Journal of Construction Education
Fall 1996, Vol. 1, No. 2, pp. 66 - 78

1522-8150/96/$3.00/Educational Practice Manuscript

Curriculum Development and Continuing Education in Project Management for the Specialty Subcontracting Industry

Kirk Alter, and John Koontz
Purdue University
West Lafayette, Indiana

The construction industry possesses no dearth of training programs, and academia is seldom reluctant to offer its services when called upon to assist in developing educational programs for industry. Often, though, academia is unaware of the specific and separate training needs of the non-general-contracting members of the contracting community, as well as being unaware of the opportunities that lie therein. Further, most industry training programs are terminal in nature, failing to measure success in terms of the financial impact to the firms sponsoring the students. Finally, as is possible with any curriculum, many industry training programs become stagnant and dated over time because of a failure to view industry training as a highly dynamic process which must be prepared to change rapidly with changes in technology, information, and resources. The following case is a study in partnering to achieve the goals of trade-specific project management training, measurability of success, and accountability in industry education programs among the National Association of Plumbing-Heating-Cooling Contractors and a large Northeastern university.

Key Words: Continuing Education, Industry Training Programs, Partnering, Subcontractor Training Program, Trade-specific Project Management Training

Introduction

The Curriculum Committee of the National Association of Plumbing-Heating-Cooling Contractors (NAPHCC) Education Foundation agreed in the spring of 1995 to pursue implementing a Project Management course for contractor members' employees. The original intent was to provide on-site courses at a selected university, and a continuing education program in the form of a home study course. To that end, they selected five universities as potential candidates and mailed them an initial Request For Proposal (RFP) form. The universities initially queried were Purdue University, Arizona State University, Pennsylvania State University, Kutztown University of Pennsylvania, and the University of Florida. Only three elected to respond: Purdue, Arizona State, and Penn State. At the NAPHCC meeting in Minneapolis on June 7, 1995, Purdue University and Arizona State were selected as finalists.

Based upon discussions at the Minneapolis meeting, a consensus was reached regarding sending the two finalists a revised RFP which expanded the set of guidelines to be addressed in the final proposals. Both universities responded expeditiously, and an NAPHCC Task Force was created to visit both facilities. Prior to these campus visits, all NAPHCC Curriculum Committee

members received copies of the final proposals and were asked to submit written comments to be used during the on-site evaluations.

The Task Force visited this university on August 22, 1995, and Arizona State on August 29, 1995. Since both universities indicated that preparing a home-study course prior to the start of the in-residence portion of the program (as called for in the Revised RFP) would delay the start of the program until Fall 1996, it was decided by the Task Force to restructure the program requirements of the Revised RFP as follows:

- Self Examination and Evaluation by Employer for participant inclusion to initial class to be held in Early 1996.
- Intensive on-campus instruction and team participation for 24 (maximum) attendees. Minimum of one-week course instruction, with follow-up, evaluation, and inclusion of a continuing education component post-instruction. The consensus of the Task Force was that, with the amount of initial course study, two weeks of on-campus instruction would be required, and that the best format to follow would be two one-week in-residence sessions separated by 3-4 months.
- Continuing education program with inclusion of a Project Management Reference Manual, updated annually (mid-September).

Using these guidelines, both schools provided tours of their facilities, introduced faculty and staff members, and discussed their proposals including proposed budgets.

On August 30, 1995 the Department of Building Construction and Contracting was notified that it had been selected as the successful candidate, and was awarded a letter of intent.

Following the award, and to maintain the momentum of the process, a Foundation Project Management Techniques Symposium was scheduled and held at the Falls Church, Virginia, NAPHCC headquarters September 29 - October, 1, 1995. The Foundation provided an independent facilitator to lead the conference of a representative group of NAPHCC Contractor chief executive officers and chief operating officers (CEOs/COOs), and key selected personnel from the university. The purposes of the symposium were to brainstorm course topics and identify the format and content of the course of study and the course manual.

At that meeting, the Board of Governors agreed to utilize the partnering process to specifically design and implement a program of instruction to aid, assist, and upgrade the plumbing, heating, and cooling contracting industry in the area of the Process of Project Management. The collaboration of contractors and educators committed themselves to provide an intensive course of study to include the following proposed approach:

- 80 hours of on-campus instruction comprised of two, 40-hour sessions (Mid-February 1996 and May 1996)-- each consisting of 16 modules of instruction (Appendix A)
- Project Management reference manual/text (available September 1996)

Serving the Needs of the Non-General Contracting Members of the Contracting Community

The National Association of Plumbing-Heating-Cooling Contractors (NAPHCC) Association has over three thousand members and takes a proactive approach to improving the knowledge and quality of their industry. They have a well-funded Education Foundation and a long-term commitment to both their members and their industry. They are committed to industry education for the following reasons:

1. Education has a positive financial impact on the bottom line. See Table 1 for an example of an abbreviated sample financial statement for a PHCC contractor indicating the economic impact of an effective training program.
2. On-the-job training has its merits, but distractions and responsibilities limit the ability of employees to learn new techniques in their everyday work environment.
3. Today's clients expect continuous employee education of all employees
4. Long-term employee productivity is enhanced through education in spite of short-term productivity losses incurred during off-site educational experiences.
5. If contractors don't train their employees, their competition will.
6. Changing industry technology, business methods, and customer demands mean that contractors must consider continuous training as a part of doing business.
7. Managers of Projects are responsible for most of the costs of a construction project and will benefit most from effective training.
8. Training managers during slow times prepares both the employees and the company for the inevitable upturn in the business cycle.
9. Training managers during busy times provides instant feedback on new techniques learned during a training program.
10. Not providing training for managers is too expensive in a construction climate with thin profit margins, increased competition, and reduced opportunities for additional work. The cost of rework on one job could easily amount to ten times the cost of a full training program.

Role of Construction Academia as Partners with Specialty Contractors

Partnering can be described as the conducting of a cooperative enterprise between two or more parties dedicated to achieving a common goal for mutual benefit with a minimum of dispute and conflict. Benefits of partnering include improved efficiency and cost effectiveness, improved communications, timely problem identification and resolution, improved scheduling, better relationships, increased opportunity for innovation, and improvement of products and services. The underlying hallmarks of this relationship are trust, cooperation, teamwork, shared vision, and the attainment of mutual objectives. It is a change of attitude rather than a formally contractual agreement that characterizes partnering.

For academia, preparation for designing a curriculum for industry education programs rather than college programs requires learning as quickly and as inexpensively as possible about the precise nature of industry customer demand, the suitability of the new curricula or delivery concept, and determining the necessary adjustments in market strategy from academia to

industry. These objectives can be accomplished by involving key industry customers early in the development phase, by regularly testing appropriateness and effectiveness of training techniques with customers in small-scale experiments, and by working with a partner to gain insights into a new and unfamiliar class of customers.

NAPHCC and this university have undertaken this type of partnering process that provides a new value creation model for construction educators. Whereas most construction education programs extant have created value in being directed towards educating future employees of general contracting firms, the NAPHCC and this university partnership has created value by entering into a joint venture to create *appropriate and specific* education for managers in their industry in a climate where *demand* for continuous education is high, and where the *availability* of high-quality construction education specifically oriented to Specialty Contractors is scarce (Figure 1).

Table 1

Abbreviated sample financial statement for a PHCC contractor indicating the economic impact of an effective training program

Abbreviated Sample Financial Statement for an NAPHCC Contractor		
Revenue (Annual Sales)	$15,000,000	
Direct Costs:		***% of Annual Sales***
Material	$5,250,000	35%
Labor	$4,050,000	27%
Subcontractors	$1,500,000	10%
Other Direct Costs	$600,000	4%
Total Direct Costs	$11,400,000	76%
Gross Profit	$3,600,000	24%
Overhead	$3,300,000	22%
NET PROFIT PRE-TAX	$300,000	2%
Assume 5% increase in productivity through an effective training program.		
Labor Savings	$202,000	
Payroll/Ins. Savings (20%)	$40,500	
New Profit	$543,000	or 3.62%
% Profit Increase		81%
The Net Result of this example would have the SAME EFFECT as increasing sales by $12,150,000!		

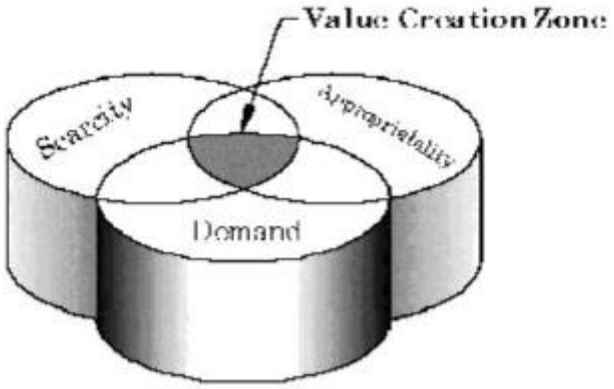

Figure 1. What makes construction education valuable to specialty contractors?

This value creation model reaps rewards for both the specialty contracting industry and the construction academia. The foresight of the NAPHCC will not only lead to better educated employees who will help to improve the financial returns on their firms' investments in human capital, but will also help to build a better educated plumbing, heating, and cooling industry, and lessen the number of contractors doing business at unacceptable margins. For construction educators, the rewards include a new target market where demand for education, instructional materials, and research is high, and opportunities for funded research are highly probable.

Mitigating the Terminal Nature of Training Programs

There are several training programs currently in existence that offer project management education to individuals employed in the construction industry. The Associated General Contractors (AGC) offer a *Construction Project Manager Course*; the Associated Builders and Contractors, Inc. (ABC) through their academy approach, offer project management training; the National Association of Home Builders (NAHB) offers a *Graduate Builders Institute*, and the Mechanical Contractors Association of America, Inc. (MCAA), through their Institute for Project Management, offers a *Managing for Profit* program oriented towards teaching project management skills to mechanical project managers.

While not exhaustive, the list of programs above is representative of the educational opportunities for project management training for industry available today. Certainly there are differences in these and other project management programs, yet for the most part, each of these programs utilizes similar pedagogical approaches. They are usually offered as intensive one-week sessions, with the MCAA program offered as two, one-week sessions held several months apart to "make the course easy on your project schedule." Generally, the course structure in these programs is topically organized, is taught by multiple instructors, and bears the risk of presenting project management as a series of steps (or topics) to master rather than as an integrated process which is constantly in flux.

The experiential learning model of Kolb provides us with a framework for examining the current project management approach, and suggests ways in which greater success in project management courses may be achieved. Kolb has postulated that learning involves a cycle of four processes, each of which must be present for learning to occur most completely (see Figure 3).

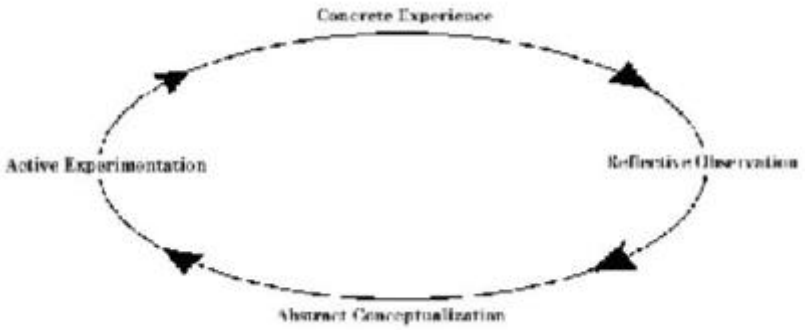

Figure 2. The Experiential (Kolb) Learning Cycle

First, the cycle begins with Concrete Experience, the learner's personal involvement in a specific experience. In the case of individuals employed in the construction industry who are sent to project management seminars, this is their existing knowledge about the project management and construction process.

Second, the learner reflects (Reflective Observation) on this personal involvement in a specific experience from many viewpoints, seeking to find its meaning. CEOs/COOs of construction companies typically tend to send only those employees who show some promise of future success to these not inexpensive programs that seems to suggest that the learner has already reflected to some degree upon the project management process.

Third, out of this reflection, the learner draws logical conclusions (Abstract Conceptualization), and may add to his or her own conclusions the theoretical constructs of others. This is where existing project management programs begin, instructing the learner using lectures, papers, case studies, projects, and assignments in very brief but intensive training sessions (see Figure 4). Finally, the conclusions and constructs gained by the learner in the third stage (Abstract Conceptualization) guide decisions and actions (Active Experimentation) that lead to new concrete experiences. This is the goal of both the CEOs/COOs and the instructional entities that newly educated individuals will take what they have learned in the classroom back to the workplace and apply it.

Figure 4. Instructional activities that may support various aspects of the learning cycle

Problems arise, however, when training programs truncate at the end of Stage Four (Active Experimentation), because even if the knowledge conveyed during the third stage (Abstract Conceptualization) was fully understood, and the learner eagerly committed to taking the learned material back to the workplace and implementing change into the project management process

(Active Experimentation to Concrete Experience), usually success will be minimal without a specific and directed mechanism to force the application of newly acquired knowledge. Much, if not most, of the gained knowledge will be lost rapidly as a result of a compressed instructional delivery design.

While compressed course schedule design may be inviolate due to the nature of both the industry and the student, greater retention of the fundamental concepts and practices may be accomplished by modifying the instructional approach to present a cross-curricular, thematic approach to educating the learner in the process of project management when accompanied by applications which lead to a second revolution around the Experiential Learning Cycle. Additionally, if such applications are accompanied by mandatory reporting, follow-up, and a demonstration of economic value added for a period of one year post-completion of the training, then greater success may be achieved.

The NAPHCC and this university joint venture includes a major emphasis on the application phase, which forces the learner to make the transition from Active Experimentation to Concrete Experience, and to report to both employer and educational consultant at this university on the economic value that the learner is personally adding to the firm's effort as a result of newly gained knowledge.

Measuring Program Success

In the long run, the NAPHCC this university program will be a success if the contractor members who send students to the program gain improved economic results in real terms on those projects that are managed by individuals who have graduated from the program. Integrated application assignments created to provide every individual with at least one useable tool, method, or technique that the individual may directly apply and put to use immediately in the company is a critical element of the program. Application assignments occur during the inter-session between the two in-residence sessions, and post-completion of the second in-residence.

The first application assignment is returned, evaluated, and measured for economic impact by the student, the educational consultant, and the CEO or COO who enrolled the student. If because of the nature of the individual's job, or the firm's financial reporting system, the student is unable to report actual economic value added, the student will be required to make an accurate projection of *expected value added* in the near future. This projection will be evaluated by both the educational consultant and the CEO/COO of the partner firm to assess the expected accuracy of the projection.

The second application assignment is monitored and evaluated on a quarterly basis for the period of one year post-completion of the program by the student, the educational consultant, and the CEO/COO, with site visits and consultation by the instructor as needed by the firm to demonstrate and substantiate real economic value added. If after one year, the CEO/COO of the firm cannot readily attribute specific economic gains to the knowledge or processes gained by the student in the program, the program will have failed for that firm.

Methods for Keeping Industry Education Programs Current

One of the most severe criticisms by the NAPHCC of existing programs, and impetus for choosing to sponsor the development of a training program specific to their needs, originated from their perception that over time, existing programs become stagnant, outdated, and outmoded. They attributed this to a lack of an institutionalized and methodical approach to constantly monitoring, evaluating, and revising the programs. With the rapidly evolving technology changes in software, communications, and information collection and management, it was felt that industry education programs must constantly change in order to meet the needs of a dynamically changing business environment.

To that end, they have institutionalized several mechanisms to ensure that their program stays not only current, but on the cutting edge of the industry.

First, they have created a formal Audit Committee that will continuously monitor NAPHCC and this university program efficacy. This committee will enroll at least four members in every class, and will provide feedback to both the industry and educational entities.

Second, each instructional module development and maintenance team will be composed of both educators and industry leaders. This composition is intended to create an environment whereby changes in industry practices or requirements are rapidly incorporated into the curriculum.

Finally, the application and economic evaluation methodologies will provide constant feedback of the effectiveness of the educational experience, and act as a trigger-point in bringing the program back on target if required.

Conclusion

As changes in technology, information management, and resource allocation provide opportunities and challenges for specialty contractors in the construction industry, the role of educators as partners with industry becomes crucial. While most, if not all, of the topics of construction project management are similar regardless of the type of construction performed by a firm, it is important that educators be able to provide industry training programs which are designed specifically for subcontractors and specialty contractors. The lens through which subcontractors and specialty contractors view the construction process is significantly different than that of the general contractors. This, coupled with the fact that subcontractors perform close to 90 percent of all construction labor on projects today, gives one pause when contemplating that most project management programs are oriented towards general contractors.

The pedagogy of intensive training over short intervals is also troublesome, and should lead educators to find appropriate methodologies to compensate for the apparent necessity for condensed class time. Some methods examined herein included collaboration with industry to develop educational goals and objectives, systematic measurement of actual economic results of the training, accountability of all parties including students, educators, and CEOs/COOs, and the

implementation of multiple application phases to foster the transition from Active Experimentation to Concrete Experience.

Recommendation

Considering that students in the program will be entering with various and diverse skill levels, a recommendation is to take advantage of the notion of "contractor-to-contractor" education and produce a pre-session Skills Assessment Form. This form would gauge the levels of experience and expertise of the incoming students in the areas of computer literacy, formal education, age, trade experience, management experience, office experience, industry experience, primary focus of firm, job title, and size of the organization in volume, in order to develop heterogeneous work teams who will learn from each other, and compensate as a team for individual weaknesses.

References

Clough, R. H., & Sears, G. A. (1994, 6th ed.). Construction contracting. New York: John Wiley & Sons, Inc.

Collis, D., & Montgomery, C. (1995, July-August). Competing on resources: Strategy in the 1990s. Harvard Business Review, 118-128.

Deibel, S. (1992, April). Training to compete in a tough market: A long-term strategy. Fails Management Institute Construction Management Journal Special Collection, 13-17.
Hamel, G., & Prahad, C. K. (1994). Competing for the future. Boston: Harvard Business School Press.

Kolb, D. A. (1984). Experiential learning: Experience as the source of learning and development. Englewood Cliffs, NJ: Prentice-Hall.

Lientz, B., & Rea, K. (1995). Project management for the 21st century. San Diego, CA: Academic Press, Inc.

Svinicki, M., & Dixon, N. (1994). The Kolb model modified for classroom activities. In K. Feldman & M. Paulsen (Ed.), Teaching and learning in the college classroom (pp. 307-315). Needham Heights, MA: Ginn Press.

Appendix

Project Management Course Modules

Course Module 0 Course Introduction

(Estimated Instruction Time: 1.5 hours)

- Quality
- Planning
- Marketability
- Profitability
- Safety
- Technology
- Construction as a Process not a Product

Course Module 1 Business Management/Quality/Pre-Planning

(Estimated Instruction Time: 4 - 8 hours)

- Continuous Improvement Process
- Quality Assurance
- Quality Control
- Managing Uncertainty
- Business Failures
- Managing Change in the Organization
- Delegation
- Problem Solving & Decision Making
- Mastering Financial Statements

FOCUS ON TECHNOLOGY:

- Computerized Labor Tracking & Analysis

Course Module 2 Marketing

(Estimated Instruction Time: 1 - 2 hours)

- Proposal & Scope
- "Redlines", Design & Engineering
- Conceptual Estimating
- Design Team Liaison
- Manager Marketing - Controlling the Client, Selling Changes & Enforcing Contracts While Retaining the Good will and Confidence of the Client (*NOTE: Suggest 1 hour course time dedicated to this topic)

FOCUS ON TECHNOLOGY:

- New Markets - Using Technology to Capture Work and Increase Margins

Course Module 3 Mechanical Estimating in the 21st Century

(Estimated Instruction Time: 8 - 12 hours)

- Estimate Analysis (*NOTE: Suggest "Homework"/Personal Time)
- Overtime & Delay Impact
- Computers & Digitizers
- "It's Not a Takeoff! It's an Estimate!"
- Margin Analysis
- Bid Estimating Summary & "What if" scenarios
- Estimating Forms
- Estimate Review
- Takeoff Sheets & Audit Trail Data

FOCUS ON TECHNOLOGY:

- Digitizers
- Computerized Estimate Analysis
- Building a Computerized Historical Database

Course Module 4 Contracts/Claims/Construction Law

(Estimated Instruction Time: 4 - 8 hours)

- Guidelines for Contract Review
- Sales Proposal

Scope of Work
Contract Documents
Contract Review
Changes
Scheduling
Termination
Liquidated Damages
Warranty
Construction Law Case Studies
Avoiding Claims
Request for Equitable Adjustment
Claimable Cost Items
Calculating the Amount of the Claim
Preparing the Claim
Different Methods of Resolving a Claim
Bidding Private Work
Bidding Public Work
Breach of Contract by Owner
Mechanic's Liens, Stop Notice, Payment Bond
Litigation or Arbitration
Labor & Cost Control

Course Module 5 Pre-Construction Planning and Profitability

(Estimated Instruction Time: 8 - 12 hours)

General Contractor Qualifications
Document Review
Re-Estimates
Shop-Drawings/CAD Awareness
Project Team
General Contractor Liaison Coordination
Reimbursable Costs
Scheduling for Maximum Productivity & Profit
Partnering
Pre-Fabs

FOCUS ON TECHNOLOGY:

Computerized Scheduling
Computerized Spreadsheet Analysis
CAD for Mechanical Contractors

Course Module 6 Construction Plan

(Estimated Instruction Time: 6 - 10 hours)

Project Turnover
Preliminary Meeting
Computerized Optimal Scheduling
Materials Handling Plan & Expediting
Construction Plan
Construction Plan Format
Construction Plan Meeting
Commissioning Plan
Schedule of Values & Front-loading

FOCUS ON TECHNOLOGY:

Commissioning & the Mechanical Contractor
Computerized Front-loading & SOV
Using Historical Database to Predict Material Costs & Productivity

Course Module 7 Project Control

(Estimated Instruction Time: 20 - 24 hours)

Communications
Mobilizations

Site Planning
Staffing
Labor Feedback
Manpower Loading
Schedule
Spreadsheet & Other Computerized Management Techniques
Tracking Equipment & Materials
Computerized Schedule Updating & Maintenance - A Guide to Changes
Short Interval Scheduling
Managing Productivity
Project Accounting
Managing Cash Flow
Forecasting
Project Meetings
Job Walks
Project Safety & Controlling Workmen's Compensation
General Contractor Control
Change Order Procedures
Conflict Management & The Art of Negotiating
Managing the Labor Agreement: Two-gate Projects, Strikes, Crew-Mixes, and Optimizing Labor

FOCUS ON TECHNOLOGY:

Computerized Scheduling & Adjustment
Spreadsheet Analysis & Forecasting
Cost Tracking with Computers

Course Module 8 Project Records

(Estimated Instruction Time: 4 hours)

Tracking Costs
Cost Control Logs
Change Order Logs
Purchase Order Logs
Submittal/Delivery Logs
Construction Schedule
Construction Photographs & Videos
Telephone Conversation Record
Letter of Transmittal
Project File Categories

FOCUS ON TECHNOLOGY:

Using Integrated Project Management Software to Achieve a Well Documented Project

Course Module 9 Purchasing/Vendors

(Estimated Instruction Time: 2 hours)

Purchasing Policies & Ethical Procedures
Buyouts
Purchase Order System
Changing P.O.'s After Issuance
Submittal Data Review
Receiving
Shop Receiving
Job-site Receiving
Bar-coding

FOCUS ON TECHNOLOGY:

Bar-Coding
Computerized Purchasing Control

Course Module 10 Subcontractor Management

(Estimated Instruction Time 2 - 4 hours)

Subcontract Release
Subcontract Billing

On-site Management of Subcontractors
Subcontract Change Orders
Deductive Change Orders/Back Changes
Subcontract Termination

Course Module 11 Fab Shops/Field and Warehouse

(Estimated Instruction Time 4 - 8 hours)

Standardization of Fabrication & Installation Methods for Maximum Productivity
Shop Construction Standards
Field Construction Standards
Spool Sheets
Pre-Fab & Productivity
Deliveries

FOCUS ON TECHNOLOGY:

Spooling on CAD

Course Module 12 Personnel/Motivation/Leadership

(Estimated Instruction Time 8 - 12 hours)

Hiring Procedure
Alcohol/Substance Abuse
New Employee Orientation
Motivation & Leadership
Management Styles
Team Building & Team Dynamics
Time Management

FOCUS ON TECHNOLOGY:

Personality Profiles & Team Building

Course Module 13 Job Close-out

(Estimated Instruction Time 4 - 8 hours)

Commissioning
Start, Text & Balance
Demobilization
Final Payment
Warranty
Achieving Documentation

FOCUS ON TECHNOLOGY:

Commissioning
Archiving on CD-ROM

Course Module 14 Post-Job Analysis

(Estimated Instruction Time 4 - 8 hours)

Formal Customer Interview by 3rd Party
Post-Feedback Meeting
Leap-frogging Completed Project to New Work
Use Your Database to Make Decisions About Future Projects
Feedback for Estimating
Service After the Sale
Service Agreements

FOCUS ON TECHNOLOGY:

Computerized Database Building & Manipulation

Course Module 15 - Focus on Emerging Technology

(Estimated Instruction Time 4 - 6 hours)

Maximizing Profit by Staying Current
Computers
Spreadsheets
Digitizers
Bar-Coding
Multi-Media Presentations
Photos & Videos