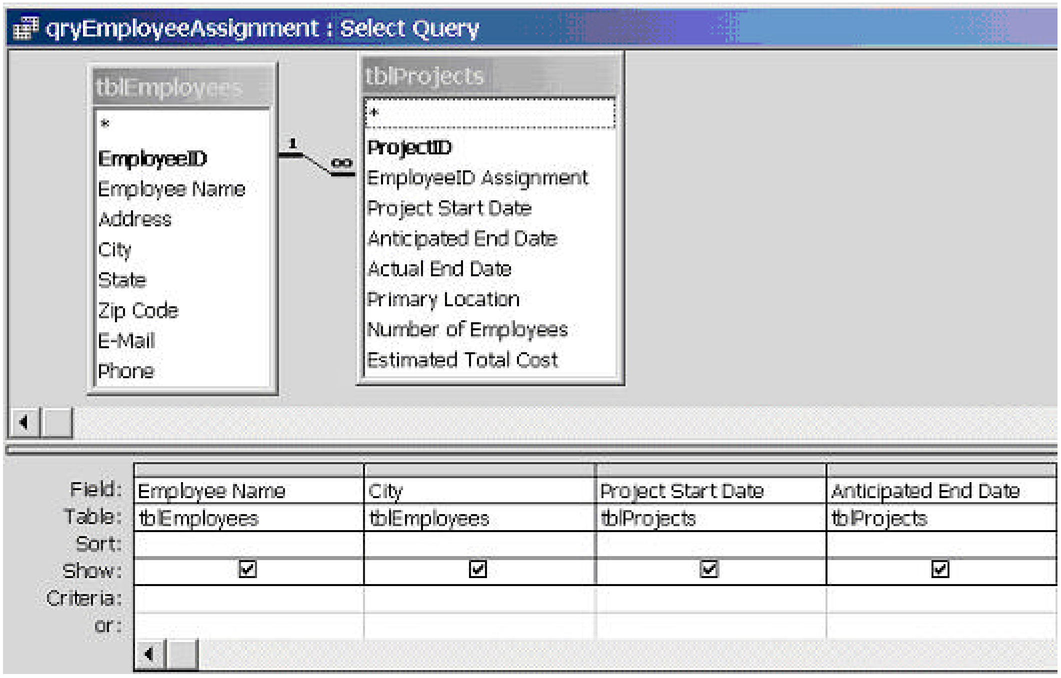

Figure 3: Query Design View for a Select Query

Action Queries are not used to simply display a particular record set like is the case with Select queries. Rather, they are used to manipulate data in an existing table. For example, if you would like to change the wage rate in your employees table, you can use an Update query to update the wages in that table. Other types of action queries include Append queries that append records from one table to the records of another, and the Delete query where records in a table are deleted according to specific criteria.

If you want to find information about how many deliveries a particular employee of your company made to a particular jobsite, a cross-tab query would be used. The cross-tab query calculates (e.g., sums, multiplies) information at the intersection of a row and a column. In the above example, jobsites would be displayed as column headings while the employees would be displayed as row headings. At the intersection of each row and column, the volume of deliveries person A made to projects A, B, C, and D would appear.

Forms and Reports

For a nice display of whatever has been queried from the tables, a variety of reporting tools are available (Figure 4). Reports themselves can be customized to the extent that calculations, summaries, and sort features can be included. Print features of the reports can vary from printer per customer, per country, in alphabetical order or by sales volume.

Turnover by Employee

Employee Name	Start Date	Anticipated End	Actual End	Location	Total Cost
Jason Kline					
	1/1/2002	1/30/2002	2/15/2002	Detroit	$12,000.00
	12/1/2001	3/1/2002	3/15/2002	Chicago	$34,000.00
Summary for 'Employee Name' = Jason Kline (2 detail records)					
Sum					$46,000.00
Jeff Johnson					
	9/20/2000	1/15/2001	1/15/2001	Chicago	$48,000.00
	6/1/2000	9/15/2000	9/15/2000	Chicago	$24,000.00
Summary for 'Employee Name' = Jeff Johnson (2 detail records)					
Sum					$72,000.00
John Smith					
	9/1/2001	3/1/2002	3/1/2002	Chicago	$34,000.00
	2/15/2000	4/25/2000	4/30/2000	South Bend	$20,000.00
	1/15/2000	4/15/2000	4/15/2000	Chicago	$40,000.00
Summary for 'Employee Name' = John Smith (3 detail records)					
Sum					$94,000.00

Figure 4: Part of a Report displaying Turnover by Employee

Forms are the important front-end of the database (Figure 5). Forms commonly are equipped with Filtering features to display selected records or groups of records in a particular format. In addition, data entry clerks without any knowledge of database design may use forms.

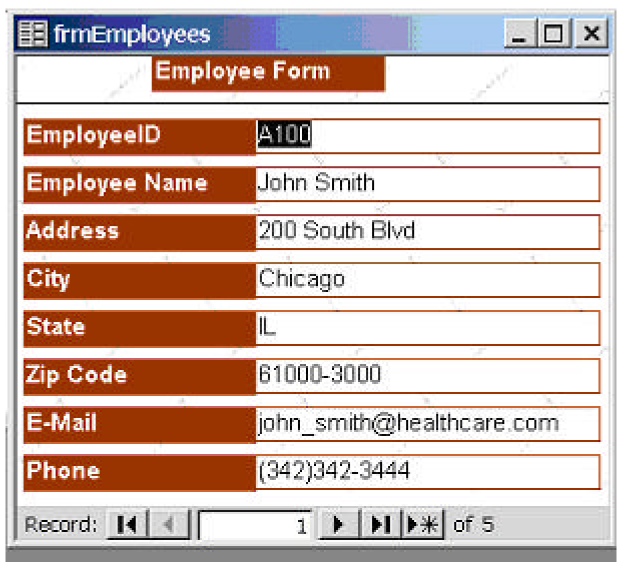

Figure 5: Data Entry Form for frmEmployees

Database Exercises in Construction Management Courses

Students learn most effectively when they see immediate application of their classroom experience to real world problems. Integrating database applications into the curriculum provides these experiences. Students must connect their classroom experience with database concepts in order to understand and meaningfully use database software (Hill, 1999). For example, a course in estimating is a natural application for the use of databases. In an introductory estimating course Sophomore and Junior students set up their own Microsoft Access database tables and store employee and information (e.g., employee name, address, phone) and project data for the purposes of bidding. This type of exercise provides an excellent opportunity for teaching database concepts. Tables can be used to teach students the powerful functionality of databases. The students can develop queries based on relationships (e.g., Employee ID) and link the tables.

Project Management courses is another area that provides multiple opportunities for teaching and integrating relational database fundamentals into the curriculum. General jobsite records like requests for information, labor administration, and purchasing are areas that can be more effectively managed using database technology (Flowers, 1996). In fact, many of the more sophisticated Project Management specific software programs available on the market (e.g., Prolog, Expedition) are specialized database programs. These types of programs have been created with pre-designed forms for easier data entry and analysis. Students learn to create forms for data entry based on paper forms they are likely to see in their professional career. For example, the request for payment, requisition forms, and employee hire data.

Scheduling courses also provide opportunities for teaching database creation and usage. Students can learn about the different types of existing database models. Most scheduling programs, like Primavera Project Planner or Microsoft Project, allow the scheduler to develop composite construction crews, set labor rates and other operational data within an internal database. Particular scheduling software programs help the instructor demonstrate how databases are used, and how they are structured. In addition, the instructor can emphasize the role databases play in the implementation and administration of scheduling programs. Students learn how to use relational database programs for labor allocation and control, labor cost data, embedding objects and to produce customized reports based upon queried data.

Instructional Methods and Strategies

In an introductory class ‘Cost Estimating and Project Planning’ students are introduced to database technology by lecture. These lectures are followed by several detailed step-by-step homework assignments (see Appendix A). Each homework assignment is designed to get the students familiar with the software package (e.g., Microsoft Access) via “action learning” (Fryer, 1997). Many students, particularly those with a limited experience in computing, depend on detailed instructions about the software before they can begin to see its potential applications. Students with low confidence in their computing skills are initially hesitant to try out computer applications on their own (Lambrecht, 1999). Lambrecht (1999) encourages systematic computing instruction by providing straightforward, applied assignments. Based on these assignments, students learn how to create tables, manipulate data, run queries and export the results of a query to another program.

The real test of the student’s abilities comes from being able to apply their new skills to situations that require critical thinking (Lundgren, Lundgren, and Mundrake, 1995). Then, students can demonstrate that they have moved beyond the basic mechanics of software program tutorials and are able to solve real-world problems. Students cannot become mired in lower level concept and skill development. To overcome the push-button mentality of the introductory tutorials, students enrolled in the more advanced ‘Computerized Estimating and Scheduling’ course are paired to analyze a construction firm and produce a database that can be used to track subcontractors and vendors for a construction project. Students in this class are primarily seniors and are expected to synthesize earlier learning concepts. Developing data models and creating databases encourages teamwork and collaborative learning which occurs as each student plays a different key role in a team. One student is assigned the role of database administrator and the other student assumes the role of a system user. Students that served as the database administrator in one pairing are assigned the role of program user in a second team. Design failures, problems of data integrity or project inadequacies can be determined almost immediately by the team. Student “action learning” is maximized, because immediate feedback is provided regarding their database’s design strengths and weaknesses (Skinner, 1968, Fryer, 1997). Solid design of relational databases is important if the database system is to function correctly. The student teams are actively engaged, developing their own business rules, testing the integrity of the data and table schema, and ensuring the validity of the output. Information about design failures in one group is shared with other groups so that such errors might be prevented in the future.

Additional team projects have included the use of formalized database modeling techniques such as Entity Relationship Modeling (ERM) and Data Flow Modeling (DFM). These team projects help develop an understanding of the relationship between employees and how data will be handled. Simsion (1994) defines ERM as the processing of designing an appropriate set of entities and relationships to meet a business problem. Using ERM, students develop a flowchart model of the relationship between entities such as field operations staff and the accounting department within a construction firm. The ERM project requires that students ask questions about structure of the construction firm and find out exactly what activities employees, particularly project managers, are responsible for.

Data Flow Modeling, on the other hand, has the main objective to define the functional structure of an organization by means of the combined consideration of functions and data. The data flows are the interfaces between these functions. In DFM, information collected by a construction firm is graphically represented. Students studying DFM are forced to think through the business processes and seek to understand the differences between the types of data that is collected (e.g., material costs, purchase orders, labor records, financial statements or job cost reports) and the way data should be reported.

Peer evaluations of each team’s finished design is used to assess the quality of the database produced. Faculty evaluates students based on (1) their performance on completing the introductory individual assignments (e.g., creation of a database and tables, filtered queries, report creation and exporting data to another software program) and (2) the collaborative effort and project performance of the team’s database to track subcontractor and vendor performance.

Closing Thoughts

Relational database concepts and database design remain a missing component in the technical background of construction management students. However, each course taught in the CM core curriculum provides opportunities to include concepts of databases and their design. A firm understanding is necessary for a technically proficient construction manager to succeed in the construction industry (Paulson, 1995). Databases are the basis for many other software programs in this industry. Zhang and Espinoza (1997) observed that, "instructors should provide activities that will assist students to learn the importance of computers in their future careers." Hands-on activities will help students overcome fear and gain a feeling of confidence when using computers and new software packages. Additionally, developing good database design requires students to draw on their prior education in business management theory and quality control. The repeated use of database software throughout a student's course of study will reinforce instruction and ensure that students enhance skills and knowledge they have acquired in previous classes.

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Appendix A
Introductory Exercise (Example)

Scenario: You are to create an Employee Allocation Database that details all the needed information about your company's employees and how they are assigned to various projects of your construction management company. Goal of this project is to produce a report that displays specifically how many projects an employee is assigned to and what the total 'volume' of the projects are for each employee.

1. Create an Access database and name it EmployeeAllocation.mdb
2. Create a first table called tblEmployees containing the following information:

Field Name	Data Type	Properties
EmployeeID	Number	Input Mask: 5 digit numbers only
EmployeeName	Text	Field Size 40
Address	Text	Field Size 60
City	Text	Lookup Wizard, add 4 cities of your choice
State	Text	Default Value 'IL'
E-Mail	Hyperlink	Required: Yes
PostalCode	Text	Input Mask (use wizard)
Phone	Text	Input Mask (use wizard)

3. Make EmployeeID the primary key field for tblEmployees.
4. Enter 5 complete records into this table. Use a wizard to create a form that helps you facilitate data entry. Your first employee should have the EmployeeID A100; the second of A101; and so on!
5. Create a table called tblProjects with the following fields:

Field Name	Data Type	Properties
ProjectID	Text	
EmployeeID	Number	5 digit numbers only
StartDate	Date/Time	Format 'Medium Date'
AnticipatedEndDate	Date/Time	Format 'Medium Date'
ActualEndDate	Date/Time	Format 'Medium Date'
Location	Text	Required: No
Number of Staff	Number	Default Value '1'
RatePerHour	Currency	Required 'Yes'
TotalPrice	Currency	Required 'Yes'

6. Make ProjectID the primary key field for tblProjects.
7. Add 10 complete records to this table. One employee can be assigned to multiple projects. Enter data as follows: ProjectID 2000-1-12, EmployeeID A100; (this means Employee A100 was assigned to Project 2000-1-12); ProjectID 2000-2-15, EmployeeID A100; ProjectID 2000-3-01, EmployeeD A101; and so forth.
8. Open the relationship window. Add both tables to the window.
9. Create a one-to-many relationship. Make sure you check the referential integrity box! Use an Outer Join Type that displays all records from your Customer table!

Scenario: You want to create a **query** to combine information about the employees and the projects they have been assigned to. This query will be based on information from both tables! You will add a **report** based on this query to display and summarize the total value of the projects by employee.

1. Create a query called qryEmployeeAssignment. Include the following fields from tblEmployees: EmployeeName, City, State. Include the following fields from tblProjects: ProjectID, StartDate, AnticipatedEndDate, ActualEndDate, TotalPrice.

2. Run the query! You should see each employee's information for as how many many projects they have been assigned to. E.g., if an employee has been assigned to two projects, you should see the information about this particular employee twice.
3. Using the report wizard, create a report based on above query in which you summarize the total value of the project. Display each project an employee is assigned to, the value of the project, and a summary of the totals for all projects.

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Needs Assessment – A Construction Management Bachelor of Science Degree Program in Alaska

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The Alaska construction industry contributes 7.5% of a $24.4 billion gross state product. Alaska is one of seven states that do not have a postsecondary construction education program. The closest program is 2,435 miles away at the University of Washington. The purpose of this research effort was to investigate the perceived needs of Alaskan contractors in hiring entry-level construction management personnel. This includes the number of graduates needed, the salaries contractors are willing to pay these employees, and the skill sets employers want the graduates to possess. Ninety-nine respondents from the construction industry participated in a survey including general contractors, subcontractors, construction management consultants, and engineering consultants. Results indicate the need for approximately 31 construction management graduates annually. The required skills identified in the survey will be used as a basis to develop a new construction management program curriculum specific to the unique Alaskan environment. These findings correlate well with existing research that predicts the supply and demand for construction education graduates nationwide and indicate the need for a Construction Management Bachelor of Science degree program in Alaska.

Keywords: construction education, construction management, construction engineering, construction industry, project management

Introduction

Members of the Associated Schools of Construction include 91 postsecondary construction education programs at colleges and universities in 43 States. These programs produce graduates with Bachelor of Science degrees in Construction Management, Construction Engineering, Construction Engineering Management, Construction Engineering Technology, and Construction Management Technology among others. Emphasis areas in these programs include construction, engineering and business. Graduates from these programs fill entry-level positions in the construction industry with titles and duties that include estimator, field engineer, scheduling engineer, office engineer, project engineer, or project manager. The most common degree title is Construction Management among 51 of the 88 members of the Associated Schools of Construction that responded to an Engineering News-Record (ENR) survey (Rosenbaum & Rubin, 2001). The various degrees are referred to as CM. Survey results are included in the Appendix A. There are CM programs in at least 43 states in the continental United States. Five states in the continental United States do not have CM degree programs. In these states major universities are less than a four-hour drive from a CM program in a neighboring state, and the majority are 65 miles or less away from an existing CM program.

High school graduates in Alaska, and personnel currently working in the Alaskan construction industry, who are interested in a CM degree, must travel at least 2,435 miles to Washington State to find this type of postsecondary program. There is a high demand for CM graduates in the lower 48. Existing CM programs are unable to keep up with demand for graduates at a rate that is increasing by 600 graduates per year (Bilbo, Fetters, Burt, & Avant, 2000). Anecdotal evidence suggests that many Alaskans who travel outside to study CM do not return upon graduation. Lower 48 construction companies interview CM graduates and make offers of employment. This research focuses on the perceived needs of the Alaskan construction industry for CM graduates. Our results indicate an industry need of approximately 31 CM graduates annually.

The Bureau of Labor Statistics, in the 1998-1999 Handbook, stated that construction managers held 249,000 jobs in the United States in 1996, and that between 1996 and 2006 employment of construction managers will increase between 10 and 20 percent (Bilbo, Fetters, Burt, & Avant, 2000) at a relatively steady annual growth rate so that young college graduates can have a predictable employment opportunities. This can be compared to other industries such as information technology and oil and gas where employment is extremely sensitive to external pressure from the economy and the price of oil, creating cyclical hiring and firing. These factors seem to indicate that development of a Construction Management Bachelor of Science degree program in Alaska would be beneficial.

The History of Construction Management Education

The first identifiable construction education program in the United States was at the University of Florida Gainesville (Robson & Bashford, 1997). Prior to World War II, the light construction industry had a volume of around $6 billion per year (Knievel, 1965). A Johns-Manville pamphlet titled "New Career Opportunities in the Building Industry" stated, "The United States Department of Commerce has recently (1946) estimated the dammed-up demand for housing will reach 40 billions of dollars by 1947." (Knievel, 1965) Johns-Manville and representatives of the building industry approached colleges and universities to set up programs with curriculum that would train students to meet the demand for construction management projected by the federal government. For example, the Light Construction and Marketing program was initiated at Colorado Agricultural and Mechanical College, currently Colorado State University, in 1946, and was administered by the Industrial Arts Department (Hauck, 1998 and Knievel, 1965). The first graduates from this program received degrees in 1949. This was a program similar to programs installed at 20 other universities as a result of being approached by Johns-Manville and representatives of the building industry (Knievel, 1965).

The first college-level construction education program earned legitimacy 25 years ago through accreditation. There are currently as many as170 construction education programs in the United States with at least 82 of those programs being accredited by American Council for Construction Education (ACCE), Accreditation Board for engineering and Technology (ABET), and/or National Association for Industrial Technology (NAIT). ACCE accreditation covers programs focused on construction management, whereas ABET accreditation is focused on construction engineering. NAIT accreditation does not require a construction focus. (Rosenbaum & Rubin, 2001).

Supply and Demand for Construction Education Graduates

A study (Bilbo, Fetters, Burt, & Avant, 2000) started in 1999 and published in 2000 predicts that the demand for construction education graduates is increasing at a rate of approximately 600 per year. This study concludes that the 54 universities with construction education programs accredited by the ACCE and ABET that were used in the study produce 2,350 graduates per year, and the study predicts that by the year 2005 the demand for CM graduates will be over 6,500 per year. This prediction is based on survey responses from these programs and over 773 non-Alaskan companies that consistently hire graduates from these programs. An average of over 40 organizations recruit students at each of the 88 schools that responded to the ENR survey (Rosenbaum & Rubin, 2001).

The five lower 48 states that do not have a CM program at any of the state's colleges or universities are close enough to CM programs in neighboring states to allow construction companies from those states to easily travel to existing CM programs to interview for potential entry-level CM personnel. Refer to Table 1 for the distances from a major university in a state that does not have a CM program to a CM program in a neighboring state (Road Atlas, 2002 and Fitzpatrick & Modlin, 1986).

Table 1

Seven states that do not have a CM program

State without a CM program	Major University	City, State	Miles to	Major University with a CM Program	City, State
Alaska	University of Alaska Anchorage	Anchorage, AK	2,435	University of Washington	Seattle, WA
Delaware	University of Delaware	Newark, DE	45	Temple University	Philadelphia, PA
Hawaii	University of Hawaii	Hilo, HI	2,461	California State University	Long Beach, CA
New Hampshire	University of New Hampshire	Manchester, NH	47	Wentworth Institute of Technology	Boston, MA
Vermont	University of Vermont	Burlington, VT	260	State University of New York	Syracuse, NY
West Virginia	West Virginia University	Morgantown, WV	213	Pennsylvania State University	Middletown, PA
Wyoming	University of Wyoming	Laramie, WY	65	Colorado State University	Fort Collins, CO

The proximity to an existing CM program hampers the ability of Alaskan contractors to find entry-level CM personnel. The construction industry in Alaska is unable to interview potential entry-level employees without flying down to lower 48 universities that have CM programs, or paying to fly potential employees up to Alaska for an interview. Both options have a high cost, and are not convenient or practical for contractors. Hiring an employee based solely on a resume and a telephone interview has high risk for the contractor. If an Alaskan contractor does hire an individual from the lower 48 then there are additional costs of relocation, and Alaska state law requires the contractor to move the employee back to the lower 48 at the termination of employment.

Alaskan Construction Industry Survey

A survey was developed to evaluate the perceived needs of the Alaskan construction industry for CM graduates.

The survey asked recipients if a CM program existed:

- Do they have a problem finding entry-level management personnel?
- How many and how often students would be hired to fulfill internship requirements?
- How many and how often graduates would be hired?
- What is the starting pay for recent CM or engineering graduates?
- What is the starting salary for graduates with six months of internship work experience?

Respondents were asked to score the importance of skills possessed by CM graduates on a Likert scale. The skills listed were developed from ACCE accreditation curriculum requirements, and skills taught in various similar programs. Respondents were asked to indicate industry sectors they served.

Survey Population

The list of survey recipients was obtained from three sources. The Associated General Contractors of Alaska (AGC) distributed the survey to the AGC General Contractor Members (81), Specialty Contractor Members (204), and Associate Members (278); from a list of Associated Builders and Contractors (ABC) members in Alaska, 22 surveys were sent to eight general contractors and 14 subcontractors; and from a list of companies provided by the Alliance of Process Industries in Alaska, 66 surveys were sent to contractors that primarily provide goods and services for the oil industry. Surveys were also sent to five construction management firms and owner's project representatives and project managers known to the authors and identified as not on the lists above. Out of the total 651 surveys sent out, 99 surveys were returned. This is an overall response rate of 15.2%. Within the category of general contractor the response rate was 49.4%.

The authors asked several suppliers, associate members of the AGC of Alaska, why they did not return the survey. The responses were very consistent. For example, "We are a small shop, just me and my wife. I didn't think the survey really applied to me, and I didn't want to hurt the results," said the owner of Aurora Construction Supply in Fairbanks, Alaska. Since the AGC Associate member category includes material suppliers, bankers, insurance brokers, bonding companies, and other similar entities, it appears that the low response rate for all surveys sent out is due to the recipients believing that the survey did not apply to them. This resulted in a low response rate for that category of recipient, and lowered the response rate for all recipients.

Figure 1 illustrates industry sectors of the respondents. The “Other” category includes five specialty subcontractors, four owner’s representatives, four material suppliers, two hazardous material contractors, two engineering design firms, one manufacturing company, one mining company, one oil refining company, one heavy equipment leasing company, and one freight/material transport company. The respondents were encouraged to check as many industries as are applicable to their firm.

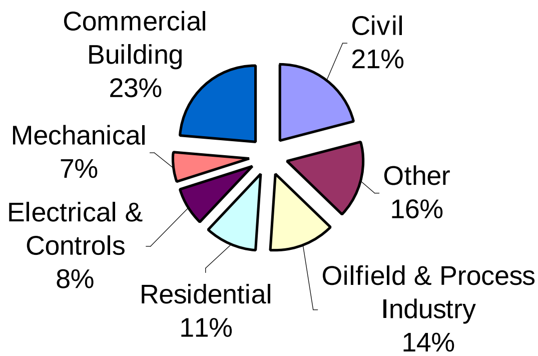

Figure 1: Construction Industries in which the Survey Respondents Work

Difficulty Finding Entry-Level Employees

The survey asked for a response to the statement, “It is very difficult to find entry level construction management or project engineering personnel in Alaska” with the response choices being: 1 = Strongly Disagree, 2 = Disagree, 3 = Not Sure (neither agree nor disagree), 4 = Agree, 5 = Strongly Agree. The mean response was 4.01, so that the average contractor that responded agreed that it is difficult to find entry-level personnel.

The average response to the statement, “Our firm would save some of the costs of training new hires to fill a position in project management or project engineering when we hire a graduate from a construction management program compared to hiring a recent design engineering graduate” was 3.86 using the same response scale. Results clearly indicate that the average Alaskan contractor has difficulty finding entry-level employees and they have the burden of additional training costs if they hire from an existing engineering program in Alaska.

How Many CM Graduates and Interns would be Hired

The survey asked, “If a construction management program existed in the University of Alaska system, would your firm hire graduates from that program: Never, Once Every Five Years, Once Every Other Year, One Graduate per Year, more than One Graduate per Year. Responses indicate that the respondents predict that their firms would hire an average of 31 graduates per year.

Based on the responses from the 88 programs that responded to the ENR survey, the mean number of CM students that graduated from one of these programs during the 2000 – 2001 academic year was 38.73, with the median number of graduates being 30. With a standard deviation of 30.82, there are large differences in the number of graduates from the 88 CM programs. The highest number of graduates from one program was 156 from Purdue University in West Lafayette, Indiana, and the lowest number of graduates from one program was two from Tri-State University in Angola, Indiana.

In addition to hiring CM graduates, the responses to the survey indicate that the contractors would be willing to hire 58 students per year to fulfill internship requirements.

Faculty and administrators involved in existing CM programs in the lower 48 have continued to meet with their local construction industry representatives to determine what attributes possessed by CM graduates are needed by these companies (Rosenbaum & Rubin, 2001). The responses were most often centered on practical experience. For example, the CM program at Colorado State University found that since many industry supporters favored six months of contiguous internship experience, the program allows either two three-month or one six-month internship placement to fulfill program requirements (Hauck, 1998). The ENR survey determined that 46% of the CM programs that responded include an internship as a graduation requirement (Rosenbaum & Rubin, 2001). Even if an internship is not a formal graduation requirement, practical construction experience is strongly encouraged by advisors and educators in CM programs.

Entry-Level Starting Salaries

The survey asked two questions regarding the starting salaries that the Alaskan contractors would be willing to pay entry-level CM or Engineering graduates. The first question asked what salary range they would be willing to pay for a graduate with little or no experience. The calculated average annual salary was $39,006 for the first question. The second question asked what salary range they would be willing to pay for a graduate with six months of internship work experience. The calculated average annual salary was $42,233 for the second question. This compares very favorably to the results of the ENR survey in which the average response from the 88 CM programs responding said that the average salary for their graduates was $40,983. (Rosenbaum & Rubin, 2001).

CM Graduate Skill Requirements

To assess the entry-level skill sets needed by the industry, the survey asked respondents to evaluate the importance of skills using a scale from one to five, with five having the highest importance. A list of 16 skill areas was developed from ACCE curriculum accreditation requirements, discussions with construction industry managers, and skills that would be primarily taught in other education programs. Refer to Table 2 for the results of the survey responses.

Skills listed by the respondents under “Other” included: practical experience, geology, blasting, negotiation and conflict resolution, team building, labor relations, blueprint and topography reading, codes and permits, on-site education and training, equipment and labor productivity, leadership and management skills, and soft skills including listening, personnel management, and people skills.

Table 2

CM Graduate Skills Required by the Alaskan Construction Industry

Rank	Skill Description	Score
1	Oral and written communication	4.62
2	Planning and scheduling	4.53
3	Estimating including quantity take-off and bid analysis	4.45
4	Project administration and management including documentation at job site & office, submittal review/processing, quality control procedures, and computer applications	4.43
5	Decision making including analysis of alternatives, cost/benefit, return on investment, and net present value	4.25
6	Safety practices, compliance, training, and records	4.22
7	Accounting and cost control	4.13
8	Construction methods and materials including concrete, steel, wood, and soils	3.96
9	Logistics including material management, transportation, storage, and procurement	3.90
10	General education including humanities, social sciences, math and sciences	3.62
11	Business and construction law	3.55
12	Drawing/drafting or CAD skills	3.25
13	Environmental management including haz-mat reporting & training, EMS plans, and response planning	3.24
14	Civil and/or structural design	3.18
15	Construction surveying	3.15
16	Mechanical or electrical design	3.08

A study conducted in 1994, surveyed construction experts to determine the rank order of skills required by entry-level constructors (Mead & Gehrig, 1994). Although the list of skills is not exactly the same, comparing the lists show similarities. From that survey, the rank order of future skills: 1. Communication Skills; 2. Business Management 3; Leadership Skills 4;. Technical Knowledge 5; Field Experience 6; Planning and Scheduling 7; Computer Skills 8; Attitude & Eagerness 9; Estimating Skills 10; Construction Law.

The most important skills as determined by the recipients of both surveys are communication skills. But in the past six years the importance of planning and scheduling, and estimating skills has increased, or these skills are more important to contractors in Alaska, which may be due to remote construction sites and the short construction window in Alaska when compared to states with a longer time in which the projects can be completed or enclosed. Weather protection, complicated logistics involving ice roads, access by air only, barge transportation, access to ice locked ports, planning for harsh weather and snow drifting, and difficulties in getting missing supplies, power, fuel, and communications to remote locations, for example, are activities not always included in lower 48 construction projects. Construction law by comparison to other skills is low in importance to the respondents in both surveys. Computer skills, which is ranked six out of ten in the 1994 survey, are skills that are implicitly required in the top five in the Alaska survey: written communication, scheduling, estimating, project administration, and decision making.

Respondent Information

The 99 respondents indicated that of the 622 employees that worked for their companies, 11% had CM degrees. If the responses from the engineering consultants are removed from the survey, 16% of their employees had CM degrees. The 99 respondents indicated that 52 were owners or presidents of their company, 17 were project managers, six vice presidents, six operations or general managers, and the rest filled a variety of positions in the construction industry.

The Construction Economy

The gross state product for Alaska in 1997 was $24.494 billion, and construction industry contributed 4.1% of the total (Bureau of Economic Statistics, May 2000). In 1998 the construction industry in Alaska had a 7.5% share of earnings, which can be compared to 5.9% for the entire construction industry in the United States (Bureau of Economic Statistics, March 2000). The construction industry in Alaska is an important part of the Alaskan economy. In 1990 an average of 10,503 individuals were working in the construction industry, 4.5% of the entire work force. By 1999 an average of 13,835 people were working in construction, 5.0% of the work force (Alaska Department of Labor, 1999). On the national level there are more than six million people employed in the construction industry in the United States. This yielded "more than $600 billion worth of new construction projects such as new hospitals, schools, highways, bridges, homes, office buildings, stores, etc. That is about 10 percent of America's Gross Domestic Product" (Herring, January 2002).

The Indiana Factbook (Indiana University Press, May 1998) projects that the construction industry in Alaska will experience a 27% increase in employment from 2005 to 2045, compared to a 24.5% increase in construction employment for the entire United States during that same time frame. The projected construction industry employment in 2005 will be 21,500 individuals, 5.1% of the Alaskan work force. By 2045 the projected employment in the construction industry will be 27,300 individuals, 5% of the Alaskan work force. This increase in the number of individuals working in the construction industry will require an increase in project management staff as well. Having as many construction education programs available as possible would assist the construction industry in being prepared to manage the projected employment increase.

The Aging of Alaska's Workforce

The Alaska Department of Labor and Workforce issues a publication called Alaska Economic Trends, which along with other economic trends, studies the aging of the Alaska workforce. This research points to the fact that there has been a decline of young adults in Alaska, and that the number of Alaskans age 20 to 34 has declined by 36,000 since the 1990 census. The median age of Alaskans has risen from 29.3 in 1990 to 32.9 in 1999. General Contractors in the building construction arena employ workers, 36.9% are over 45 years old and 13.8% are over 50 years old. This picture gets worse for the heavy construction aspect of the industry in which 40.1% of employees are over 45 years old, and 21.1% are over 50 years old. As stated in Alaska Economic Trends, as this trend continues, "the 'graying' of the Alaska worker will place new demands on training institutions." (Hadland & Williams, September 2000)

Conclusions

This research shows strong support for the creation of a Construction Management Bachelor of Science degree program in Alaska. Out of the 99 respondents, 58 indicated that they “would be willing to write a letter in support of creating a Construction Management Bachelor of Science degree program in the University of Alaska system”. This demonstration of support from the construction industry reveals the underlying need for a construction education program in Alaska. Coupled with the current and projected demand for CM graduates in the lower 48, the need for a CM program in Alaska is amplified. Another factor that will increase future need for CM graduates is the aging Alaskan work force. As project management personnel currently working in Alaska retire, a source of well-educated and well-trained replacement personnel is needed with an increased emphasis on making those opportunities for training and job placement available to Alaskans.

There continues to be a strong need in the construction industry for civil, structural, and architectural designers, and that specific need could be the subject of additional research. But there are skills taught in construction management education programs that are required by the construction industry and are not provided by the design program curricula. A minor in CM could be made available should any individual focused on a degree in one of the design areas of study desire to gain the project management skills identified by the Alaskan construction industry, and as defined by the curriculum requirements as defined by ACCE as an accreditation requirement.

Accreditation of a CM program in Alaska would provide the credibility that the graduates deserve, and that the program needs in order to grow. CM program accreditation would help the University of Alaska recruit out of state students, another potential resource for the Alaskan construction industry. A Construction Management Bachelor of Science degree program is needed by the Alaskan construction industry to be prepared to meet the construction needs in Alaska for the 21st century.

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Appendix A

Engineering News-Record Construction Schools Survey Data, based on 88 responses from construction education programs that are members of the Associated Schools of Construction.

Colleges/Schools where Degrees Resides			
Engineering	Architecture	Business	Other
31	9	4	44

Degree/Program Titles			
Construction Management	Construction Engineering Management	Construction Engineering Technology	Other
51	9	12	16

Degrees Offered			Accreditation		
Bachelor of Science	Master of Science	Ph. D	ACCE	ABET	NAIT
50	22	16	55	23	8

Enrollment			
Total Number of Under-Graduates	Average Number of Under-Graduates	% Full-Time	% Part-Time
15,314	174	85%	15%

Average Curriculum Percentage		
Construction	Business	Engineering
35.3%	12.8%	11.2%

Bachelor of Science Graduates		
Total	Male	Female
3,408*	3,067	328

Recruiting (Average)	
Starting Salary	Number of Organizations Recruiting
$40,983	40.5

*One of the programs surveyed listed 13 total graduates with no gender break down.

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Using Technology Mediated Instruction to support an Introductory Structures Course for Construction Undergraduates

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An incremental approach to developing a web site to support an introductory structures course at Texas A&M University is presented. The development of the web site from an initial on-line presence at the start of the Spring 2000 semester through to a fully functioning web site in Fall 2000 is described. The structure of the web site is outlined and the preparation of web lecture pages that contain a mixture of text, graphics and animations is described in detail. A survey conducted among undergraduate students during the Fall 2000 and 2001 semesters provides details of how students use the web site while enrolled in the class. The survey also investigated how students perceived the usefulness of the web site. Results of the survey suggest the web site is a useful tool in supporting an introductory structures course.

Key Words: Structures coursework, Technology mediated instruction, Undergraduate education.

Introduction

The Internet is a valuable resource that can enhance the traditional classroom delivery system. The limitations of the traditional classroom environment and methods of communication make the explanation of introductory concepts difficult. Computer graphics and animations help support traditional classroom lectures. Students in the classroom and other locations, such as a computer lab or home, can access instructional material. The use of the Internet to aid instruction is called Technology Mediated Instruction (TMI) by the Texas A&M University System. TMI is defined by the Texas A&M University system as instructional activities that use technological innovation in the development and delivery of course content to students whether in a traditional setting or through distance education. The use of computers and computer software are considered technological innovations. This paper describes the development of a web site to support an introductory structures course and surveys students on how they use the site and their perception of the sites usefulness.

The Traditional Instruction Method

The Department of Construction Science at Texas A&M University has a group of four structures related courses: COSC320 Soils in Construction, COSC321 Structural Systems I, COSC421 Structural Systems II and COSC422 Structural Systems III. This paper is focused on introductory structures course COSC321. COSC321 covers basic statics and strength of materials concepts. The course has been offered in its current format since the fall of 1998. The author has taught the class since the fall of 1999. The traditional way of teaching COSC321 is to have three 50-minute lectures and three 50-minute labs each week.

The traditional instructional method involved lecturing to the class and explaining key concepts using models and black and white board sketches. The time constraints on the class, and the instructor's drawing ability produced poor quality sketches. In the lab sessions, students solved problems set from the required text. By the end of the session, the instructor worked through the problems on the board in order for students to check their work and answer questions. The required text includes answers without fully worked solutions.

The Incremental Approach to Technology Mediated Instruction

In 1999 the Department of Construction Science initiated a plan to offer the Master of Science in Construction Management by distance learning. COSC 321 is a required leveling course for career-change students seeking a Masters degree. The leveling courses were selected to be the first courses to be offered on-line. A tentative date for pilot testing the COSC 321 course was set for the Fall semester of 2000. Before the spring 2000 semester, when development for the web COSC 321 class began, there was no online content for this class. An incremental approach to developing a web site is the step-by-step enhancement of existing face-to-face courses that builds on the strengths of online learning into campus-based courses (Eastmond, Nickel, du Plessis & Smith, 2000).

Microsoft web development software Front Page 98 & 2000 was used to develop and manage the site. When the site went on-line, prior to the commencement of the Spring 2000 semester, the following components of the class were included as menu items:

- Syllabus
- Schedule with lecture topics
- Expected student behavior statements
- Basic trigonometry formula

This was the basic information students required at the beginning of the semester. Figure 1 shows a screen capture from the site showing the menu items currently available. Most information on the web site was already in an electronic format as Microsoft Word documents. A minimum amount of work was required to convert these to HTML documents. As the semester progressed the following additions were made to the web site:

- Hyperlinks for weekly homework assignments were added. Homework problem numbers were linked to their respective solutions. These on-line solutions were scans of the solutions solved on traditional engineering paper. The students used these on-line solutions to check their homework.
- Past quizzes and quiz solutions were added as menu items. Quizzes and solution sheets had been prepared using freehand text and sketches. These were scanned and saved as GIF images and then added to HTML documents.

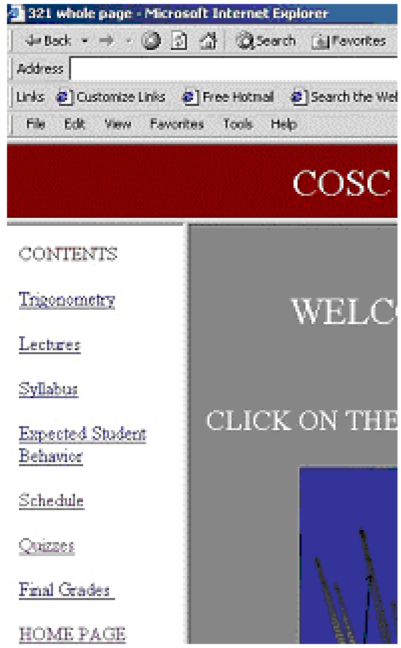
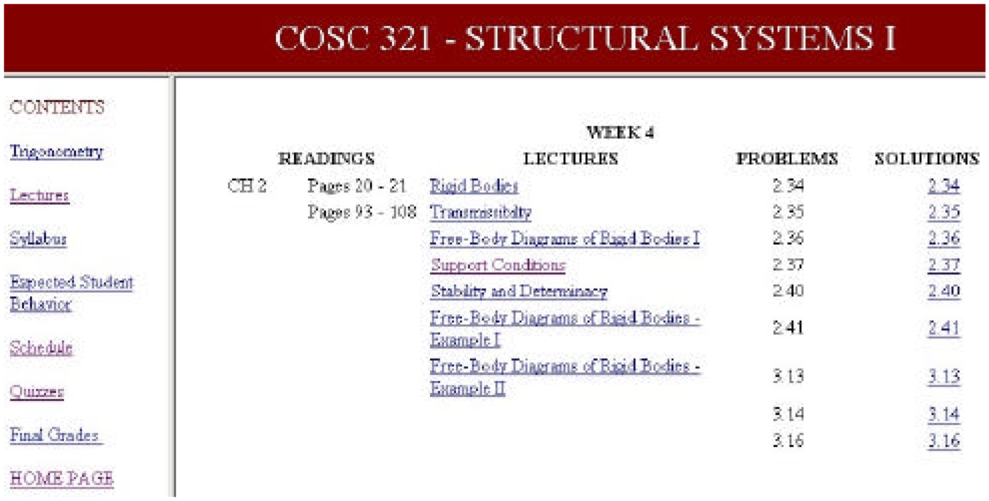


Figure 1: Sample of main navigation of the COSC 321 class

More recently, quizzes have been created using Microsoft Word, with illustrations from Adobe Illustrator. This allows for easy conversion to HTML. By the end of the spring semester, the web site allowed students easy access to support information for COSC 321. The next step involved adding lecture content to the site. The Department of Construction Science obtained funding from the University to help develop web-based material for the Master of Science in Construction Management during the summer of 2000. The author received funding for a six-week period at the end of the summer to produce lecture content for the web site. Lecture material for the web was developed using a combination of text, images, and animations. By using this method the illustrated material could be used in the classroom environment as well. The web lectures are arranged into weekly groups that follow the traditional classroom schedule. Figure 2 shows a screen capture from the week 4 lecture web page. Each week of the semester has a separate web page that contains the following information:

- Readings from the required text
- Web lecture topics with hyperlinks to web lectures
- Homework/Lab problems from required text with hyperlinks to their solutions



COSC 321 - STRUCTURAL SYSTEMS I

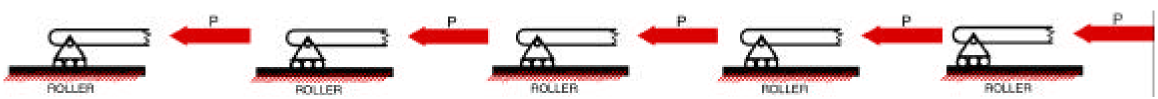
CONTENTS
Trigonometry
Lectures
Syllabus
Expected Student Behavior
Schedule
Quizzes
Final Grades
HOME PAGE

WEEK 4

	READINGS	LECTURES	PROBLEMS	SOLUTIONS
CH 2	Pages 20 - 21	Rigid Bodies	2.34	2.34
	Pages 93 - 108	Transmissibility	2.35	2.35
		Free-Body Diagrams of Rigid Bodies I	2.36	2.36
		Support Conditions	2.37	2.37
		Stability and Determinacy	2.40	2.40
		Free-Body Diagrams of Rigid Bodies - Example I	2.41	2.41
		Free-Body Diagrams of Rigid Bodies - Example II	3.13	3.13
			3.14	3.14
			3.16	3.16

Figure 2: Sample of Week 4 lecture web page

The web lecture pages are a combination of text, graphics and animations. The text content was produced in Microsoft Front Page and the graphics were created using Adobe Illustrator. Tables were chosen to contain content so that resources remained in the same location regardless of screen size (Ryan, 2000). Manipulating the Adobe Illustrator images produced animations; each image was changed slightly to illustrate movement. For most of the animations approximately five to six manipulations were required. Figure 3 shows the five images used to produce an animation of a roller reaction. The animations were produced using JASC Animation Shop software.



1 2 3 4 5

Figure 3: Five images used to produce an animation of a roller reaction

Figure 4 shows a screen capture from a web-lecture page showing the use of graphics, animation and text. The illustration of the pin or hinged reaction is in fact an animation. The animation shows how the force F causes the cantilever beam to move downward from its horizontal starting position. The animation is a loop of five or six images that continues to animate while the page is being viewed. This animation helps to explain to students the limitations of a pin or hinge support condition. Animated files create a sense of motion that can help understanding (Ryan, 2000).

The time spent in developing these web pages depends on a number of factors. Familiarity with the illustration and animation software is a major factor. The amount of graphics and hyperlinks on a particular page will also affect production time. An average of between 15 and 20 hours of development time were spent for the material covered in a 50-minute classroom lecture.

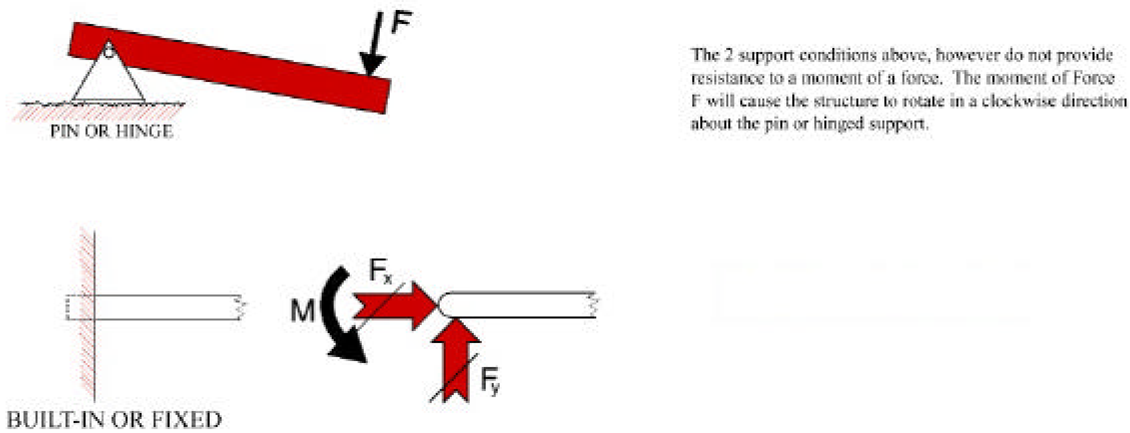


Figure 4: Screen capture of a web-lecture page showing graphics, animation and text.

Student Use Surveys

In order to identify the usefulness of the web site from a student's perspective, a survey was conducted among the students taking the introductory structures class. The surveys were conducted among the Fall 2000 and Fall 2001 classes.

Objectives

The main objectives of the surveys were:

- To identify how students use the web site while they are enrolled in the introductory structures class.
- To ascertain how the students perceive the usefulness of the web site

Method

A short, one-page, survey was given to all the students enrolled in the Fall 2000 and Fall 2001 classes. In Fall 2000 semester there were 97 students enrolled and 115 in Fall 2001 semester. There were 61 completed surveys in 2000 and 74 in 2001, giving response rates of 63% and 64% respectively.

Results

The first series of questions on the survey dealt with how the students used the web site while enrolled in the class.

1. Where is the computer that you usually use to access the introductory structures course web site?

Table 1

Where students access the introductory structures course web site

Location	Fall 2000	Fall 2001
At Home	52%	56%
College Computer Lab	39%	35%
University Computer Lab	8%	7%
Other	1%	2%

2. How often did you visit the introductory structures course web site?

Table 2

How many times a week students access the introductory structures course web site

How often	Fall 2000	Fall 2001
Never	2%	12%
Once a week	34%	46%
One to three times a week	46%	38%
More than three times a week	18%	4%

3. When you visit the site, on average, how long do you stay?

Table 3

How long, on average the students stay at the introductory structures course web site

How long	Fall 2000	Fall 2001
Never visit	0%	1%
Less than 5 minutes	16%	12%
5 – 10 minutes	49%	53%
More than 10 minutes	35%	34%

4. How did you use the web lecture pages?

Table 4

How the students used the web lecture pages

How students used web lecture pages	Fall 2000	Fall 2001
Never visited them	2%	4%
Visited them only to print the pages to read	45%	49%
Visited them and read the pages on-line	18%	11%
Visited them, read the pages on-line and printed them	35%	36%

5. How did you use the lab/homework problems and solutions?

Table 5

How the students used the lab/homework problems and solutions

How students used the lab/homework problems and solutions	Fall 2000	Fall 2001
Did not use them	8%	12%
Printed them out before the lab to use during lab	18%	23%
Printed them out after lab to check solutions	45%	47%
Other	29%	18%

The second series of questions dealt with how the students perceived the usefulness of the web site.

6. Identify the response that best reflects your response to statement “The Web-lectures helped support the material I was given in the lectures”.

Table 6

Students response to the statement “The Web-lectures helped support the material I was given in the lectures”

Response	Fall 2000	Fall 2001
Strongly agree	62%	57%
Agree	26%	32%
Neutral	12%	10%
Disagree	0%	1%
Strongly disagree	0%	0%

7. Identify the response that best reflects your response to statement “The animations in the Web-lectures helped explain difficult concepts”.

Table 7

Students response to the statement “The animations in the Web-lectures helped explain difficult concepts”

Response	Fall 2000	Fall 2001
Strongly agree	51%	47%
Agree	34%	39%
Neutral	15%	14%
Disagree	0%	0%
Strongly disagree	0%	0%

8. Identify the response that best reflects your response to statement "If I missed a lecture, the Web-lecture helped to explain the work I missed".

Table 8

Students response to the statement "If I missed a lecture, the Web-lecture helped to explain the work I missed"

Response	**Fall 2000**	**Fall 2001**
Strongly agree	53%	41%
Agree	23%	42%
Neutral	22%	17%
Disagree	0%	0%
Strongly disagree	2%	0%

9. Identify the response that best reflects your response to statement "It was a waste of time visiting the web-site".

Table 9

Students response to the statement "It was a waste of time visiting the web-site"

Response	**Fall 2000**	**Fall 2001**
Strongly agree	0%	0%
Agree	0%	0%
Neutral	0%	5%
Disagree	20%	23%
Strongly disagree	80%	72%

Discussion

The results of the first series of questions give valuable information on how students use the web site while enrolled in the class. The results show the majority of the students access the web site from their home computers. This means that many students will only have access to the web site via slow Internet connections. In these circumstances, the file size of each web page becomes an issue, as graphic intensive pages take longer to load via slow cable modems. The Front Page software has a function that provides details of the time it takes to load a page over connections of various speeds. For example the web page, which contains the graphics shown in figures 3 and 4, is estimated to take 13 seconds to load over a 56.6 modem.

The vast majority of the students taking the class accessed the web site at least once a week and the majority of the students stayed less than ten minutes at the site. This short period of time spent at the web site is most likely explained by the results to question 4 that showed 45% of the students in Fall 2000 and 49% in Fall 2001 only visited the site to print the pages to read. Question 4 also revealed that over 80% of the students print the web pages to read. This raises two points, the first is, what is the point of producing animations when most of the students print the pages and the animations appear static and secondly the clarity of the pages when printed becomes important. The first point is answered by the responses to question 7 that showed that over 85% of the students agreed that the animations helped explain some of the difficult concepts. This might be due to the fact that the animations are also used during the classroom lectures to help explain concepts. The second issue was addressed by printing out web pages during the construction phase and inspecting for clarity. Students were also encouraged to inform the author of any problems regarding the site and during the early days of the web site most of the complaints were about the clarity of the printed pages. The results to question 5 show that the majority of the students used the problem solutions in some form. The instructor encourages the students to use the solutions to check their own solutions only after they have solved the problems themselves.

The results of the second series of questions reveal how the students perceived the usefulness of the web site. The results of question 6 show that the vast majority of the students agree with the statement that the Web-lectures helped support the material they were given in lectures. This would indicate that the Web-lectures are a useful tool for supporting traditional classroom instruction. The results of question 7 show that the students perceive the animations on the web site as helping to explain difficult concepts. This is a strong argument for developing these animations, even though the time spent in developing them can be long. The students also agreed that web lectures were also useful in helping explain the work they missed if they were absent from a lecture. The results to question 9 would seem to confirm the results of earlier statements, as none of the students agreed with the statement that it was a waste of time visiting the web site.

The results of the student surveys suggest that the web site is a useful tool in supporting an introductory structures course. The results however are based on surveys conducted over two semesters at one university and may not be applicable to other classes at other universities. The results show that the web site is useful to the students but does not address how it improves student learning. Future research will focus on the effect the web site is having on the student's ability to understand some of the structural concepts mentioned earlier.

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