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The *Journal of Construction Education* (ISSN 1522 8150) was founded in 1996 by the Associated Schools of Construction, an association of 94 international colleges and universities with construction education programs. The purpose of the *Journal* is to provide an important process necessary for the preservation and dissemination of manuscripts that report, synthesize, review, or analyze scholarly inquiry. The *Journal* is an important way of our focusing international attention on and contributing to the understanding of the issues, problems, and research associated with construction education and training. The recognition of scholarly work within the realms of curriculum information, contemporary educational practices, educational research and instructional application development within construction departments, schools and colleges, and industry are the reasons for the *Journal's* existence. The *Journal's* mission is to provide construction educators and practitioners with access to information, ideas, and materials for improving and updating their understanding of construction education and training. It is also intended to help its constituency become more effective in developing the talents of learners within construction programs. This *Journal* is not only a living textbook of construction education, but also a perpetual and dependable learning source for construction professionals whether they are within academia or within industry. The *Journal* will be published tri-annually (Spring, Summer, and Fall issues). The divisions of the *Journal* include invited and editorially reviewed Book Reviews and Teaching Profiles, and blind peer reviewed Educational Practice and Research Manuscripts.

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

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

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The *Journal* considers it unethical for authors to withhold the data on which their conclusions are based from other competent professionals who seek to verify the substantive claims through reanalysis and who intend to use such data only for that purpose, provided that the confidentiality of the participants can be protected and unless the legal rights concerning proprietary data preclude their release. JCE expects authors submitting to the *Journal* are expected to have available their data throughout the editorial review process and for at least five years after the date of publication.

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Educational Practice Manuscripts

General Manuscripts

Other

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Development of a Career Awareness Program for Students in Grades Eleven and Twelve

Gene Farmer
Florida International University
Miami, Florida

This paper describes the background and process of developing a Career Awareness Program for high school students in grades eleven and twelve. It discusses not only the need for the program but some of the findings concerning the age at which students apparently become able to focus on a career decision. The paper describes a multi phase career awareness program with a specific script for a student presentation to be given by any construction professional.

Key words: Career Awareness, High School, Career Decisions

Introduction

Construction is one of the worlds oldest and largest industries, then why is it that there is not an abundance of persons choosing construction as a career. While the reason may be multi faceted and complex one reason is that there is a lack of current information available for those choosing careers to review. Not only must this information be available but also it must be available at the proper time to be valuable.

This project will involve the development of a Construction Industry Career Awareness program. This program will be initially targeted at students in grades eleven and twelve. The project has been composed of the following six phases.

Program Development

Phase One: Development of list of source organizations

The first phase of this project involved the development of a detailed list of potential source organizations that have readily available educational material that will be appropriate to include in any career awareness program. A detailed compilation of organization names, addresses, phone numbers and contact persons has been developed. These organizations are listed in Appendix I:

Phase Two: Organization Inquiries

The second phase of this project involves the mass mailing of requests for information to all of those listed in the previous phase. A form letter was developed to request any career awareness information the organization might already have.

Phase Three: Receipt and cataloging of the information

The third phase of this work involved the receipt, review and cataloging of the information received from our request mailed out in Phase Two. Appendix II is a listing of the information received.

Phase Four: Development of the preliminary career awareness program

This phase involved the development of the preliminary draft of the career awareness program that the program developer was able to test in the next phase.

Program Testing

Phase Five: Preliminary testing of the program

During the course of the work stipulated in the grant the program developer saw an opportunity to broaden the scope and enhance the work product by testing the preliminary career awareness presentation. The program developer pursued and was given the opportunity to host a meeting of 100 career guidance counselors from the Dade County Public School system at F.I.U. At this meeting the program developer presented a lot of the material the program developer had developed during the course of this project as a pilot to determine its effectiveness. After the meeting the program developer received numerous comments and feedback on the presentation which the program developer incorporated into the final presentation.

In addition, as a result of this presentation, the program developer was invited to give a personal Career Awareness presentations to the students at several Dade County High Schools. The program developer was able to give 18 career awareness presentations to a total of over 400 senior high school students. The experience gained through these presentations was invaluable in the refinement of this Career Awareness program.

Program Observations

The experienced gained in the presentation of the prototype Career Awareness Presentation to over four hundred high school students in 18 classes has lead this investigator to the following observations.

1. The Florida School system is divided into three grade-grouping components. The first component is the elementary school comprised of students in grades one through five,

these students range in age from 6 to 11. The second component is the Middle School that groups grades six, seven and eight. Students in middle school generally range in age from 12 to 14. The third component is the High School with the grouping of grades nine, ten eleven, and twelve. Students in high school range in age from 15 to 18.

The concept of seriously considering a career is something that must be accompanied by the students' general maturity. Didn't many of us, at one time or another, want to be cowboys, astronauts or models. As we matured each of us a different rate, we at some point in time began to seriously examine career possibilities. Being a cowboy was most of the time no longer a consideration. The intent of this research project was to develop a career awareness program for students in grades seven through twelve. As previously stated the program developer have made presentations to many students within the nine to twelfth grade range and have found a vast difference in the maturity level of students between the ninth and twelfth grades. The ninth and tenth grade students are often still in the honeymoon stage of career consideration. While no longer really considering being a cowboy it still seems the only careers which excite them are careers like a fighter pilot, navy seal, secret agent etc. The program developer found the tenth, eleventh and twelfth graders to be substantially more mature when it comes to career consideration. They listen attentively and tend to ask more relevant questions.

Because of the disparity in the maturity of students in the ninth and tenth grades and those in the eleventh and twelfth grades which ultimately affects their ability to receive and understand the message the program developer have concluded that any Career Awareness Presentation of this nature be focused at students in the eleventh and twelfth grades. A much more superficial awareness presentation could be developed at a later date to expose younger students in the lower grades.

2. While these types of career awareness presentations are helpful, most high school students have an inherently short span of attention. They also tend to have rather short memories when it comes to things such as information presented to them such as this. The experiences the program developer have had lead me to believe that the best and most effective way of disseminating the information about construction as a career choice to the students may not be by presentations directly to the students but through both the guidance counselors and the general school faculty.

   Many high schools have career awareness presentations, meetings or demonstrations which are held for faculty and guidance counselors only. In as much as the guidance counselors and general faculty have the most interaction with and trust of the students it is only logical to attempt to educate these individuals about the advantages of a career in construction and let them carry the banner to the students.

3. In addition to the career awareness presentation that can be personally given to the high school faculty or guidance counselors, a self-contained self-explanatory construction career information package can be distributed to the guidance counselors at each school.

Career Awareness Day Presentation to Students in Grades Eleven and Twelve

There appears to be two distinct types of High School career awareness day presentations. The first and least common is the formal 30-minute to 60-minute presentation given in an auditorium, meeting room or specially prepared classroom. In this presentation the presenter has at his or her disposal all of the equipment required to complete the presentation including TV and video tape player, overhead projector and screen, black or white board etc. The presenter is generally alone i.e., a singular subject presentation or perhaps with one or two other presenters from different careers. One of the key elements of this type of presentation is that the presenters remain in the same space while the audience changes, as students file in and out during breaks between presentations. This is the preferable method of presentation because of the following advantages:

1. The presentation space remains constant, giving the presenter an additional comfort level with the acoustics and lines of sight.
2. The equipment is available and positioned as required by the presenter to facilitate a smooth presentation. The resulting smoothness of presentation allows the presenter to retain the attention of the audience throughout the presentation.
3. There is no additional time lost for set up and take down between presentations.

The second and most common type of presentation is when the students remain in their classes and the presentation is asked to travel from class to class to make the presentation. These presentations generally last from 5 to 10 minutes. Disadvantages to this type of presentation include the following:

1. The presenter does not always have the required equipment since all classrooms are equipped differently. This can be extremely detrimental to a multi media based presentation.
2. There is significant time lost and effort expended in the setting up and taking down of presentation materials.
3. In general this type of presentation results in a less polished appearing presentation than the longer type of presentation.
4. Students are bombarded with 5 to 6 presentations per hour over a two to three hour period. Student fatigue generally sets in after the first three or four presentations. This fatigue ultimately results in the students' loss of concentration on the material presented. Appendix III is prototype outlines of the two types of Career Awareness Day Presentations.

Budget for the further development of these Career Awareness Information Packages.
The following, Table 1, is a budget for the printing of these Career Awareness packages.

Recommendations

The following are recommendations for future work in the career awareness area.

Table 1

Printing Budget

	Item	Price
1.	Career Information Packages for Career Guidance Counselors - 2000 copies	
	printed cover 8.5X11 Brochure folder glossy one color	$1900.00
	printed cover 8.5X11 Brochure folder glossy two color	$2071.00
2.	Four tier information inserts - 2000 copies	
	Four tier (4 sheet) insert on heavy weight paper B/W	$85.00
	Four tier (4 sheet) insert on heavy weight paper one color	$103.00
3.	Four tier information inserts - 2000 copies	
	Four tier (4 sheet) insert on card stock B/W	$91.00
	Four tier (4 sheet) insert on card stock one color	$111.00
4.	Brochure handout to students - 10,000 copies	
	8.5X11 trifold brochure with 4 photos on flat card stock B/W	$1267.00
	8.5X11 trifold brochure with 4 photos on flat card stock one color	$1327.00
5.	Brochure handout to students - 10,000 copies	
	8.5X11 trifold brochure with 4 photos on glossy card stock B/W	$3372.00
	8.5X11 trifold brochure with 4 photos on glossy card stock one color	$3878.00
6.	Overhead projector slides (transparencies) - 200 copies	
	(24 originals) 8.5X11 Overhead Projector Slides B/W	$2400.00
	(24 originals) 8.5X11 Overhead Projector Slides one color	$4800.00
	(24 originals) 8.5X11 Overhead Projector Slides two color	$4800.00
7.	Overhead projector slides (opaque copies) - 2000 copies	
	(24 originals) 8.5X11 Brochure inserts 20lb bond B/W	$1785.00
	(24 originals) 8.5X11 Brochure inserts 20lb bond one color	$2031.00
	(24 originals) 8.5X11 Brochure inserts 20lb bond two color	$2591.00
8.	Overhead projector slides (opaque copies) - 2000 copies	
	(24 originals) 8.5X11 Brochure inserts glossy B/W	$6336.00
	(24 originals) 8.5X11 Brochure inserts glossy one color	$6850.00
	(24 originals) 8.5X11 Brochure inserts glossy two color	$8127.00
9.	Youth Fair Presentation Boards - 200 copies (2 boards each)	
	30X42 mounted on foamcore	$4000.00

1. Production
    a. Production of the prototype career awareness packages developed in this work. The next step in this process should be to select the style i.e. paper, color etc. of the final presentation format and begin production.
2. Distribution
    a. The second step would be the development of a distribution matrix that would define exactly which individuals across the state would receive copies of the career awareness package.
    b. This list would probable include, at a minimum, all high school career guidance counselors across the state.
    c. The final career awareness package would then be distributed to those defined on the list.
3. Career Awareness Training
    a. A further phase of this work would involve the development of a career awareness training session which would be given throughout the state to prepare

persons to go into the high schools and make comprehensive, exciting career awareness presentations.

4. Development of a Multi-Media computer presentation.
    a. A final phase of this career awareness package would be the development of a self contained Multi-Media Career Awareness Presentation which would be contained on a CD ROM. This CD would be a totally self contained presentation incorporating overhead projector type slides, photos, text, video and sound. It would be distributed to those on the distribution matrix for use in either the career guidance counselor's office of the school library. It could also be distributed to community colleges and universities.

Appendix I

Air Conditioning And Refrigeration Institute
1815 North Fort Myer Drive
Arlington , Virginia 22209

Air Conditioning Contractors of America
1513 16th. St., N.W.
Washington , DC 20036

American Building Contractors Assoc.
12123 Woodruff Ave.
Downey , CA 90241

American Iron And Steel Institute
1000 16th. Street NW
Washington, DC 20036

American Plywood Association
P.O. Box 11700
Tacoma, Washington 98411

American Society for Concrete Construction
1902 Techny Ct.
Northbrook, IL 60062

American Society for Testing and Materials
1916 Race St.
Philadelphia, PA 19103-1187

American Subcontractors Association
1004 Duke St.
Alexandria, VA 22314

American Wood Council
1250 Connecticut Ave. N.W., #200
Washington, DC 20036

ASHRAE
1791 Tullie Circle N.W.
Atlanta, GA 30329

Asphalt Roofing Manufacturers Association
6000 Executive Blvd., Suite 201
Rockville , MD 20852

Associated Builders Contractors
1300 N. 17th St., 8th Floor
Rosslyn, VA 22209

National Association of Home Builders
1201 15th St., N.W.
Washington, DC 20005

National Association of Minority Contractors, Inc.
806 15th St., Suite 340
Washington, DC 20005

National Association of Plumbing-Heating-Cooling
Contractors
180 S. Washington St., P.O. Box 6808
Falls Church, VA 22040

National Association of Tile Contractors
626 Lakeland East Drive
Jackson, MS 39208

National Association of Women in Construction
327 S. Adams St.
Fort Worth, TX 76104

National Concrete Masonry Association
P.O. Box 781, 2302 Horsepen Road
Herndon, VA 22070

National Electrical Contractors Association
7315 Wisconsin Ave.
Washington, DC 20014

National Fire Protection Association
P.O. Box 9101
Quincy, MA 02269

National Frame Builders Association
4840 W. 15th. St. 1000
Lawrence, KS 66049-3876

National Hardwood Lumber Association
P.O. Box 34518
Memphis, TN 38184-1818

National Institute of Building Sciences
1201 L St., N.W., Suite 400
Washington, DC 20005

National Mechanical Contractors Assoc.
c/o Tom Obert Associated Builders and Contractors.
1300 N., 17th. St.
Rosslyn, VA 22209

Associated General Contractors of America
1957 E St., N.W.
Washington, DC 20006

Associated Sheet Metal Contractors, Inc.
3000 W. Hallandale Beach Blvd.
Hallandale, Fl 33009

Bruce Engineering Company
2000 Tucker Industrial Rd.
Tucker, GA 30084

Cast Iron Soil Pipe Institute
5959 Shallowford Rd., Suite 419
Chattanooga, TN 37421

Ceiling and Interior Systems Construction Association
5700 Old Orchand Rd., 1st Floor
Skokie, IL 60077

Ceramic Tile Institute of America
700 N. Virgil Avenue
Los Angeles, CA 90029

Drywall, Lath, and Plaster Bureau c/o W.F. Pruter Associates
3127 Los Feliz Blvd.
Los Angeles, CA 90039

Electrical Contractors Council c/o Tom Obert Associated Builders and Contractors
1300 N., 17th. St.
Rosslyn, VA 22209

Flat Glass Marketing Association
3310 S.W. Harrison St.
Topeka, KS 66611-2279

Gypsum Association
810 1st St., N.E., Suite 510
Washington, DC 20002

Hardwood Manufacturers Association
400 Penn Center Blvd., Suite 530
Pittsburgh, PA 15235

Hardwood Plywood & Veneer Assoc.
1825 Michael Farraday Drive P.O. Box 2789
Reston, VA 22090

National Roofing Contractors Association
O'Hare International Center
10255 W. Higgins Rd., Suite 600
Rosemont, IL 60018

National Spa and Pool Institute
2111 Eisenhower Avenue
Alexandria, VA 22314

National Wood Window and Door Manufacturers Association
1400 East Touhy Avenue, Suite g-54
Des Plains, IL 60018

Plumbing, Heating, Cooling Information Bureau
3 Illinois Center
Chicago, IL 60601

Portland Cement Association
5420 Old Orchard Rd.
Skokie, IL 60077

Prestressed Concrete Institute
20 N. Wacker Drive
Chicago , Illinois 60606

Professional Women in Construction
342 Madison Ave. Rm. 451
New York, NY 10173

Sheet Metal and Air Conditioning Contractors' National Association
4201 Lafayette Center Drive
Chantilly, VA 22021

Small Homes Council-Building Research Council
1E St., Mary's Rd.
Champaign, IL 61820

Standard Building Code/Southern Building Code Congress International
900 Montclair Rd.
Birrngham , AL 35213

Steel Joist Institute
12405 48th St. N., Suite A
Myrtle Beach, SC 29577

Tile Contractors Association of America
112 N. Alfred St.
Alexandria, VA 22314

International Association of Plumbing and Mechanical Officials
20001 Walnut Dr. S.
Walnut, CA 91789

International Conference of Building Officials
5360 W. Workman Mill Rd.
Whittier, CA 90601

International Council of Employers of Bricklayers and Allied Craftsmen
Mason Contractors Association of America
1550 Spring Rd., Ste. 320
Oak Brook, IL 60521

International Institute for Lath and Plaster c/o W.F. Pruter Associates
3127 Los Feliz Blvd.
Los Angeles, CA 90039

Kitchen Cabinet Manufacturers Association
1899 Preston White Drive
Falls Church, VA 22091

Masonry Contractors Association of America
17 W. 14th St.
Oak Brook Terrace, IL 60181

Mechanical Contractors Association of America
1385 Piccard Drive
Rockville, MD 20850

Metal Building Manufacturers Association c/o Thomas Associates, Inc.
1300 Summer Ave.
Cleveland, OH 44115

Metal Construction Association
1133 15th St., N.W., Suite 1000
Washington, DC 20005

Truss Plate Institute
583 D'Onofrio Drive
Madison, WI 53719

Urethane Foam Contractors Association
4302 Airport Blvd.
Austin, TX 78722

US Chamber of Commerce Construction , Housing, and Community Development
1615 H St. N.W.
Washington, DC 20062

U.S. Department of Commerce
14th St. and Constitution Ave., N.W.
Washington, DC 20230

U.S. Government Printing Office Superintendent of Documents
N. Capitol and H Streets, N.W.
Washington, DC 20405

Western Lath, Plaster, Drywall Contractors Association
8635 Navajo Rd.
San Diego, CA 92119

Western Wood Products Association
Yeon Building 522 S.W. 5th Ave.
Portland, OR 97204

Wood Truss Council of America
5937 Meadowood Drive, Suite 14
Madison, WI 53711

Appendix II

American Institute Of Steel Construction
One East Wacker Drive, Suite 3100
Chicago, IL 60601-2001
Brochures: "Steel career opportunities."

American Society for Heating, Refrigerating and Air Conditioning Engineers
1791 Tullie Circle, N.E.
Atlanta, GA 30329
Brochures: "Engineering and you." National Society of Professional Engineers
Brochures: "Careers in heating, ventilating, air conditioning and refrigeration."
Brochures: "Your future in air-conditioning, heating and refrigeration industry."
Brochures: "Career profiles in ventilating, air conditioning and refrigeration."

Associated General Contractors of America
1957 E Street, N.W.
Washington, D.C. 20006
Brochure describing career opportunities for men and women in the construction industry.

Glass Association of North America
3310 S.W. Harrison St.
Topeka, KS 66611-227
Brochure: "Glass industry's most used manuals available through; Glass Association of America."
Brochure: Publications price list.

International Congress of Building Officials
5360 Workman Mill Road,
Whittier, CA 90601-2298
Brochure: "Modern building inspection; a dynamic rewarding career

International Association of Plumbing and Mechanical Officials
20001 Walnut Drive South
Walnut, CA 91789-2825
Letter suggesting that we contact the "National Association of Plumbing Heating and Cooling Contractors."
At: 1-800-533-7694.

Metal Building Manufacturers Association
1300 Summer Avenue
Cleveland, OH 44115
Video: "Metal building systems: images of the future."

National Association of Home Builders
1201 15th. Street, N.W.
New York, NY 10005-3902
Brochure: "Home Builders Institute: trained and real"
Brochure: "Skills; job corps, train for your future."
Brochure: "Student chapters; building the future."
Brochure: "Home Builders Institute; the educational arm of the National Association of Home Builders."
Letter: information about "Miami Job Corps center."

National Association of Plumbing, Heating, Cooling Contractors & Mechanical Contractors Of America
180 S. Washington St.
Falls Church, VA 22046
Brochures: "Your pipeline to hot careers and cold cash Careers in the plumbing & HVAC industry."
Brochure: "Management & engineering careers in mechanical contracting. Take your career to the max."

Form to order the booklet "Your pipeline".
Form to order video & brochure "Take your career to the max."
Video: "Your pipeline to hot careers and cold cash; careers in the plumbing and HVAC industry." Rt: 9:39

National Association of Tile Contractors
626 Lakeland East Drive
Jackson, MS East 39208
Brochure: "Career craftsmanship." By the Lighthouse Group Address 901 Montgomery Highway, Birmingham, Al 35216

National Electrical Contractors Association
16201 Trade Zone Ave., Suite 105
Upper Marlboro, MD 20772
Brochure: "Electrical apprenticeship." By the National Joint Apprenticeship and Training Committee

National Fire Protection Association
1 Batterymarch Park,
Quincy, MA 02269-9101
Brochure: "Fire protection engineering."
Brochure: "National Fire Academy: open learning fire service program."
Brochure: Fire protection information and career opportunities.
Article: "National fire academy issues higher education challenge." Fire Engineering, March 1994.
Article: "FPE educators on international programs." NFPA Journal January/February 1993
Educating the fire protection engineer." Fire Journal, September/October 1989
Article: "Protective service occupations and compliance inspectors." Reprinted from the Occupational Outlook Handbook, 1994-1995 edition
Article: "Fire fighters and inspectors." Chronicle Guidance Publications, J January 1995.
Career summary: "Firefighter", Careers inc. January 1995.

National Frame Builders Association
4840 West 15th. Street, Suite 1000
Lawrence, KS 66049-3876
Brochure: "Why NFBA?, What is NFBA?: The only trade association representing the post-frame industry."
NFBA membership application

National Roofing Contractors Association
10255 W. Higgins Road, Suite 600
Rosemont, IL 60018-5607
Roofing career video
Study guide for roofing career video
Guide of NRCA affiliate organizations

Portland Cement Association
5420 Old Orchard Road,
Skokie, IL 60077-1083
Brochure: "Portland cement & concrete: a brief guide to the industry, its products, & resources."

Society for Women Engineers
120 Wall Street-11th. Floor
New York, NY 10005-3902
Brochure concerning women in the engineering field

Standards for Materials, Products, Systems & Services
100 Barr Harbor Drive
West Conshohocken, PA 19428-2959

Magazine: "Standardization news", vol. March 1996
Brochure: "What is ASTM?
Brochure: "Advantage; the ASTM advantage: credibility, quality and market acceptance."
Catalog: "1995 ASTM publications catalog."

U.S. Government Printing Office
Superintendent of Documents
Washington, DC 20402
Occupational Outlook Handbook: Information for sale from the U.S. Government Printing Office.
Special ordering information for State and Local Institutions.
United States Government Information order form.

Western Wood Products Association
Yeon Bldg., 522 S.W. Fifth Ave
Portland, OR 97204-2122
Brochure: "W.W.P.A serving lumber producers"
Brochure: "Rec. Lumber terminology & invoice procedures."
Brochure: "Wood frame design."
Brochure: "Common framing errors."
Brochure: "Picture perfect framing."
Brochure: "From forest to grade stamp."
Brochure: "Environmental information directory."
Brochure: "Product information literature list."

Wood Truss Council of America
5937 Meadowood Dr., Ste. 14
Madison, WI 53711-4125
Brochure: "Framing the American art; a demonstration of the art of framing."
Brochure: "Partition separation: prevention and solutions."
Brochure: "Quiet, capable performance from southern pine floor trusses."
Brochure: "Standard responsibilities in the design process involving metal plate connected wood trusses. WTCA 1-1995."
Miscellaneous information concerning:

?? Truss educational programs.
?? Order form for publications and services.
?? WTCA order form for TPI publications.
?? Framing the American art: video/report information.
?? Framing the American art: summary of framing facts.
?? Building with floor trusses. Order form for publications
?? Bracing and erecting wood trusses. Order form for video.
?? Partition separation brochure. Order form for brochure.
?? Woodwords publication subscription form.
?? Metal plate connected wood truss handbook. Order form.
?? Letter referring to the recent undertaking of 12 educational slide programs.
-Storage, handling, installing and bracing of metal plate connected wood trusses.
-Connectors and tie down's for residential and light commercial construction.
-Standard responsibilities in the design process involving metal plate connected wood trusses". WTCA 1-1995 engineered wood products.
-Fire performance of metal plate connected wood trusses.
-Inspection of installed wood girder trusses
-Truss history, inspection of installed wood trusses, lumber growth, harvest, transportation, processing and grading.
-Truss design and truss field repair

Appendix III

CAREER AWARENESS PROGRAM: COMPONENT ONE

Career Awareness Day Presentation One to Students in Grades, Eleven and Twelve
Approximate length: 30 minutes
Overhead projector slides: 25

1. Greeting and Introduction
   Overhead projector slide one: Title

   A. The presenter should start each presentation with a greeting, i.e. "Good Morning or Good Afternoon". He or she should also thank the host for inviting him or her to make this presentation.
   B. The presenter should then introduce his or her self and give a little background about themselves or the organization they represent.
   C. The presenter should thank the host for inviting him or her to make this presentation.
   Example:
   Good morning, my name is Joe Constructor, I am a licensed contractor and member of the local contractors association. I want to thank Mr. Wilson for inviting me to make this presentation on the opportunities and potential of a career in construction.

2. History
   Overhead projector slide two: History

   A. The presenter should briefly discuss the history of the industry as one of the world's oldest industries.
   Example:
   One of man's first and still most important requirements is the need for shelter. It was through the creation of man's first shelter that the concept of construction was born. At first it was every man for himself. Then in an effort to build bigger and better dwellings teams of people would be formed to undertake the building. It couldn't have been very long before one person, through assisting several other persons in the creation of their dwellings, became more knowledgeable about the process than those around him. Thus was born the first construction specialist.

3. Definitions
   Overhead projector slide three: Typical Owner Contractor Relationship

   A. The presenter should briefly introduce and define some of the major players in the industry and their relationship to one another. These should include the following.
      a. Owner
      b. General or Prime Contractor
      c. Sub Contractor
      d. Architect
      e. Engineer
      f. Material Supplier

   Example:
   The construction of any given building is a fairly complex entertwined process consisting of many different people working together towards a common goal Before I continue let me introduce some of the prime persons responsible for the construction process.

   First we have the OWNER without whom the project would not exist. After recognizing the need for the project one of the first steps the owner takes is the hiring of an architect. The ARCHITECT is responsible for the design of the building. His responsibility includes the development of a set of construction drawings and specifications the contractor will use to construct the building. Assisting the architect are several consulting engineers. These ENGINEERS are responsibly for the detailed design of the structural, mechanical, plumbing and electrical system of the building.

Upon completion of his or her work the architect and owners release the drawings and specifications called the construction documents to one or more contractors to bid on the project. Once selected the CONTRACTOR is responsible for the entire construction process. In addition to being responsible for the quality of the construction, the contractor is responsible for making sure the project is progressing on schedule and for the agreed upon cost.

Working for the contractors are several subcontractors. These SUB CONTRACTORS are generally specialty contractors responsible for entire sub parts of the building such as the electrical, plumbing and mechanical systems of the building to name a few.

The people who supply the materials for the project are called material suppliers. The material suppliers supply both the general contractor and the sub contractors.

Overhead projector slide four: Typical Construction Management Relationship

A. The presenter should briefly introduce the concept of the construction manager and describe his or her relationship to others in the industry.

Example

As both the industry and the requirements of Owners become more specialized and complex the need for a new construction professional has developed. This professional is called the Construction Manager. The responsibilities of the construction manager may vary from project to project but in all cases the construction manager acts as the owner's representative during the construction process. In fact in some cases the construction manager actively participates from the inception of the project giving input on the selection of the design professional.

4. Categories of Construction

Overhead projector slide five: Categories of Construction

A. Using the prepared overhead projector slides with attached commentary, the presenter should explain the four major categories of construction.
   a. General Building Construction
   b. Highway Construction
   c. Heavy Industrial Construction
   d. Utilities Construction

Example

The construction industry is a complex network of many types of projects. These projects can be roughly divided into the following our major categories.

General Building construction is the single largest category of construction. It accounts for approximately 60% of the entire industry. Included within the category of general building construction is the construction of all office buildings, schools, apartments, churches, shopping centers, government buildings and almost every other type of shelter need.

The second category of construction is highway construction. Highway construction consists of all highway and roadway construction including the roads themselves, drainage, bridges and landscaping.

The third category of construction is called heavy industrial construction. This category consists of the construction of all heavy industrial uses including but not limited to airports, tunnels, dams, refineries, railroad projects and nuclear power plants.

The fourth category of construction is referred to as utilities construction. It consists of pipeline installations, sanitary sewer facilities, waste water treatment plants and all other utility and service needs.

5. Current Trends

Overhead projector slide six through fourteen

a. Using the prepared overhead projector slides with attached commentary, the presenter should explain the various segments of the industry and their current trends including but not limited to the following:

Value of Construction
Overhead projector slide Six: Total Value of Construction
Example
The total value of construction in the United States has cycled like most other aspects of the economy, but has generally risen. The current volume of construction in the United States is over 500 billion dollars. Comprising 6% of the country's gross domestic product Construction is one of the United States largest industries.

b. Office Construction
Overhead projector slide Seven: Total Value of Office Construction
Example
1996 was the busiest year in office construction in five years. With a total current volume of 26 billion dollars, office construction is one of the largest segments of the construction industry.

c. Retail Construction
Overhead projector slide Eight: Total Value of Retail Construction
Example
The retail construction segments has showed a steady growth since 1992 and is currently estimated at an annual volume of 40 billion dollars.

d. Single Family Construction
Overhead projector slide Nine: Total Value of Single Family Construction
Example
While dipping slightly in 1997 the single family residential market is still viewed as a strong component of the construction industry. It is currently estimated at 146 billion dollars per year.

e. Multi Family Construction
Overhead projector slide Ten: Total Value of Multi Family Construction
Example
The volume of multi family construction has steadily risen since 1993 to its current volume of 20 billion dollars.

f. Educational Construction
Overhead projector slide Eleven: Total Value of Educational Construction
Example
The Educational Construction market has continued to increase over the past 8 years with a current volume of 40.4 billion dollars. In addition the National Education Association predicts a need for 250 billion dollars to repair existing schools.

g. Hotel Construction
Overhead projector slide Twelve: Total Value of Hotel Construction
Example
After a dip in the early 90's the hotel construction market has increased approximately 1 billion dollars per year to a current volume of 8.7 billion dollars.

h. Highway Construction
Overhead projector slide Thirteen: Total Value of Highway Construction
Example
Highway construction has continued to increase with a current volume of 45 billion dollars. Because of the general decay of many of the country's highways it is estimated that it will take approximately 150 billion dollars to facilitate the required repairs.

i. Industrial Construction
Overhead projector slide Fourteen: Total Value of Industrial Construction
Example
The volume of industrial construction has shown a steady increase over the past 5 years to a current volume of 35 billion dollars.

j. Infrastructure Construction
Overhead projector slide Fifteen: Value of Infrastructure Construction
Example
The volume of construction involving the country's infrastructure including municipal sewer and water facilities has steadily increased to its current volume of 111 billion dollars.

6. Sources of Employment
Overhead projector slide Sixteen, Seventeen and Eighteen: Sources of Employment

A. The presenter should discuss the potential sources of employment i.e. employers including but not limited to the following:
a. Construction Management Firms
b. General Contracting Firms
c. Sub Contracting Firms
d. Electrical Contractors
e. Mechanical Contractors
f. Plumbing Contractors
g. Governmental Organizations
h. School Boards
i. Airport
j. Port Authority
k. Building Departments
l. State Dept. of Transportation
m. Federal Agencies
n. Architecture Firms
o. Engineering Firms
p. Interior Design Firms

7. Positions
Overhead projector slides Nineteen & Twenty: Positions

A. The presenter, using the attached position descriptions, should discuss the possible positions within the industry, which are available to interested individuals including the following.
a. Construction Manager
b. General Contractor
c. Estimator
d. Scheduler
e. Project Manager
f. General Superintendent
g. Job Superintendent
h. Foreman
i. Journeyman
j. Construction Engineer
k. Safety Engineer
l. Expediter
m. Clerk of the Works
n. Building Inspector

Example
a. Construction Manager: The Construction Manager as previously mentioned acts as the Owner's representative during the entire construction process. He or she will be responsible for reviewing the work

of all parties involved to protect the Owner's interests. The Construction Manager might be brought into the process early enough to give input on the selection of the design professional.

b. General Contractor: The General Contractor as discussed before is often a company owner. He or she must be both a business person and a construction specialist. The General Contractor is responsible for all construction activities dealing with all key individuals on a project including the architect, the owner, the subcontractors and company personnel.

c. Estimator: The Estimator prepares basic data concerning a proposed construction project (usually from plans and specifications-- including quantities of materials, man-hours to perform items of work, methods to be used, equipment required, and with the assistance of other members of the office staff, computes the cost of construction which represents the contractor's competitive bid or the job.

d. Scheduler: The Scheduler is responsible for the preparation of the construction schedule. He or she might also be responsible for reviewing the project schedule as the project progresses.

e. Project Manager: The Project Manager directs all construction functions on the project for the General Contractor. He or She establishes and develops methods, procedures, schedules, and policies for the work. The PM is responsible for coordinating the work of all units and divisions within his company and performs such administrative duties as are required for proper completion of the project.

f. General Superintendent: The General Superintendent directs all on site construction functions for the project. According to established schedules, specifications, methods and procedures the General Superintendent supervises the job superintendents which work under him or her.

g. Job Superintendent: The Job Superintendent directs all construction functions on small or medium size projects or on specific phases of large projects. He or she is responsible for establishing and maintaining proper work schedules, cost control procedures, and quality control methods.

h. Foreman: The Foreman supervises all journeymen of a particular trade working on a project. He or she is responsible for planning the work, maintains schedules, and ensuring proper procedures s directed by the superintendent.

i. Journeyman: The journeyman can be a carpenter, mason, operating engineer, or any member of one of the building trades who performs the work of a particular craft as directed by the foreman.

j. Construction Engineer: The Construction Engineer is responsible for technical aspects of a project including the design, testing and analysis of specifications and materials, planning, surveying, research and other critical factors in the building process. Though referred to as an engineer this individual is often not a registered engineer.

k. Safety Engineer: The Safety Engineer is responsible for setting up job site safety operations, ensuring safety consciousness of employees, ensuring that activities are conducted in accordance with federal and state safety and health regulations and procedures, and providing professional advice on the safety of various construction activities. Again though referred to as an engineer this person is seldom actually a registered engineer.

l. Expediter: The Expediter is generally an entry level position. The responsibilities vary from company to company but he or she is generally responsible for reviewing deliveries, scheduling arrival of materials and men at job sites, establishing work priorities, and obtaining necessary clearances.

m. Clerk of the Works: The Clerk of the Works is also an entry level position. This person is generally located at the jobsite and is responsible for managing and coordination all of the paperwork and submittals for the project.

8. Rewards
Overhead projector slide 20: Rewards

A. The presenter should discuss the rewards of a career in construction. He or she should touch upon both the intangible rewards as well as the tangible rewards.
Example
There are many personal rewards which can be derived from a career in construction. The first is the satisfaction of creating, which is one of the most rewarding feelings a person can experience. The second is seeing the fruits of your labor in permanent form. Buildings often outlive their creators and being able to see your work day after day in permanent form can be extremely rewarding. A third reward is in knowing that you through your creation are helping others.

In addition to these intangible rewards a career in construction can also offer substantial tangible rewards. The current nationwide average salary for non supervisory personnel in construction is $15.00 per hour. Supervisory personnel have the opportunity to make considerably more.

9. Pathways to success
Overhead projector slides Twenty One: Pathways to Success

A. The presenter should discuss the three primary pathways to success in the construction industry.
Example
While there are in fact many ways to enter and gain success in the industry, there are three commonly used pathways to success. These differ according to the amount of training and formal education the individual has.

a. Directly from high school through an apprenticeship program or similar organized training program.

For those who want to enter the construction industry through the trades, apprentice training programs have been established to prepare young people for a career as journeymen. These programs, set up by cooperative management and labor organizations or by management groups alone, are 2-4 years in duration and combine on-the-job training with classroom instruction on the use of tools and procedures of the trade. Apprentices, whether union or open shop, receive regular hourly wages which are a percentage of the journeyman's rate and this percentage increases every six months throughout the duration of the training program until journeyman status is reached.

b. Through successful ,completion of a two year technical school or community college program after high school.

There are many two year programs available to people wishing to enter the industry at the company level. These programs provide a general background in construction practices and procedures and include such courses as surveying, plans and specifications, preparation and interpretation of documents, basic construction computations, estimating, drafting construction materials and management techniques.

c. Through the successful completion of a four year college degree program in construction or construction management after high school.

When all other things are equal, the people who progress the fastest and advance the farthest are those with the most complete preparation. Construction is no exception and for men and women interested in management positions, the best path to follow begins with four or five years of study in a college level construction engineering or construction management curriculum.

In any case the construction industry offers each person an almost unrestricted opportunity for advancement. An individual's progress within the industry is generally dependent upon three factors. The first of course are the requirements of the employer. The next two factors are how well the individual has prepared his or herself for advancement and the second is how well that person carries out their current responsibilities. Just remember STAY IN SCHOOL and complete your high school education.

CAREER AWARENESS PROGRAM: COMPONENT TWO

Career Awareness Day Presentation Two to Career Guidance Counselors and General Faculty
Approximate duration: 30 minutes
Overhead projector slides: 25

This presentation is virtually the same as the student presentation except for some of the focus of the wording. It has been omitted from this paper for brevity.

CAREER AWARENESS PROGRAM: COMPONENT THREE

Career Information Packages for Career Guidance Counselors

A third component of this career awareness program is the career awareness package for the career guidance counselors. This package can be given as a part of the formal presentation or can be used as a stand alone information package when no presentation is given. This package will consist of the following:

A. Printed two-fold brochure cover with two pockets.
B. Four part stepped information insert covering the following topics
   1. History
   2. Current Trends
   3. Employment Opportunities
   4. Pathways to success
C. Package of typical job descriptions found in the construction industry
D. Hard copies of the presentation overhead projector slides
E. Copies of the tri-fold brochure

CAREER AWARENESS PROGRAM: COMPONENT FOUR

Career Awareness Brochure for Career Guidance Counselors, Classroom Teachers and Students

This career awareness brochure is a stand-alone tri-fold out brochure intended to briefly give the student an overview of the industry while outlining many of the opportunities for success. It will also have organizations which they might contact for additional information. The following topics will be covered.

A. The Industry
   1. Construction Values
   2. Employment
B. Categories of Construction
C. Sources of Employment
   1. Employment
   2. Positions
D. Pathways to Success

CAREER AWARENESS PROGRAM: COMPONENT FIVE

Career Awareness Poster for presentation at County Fairs and High School Career Fairs

This will involve the creation of a two-panel poster board presentation consisting of two 30" X 42" presentation boards. These boards would basically duplicate the tri-fold brochure developed earlier.

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International Construction Employment: Challenges and Opportunities for Construction Graduates

S. Narayan Bodapati and Dianne H. Kay
Southern Illinois University at Edwardsville
Edwardsville, Illinois

In the changing world economy, the American construction industry faces new challenges. Eighty percent of global construction dollars are spent outside the U.S. and domestic construction spending has been on a downward trend for 25 years. Foreign contractors are doing a small, but increasing, share of work within this country, as well. Because of these trends, some of today's construction graduates may one day seek work outside the U.S. This paper examines some of the trends in domestic and international construction, the opportunities for work overseas, and some preparations necessary for an international construction career.

Key Words: Career Development, Construction Industry - United States, Construction Management, Developing Nations - Employment, Employment in Foreign Countries.

Introduction

For the past 30 years, the growth rate of the U.S. construction industry has barely kept pace with inflation. Domestic construction spending as a percentage of Gross Domestic Product (GDP) has been decreasing from a high of 11% in 1972 to 7.2% in 1996 (Figure 1). The U.S. Department of Commerce *Construction Review* (1997, Spring) predicts only modest growth in construction for the period 1996-2001, in line with the predicted average growth rate of 2% for the GDP.

The same source reports that 80% of the global construction dollars currently are being spent outside the U.S., with the emerging countries of the Pacific Rim comprising the most booming construction market. In the decade 1986 to 1996, the total volume of international construction (work done outside the home country of the contractor) grew from $74 billion to $126.8 billion.

However, to foreign construction firms, the U.S. is an international market. Foreign contractors reported over $14 billion dollars worth of work in this country in 1996 (ENR, 1997, August 25), up from $10 billion in 1994. Although this currently represents only about 2% of total spending on new construction, the trend is not encouraging. The total involvement of foreign contractors on U.S. projects is difficult to ascertain because of the many joint-ventures and mergers which have taken place.

In the face of the forecast of tighter domestic construction markets, increased foreign competition within the U.S., and with the promise of more opportunities overseas, many American firms are entering the global arena. In 1994, only two U.S. contractors ranked among the first 20 firms listed in the annual ENR Top 225 International Contractors based on revenues. In that year, Fluor Daniel Inc. ranked 5th and Bechtel Group Inc. ranked 15th. By 1996, four firms made the top twenty: Fluor Daniel Inc. (3), Bechtel Group Inc. (5), Brown & Root Inc. (15), and Foster Wheeler Corp. (18). A total of forty-eight U.S. firms made the ENR Top 225 list in 1996, and together accounted for $22.5 billion worth of international construction (ENR, 1997, August 25) or 17.8% of total international construction revenue, up from 16% in 1994.

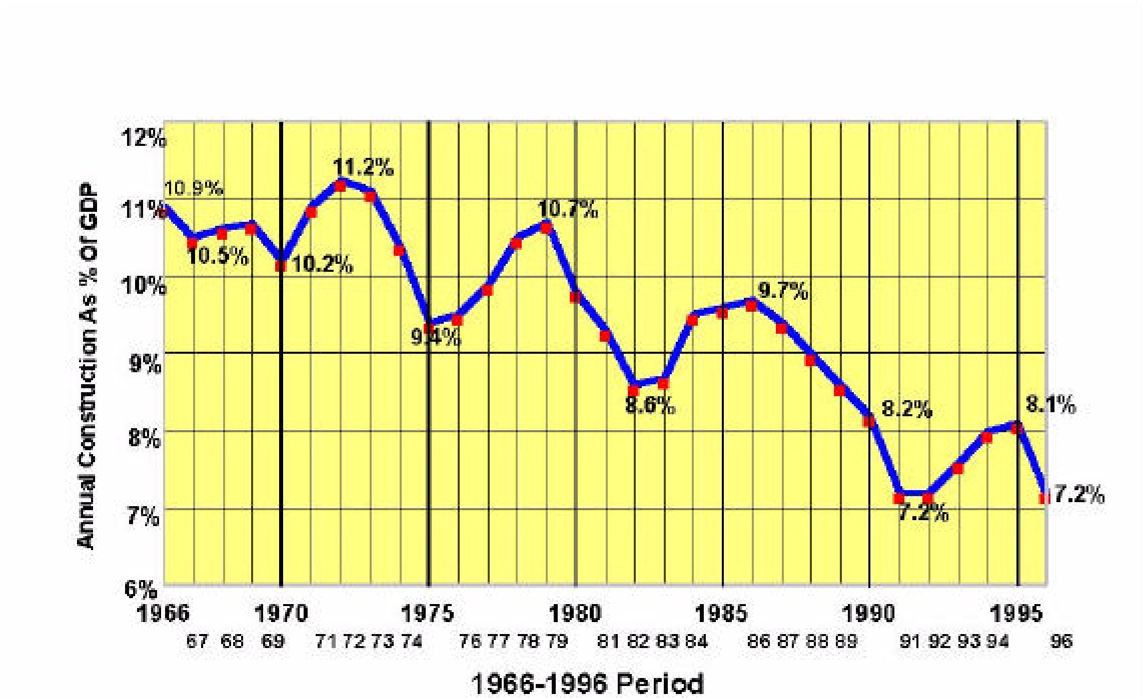

Figure 1. Annual Construction as % of Gross Domestic Product (GDP) (Source: U.S. department of Commerce)

Given the trends of the past decade, there may be more opportunities for graduates of construction programs to work overseas, or for a multi-national company. The personal experiences of the primary author working on international projects in several countries over the last 30 years have shown that overseas work can be very rewarding and challenging. However, international work requires some educational and personal preparation that may be overlooked by students intent on working in the United States. This paper will examine some of the advantages of and opportunities for work in international markets, and describe some of the preparations necessary for a career in international construction work.

International Employment Opportunities

According to the *Futurist* magazine (1995, Jan./Feb.), developing countries could represent up to 87% of the world's population by the year 2030. The infrastructure and building programs required to cope with the demands imposed by the current and future populations of the emerging and third world countries will be staggering. Krannich (1992) predicts that there will be demand for rural and urban infrastructure, dams, roads, mass transit, power, water and sewer construction in developing areas such as Africa, South America, Latin America, and Eastern Europe.

U.S. firms compete in all sectors of the international construction market, and rank in the ENR top 10 in industrial/petroleum, hazardous waste, sewer/waste, power, and manufacturing. The Fischer Report, a twice-monthly newsletter on international contract awards, bids, and construction business news, recently listed a total of thirty-three projects. More than half of these projects were located in the Middle East, traditionally a strong area for U.S. contractors. The remaining projects were located in emerging markets such as Asia (9), Latin America (3), the former Soviet Union (2), Africa (1) and India (1) (Fischer Report, 1997, September 15).

Historically closed markets such as India have begun to open to foreign companies for the building of manufacturing facilities, power plants, and other industries. U.S. corporations such as McDonald's, IBM and Coca-Cola are thriving overseas, opening a niche market for construction of their facilities. McDonald's, for example, added 2,023 restaurants outside the U.S. during the year ending June 30, 1997, compared to 497 constructed in this country over the same period. The company expects its international restaurants to contribute fully 70% of McDonald's operating income within the next five years, and sees nothing but growth in international markets (McDonald's MidYear Report to Shareholders, 1997). Coca-Cola is looking to the huge untapped markets of India, China, and East Central Europe for its future growth. Coke recently returned to India after an absence of 16 years, and began distribution in 7 major cities (India Abroad, 1995, July).

Developing nations all across the globe are providing the construction industry with opportunities for growth. The current "hot" regions for construction industry growth include Southeast Asia, China, and the former Soviet Union, especially the oil-producing states. Newly developing countries such as Albania, Latvia, Bosnia-Herzegovina, Bulgaria, Croatia, and the Ukraine are also generating demand for construction in communications, agricultural and water resource development (Krannich, 1992).

Forecasting growth in the volatile political climates of emerging nations is extremely difficult. Experts point to India, Latin America (especially politically stable areas such as Chile, Brazil and Argentina), and Russia as areas to watch. However, the stability of these regions is susceptible to sudden and sometimes dramatic undermining, as illustrated by recent events in Asia. In the early 1990s, Southeast Asia was hailed as a region of opportunity. A free-trade zone joining Thailand, Malaysia, Singapore, Indonesia, Brunei and the Phillippines was fueling tremendous growth in the area. U.S. firms saw opportunities to sell heavy equipment for power plants, aircraft, high technology and consumer goods (St. Louis Post-Dispatch, 1994, June 27). Recent financial weakness in Southeast Asian banks, however, has led to doubts concerning the continued growth of that region. The construction industry in Indonesia, a recently booming area, is beginning to shut down as rapidly increasing inflation affects the cost of imported building materials (ENR, 1997, December 22). The Indonesian economy, which has grown at an annual rate of 8% for the past two decades, has been slowed by the worst drought in 50 years. Financial crisis has ensued as businesses struggle to repay dollar-based debts with rupiahs which are losing value to inflation (Wall Street Journal, 1997, October 6). Other countries in the region are struggling under a banking crisis that has limited overseas borrowing by the Thai government and driven interest rates up over 20%.

The potential for development in emerging nations, including those of Southeast Asia, is tremendous, however. Many firms will weigh the reward versus the risk and continue to pursue international work.

Preparation for an International Construction Career

Experience

As the U.S. construction market tightens and American construction companies enter the global marketplace in ever-increasing numbers, the demand for construction professionals willing and equipped to work in an international environment will increase. The number of American construction professionals with the necessary attributes and qualifications to work overseas, however, is limited.

The National Research Council's (NRC) report *Building for Tomorrow: Global Enterprise and the U.S. Construction Industry* (1988) listed four key areas in which young construction professionals need strength in order to compete globally: this list remains pertinent today.

- A strong technical base
- A clear understanding of design
- An understanding of the intimate connection between technology and culture
- An understanding of foreign languages and regional studies

The NRC report acknowledged that such strengths could not be an expected outcome of four years of undergraduate education alone. The skills and attributes necessary to manage construction projects overseas are developed over a period of time, perhaps decades. The undergraduate educational experience should provide students with a firm base in the skills, understanding, and intellectual outlook necessary to pursue a long-term career goal of managing projects overseas. In most instances, bachelor's and master's degrees in engineering or construction, coupled with ten or more years of appropriate experience in domestic construction management would constitute proper preparation for becoming an international construction manager.

Working in an international environment is not for everyone. Special skills and attributes are required for Americans seeking to manage construction projects overseas. Kangari and Lucas (1997), for example, state that an international project manager should be competent, able to prioritize and plan, be aware of details, have good communication skills (in more than one language), have professional curiosity, leadership skills, and a respect for other cultures. The demands of working away from one's "home turf" require an extraordinarily adaptable and flexible personality. This list implies that international construction management requires a good deal of personal and professional maturity and experience in domestic project management as prerequisites.

Based on the foregoing, for construction graduates contemplating an eventual international career, planning should begin early. If eventual international work is desired, the construction graduate would be well-served to gain domestic experience working for a company which is currently in the international market. This may be either a U.S. firm currently involved in international work, or a foreign firm working within the U.S. Such “insider” status would provide insight and information on work opportunities in various regions of the world.

Attitude

Americans who work in overseas construction are traditionally an iconoclastic group. The *Fischer Report* subscribers cheerfully refer to themselves and each other as hobos, reflecting a personality type that delights in travel and rootlessness. However, even relatively staid individuals may seek overseas work for its many benefits, including cross-cultural exposure, personal and professional challenge, opportunity for accelerated professional advancement, travel, and financial rewards. Indeed, the tax advantages of overseas work may draw some to consider going global. Under the current tax law, the first $70,000 of foreign earned income is exempt from U.S. income taxes. The new budget reconciliation and tax bill increases that figure to $80,000 over the next 5 years (Fischer Report, October 14, 1997). Benefits of foreign work often include moving expenses, housing, home leave, per diem allowances for food and incidental expenses. Some remote job sites offer little opportunity to spend paychecks, giving workers a chance to save a large percentage of the salaries earned while working overseas. This combination of tax-free earnings and savings could be a tremendous boost to a young construction professional. However, there can be tax liabilities related to working overseas, and one should consult IRS Publication 54 (Tax Guide for U.S. Citizens and Resident Aliens Abroad), or a tax adviser for information concerning specific situations.

Education

Language

One of the most important educational requirements for the prospective international worker is the exposure to a foreign language (Krannich, 1992). Fluency or even facility in a foreign language would place a candidate for an overseas career in an elite group. In the U.S., only about 7% of elementary schools offer foreign language instruction in which students are likely to gain fluency. Only 4% of secondary schools offer conversation classes in a foreign language, an indication that most high school students are not attaining a high level of proficiency in the languages studied (Center for Applied Linguistics, 1997). In 1995, 4% of all students enrolled in two-year colleges and 10% of all students enrolled in four-year institutions registered for a foreign language (Brod and Huber, 1997). Traditionally, there has been little emphasis on the need for foreign language skills in construction or engineering education. The NRC report previously cited also emphasized the need not only for foreign language study, but an exposure to world geography, business and culture. The report suggested that the study of language be in conjunction with the study of the technology and culture of a particular country.

Before undertaking the study of a particular country or region, it is necessary to narrow the focus, based on the individual’s interest in an area, prospects for employment, and background, perhaps including knowledge of a foreign language. The most popular languages studied by American high school and college students, German, French and Spanish, are together spoken by only 11% of the world's population. Far greater numbers speak Mandarin Chinese but that language is only now becoming available to American foreign language students. Other important world languages, such as Arabic, Hindi, Japanese, Russian, and Bengali, have far fewer students than the European languages, although they are spoken by relatively large proportions of the world's population (Figure 2). While English is an international language, and most foreign professionals in the design, engineering and construction fields may use English, it would not be practical to supervise foreign construction workers in a country for an extended period without learning the rudiments of its language.

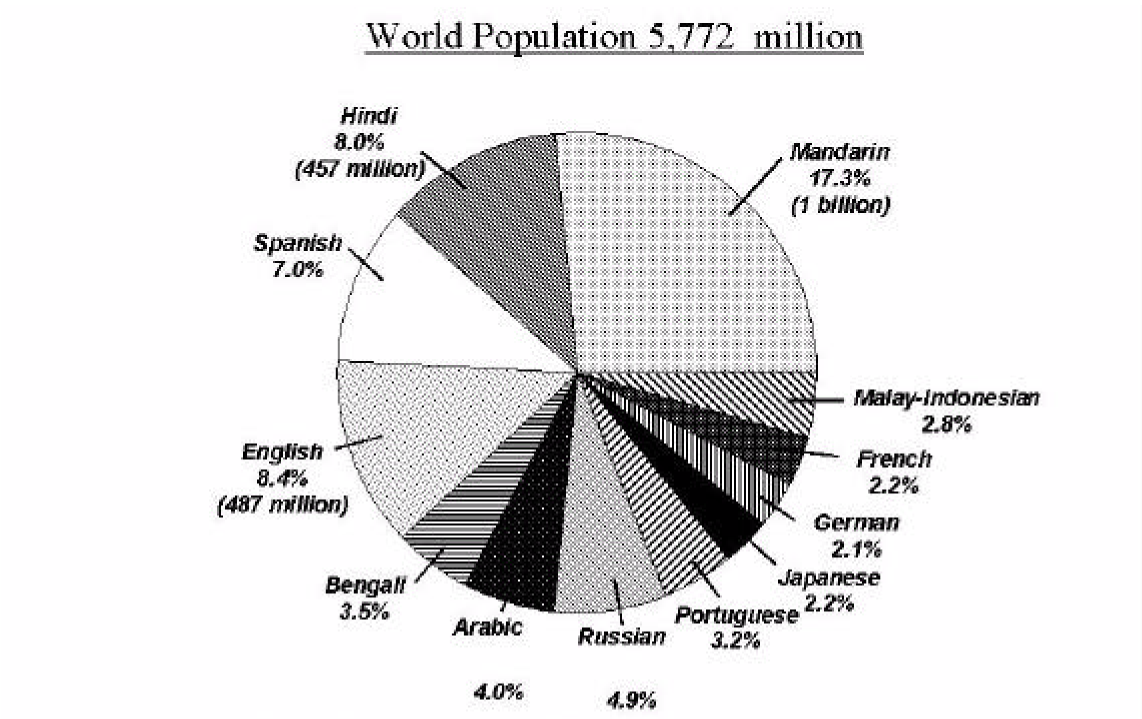

Figure 2: Principle World Languages (Languages with over 100,000,000 Speakers) (Source: The World Almanac and Book of Facts 1997)

Attaining a "survival level" in one of the European languages may take at least two years of training at the undergraduate level (Mann, 1997, personal communication). Attainment of language skills in non-European languages may take many years. Dr. Charles Adams, professor at the Institute of Islamic Studies at Montreal's McGill University estimates that "it would take 18 months of hard work to become proficient enough in Arabic to speak" at a level which would allow one to communicate (Forbes, 1974, September 15).

Culture

There are many resources for quickly gaining a comprehensive knowledge of foreign countries or regions. One of the best is the *Area Handbook Series* written by the Federal Research Division of the Library of Congress, as part of a program sponsored by the U.S. Army. There are over 100 titles in the series, each covering in depth one country or small group of closely related countries. The books describe and analyze the political, economic, social, and national security systems, and the ways these institutions have been shaped by the history and culture of the country. The books give a great deal of information on the people who live in the country, and explain the customs, beliefs and attitudes which are important for understanding and interacting with the society. The series is available through the U.S. Superintendent of Documents.

Familiarity with foreign customs and culture can be gained in other ways. Ex-military personnel or their children, who have been posted in various countries, may have a distinct advantage. Having a foreign-born parent or other early exposure to a second language and culture can also be a bonus. Travel with family, foreign exchange experience during high school or college, and activities such as overseas mission projects through churches or government programs can give valuable experience. Overseas study through the college or university construction program is another possible means for gaining experience. In addition, most international contractors will offer cultural training for their professional staff working overseas.

Engineering and Construction Practices

Another field of study for the prospective international construction manager is foreign construction and engineering practices. For an American used to working with competent and innovative specialty subcontractors in the U.S., it may be a rude awakening to find that overseas, the workforce will often have to be trained, and activities demonstrated before they can be performed. The construction manager must have a good understanding of engineering design, and design principles, and know when changes can be made without causing disastrous consequences. Although some projects for U.S. clients may be built to familiar American standards, various foreign standard specifications may be used (German DINS, British Standards, French Norms, and others) with which an American will likely have no previous experience. In addition, the American construction manager should be familiar with the metric system of measurement, which is the standard in most foreign countries.

Equipment and construction techniques may be very different from the familiar American ones, not necessarily because more modern methods are unknown. In southern India in the late 1960’s, the Nagarjuna Sagar dam was built as a masonry gravity dam, the largest of its kind. The 370 foot high dam was built of locally quarried stone rather than concrete, which would have been the preferred material in the U.S., because the project could be done more cheaply using abundant local labor and local materials. Use of the local material also saved the Indian government considerable foreign exchange since all the equipment for concrete batch plants would had to have been imported.

Political Climate

Knowledge of the political climate of a country or region can be extremely important to an American working abroad. Some countries are avoided by international companies because of the potential danger of kidnapping or terrorist activities against employees. In addition to information that may be available from the company, an individual should keep abreast of current events in the region of interest through the news media.

Practical Considerations

Finally, the international worker must look at the practicalities of working and living abroad. For many, this will include concerns about family housing and schooling. For dependents living in the same country as the worker, knowledge of the local culture and customs regarding restrictions on spousal employment and travel are important. In many Middle Eastern countries, there are dress and travel restrictions for women. Often, adequate schooling is unavailable for American children, and the dependents may be based in a city far from the job site. Periodic vacations and travel benefits for workers in such situations may be part of the compensation package.

The availability of health care, and coverage of health care costs overseas should be investigated. In many developing countries, hospitals and emergency medical care fall far below American standards. Treatment for serious illness, especially those requiring surgery, may necessitate airlift to another country for adequate care.

Other practical considerations for the employee and dependents include: rules and regulations with regard to obtaining valid work permits, resident visas, entry and exit visas; customs regulations on importing and exporting professional and personal items; travel restrictions; taxes and foreign exchange repatriation regulations in the host country.

Conclusions

For many years the United States enjoyed a position of strength in several international construction sectors, including petroleum/industrial, dams and power generation. Today, construction firms in Japan, Korea, Germany, Italy, the United Kingdom and other European nations have equalled U.S. expertise in these areas. Other nations in Asia, Latin America, and the former Soviet states have emerged to take their places as industrializing nations. The increased competition will pose a continuing challenge to the U.S. construction industry, especially to those firms which compete for international work. However, the development taking place abroad holds many opportunities for those firms and individuals with the necessary experience, attitude, and education ready to accept the risks of overseas work in order to reap the rewards.

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The Industry Advisory Council and the Del E. Webb School of Construction at Arizona State University

William W. Badger
Arizona State University
Tempe, Arizona

As technology and construction methods have changed, advice from the construction industry has become important in keeping academia and graduates of the program current. Unfortunately, many universities are slow to accept the increased requirements for educating and hiring construction professionals. Without the construction industry's direct involvement with the university, some academic administrators are hesitant to invest in construction education. Industry is instrumental in helping construction management programs realign themselves within the University systems; the construction industry must actively support local construction programs and demand more resources for construction management programs. The Industry Advisory Council (IAC) has been a powerful resource for the Del E. Webb School of Construction (DEWSC) at Arizona State University (ASU). It has given advice and support, knowledge of the needs of the modern, highly technical industry, and funds to ensure that the School has the resources it needs. In turn, the School has given to the industry the results of its research and the educated constructors the industry needs. This paper traces the development of the School's industry relations from 1987 to the present, covering the joint initiatives, financial efforts, and the IAC's support. It recounts the successes and the lessons learned in establishing and running academic outreach programs

Key Words: Industry Advisory Council, Industry-Education Alliances

Introduction

Budget constraints, an exploding student enrollment and technological advances, a growing public awareness of ecological problems, and international competition, all at a time that construction as an academic program has been trying to gain a foothold in institutions of higher education, have made it necessary for educational programs to seek alliances with the business world. Industry is necessary for funding, for advice to stay current to what is happening in the "real" world, and the resources and clout necessary to compete on all fronts (Adcox, 1993).

This paper recounts the tremendous, beneficial impact the Construction Industry Advisory Council (IAC) has had on the growth and success of the Del E. Webb School of Construction (DEWSC) at Arizona State University (ASU). It will also, hopefully, serve as an inspiration to other educational construction programs to establish their own alliances with industry and will provide ideas they can use in their endeavors to establish such alliances.

Background

The ties between the construction industry and the ASU construction program have always been strong. Indeed, the program exists because leading contractors in Arizona in the late 1950's lobbied the State Legislature to create a construction program at one of the three state universities. Arizona State University (ASU) was selected to be the site of the program.

The first classes were offered in 1972. A number of industry leaders supported the construction program, largely through giving advice and suggestions to keep the curriculum current to the needs of the industry. The committee, however, was not a formal organization.

The American Council for Construction Education (ACCE), ASU's construction program's accreditation body, was a consistent driver for the construction program at ASU to work closer with industry. The ACCE Visitation Report (1983) maintained that although the strong tie between the ASU construction program and industry was commendable and beneficial, a more formal, organized industry committee was needed.

Lesson Learned

Close industry relations are essential for continued success in re-accreditation.

Following the advice of the ACCE, the industry committee was formalized in 1983 under the name Construction Education and Research Council. Its mission was to "advance or initiate programs of education, research and service" to benefit the Construction Industry and the public it serves. The Council, which served, in the main, as an advisory board, initiated a fund-raising effort for a building program that was abandoned in 1994 when ASU determined that an Applied Science Center would not be built. With the approval of the donors, the construction department retained for later use the funds that had been collected.

Construction Industry Advisory Council (IAC)

In raising the funds for the Applied Science Center the Council displayed a great deal of resourcefulness, knowledge of who the "movers and shakers" were, organization, and dedication to the professionalism of the industry. In its relationship with the Department (at the time), however, it was limited by its structure to merely advising and to helping raise funds for special projects. It seemed to members of the Council and the administrators of the construction program that, if the program were to be the "world-class" program they envisioned, the Council and the Department needed to be more actively involved with each other.

To achieve a program that would integrate industry, the Department, the students, and the community, the organization was re-engineered in 1988. Its name was changed to the Construction Industry Advisory Council (IAC) to emphasize its service as an active advisory council working on empowering the academic program and improving the quality of the graduates entering the construction industry. Recognizing that the integration and the determination of goals and what committees were required would determine the success of the alliance (Adcox, 1993), the Council appointed a Peer Evaluation Committee to evaluate the program and to prepare a report that would provide new direction. The Committee recommended a peer review by two leaders (Brown, 1988 and Rodgers, 1988) from competitive programs who recommended:

1. Recruit at the high school and community college levels.
2. Continue working for graduate and research programs.
3. Develop funding sources by obtaining on each contractor's license a surcharge to be used in university research.

Lesson Learned
Learn from the competition.

Setting Goals and Objectives

The Executive Board developed a five-year Strategic Plan, a marketing awareness program, to supplement the five-year plan of the Department of Construction. The purpose of the Plan was to identify those areas in which the IAC could provide financial support to the program. The plan identified a number of areas requiring extra financial support (IAC, 1990):

1. Recruitment. Increase the number and the quality of the students enrolled in the program.
2. Tenured Faculty. Expand the faculty base with additional academically qualified and work-experienced tenure track faculty.
3. Augmentation Faculty. Establish at least one chair, sponsored by the construction industry, for a distinguished professor of construction. Too, establish an industry financial support fund to provide supplemental funding to that provided by the State.
4. Laboratories. Upgrade and maintain the Surveying Lab renovation program, surveying equipment, and expendable supplies. An Estimating Lab was also needed.
5. Departmental office and system network. Upgrade all of the systems and the network, and automate the departmental office.
6. Hall of Fame Award. Recognize and honor those who have given outstanding dedication and service to the Department and to the construction industry.
7. Graduate level scholarships.
8. Graphics and surveying. Fund a graduate assistant to teach construction graphics and surveying.
9. Continuing education. Develop plans for a continuing education program for the construction industry.

The ambitious plan for the construction program required extensive fund raising. The IAC recommended that the initial funding for the total Plan come from the income earned on the investment of donations contributed to the Department of Construction for the building project. It was believed that the reliance on the use of investment income would diminish over a three-year period as increased funds were generated from private and university sources for the support of the proposed activities (IAC, 1990).

Increasing Enrollment

The Council determined that the Construction Program had to increase its student enrollment and consistently upgrade the quality of incoming freshman and, therefore, of the program's graduates. It was necessary, therefore, to appeal to the best and brightest students by improving the construction industry's image and to show the opportunities available in the industry. Two committees, Marketing and Recognition and Recruitment, were appointed to evaluate and to make recommendations for a recruitment program.

Marketing Plan Committee

The committee prepared a marketing plan to promote the Department and to help in recruitment. The committee focused on defining potential customers (target audience), the media that would be used to reach the target audience, and the deliverables that would be produced by the program.

Target audience:

- High School and community college students, parents, math and science teachers, and counselors
- Industry:
- Potential employers and partners in research
- College Advisory Council
- Construction excellence partners
- Other programs within the university
- National professional organizations
- Governmental agencies that fund construction research
- Construction Alumni
- University level other faculty, staff, & decision makers (president, provost, dean)
- Arizona Board of Regents (ABOR) and State Legislature

Media:

- The News Media (Nationally & Locally), Newspapers, TV, Radio, & National Journals
- World Wide Web Users (Review the web home pages to ensure quality control)

Potential products:

- Graduates (BS & MS) to serve in the industry
- Enhancing technology transfer through research collaboration
- Continuing professional education
- Driving economic development through support of high technology
- Research reports from programs and publications
- Service to industry
- Service to national and local governments

Recognition and Recruitment Committee

As one of the objectives of the committee was to improve the public image of construction, one of the first tasks undertaken was to determine that construction professionals should be known as ”constructors” rather than “contractors.”

The committee further recommended that an annual dinner serve as an outreach program to which area high school and community college counselors and math and science teachers could invite interested students. The purposes of the industry-sponsored banquet are to improve the image of the construction industry and to inform the banquet guests of the career opportunities in the industry and the superior education available in the ASU construction program. As Table 1 shows, the banquet has been a great success, with the number of attendees limited only by the accommodations available. Funds raised by the event are used throughout the year for recruitment.

Table 1

Construction Recognition Banquet History

Year	#	Keynote Speakers	Organization	No. Attending	Income	Theme
1989 (April)	First	Tom Mack	Bechtel Corp.	285	$ 9,000	Recognition
1990 (April)	Second	Vernie Lindstrom	AGC	380	$19,700	Women
1990 (Oct) (for 1991)	Third	Eddie Basha	ABOR	480	$19,500	Industry Support
1991 (Oct)	Fourth	Richard Tucker	CII	520	$24,550	The Construction Industry
1992 (Oct)	Fifth	Jerry Colangelo	Phoenix Suns	538	$21,270	Team Building
1993 (Oct)	Sixth	Ernest Harroll	USACE General	580	$29,050	Minorities
1994 (Oct)	Seventh	Ted Kennedy	BE&K	550	$21,300	A Dynamic Team
1995 (Oct)	Eight	Denise Norberg	ASA	589	$30,000	Alumni
1996 (Oct)	Ninth	Dan Bennet	NCCER	557	$29,900	Students
1997 (Oct)	Tenth	J. Doug Pruitt	Sundt Corp	582	$33,000	Construction: an excellent career
1998 (Oct)	Eleventh	Thomas Schleifer	Schleifer’s Consulting	600	$36,000	Construction beyond the hard hat

The banquet offers three types of sponsorships:

1. Patron Sponsor for $1,000. The sponsor also gives a $250 educational grant that is awarded from a drawing the night of the banquet. The sponsor receives four tickets for company representatives.
2. Gold Sponsor for $500. The sponsor receives four tickets to the dinner.
3. Silver Sponsor for $250. The price includes two tickets for company representatives.

Awards presented at the Recognition Banquet may include:

Outstanding Woman in Construction Award. Co-sponsored by ASU and the Greater Phoenix Chapter of the National Association for Women in Construction (NAWIC). The purposes of the award are to promote women in construction and to improve the recruitment and enrollment of women in construction education (29). The program is fulfilling its purposes: enrollment figures show that the DEWSC enrollment of women has grown from 5 percent of the student enrollment in l988 to 13 percent in the fall of 1998.

Outstanding Minority Contractor Award. Co-sponsored by the National Association of Minority Contractors (NAMC), Phoenix Chapter, and ASU, the award was established to recognize minorities to improve the recruitment of minorities. The criteria for nomination and election to the award, and the benefits received, are similar to those for the Outstanding Woman in Construction. In the fall of 1998 minorities accounted for approximately 17% of the DEWSC student body.

Lesson Learned

Marketing diverse role models is an excellent way to recruit diverse students.

PLUS ONE Award. Established to honor individuals committed to the School, the IAC, and industry.

Hall of Fame Award. Established to honor those who have shown great commitment and dedication to the industry, the School, and to construction education.

Lesson Learned

The Hall of Fame and the Plus One awards are beneficial in recognizing professionals who perform outstanding service to the program.

Outstanding Alumni Award. An award to honor alumni for achievements in industry, continued support to the School, and contributions to the community.

Measurement of success

Undergraduate student enrollment has increased from 209 in 1988 to 262 during the fall of 1998. The recruitment of quality undergraduate students has certainly been successful. Of the 265 undergraduates enrolled in the construction program during the fall of 1997, 46 of them, or 17.3%, made the Dean's List/Honor Roll. Of the 250 students enrolled in the spring of 1998, 43 students, or 17.2%, made the Dean's List/Honor Roll. The DEWSC has generally had one or two students enrolled in the Honors Program during any given semester, and in AY 1997-98, five were enrolled. Forty-six undergraduate students attended DEWSC on scholarship during Academic Year 1997/1998, and 51 scholarships totaling $105,000 were awarded for AY 1998/1999. Scholarships are awarded on the basis of academic achievement.

Lessons Learned

- **The banquet is an outstanding marketing tool, reaching into the local high school and community colleges.**
- **It provides a good platform to have the industry work with the School and to celebrate the construction industry's many successes,**
- **It provides a superb forum to market the School and to celebrate the many achievements of the School,**
- **It offers the opportunity to present awards for outstanding service and achievement.**
- **Target audiences should include quality students, parents, student suppliers, industry, industry employers, local & national professional associations, peer programs, potential faculty, alumni, and college & university decision makers.**
- **Industry representatives market better than academia; industry, therefore, should be involved in marketing.**
- **Each program needs a recruiting tape, good brochures, publications, and the World Wide Web (WWW) network.**
- **Deliverables are graduates, publications, research results, continuing education, WWW pages, and recognition.**

Increasing Research

Research forms a vital link between a university and industry, which needs graduates who have modern management techniques, new technologies, and a cultural understanding they can take into an increasingly global industry. The program of any educational program is greatly enhanced by research. Graduate students assist the faculty in accomplishing faculty goals and desires. They serve as research assistants and teaching assistants to help the faculty with research, publications, and classroom duties, freeing the faculty member from some of the tasks which can be performed by assistants, allowing the faculty to leverage their time and become more productive. Graduate students are also valuable to the faculty in assisting with research. The knowledge gained from research is incorporated into undergraduate classes. Thus, the entire educational and industrial communities gain from research and a graduate program.

The Graduate Program Committee was established to institute a graduate program in construction at ASU. On July 19, 1991, ABOR approved a Master of Science with a major in Construction, with three areas of concentration: Construction Management, Construction Science, and Facilities Management (IAC minutes, Sept. 12, 1991). Here, too, the efforts of the IAC in marketing and recruitment, the funding of resources, including faculty and equipment, and the support of the DEWSC Alumni Association, which retains representation on the Council, have borne fruit: 77 students are now enrolled in our graduate program. The quality of the graduate student, like that of the undergraduate, is improving; last year, five of our graduate students were Fulbright scholars.

As was expected, research activity has greatly increased (see PBSRG and CREATE, below). Research expenditures per faculty member averaged AY the 1997-98 AY. Among the many research topics are: Cemented Soils: excavation and deep foundations, effect of wetting; Green Building; Geotechnical Construction: compaction and demolition; Computer aided constructability; Construction equipment productivity; Neural network applications to construction; Women in construction; and the use of GIS/GPS in concert with construction.

Expanding Resources

The Funding Committee was established with two goals in mind:

1. Fund additional faculty to support the new mechanical and electrical construction options
2. Obtain space and equipment for a micro-computer laboratory, laboratories for mechanical and electrical construction and for building materials, and a student technical study area.

In the spring of 1991 a classroom was converted to lab space, providing an upgraded computer lab and an expanded student area. Then, in early 1995, funded largely by the efforts of the IAC, the laboratory was remodeled into a state-of-the-art, multi-use laboratory that could be used as a study and individual work laboratory as well as a classroom with hands-on learning capabilities. Purchases included 14 multimedia workstations; one HPJ200 workstation which could be used for geographic information systems and other applications requiring large computation power; high capacity external disk drives to allow applications to be easily moved from one machine to another; three printers; estimating software packages; a digital, high definition video/still camera for developing multimedia applications; a color printer; and a page scanner. The network server was upgraded to handle the increased size of the network and to make it faster and more reliable.

To support the expansion in curriculum and number of students, one full-time, tenure track faculty member has been added to the staff as well as one adjunct faculty and three faculty associates. In addition, the Eminent Scholars program supports an Eminent Scholar in Residence, a full-time professor, and brings at least one Visiting Eminent Scholar to the campus each summer. The Scholars' experience, knowledge, and reputation add value, recognition, and excellence to the construction education program and to ASU. The Visiting Eminent Scholars, from either/or academia or industry, have lectured at both the undergraduate and graduate level, have supervised graduate research, and are experienced in conducting seminars for industry professionals. The Visiting Scholars teach one graduate-level construction course and, through the Alliance for Construction Excellence (ACE), present at least one workshop to industry professionals during one summer session.

Lessons Learned

The Eminent Scholar program imports knowledge and introduces innovation into the School and University.
Students and faculty gain new points of view.
With knowledge gained, faculty are able to develop new courses.
The program is a superb marketing event that reaches international markets.

Lobbying for a Construction License Surcharge

The Political Action Committee was established in response to the peer review committee's recommendations to get a state bill requiring a surcharge of $50 on each construction license issued in Arizona. The funds generated would be used to fund construction research projects proposed by the construction professors, with the research findings to be distributed to the industry. Three attempts to pass such a bill have been defeated. A fourth attempt to pass such a bill is underway.

Lesson Learned

The IAC is not, and should not be, a lobbying organization. Outside help is needed.

Developing a Curriculum to Meet Changing Needs

Through the years the Council has kept academia informed of the realities of the "real-world" construction industry and has offered suggestions about the curriculum. An important curriculum concern of the IAC was ensuring that the School offers courses that meet the needs of changing technology. The Specialty Option was added in 1988 to provide a program for students interested in such areas as mechanical, electrical, air conditioning, roofing, concrete, commercial and industrial refrigeration, fire protection systems, utility contracting, quarrying, and land development or other specialty areas. In January 1997 the IAC recommended two additional courses in the mechanical and electrical specialty option. The course in electrical and mechanical *estimating* was approved for the 1997-98 academic year. The course in electrical and mechanical *project management* was approved as an omnibus course, a test course that is designed to determine if the students have sufficient interest in such a course to justify adding the course to the regular curriculum. The Residential Construction option was also added to the undergraduate curriculum.

At the request of the IAC, the School has offered Cleanroom Construction, which covers the programming, design, and construction for today's fast-moving, high-tech, cleanroom construction process (see ACE), since the Spring of 1996.

Also since 1996, *all* construction students are required to take a total of 21 semester hours in business-related courses, 12 hours of which are taken through the College of Business (COB). Besides the mandatory courses in the options, the majority (80%) of construction students takes nine additional semester hours in Business. Further, in alliance with the COB the School offers a minor in business and/or a certificate of entrepreneurship to construction students willing to add to their curricula 12 semester hours of business courses developed for the construction program.

Lesson Learned

The construction industry wants more business courses, not more engineering or design courses, even when construction companies are doing more engineering.

Developing an Internship Program

For a number of years, some members of the IAC had expressed concern about construction students graduating with somewhat unrealistic expectations of at least their first job after graduation (IAC minutes, July 13, 1989). The IAC Curriculum Committee suggested developing an internship program to give the students field experience prior to graduation (IAC Curriculum Committee minutes, Sept. 30, 1996). A study was made to determine pay ranges for interns and the range of tasks and duties that could be assigned to interns. It was further determined that each intern should be assigned a mentor and should have a program of periodic evaluation. Providing support to the program, member companies of the IAC committed to hiring 10 interns during the summer of 1997 as a pilot project. At present, data is being collected to assess students' level of expertise and at what level they should be apprenticed. The program is also awaiting funding that will allow a full-time coordinator.

Continuing Education

Alliance for Construction Excellence (ACE)

The IAC Executive Committee, during 1990-1992, recognized the need for creating and running an industry outreach program (continuing education) to transfer the knowledge gained from the research program to industry. The challenges of having industry and academia work as partners indicated:

1. The School needed to create an environment in which industry could have part ownership of the program.
2. Participation of a broad base of the industry was critical.
3. The idea would first have to be marketed to industry and then to University decision-makers.
4. The new organization, the Alliance for Construction Excellence (ACE), needed planning, space, membership, staff, and leadership, all without state funding. The IAC provided much of the planning, membership, volunteer staff, and leadership. The College of Engineering and Applied Sciences (CEAS) provided space.
5. ACE would need deliverables and small successes to establish its credibility and to grow.
6. The faculty would have to support and participate in the alliance.

ACE was established to provide a forum for the construction industry and users of the construction process. It was to provide broad, nonpartisan access to both university and industry resources and was to facilitate assimilation of technological changes and research innovations into the industry, providing a resource to identify, define, and seek solutions to industry problems (Badger, June 11, 1991).

Lesson Learned

Because of the close ties between academia and the industry outreach program, the program has to be physically co-located with the academic unit.

ACE was to be a coalition of contractors, subcontractors, researchers, owners, designers, educators, manufacturers, suppliers, and other industry participants. Its program would provide for the creation, collection, analysis, management, and dissemination of information critical to the health and growth of the industry. IAC envisioned ACE as a "significant opportunity to "invest in the future of the construction industry"(IAC minutes, Sept. 12, 1991).

One objective of ACE was to become self-supporting through a multifaceted funding base that included (ACE minutes, Dec. 4, 1992): 1) Membership fees; 2) Projects that would produce direct support in the form of funding for salaries and equipment needed to execute project work; 3) Indirect funding in the form of mark-up on direct costs; 4) Fees charged for training programs; and 5) Gifts, grants, and endowments from industry and foundations. To be a founding member a company would pay an original sum of $5,000. Sustaining members would pay $2,500 annually (Badger, 1991). Ten companies served as founding members of ACE (ACE minutes, Dec. 4, 1992). One year after organizing, the Alliance had a membership of 22 (ACE minutes, Dec. 4, 1992). Within the first year-and-a-half of ACE's operations it was named the Western Hub of the Construction Industry Institute (CII) and in 1997 was named the Western Hub of the National Center for Construction Education and Research.

Lessons Learned

- **There are currently few outreach models available to construction educators.**
- **The CII model is more engineering and large-company based than is ACE.**

Task Forces. ACE's Business Plan (1992) established five Task Forces, each of which had deliverable, defined milestones that would serve as measurements to assess progress, and a sunset date. Co-ownership was critical to a successful, integrated outreach program; each task force had industry and academic co-chairs.

Lesson Learned

Co-chair each activity with Industry and Academia.

The task forces have changed to meet the technological demands of the industry. Since 1996, ACE has supported two Task Forces:

Cleanroom Construction. The purpose of the task force is to study the programming, design, and construction of the high-tech cleanroom construction process. The interest in this task force led to the development of a graduate course in cleanroom construction. The successful formation of this task force demonstrated the benefit of ACE as an outreach program. The Alliance was available to market, recruit member professionals as students, and to arrange for faculty adjunct.

Design-Build. This Task Force was created to further education, training, and research in the design-build process now being used throughout the private and, more recently, the public sector of the construction industry.

Lesson Learned

An existing outreach program enables academia to react quickly and professionally to industry's request(s) for service.

In 1996, growth of the program and a positive cash flow allowed the DEWSC/IAC to hire a full-time director and staff. In the same year, ACE grew to more than 100 member companies. By the beginning of the summer of 1997, ACE had 111 members. During AY 1997/98, ACE conducted seminars, workshops, and short courses for 502 participants.

Performance Based Studies Research Group (PBSRG)

One of the original ACE Task Forces, Research for Performance Based Studies Research Group (PBPSRG), was declared an IAC subcommittee in 1995. The mission of the PBRSG is to "create, operate, and make available a national database of construction industry performance information" by providing a new information environment through teaching, collecting, analyzing, and disseminating performance information (PBSRG, 1995). Ninety-five percent of the work is in the field with the research sponsors as partners. The information and delivery systems have been tested in roofing, janitorial, and landscaping services.

Construction Research and Education for Advanced Technology Environments (CREATE)

The Advanced Technology Facility Construction (Cleanroom) Task Force, a task force developed by the DEWSC at ASU in conjunction with industry representatives, identified the need for this center. The focus of the industry/university cooperative research center is the development and implementation of a complete research program that covers the entire life cycle of the construction process, from programming, design, construction, and startup of the production facilities to the start of manufacturing. The concept is to identify those factors that impact project management, schedule, and/or that cost the most, and to develop an overall value analysis to reduce the time of facility delivery, from inception to operation. The objectives of the proposed Center research program are in line with the National Technology Roadmap for Semiconductors (NTRS) and developments in the international arena.

Lesson Learned

- **The performance philosophy is gaining wide industry acceptance.**
- **Some in academia and industry are slow to accept change.**
- **The philosophy of service to the industry is a superb step in the information and technology transfer process and should lead to project research.**

Seminars and Conferences

Besides the CII and Eminent Scholars seminars, ACE sponsors and coordinates The Sheet Metal and Air Conditioning Contractors' National Association (SMACNA) conference. This executive training program and the SMACNA graduate program are annual events for ACE. ACE also regularly sponsors cleanroom and design-build workshops. One-time seminars have included a Governor's Conference on Partnering in the Public Sector and a North American Construction Summit.

The IAC Today

At the March 4, 1994, meeting of the membership of the IAC, the Executive Board presented new bylaws to establish a more business-like approach and to house the actual work of the IAC at the committee level. Under the new by-laws and subsequent amendments, membership in IAC is held to a maximum of 75 individuals. Membership consists of four academic members and representatives of constructors and subcontractors, owners, and construction industry support services. Membership, at a nominal fee, continues to be by invitation.

The purposes of the IAC**,** to promote and improve the construction profession by education and by defining and developing the body of knowledge, are met by the following objectives:

1. Advance and support the highest quality faculty, educational facilities, and undergraduate and graduate programs for the students enrolled in the Del E. Webb School of Construction.
2. Provide a liaison between the construction industry and the Del E. Webb School of Construction and the College of Engineering and Applied Sciences.
3. Develop and implement innovative programs to benefit the Del E. Webb School of Construction and the construction industry.
4. Offer advice and counsel and provide vision for the Del E. Webb School of Construction.

Goals and Objectives

Preparing for a February-March 1993 visit for reaccredidation, the School reviewed the five-year goals the program established in 1987 and found that all goals, i.e., increase enrollment of quality students, establish a graduate program, and create an industry outreach program, had been met. It was time, therefore, to formulate new goals (revised 1996):

1. Produce well-educated, knowledgeable baccalaureate graduates possessing technical, managerial, and communications skills based on academic and field experience, who can contribute at a high level of productivity to the construction industry;
2. Provide a high-quality, graduate-level program that complements the undergraduate curriculum and that enhances the capabilities of those moving into the upper positions of the construction industry, as well as provide a source of future educators;
3. Obtain sponsored project funding and perform leading-edge research that will provide benefits to the construction industry through innovative technology;
4. Operate a dynamic technology transfer and continuing education outreach program with the construction industry.

Lesson Learned

Joint planning improves the academic strategic plan, gets the faculty thinking outside the academic “box,” and gets industry’s buy-in to the program.

The latest Strategic Plan, 1995, iterated the following goals (IAC minutes, May 26, 1995):

1. Enhance the community's awareness of the School's successes, capabilities, and plans for the purpose of seeking help with endowments, research, and scholarships.
2. Increase industry involvement through ACE (current and new members).

The goals are accomplished by:

1. Identifying "deliverables" (what DEWSC has to offer potential donors and the construction industry)
2. Documenting current successes of the School through measuring the achievements of School graduates over a five to ten-year period
3. Identifying current and future funding requirements to enable the School to get specific with marketing messages to the industry for other funding sources
4. Identifying funding sources
5. Developing an aggressive, innovative awareness campaign to increase long-term recruitment, industry involvement, and national prominence.

To meet the objectives, the School:

1. Uses scholarships to recruit high school graduates in the upper 5 percent of their high school classes.
2. Encourages students to maintain a 2.50 GPA instead of a 2.25. Students with poor grades require a significant amount of time and effort on the part of the staff and faculty. The resulting reduced time available to teach the top-notch students has a downward spiraling effect on a class. Material cannot be covered as thoroughly as the professor would wish to cover it, frustrating the professor and robbing the student with good grades of vital information. The morale of the class is put in jeopardy, leading to a further reduction in the amount of material that can be offered and absorbed.

Lesson Learned

With a successful recruitment program, better-qualified students can be accepted, resulting in less effort by staff and faculty while producing improved quality graduates.

Creation of the Del E. Webb School of Construction

Leaders of the Arizona construction industry have had a powerful impact on the ASU construction program, first as individual leaders lobbying for such a program and then as leaders of the industry working through the aegis of the IAC. In 1990 members of the IAC introduced the Director of the ASU Construction Department to the Del E. Webb Foundation and helped to create the presentation that led to the Foundation's endowment of four million dollars. With that endowment in 1991, the Construction Department became the Del E. Webb School of Construction.

The Director of DEWSC has created a system of annually briefing the faculty on how the Webb funds are spent. Copies of the annual report to the Webb Foundation are made available to the

Dean of CEAS and the IAC. Even though the Director of DEWSC is the ASU releasing agent for the Applied Science Building Funds, he seeks authorization for amounts spent from the Applied Sciences Building fund from the donors and from the IAC; the industry raised these funds and should decide how to spend them. The Applied Building funds are under IAC approval control but released by the Director of DEWSC. It is essential that the IAC monitor the funds under the outreach program; a system of control, approval procedures, and accountability is required. The IAC Executive Committee members have to be key players.

Lessons Learned

- **An outreach program has to have the capability of collecting and spending funds.**
- **A system of fund control, approval procedures, and accountability is required.**
- **Industry needs to be a full partner in the decision making.**

Conclusion

The alliance between the IAC and the DEWSC has been successful. The IAC has been a "major link to [the School's] success and quality" (Adcox, 1993), attested to by the growth and improvement of the School in recruitment and retention; the quality of incoming and, therefore, graduating students; an expanded curriculum; the establishment of the master's degree program; and the increase in research and funding for equipment. The strength of the alliance is attested to, too, by the growth of the IAC. From a mere handful of professional contractors, the Council has grown to 70 members representing construction firms, construction suppliers, architects, attorneys who specialize in construction law, and the DEWSC Alumni Chapter of the ASU Alumni Association. The benefits to the Council members include meeting monthly in a non-competitive forum and to having an active part in the education of future constructors. Members serve as guest lecturers in classes about their particular fields, are among the first to receive the findings of research projects, and are ensuring themselves of knowledgeable and capable employees in the future.

Addressing the Council on May 26, 1995, Dr. Peter Crouch, Dean of the College of Engineering and Applied Science, ASU, said that he hoped CEAS would duplicate the successful model that the IAC and DEWSC have created.

During the ten-year history of the development of the alliance, the CEAS has had six deans. There has been a constant need to educate each Dean, even with an engineering background, about construction and construction opportunities. The ever-changing leadership has provided a high degree of freedom in the way in which the program is run but has made it difficult to become a college team player. Under the leadership of the present dean and the advice and support of the IAC, DEWSC is moving into the engineering family of schools.

Lesson Learned

The Construction Program needs to market internally with the university decision-makers about the construction industry.

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Managed Contractors Insurance Programs

Jeffrey J. Lew
Purdue University
West Lafayette, Indiana

Mike Overholt
Safety Consultant
American Contractors Insurance Group, Inc.

Programs (also known as Contractor Controlled Insurance Programs, Owner Controlled Insurance Programs, Wrap-Ups, and Consolidated Insurance Programs) have recently become commonplace in the construction industry, and are expected to be used more frequently in the future. Presented here is a discussion of the use and application of these programs as they apply to the bidding and construction processes currently being utilized in construction work. Personal interviews with construction executives and insurance industry representatives were conducted to obtain background and descriptive information on the programs. Application of the programs to actual construction projects were investigated to determine the feasibility of the programs. The information obtained indicates that properly managed controlled insurance programs can yield significant insurance cost savings and broader insurance coverage. Additionally, the controlled insurance program can be properly administrated by a program safety consultant who would ensure the establishment of a loss prevention program that yields additional profits.

Key Words: Contractor Controlled Insurance Program, Owner Controlled Insurance Program, Wrap-Up, Program Safety Consultant, Loss Prevention Program

Introduction

Common insurance coverage objectives for owners, contractors, and subcontractors on construction projects are to preserve human life, reduce accident rates, reduce the level of injuries to workers to the lowest possible rate, prevent property damage, and maintain timely completion of the construction project. In the traditional standard construction contract, the procurement of insurance coverage is a fragmented process. In the traditional insurance procurement arrangement, all contractors (prime and tier subcontractors) are required to purchase Public Liability, Statutory Workers' Compensation, and Employers' Liability Insurance. All contractors involved in the traditional insurance coverage include in their bids the cost of insurance coverage, resulting in high duplication of costs.

A new type of program has been developed in the past several years that seeks to distribute, share, and manage risk at construction sites. This type of managed program is referred to as a Controlled Insurance Program (CIP) and is known by various names including Contractor Controlled Insurance Program (CCIP), Owner Controlled Insurance Program (OCIP), Wrap-Up, or simply a Controlled or Consolidated Insurance Program (CIP).

Controlled insurance programs differ from the traditional, fragmented insurance coverage in that an injury or accident is reported to a single insurance carrier that is responsible for all entities involved in the project. The insurance carrier for the project provides information in the form of a manual to the contractor and subcontractors outlining the administrative procedures and containing the forms to be used in the CIP.

To carry out CIP objectives, the owner and contractors at a construction site implement a comprehensive safety program. The comprehensive safety program is typically monitored by the insurance company that is providing coverage for the construction project.

Additionally, each successful bidding contractor and all tier subcontractors at the site are required by the owner to develop a Loss Control Program, Accident Reporting Procedures, and other information that pertains to the operation of the program.

How a CIP works

The fundamental principle of the CIP is that the owner or contractor will furnish insurance coverage as stipulated in the contract documents for the project. This insurance coverage is related to the exposures of the project in question for the protection of the owner, the contractor, and all tiers of subcontractors.

The owner makes insurance payments directly to the insurance carrier. Bids are obtained from contractors on an "ex-insurance" basis. That is, bidders are instructed not to include the cost of insurance in their bids because the cost of the insurance is being provided by the owner.

Most CIPs include Workers' Compensation, Employers' Liability, General and Umbrella Liability (excluding Automobile Liability), and All Risk Builders Risk/Installation Floater (excess liability). The controlled insurance program provides a method of ensuring that the contractor and all tiers of subcontractors are provided this insurance.

Controlled Insurance Programs are currently being used on many major construction projects throughout the United States including the San Francisco International Airport, and the Intel Fabrication Plant in Phoenix, AZ. Many large contractors are acquainted with the concepts of CIP.

Benefits

A summary of the benefits of CIPs is presented here.

1. *Bids meet contractual requirements*. CIPs assure that the coverage included in the bid meets the standards prescribed in the bid documents.
2. *Accurate insurance information*. CIPs assure correct project insurance information, and eliminate the possibility of errors and omissions from the reviewing and accepting of certificates of insurance that are inherent to the traditional, fragmented program.
3. *Broader insurance coverage*. In the typical application of CIP, the insurance coverage and limits provided are broader and more comprehensive than what are normally available through traditional, individual contractor's programs. The insurance coverage

available to all contractors and subcontractors at a construction site is broadened in scope. This increase in insurance coverage for the same cost can be considerable.

4. *Uniform policy limits*. CIPs provide an extended, completed operations coverage, and uniform policy limits for all contractors at the project. A CIP can provide multiyear insurance rates for contractors. Insurance policy limits then can become uniform for contractors at the jobsite.
5. *Claims management*. CIPs improve claims management and provide single, coordinated loss control and claims handling program management for all parties at the project site. The program assures thorough investigation and supervision of all claims. Settlement of claims can be made on an aggressive basis. The potential for litigation among different carriers at a jobsite is eliminated when there is a single carrier.
6. *Use of a single carrier*. The use of this single carrier eliminates the possibility of confusion and conflict among insurance carriers in the event of a loss.
7. *Reduces project costs*. CIPs reduce the total cost of a construction project. The reduction in project costs is made possible through the volume of project-wide buying power. Savings are achieved by the elimination of redundant coverage, premiums, and insurance premium add-ons. CIP can provide all insured contractors at a project with the best possible insurance coverage at the best possible price.
8. *Eliminates litigation*. Extensive litigation among companies at a jobsite in order to determine ultimate responsibilities for accidents and safety can be highly time consuming and costly. Adjacent property losses such as foundation defects, movement of buildings, etc., can be settled efficiently and expeditiously due to one insurance carrier handling the project. Improved claims management reduces the litigation costs between carriers.
9. *Provides a competitive tool*. A properly managed CIP can give a contractor a competitive tool in the highly competitive construction market.

Contractors’ experience modifier (EMR) encourages contractors to improve their safety performance while allowing the insurance industry to collect the required funds to pay for the losses. The insurance premium savings offered through the experience rating plan will almost always outweigh the expense needed to improve safety performance. In other words, safety does indeed pay. Owners use the EMR to gauge the safety performance and experience of the general contractor or prime contractors, and the general contractors use it to gauge the safety performance and experience of their subcontractors. An experience modifier of .80 means that the contractor will receive a 20 percent discount on its workers compensation premium. A contractor with an experience modifier of 1.20 will pay a 20 percent surcharge on its workers compensation premium.

An EMR is more of a reflection of past safety performance than current safety performance. The EMR is calculated by three full years of payroll and loss information, ending one year prior to the effective date of the modifier. A contractor might experience good safety performance in the past, but has let the safety process lapse, and will not see the effects for perhaps 1 or 2 years.

Under a traditional CCIP or OCIP, the employer’s experience rate will be the rate the employer has with the state for that particular policy year as written by its carrier of record. Under a wrap-up, one EMR rating will be established for the entire project and the experience shall be determined by loss picks conducted by the insurance carrier that is writing the policy. This rating will not *travel* with the employer, it will only be used for the wrap-up project. In one instance, it will travel, and that is if there are subsequent phases of the same project.

In setting up a Controlled Insurance Program on a project, it is noted that a substantial amount of detail is necessary in these programs. How these details are administratively handled tends to dictate the success of the program. If set up properly, the following can also be considered beneficial due to implementation of a CIP:

1. *Administrative improvements*. CIP programs provide a system for tracking insurance credits, payrolls, and financial reporting on a construction site. In addition, certificates of insurance do not have to be checked for each contractor at the jobsite, eliminating the possibility of making errors in checking the certificates of insurance for each contractor. CIP also allows for a system for keeping track of a contractor's experience modifier (EMR). With a CIP, there is only one certificate of insurance, thereby eliminating confusion.
2. *Improved project safety*. The use of CIP enables the operation of an efficient, cost effective, and results-oriented safety program. This is made possible through the use of a coordinated approach to project safety, typically through the use of a Program Safety Consultant. In addition, smaller subcontractors may not be able to provide sophisticated loss control programs on their own. By using the CIP, the smaller subcontractors can take advantage of highly technical skilled safety managers and loss control personnel.
3. *Proactive.* CIP is proactive in that through better planning, property damage accidents can be reduced or kept from occurring while still facilitating the timely completion of the construction project.
4. *Allows for competitive bids.* The primary benefit that CIP provides to an owner is by obtaining more competitive bids for their construction projects. This reduction in project cost is made possible by freeing the contractor and all tier subcontractors from the numerous and time consuming insurance related responsibilities at a construction site.

One type of CIP—the Wrap-Up

A wrap-up or CIP is essentially the same, the name differs in that the programs described thus far in this paper are sometimes referred to as Construction Wrap-Ups. A wrap-up is a risk management program specifically designed for owners and general contractors involved with a sizeable construction project. The name differs, but the programs are essentially the same. Wrap-ups are effective because insurance is simply another cost component which the sponsor can provide more effectively and more cost efficiently than the respective contractors and subcontractors can do separately at a construction site.

Types of Wrap-Ups

Types of wrap-ups that are available are presented here:

1. *Traditional Wrap-Up.* Traditional wrap-up normally covers a single site or a multiple site of similar construction.

2. *Rolling Wrap-Up.* A rolling wrap-up usually applies to a multiple site or to an on-going construction project. An owner's capital improvements program falls into this category.
3. *Gatekeeper Wrap-Up.* Gatekeeper wrap-ups normally are applied to maintenance programs where contractors are continually at the site expanding, maintaining, or repairing the facilities and property of the owner.

Benefits of Wrap-Ups

The benefits of wrap-ups are the same as those of the other CIP programs presented in this paper. The financial or cost savings are reported to range from 2 percent to 6 percent of the total contract hard costs. With a single program in place, under the direction of the project manager, the administration of the plan is much easier. Continuity and uniformity in the areas of coverage, insurer, claim handling, and loss control convert directly into reduced management costs. Historically, pure loss ratios on major projects using CIPs or wrap-ups have averaged 21 percent to 35 percent. Based on this experience, premium savings of up to 50 percent of standard premiums are not uncommon. Other risk financing considerations such as cash flow implications of periodic payments of premiums may further enhance the economic value of a wrap-up.

The most successful wrap-ups are those with labor costs of at least 25 to 30 percent of the total project costs, and with a total of at least eight to ten contractors. Because work-related injuries are the most predictable and controllable of all construction losses, the opportunity to reduce insurance costs is greatest in the workers' compensation line of coverage. If workers' compensation premium costs are high on an individual basis, the opportunity to reduce total project costs through effective loss control is great.

CIP case studies

Presented here are case studies of how selected firms and organizations have successfully applied the controlled insurance program type of coverage. Over thirty personal interviews were conducted with Contractors, Insurance Agents, and Owners using the questionnaire contained in Appendix A. The presented case studies were selected to represent different types and sizes of construction companies, large owners, insurance agencies, and insurance companies.

American Contractors Insurance Group (ACIG)

American Contractors Insurance Group provides complete insurance coverage to 30 construction companies. During the last seven years, ACIG has conducted three major controlled insurance programs. One project was in excess of $1 billion. Based on the experience gained from these large wrap-ups, it was determined that almost all large construction projects are wrapped-up. Twenty years ago this was not the case. Insurance agents are pushing owners toward controlled programs to gain commissions. A large developer is building a $50 million project that will require $7 million in insurance premiums. Several insurance agencies may obtain insurance premiums through the various construction companies on the project. Under a controlled program, the commission is taken from the various contractors' agents and given to the owner's agent or the general contractor's agent.

The type of construction is significant due to the fact that applicable risk classifications will affect the rates that are applied to the manual premium. Projects involving underground work or steel construction require labor and liability classes that generate greater premiums based on the risk of the craft involved. Again, based on the CIP concept, these rates can be adjusted for the benefit of the contractor by reduced premiums.

The safety or loss control staff is an added benefit by providing the necessary safety training, education, investigation, audits, and inspections for all of the contractors on site. With one safety management entity that covers all project contractors, each contractor has to follow the same safety requirements on the project.

The benefits of CIPs are more profits for contractors, higher coverage limits to all contractors at the site, and one insurance carrier involved in all claims. The benefit of one insurance carrier results in the elimination of lawsuits. On large construction sites without CIPs, lawsuits typically are involved trying to figure out responsibilities for claims. These lawsuits frequently result in costs of legal fees of 75 percent of claims costs, or 75 cents for every 1 dollar paid. *(Pat Caldwell, Account Executive, Risk Management Division, personal communication, 1997)*

Eichleay Construction Company

This construction company's perspective says that a contractor's input is needed at the beginning of a project for a Controlled Insurance Program to be successful. For CIP to work, there needs to be a monetary incentive to give the program a goal. The incentive to work safely must result in the contractor earning some kind of bonus, to be paid out of premium savings. In addition, a negative incentive should exist in the form of loss or to incur additional premiums if safety goals are not met. The same rules must apply to all the subcontractors involved at all tier levels at the project. Projects that involved sharing of premium savings tended to result in success, while those that did not were not as successful. Projects need to be in the range of $100 million, with around $50 million in labor, to be large enough to successfully employ CIP. One of the largest areas in which savings can result is in the reduction in litigation. Claims are submitted to one organization and one attorney, resulting in the elimination of lawsuits. *(Dennis Wilson, Project Manager, personal communication, 1997)*

Brady Company, large sheetrock installer

Owners differ in the way they administer the CIP. The success of the CIP is based on this variance of management. If the contractor and the subcontractors pay premiums to an insurance company retained by the owner, which results in the owner receiving the insurance premium rebates, then the CIP holds no financial incentive to the contractors. The negative experiences of many construction companies not sharing in the premium rebates as a source of additional revenues has caused the current situation where the CIPs employing this feature are not used as much now as was in the early 90s. Contractor Controlled Insurance Programs were attempted, but were not as successful as CIPs. The lack of success can be attributed to the contractor not sharing the rebate savings with the subcontractors.

Currently, the better run controlled insurance programs are run by owners with revenue sharing features. For the CIP to be a success, the involvement of the owner and contractor is needed at all aspects of the project. Few owners finance the large projects out of their own funds. Money is borrowed to finance the project, therefore a lot of time pressure is placed on the project schedule. This creates a conflict between scheduled time and safety against the desire to make money. Thus CIPs need the involvement of all parties at the site with equal opportunity to share in the potential benefits of the program.

CIPs save money by offering the incentives of sharing insurance premium rebates and through partnering of safety management activities. Following these guidelines, there is a huge incentive to control workers' compensation at large construction sites. A project needs to have $75 million in total insurance requirements to be a potential success for a CIP. *(David Dolnick, Manager, personal communication, 1997)*

The Wooditch Company

CIP is the current method in which most insurance is handled on large construction projects. The generic term for CIPs is wrap-up. An important issue for the usage of CIPs stems from the contractor and subs trying to bid with and without insurance. Contractors are only covered onsite, so they must make sure employees are covered when going off site or to another job. Contractors must check with their insurance agent to make sure they have complete coverage. On the other hand, contractors need to ensure they are not covered twice. All parties at the project site are covered in the insurance agreement under a CIP, since one policy protects all. Architectural and Engineering (A/E) firms may or may not be included, depending on how the CIP is arranged, however, a supplier providing materials under a PO may not be included.

A project should contain at least $50 million in total insurance cost to make a CIP as feasible as a job cost. Another method to make CIP feasible is the use of rolling wrap-up, which involves using 3 or 4 projects to equal the $ 50 to 100 million in total requirements. Rolling wrap-up requires no start or finish days and permits organizations to get away from the minimum revenue requirements. A contractor may be faced with minimum premiums on other jobs, and may be paying for premiums anyway. All parties involved in a CIP have to know what the minimum program premium requirements are.

In California the loss ratio is 68 percent of paid insurance premiums for typical construction projects. However, under wrap-ups, the loss ratio is only 38 percent of paid premiums. The utilization of a constant safety monitor (or site safety manager) helps achieve this reduction. Since CIP is loss sensitive, the opportunity to obtain insurance refunds exists on large construction projects. *(Cathy Tovatt, Account Executive, personal communication, 1997)*

Gulf States Construction Company

A Controlled Insurance Program allows complete coverage at a construction site for the protection of the owner and all contractors. CIP allows significant savings through bulk buying of insurance which yields lower premium rates. The experience with a large industrial owner can be described as *the time spent on safety issues and improvements cost money but yielded* *significant savings*. The problem was that the savings went back to the owner, not to the contractors on the site. The owner receiving all the savings from the premium rebates in a CIP is the primary drawback of CIP. This case is similar to a previous case in the Brady Company.

All parties must be sold on safety itself or no benefits can be obtained with a CIP. The difference a CIP makes may not be directly seen or measured, unless the owner helps put a measurement of the EMR into the insurance program at the site. When the expected loss ratio is met, then a shared savings can be utilized at the site. If it is not, the affected contractor pays an additional premium.

Currently, the large industrial owner has an incentive that goes to the workers, not the contractors. A twenty-five-cent-per-man-hour incentive for all workers is available at this project site. If one worker in a company gets the incentive, they all get it. The incentive is received when the goal of maintaining the EMR is met. When a contractor at the site is charged with a recordable accident and the contractor does not meet the EMR goal, then the contractor does not receive the incentive. However, the other contractors at the site are still eligible to receive the incentive provided they are not charged with an accident, and have met the EMR goal. However, this system does not help the contractor in a monetary fashion.

Rolling wrap-up can be used for maintenance, turn around work, and capital improvement construction projects. All contractors at the jobsite are covered although several construction and maintenance projects are involved. *(Frank Douglas, Project Manager, personal communication, 1997)*

San Francisco Airport Project

The largest current CIP in the United States is being utilized and is working for the expansion project of San Francisco International airport. Employing normal insurance procedures for this project would result in insurance premiums of about $100 million. Utilizing CIP resulted in actual paid premiums of $40 million. These insurance premiums covered workers' compensation, general excess liability, and builders risk. By placing the order for insurance themselves, the owner was able to obtain a much more reasonable price.

In addition to premium savings, the CIP was able to obtain expanded coverage in the amount of $500 million for each event. Through normal bid processes, coverage in the amount of $1 to $2 million would have been realized. The huge difference in insurance coverage is a significant factor in risk management for a project the size and complexity of the San Francisco Airport project. The expanded coverage is needed to cover the risk involved when dealing with the operation of commercial aircraft adjacent to construction operations.

The $30 million in workers' compensation premiums the airport is paying still represent possible savings. The airport believes that it is possible to recover $10 million in rebates if safety goals are met. The project has been in the CIP program for three years and is experiencing a loss ratio of 30 percent. The average loss ratio for projects in the California area is 60 to 65 percent. By maintaining a fulltime safety director at the project site, the owner, insurance carrier, and contractors have been able to manage safety, reduce the accident rate, and produce the 30 percent loss ratio. Maintaining this process for the duration of the project will result in an anticipated rebate.

The airport insurance manager felt that a project needs to have a total cost of $150 million for a CIP to work. Projects less than $150 million are not feasible for CIPs. *(Marge Layne, OCIP Administrator, personal communication, 1997)*

American Contractors Insurance Group, Inc. (ACIG)

ACIG is a group captive insurance company, meaning that the policyholders share the risk of their operations among the others in the group. In essence, it is a self-insurance program, where the policyholders own the company and have various levels of equity built up within the organization. Two major components of ACIG's program is being appropriately staffed, and having the expertise to provide contractors and their subcontractors the benefits of a Controlled Insurance Program. Most of the statistical data regarding the two very large CIPs that ACIG provides are confidential, but it can be revealed that ACIG has experienced outstanding results with these types of programs. Included in these programs are substantial cost savings in insurance premiums, very few fraudulent claims, good quality work in place, and a better run and managed construction project. From an administrative standpoint, the workload is much less due to less paperwork. On ACIG projects, there is a full-time CIP administrator that tracks all of the paperwork associated with the program. The individual is located on the construction site and has access to any of the contractors' representatives. This method has proven very successful. Teamwork is another concept that has worked well on these projects. All of the contractors, subcontractors, owner representatives, insurance personnel, and owner consultants are able to meet onsite and discuss any necessary issues that do arise.

While some projects are clearly more suited to CIPs than others, almost any large project can achieve a cost savings for the owner from a well run CIP. *(Mike O'Neill, Senior Vice President, personal communication, 1997)*

Boone & Rogers Company

Most projects with costs exceeding $100 million are typically suited for a CIP. We are currently involved in a rolling wrap-up with ACIG on the East coast involving the Baltimore Ravens football stadium, Baltimore police facility, and two other projects in Massachusetts. Most insurance companies will not become involved in a project generating less than $3 million in annual premium. One key component to any CIP is loss control and loss prevention. While most wrap-ups present a higher risk due to the complex construction process of the projects, they also represent the greatest opportunity for cost savings if the losses on the project can be controlled. One position on the project that needs an experienced individual is the safety director or manager position. This individual should possess construction experience as well as insurance experience. A lot of the administrative work is accomplished up front by reviewing the certificates of insurance and verifying and confirming the coverage for the project. In addition, there is a benefit of having one insurance carrier responsible for handling claims once a loss does occur. *(Paul Newman, Vice President, personal communication, 1997)*

Conclusions

The following conclusions and summary statements that relate to CIPs are presented:

1. Significant insurance cost savings and broader insurance coverage can be produced through a well-designed and administered CIP.
2. Contractors generally must make significant adjustments in their business practices to successfully participate in CIP construction project.
3. Most construction companies, possibly acting as a subcontractor, have the opportunity to participate in CIP construction projects when they are involved in large construction projects.
4. CIP creates an economy of scale by centralizing the purchase of insurance coverage.
5. CIP streamlines insurance project management by placing a number of insurance functions such as loss control, safety management, security, and recordkeeping under a single authority.
6. The key to a successful CIP is the control of required project insurance lines like general liability, workers' compensation, builders risk, and in some cases, architects and engineers professional liability.
7. The control of a successful CIP requires the control of all subcontractors in all tiers through their contracts to control site security, loss-prevention programs, and claims management by a single owner or prime contractor.
8. CIPs are usually successfully employed on projects in excess of $50 to $100 million dollars.
9. Cost savings of 1 to 2 percent of total project costs can be realized with CIPs.
10. Financial considerations aside, other benefits are derived for subcontractors, e.g., competitive position improves due to excellent safety performance. Contractors can add CCIPs and OCIPs to their profiles and *resumes* of work, therefore, benefits flow back to them in ways other than project savings.

Recommendations

Since the value of controlled insurance programs is reflected in the bottom line profits in construction work, all students in construction education should be taught the concepts of the various forms of controlled insurance programs. Learning the design of a construction insurance program will allow students to better understand the owner's, insurance carrier's, and broker's perspectives when bidding and putting together specifications for a project. Students gain knowledge in an area of construction that normally is not addressed at the academic level. Managers of construction operations should possess a working knowledge of controlled insurance programs.

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Implementing Digital Image Photography in the Building Industry

David Riley and Jessie Whitesides
University of Washington
Seattle, Washington

Digital photography provides a versatile technique to capture, view and manage images of site conditions and project progress. The graphical nature of communication in the building industry provides many opportunities for architecture and construction firms to benefit from this technology. This report presents a study performed to investigate the feasibility of replacing existing photographic services on design and construction projects with digital photography, and identifies strategies to encourage the implementation of this technology. Surveys and interviews were performed to assess the uses for and expenditures on photographic services by architecture and construction firms. Trial applications were also carried out to assess the actual costs, necessary time investment for training, and advantages of digital image technology in the building industry. Conclusions address the most feasible project types and techniques to successfully implement digital imaging tools.

Key Words: Digital Image, Photography, Internet

Introduction

This report summarizes the results of a pilot study performed at the University of Washington, in the Department of Construction Management. Advances in technology have varied effects on particular industries. The building industry, while traditionally slow to embrace new technologies, has evolved and become more receptive to innovation. Recent research (Abudayyeh 1995, Liu 1995, Liu 1996, and Songer 1995) has begun to explore the many applications of digital image technology in the building industry. This study was performed to investigate how architecture and construction firms can most effectively begin to take advantage of the emerging technology of digital photography. While numerous organizations have begun to experiment with digital cameras and computer images, many questions remain about how this technology can improve design and construction processes.

Digital Image Photography Defined

A whole new way of taking pictures, digital photography captures images electronically making them instantly available for computer processing and output. Consequently, the image is far more versatile than a traditional photograph, which requires extensive processing. Once downloaded to a computer, the image, like any other electronic document, may be printed, enhanced, filed in a database, or transmitted to remote locations. Computers play an integral role in digital photography, adding to the considerations relevant to this technology. These considerations fall into four general categories: capturing, storing, managing, and sharing images.

Capturing Images

Images are gathered and stored inside a new breed of camera. Ranging in price from $300-$20,000, digital cameras vary greatly in capability and function. Significant variables are the resolution (number of pixels e.g. 640x1040), depth (number of colors), and storage capability (how many images can be stored in the camera's memory). While the quality of an image is highly dependent on the quality of the camera, low-end digital cameras ($500 - $1000) do provide sufficient detail and resolution for most general applications. An image that is captured by a digital camera is stored electronically in the camera's memory until downloaded to a computer.

Storing Images

Once loaded onto a computer, images can be saved onto hard drives, removable disks, or compact disks. Often larger than one megabyte in size, images will quickly absorb available memory, thus expandable forms of memory are essential tools for handling digital images. Managing stored images can also be a cumbersome task, and therefore is also an issue that must be addressed.

Management of Images

Once images are collected they must be stored in a manner that they may be accessed. For most commercial purposes, an image database is required, which can store images and detailed information about each image, including the date the image was captured, the subject matter, the project name, etc. Currently there are only a handful of packages that are capable of advanced database functions e.g. Quicksolve, and Lynx, however many are under development.

Sharing Images

One final issue that must be addressed is how images are transmitted or shared between different parties. Hard copies of images can be printed on a wide range of devices including laser and ink jet printers, with very good results. More advanced printers are also available which are capable of reproducing a high-resolution image at the same, or even greater, quality as a traditional photograph. Electronic options for sharing images include faxing images through a computer, attaching images to email messages, and accessing databases of images over a network, internet, or intranet.

Digital cameras have evolved to an important stage - they are actually easy to use. If accepted and integrated with design and construction processes, this technology has the potential to change the way architecture and construction firms communicate. Currently there are a significant number of firms in the building industry who are considering the use of digital cameras to replace or augment current photographic services. Few however, have begun to take fully take advantage of this technology. The goals of this research are to (1) demonstrate the feasibility of architecture and construction firms successfully using this technology, and (2) begin to assess the potential impacts of digital image technology on the design and construction process.

Methodology

Surveys, interviews, and trial applications were used to investigate the feasibility of architecture and construction firms using digital photography and related technology. The strategy of this research was to show that existing expenditures on photographic services by architecture and construction firms are comparable to the costs of a digital image system, and thus encourage the use and experimentation with this technology in the industry.

Surveys were distributed to Seattle area design and construction firms that explored the existing use of photography on various types of projects and contracts. Surveys also requested existing expenditures made for photographic services in order to assess the feasibility of investing in digital image technology. Several open ended questions explored the current understanding of and interests in digital image technology.

Several survey respondents were contacted and interviewed in person to examine how digital image technology may be integrated into their work processes and services. Trial applications of digital photography were also performed to gain first-hand experience using digital imaging tools. Finally, three case studies were initiated in which digital technology has been used on building projects. Currently in progress, these case studies will focus on determining the potential benefits and improvements in project communication that result from using digital image technology.

Industry Survey

A survey of twenty-five architecture and twenty-five construction contractors assessed current areas of photographic use, and expenditures on photographic services on a per-project basis. Respondents were also asked to suggest what types of projects and contract types result in increased needs for photographic documentation. Lastly, the survey assessed current experiences with and further interests in incorporating digital photography into the design and construction process.

Survey Data and Analysis

Fifteen architecture and fifteen construction firms responded to the survey. Per project and annual project expenditures were categorized into six different areas of current photographic use: *Site Analysis, Monitoring Project Progress*, *Record Keeping, As-Built Record keeping, Marketing,* and *Other*. The respondents rated each category in terms of the frequency of use of traditional photography using a scale of 0-3, three being the most frequent. Estimates of expenditures on photography in each category were also provided. Current experiences with and future interests in digital photography were compiled in a short answer format. The data collected was averaged and summarized for three areas of focus: Areas of Use, Current Expenditures on Photography, and Interest and Experience in Digital Image Photography.

Areas of use

The weighted responses (Sum of ranking where 1 = 3 pts, 2 = 2 pts, 3 = 1pt., 0 = 0 pts / total # of responses) for each category of use are illustrated in Figure 1. The architecture and construction firms responding indicated that there are extensive needs for photography in their organizations. While both types of firms use a large volume of *marketing* photos, architecture firms have greatest use for photographic documentation during initial *Site Analysis*. Construction firms rely more heavily on photographic documentation of *Project Progress*.

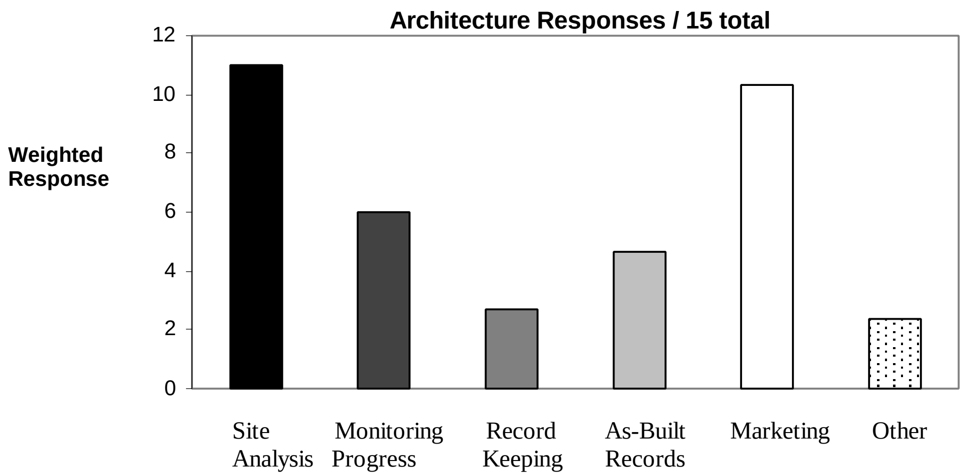


Figure 1a. Primary use of photography by architecture firms

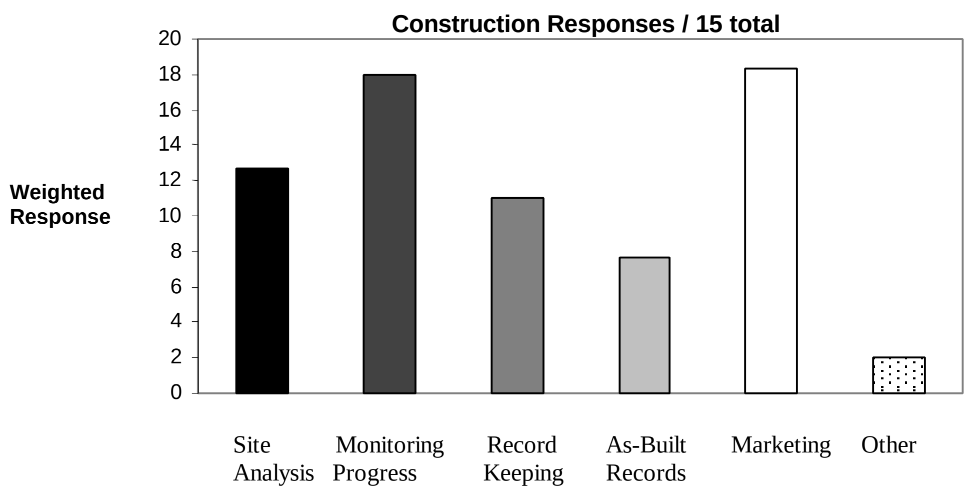


Figure 1b. Primary use of photography by construction firms.

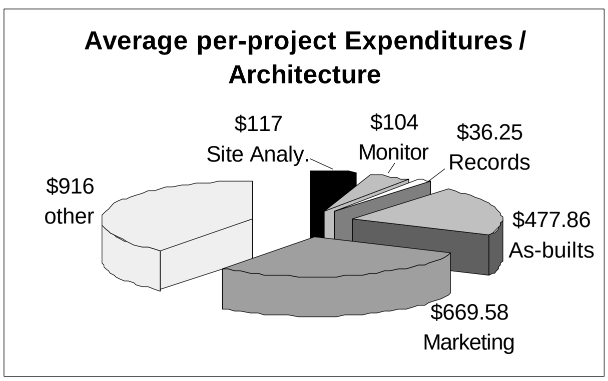
Respondents were also asked to compare their use of photography on different types of projects, e.g. New Construction, Renovation Projects, Tenant Improvement/Fit-out, Infrastructure, and

Other. Most (85%) agreed that all projects require photography in varied amounts depending on size and duration, however renovation work and new construction required many more photos for site analysis and project documentation than utility and highway construction. These photos were normally medium quality color photos taken by in-house employees.

Finally, comparisons of photographic use were made between projects with different contractual arrangements, e.g. Lump-sum, Negotiated, Design-build, Cost-Plus, and Other. While most firms indicated that there was no difference, several contractors pointed out that the higher the risk of litigation or disputes, the more photos are taken to document site conditions and project progress.

Current Expenditures

For each of the areas of use, expenditures were averaged for both types of firms responding. Architecture firms spend an average of $18,000.00/yr on photographic services, approximately $2,314.00 to support initial *Site Analysis*. Contracting firms spend an average $35,725.21/yr, on photographic services, approximately $13,000.00 to support monitoring *project progress*. Expenditures were also evaluated on an a per project basis to determine if it would be feasible to purchase and use a digital camera for site analysis or project documentation on a single project. Figure 2 illustrates the average per-project expenditures for photography by Architecture and Construction firms.



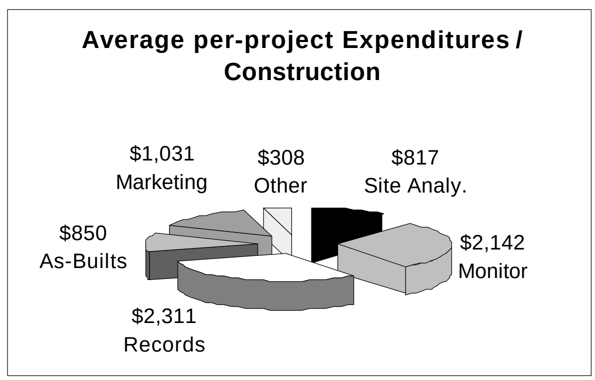


Figure 2. Average per-project expenditures on photographic services by architecture and construction firms.

While architecture firms spend the most money per project ($916 average) on high quality photos for marketing purposes, they are also spending close to $750 per project for site analysis, monitoring progress, and record keeping (services most easily replaced with digital images). Construction firms spend up to $5000 per project for site analysis, monitoring progress, and record keeping. Both of these figures were then compared to actual costs of an example digital image management system.

Current Industry Interest and Use of Digital Image Photography

The experiences of the respondents currently using digital photography have been positive. They have found added benefits in the speed in which images are available for use, compatibility with electronic media, and in the actual management of images. Two common problems experienced were the quantity of storage space and the management of large numbers of images.

Several existing field applications of digital image technology were examined to gain insight into the benefits and motivating factors experienced by users. Experiences of architects, contractors, and owners ranged from general experimentation to full fledged digital image management systems.

Architecture firms have begun using digital image technology to assist in the design process. In one case, digital photos were taken of an architectural model and used to make a presentation to a client in a remote location. Many images were displayed with a computer, and the need to transport the model to the client's office was eliminated. In another case, images were combined with CAD drafting overlays to produce construction documents for a renovation project. Discussion with several architecture firms reaffirmed that the highest use of photography outside marketing, was for site analysis at the onset of projects, particularly in renovation projects.

Construction firms use digital cameras to capture daily progress photos for historical record keeping purposes. The highest need for images is on renovation projects, where the need to show "before" and "after" conditions is often necessary. Images were stored on disks and archived for future reference, eliminated the need for cumbersome photo albums. Several design, engineering, and contracting firms have also begun to use advanced systems that are designed to catalog and transmitting images between remote locations.

Owners are driving another application of digital photography - the inclusion of images of construction projects on Internet Web pages to provide owners and project participants up-to-date progress photos of a project. Galleries of recent photos can be created using the most basic Hyper Text Markup Language (HTML) code. Real-time images can be captured by conventional video cameras, digitized by a computer, and downloaded automatically to web pages at predetermined intervals. This application could easily be adapted for time-lapse analysis of on-site operations. It has been envisioned that in the near future, project sites equipped with advanced teleconferencing systems will allow project participants in remote locations to participate in a real-time project walk-through using digital image technology.

By far the most extensive users of digital image technology are owners. Organizations like Boeing, Microsoft, the GSA, and the U.S. Postal Service have begun to transfer their project documentation from traditional photography to digital image format. In many cases, the use of digital image photography on a particular project was found to be driven by the owner.

Overall, the use of digital cameras by architecture and construction firms was found to be very limited. Actual applications that were observed were limited to basic tasks. Almost every firm contacted however, expressed a strong interest in this technology, and intentions to explore its applications. In the future, the respondents envisioned using digital photography in the following ways:

- Improving the existing use of photography, especially for site analysis and project documentation
- Transmitting real-time progress images by Internet
- Bidding and documenting of existing damage to job sites before work begins
- Developing of manuals/presentations for methods and safety training
- Developing video presentations
- Making alternative working drawing methods using photos of details from previous projects
- Including actual photo images in renovation/remodel sets to show changes
- Documenting renovation projects and as-builts

Trial Application

An example digital image system was set up and tested by the research team. This application was performed to gain first-hand experience with several popular and readily available products. The application included researching available tools and acquiring and setting up the necessary hardware and software for a basic imaging system. Images of sample projects were then captured, viewed, and archived as they would be on trial design and construction projects. The products used for the application and the associated costs are provided below. It was assumed that an existing computer would be used to process images, thus the price total reflects the purchase of the digital image tools only.

Table 1

Software Tools

Product	Purpose	Cost
Kodak Digital Science 40 Camera	Capturing Images	$800
PhotoEnhancer Software	Transferring images to a computer	(included w/camera)
Computer with 133mhz processor	View and use images	(existing)
QuickSolve Image Database	Manage images	$600
Iomega Zip Drive (storage)	Share / Archive Images	$200
Netscape Software	Add images to Web pages	(existing)
PowerPoint Presentation software	Present images at meetings	(existing)
	Total	$**1600**

The above tools were used to capture and manage sample images. These images were then used for a number of practical purposes including:

1. Capturing images from a site investigation and cataloging in a database,
2. Superimposing images of an architectural model onto images of a prospective site,
3. Viewing images on a high-resolution screen to analyze site conditions in detail,
4. Including images on a sample project specific web page, and
5. Presenting a project proposal with images in a PowerPoint presentation

Results

The tools selected for this application were very easy to use and readily available. Images were most clearly viewable on a computer monitor, and printed on a laser printer. Images were also very easily added to project reports, PowerPoint presentations, and web pages for dissemination to project players. Figures 3-6 illustrate several photos taken with the Kodak DC40 Camera and a variety of architectural and construction applications.

Figure 3. Progress image of the Henry Art Gallery Expansion at the University of Washington Campus, Seattle, WA.

Figure 4. Close-up images of building details can be placed on Internet sites and viewed instantly by project players in remote locations.

Figure 5a. Before-Site analysis image of a prospective building location.

Figure 5b. After-Image of architectural model combined with image of prospective site to assess impact of project on setting.

Figure 6. Images taken from neighboring buildings at regular intervals provide an excellent record of project progress.

The image database allowed large numbers of images to be stored, sorted and retrieved effectively by using key words and captions created by the users. The Zip drive allowed up to 80 full size and 300 compressed images to be stored on one 100Mb disk, which is essential with a large number of images.

One drawback of this system was that images were recorded in a format that allowed them to be edited or altered. This is considered to potentially make them inadmissible as evidence should they ever be needed to resolve a dispute. Several methods are available however, to store images in a format in which they can not be changed. These include writing the images to a compact disc (physically burns image onto disk), and proprietary systems (Lynx) that prohibit alteration of images once they are downloaded from a camera.

The training required to learn the tools in this application could easily be accomplished in a day. It was estimated that a project engineer on site would require approximately 1 hour per day to annotate and archive 25 images taken on a daily project walk-through. This time would be added to the time needed to complete daily project logs and progress reports.

Lessons Learned

The following practical lessons learned through the trial application and case studies are provided as a practical guide for setting up and implementing a basic digital image photography system.

Capturing Images

Most affordable cameras ($350-$1000) provide sufficient image resolution and depth for most applications needed. In short, they are most suited for capturing *large quantities of medium-high quality images*. High quality photos for marketing presentations and brochures are more affordable with traditional photography. However digital images can be easily incorporated into multimedia presentations for rapid generation of proposals. Highly desirable features to look for in a camera are (1) the ability to store at least 50 images, to minimize the need to download images, (2) easy-to-use cross platform software to perform the transfer of images to a computer, and (3) an adjustable zoom lens.

Storing Images

One of the most significant issues to resolve is how to store the large number of images that accumulate. The most economical choice for users of digital photography are removable disk e.g. Iomega Zip (100Mb) or Jazz (1Gb) drives. These new systems offer speedy access and can also provide a means to exchange images between parties. It is also possible to compress images from their original size (1000K) to much smaller (26K) sizes. Several file formats are available on most machines, however JPEG and GIFF images are generally recommended. If it is necessary to store images in an unalterable format, a CD ROM writer may be used to save images. Commercial software packages are also available to compress and save images so that they can not be altered.

Managing Images

There are several digital image databases on the market, all fairly new and unproven. The most established, QuickSolve, was developed in conjunction with Kodak and provides a fairly affective tool to store images and a variety of other documents such as presentations, text files etc, along with up to 50 fields of detailed information about each document. Other, less expensive programs provide photo-album type image managers with far fewer programmable database features.

Sharing Images

While a wide variety of techniques were found to share images, only three are practical and reliable. The first, over a network has the disadvantage of requiring an infrastructure of network cables and software. The second, via removable disks has the advantage of being fairly simple and inexpensive. It is clear, however that the most versatile method for people in remote locations to share and view common images is through web sites and the Internet. At least one advanced system (Lynx) is currently available to help manage and share secure images of construction projects. While it is relatively expensive, many owners are currently using it to document project progress and resolve conflicts that occur in the field.

In summary, the products used in the trial application were easy to work with, and produced useful results. The cost of the necessary tools ($1600) was also found to be well within the range of typical expenditures on photographic services for a single project ($914 - $5000). The advantages of easily accessible site analysis photos to architects combined with the simplicity of combining images with design information make this technology of great interest to the architecture profession. Documenting large numbers of progress photos also proved to be quite feasible and attractive to construction contractors.

Conclusions and Recommendations

The goal of this study was to assess the feasibility, and best applications for using digital photography in the building design and construction process. It is evident that the graphical nature of communication in the design and construction process can be immediately enhanced by the capability to capture and exchange images of site conditions and work progress. By evaluating existing use and expenditures for photographic services, as well as the affordability of digital cameras, it was found that most medium to large firms could easily begin replacing traditional photographic services for site analysis and project documentation with digital photography. This initial change would allow the advanced features of this technology to be explored, largely driven by client needs and marketing initiatives.

Renovation projects, above all, have the highest need for photographic records for both architecture and construction firms. For the most part however, the need for photos is driven by two factors: project location and potential litigation, regardless of project type or contract arrangement.

It is feasible and in most cases cost effective for architecture and construction firms to begin using digital image technology. In many cases, the benefits are already being experienced by firms who have purchased digital cameras and begun using them on site. One important trend to note is that more owners are beginning to expect high quality and timely progress reporting provided by digital image photography. Eventually this service will be required of architects and contractors, and should therefore be offered during marketing proposals.

Three factors will continue to encourage architecture and construction firms to use digital photography. First, specific needs and requests of clients to provide digital photography services on a project will increase. Second, digital image photography can replace traditional photographic services at some savings and in many cases, with improved management and versatility of images. Third, digital image technology improves the communication of site conditions and work-in-progress between design and construction firms.

A recommended strategy to encourage experimentation with this technology is to replace existing use of traditional photography for site analysis and project documentation with digital photography. In time, as the need arises, the use of the technology can be expanded to some of the more advanced functions discussed above

Future Research

It is evident that the use of digital photography will continue to grow in the building industry. As a result, more avenues to take advantage of this technology will surface. Questions being asked by architects and contractors are not whether or not to use this technology, but how to best put it to use to improve design and construction processes. In response to this question, further case studies will be performed to determine how the ability to share current images of the site and construction progress can be used to and improve project communication and the productivity of designers and project managers.

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Intranet Internet Applications for the Construction Industry

Neil D. Opfer
University of Nevada, Las Vegas
Las Vegas, Nevada

Intranets offer contractors a method to manage construction project information more effectively and efficiently utilizing low-cost hardware and software. The current infrastructure of the Internet can provide the backbone for these project Intranets. Intranets can improve project communications, save personnel time, and reduce paper requirements. Security requirements, Intranet structure, content updates, and various disadvantages must be given due consideration by contractors

Key Words: Cost benefits, construction applications, consultants, hardware, information, Internet, intranet, security, software, and transaction costs.

Introduction

There has been a significant amount of coverage in the media about the Internet and the so-called "Information Superhighway." To be sure, the popularity of the Internet is an important trend. It is one that many businesses including those from the construction industry are racing to use as a technique for marketing from business to consumer. One large homebuilder has a prototype Internet site where prospective purchasers can view subdivisions, model house plans within subdivisions, and further look at pictures of a typical room by further searches (Pulte, 1996). Overlooked by many contractors in this frenzy is the potential for inside business or Intranets utilizing the Internet as a communications backbone. The construction industry can realize that there will typically be much more impact through this Intranet model on improving the business operations of construction organizations. Construction organizations are typically conservative and have been amongst the latter adopters of new technologies such as computer and information technology. The revolution in computer technology with processing power, memory, disk capacity, and constantly-lower costs that all continue to improve seemingly without any scientific limits means both practicality and affordability for the typical construction organization. When it comes to the Internet, the popular press has focused on such issues as security and personal abuse which perhaps is an immediate impediment to construction organizations in adopting these intranet tools. The goal of this paper is cover applications along with the practicality of the technology, cost savings, hardware issues, software issues, and security topics. Progressive construction organizations that have adopted Intranet strategies have achieved significant benefits. There are no lengthy histories of successful implementations, of course, since the enabling features such as commonly available high data transmission rate hardware and software ease-of-use are such recent innovations. While contractors are not information technology wizards, they don't have to be to successfully implement Intranets for construction project sites.

Intranet Definition

Those familiar with computers and networks are conversant with the idea of client-server architecture. The client-server model serves as a starting point in that Intranets are a client-server platform with universal clients, servers, and protocols. The client is universal and browsers can access all servers. The same face, in essence, is presented to the world and the universal client browser can talk to all applications.

The importance of the Intranet concept is perhaps best illustrated by some brief history of personal computer applications. Ten years ago, documents from personal computers were stand-alone documents. Therefore, if one wanted to have a spreadsheet attached to a word processing document they utilized a stapler to attach the two documents together. Five years ago, OLE (object linking and embedding) technology began to enable compound documents. Therefore a spreadsheet could be embedded in a word processing document. The linking feature meant that when information in the spreadsheet changed, these changes flowed automatically to the word processing document as well. These compound documents with their varying content types point the way for the power of the Intranet. The typical construction organization has a vast array of information including documents plus images that make up their files for any given construction project. As an example, a given estimate work package line item finds representation in schedules, cost reports, and purchase orders. This data is locked in desks, file cabinets, and heads of employees. The contractor's data must be accessed by employees in far-flung locations, subcontractors, and suppliers. Intranets are basically taking Internet standards and bringing them down to firm standards.

These documents can't be considered as independent entities but instead as a single unit and therefore changes or updates to one item should update everything else in tandem. Certain construction projects are developed on a fast-track basis in that portions of the project are under construction while design is still underway or is not yet started on other project elements. The benefit of the fast-track process is a shorter cycle time for the client in terms of project delivery. The inherent fast-track problem is, due to poor communications, re-work and scrap costs can significantly reduce savings. Improved construction site-fabricator-designer communications through the Intranet can produce substantial benefits. Two large design-constructors were separately commissioned by a chemical company to construct two plants both on a fast-track basis. Plant A was for $60 million and Plant B was for $150 million. Plant A was built by a firm with Intranet communications links between the design-construction-fabrication entities. Plant A ended up with $30,000 in leftover/scrap material whereas Plant B ended up with $1.2 million in leftover/scrap material (Marquardt, 1995). The cost savings accrued from faster and more accurate communications in these situations through Intranets by avoiding materials procurement mistakes.

Intranet Cost Rationale

Construction organizations are almost by definition, paper-based organizations. Field construction people must translate lines on drawings and words in specifications into the reality of a constructed project. To accomplish this, other paper in the form of estimates, shop drawings, sketches, memos, purchase orders, punch lists, meeting minutes, and other data are in part the tools of this process. The cost on a manual basis to locate this information or repair mistakes due to ignorance of already-available information can be staggering. One construction firm surveyed its project managers and found 15% of their workday was spent on searching for information (Bronken, 1996).

What makes the Intranet so compelling from a cost standpoint is that:

- Intranets are easy to deploy in that web browsers (software programs that enables system use) are easily distributed
- Web browsers are easy to utilize requiring no real training
- Low or no acquisition cost for web browsers
- Inexpensive data connection transmission rates

Consider a construction organization with 25 cellular phones and an annual cell phone bill of $50,000 or more. If effective Intranets through enabling systems such as e-mail can reduce this cellular messaging traffic by 50%, the cost savings are important. Similarly, what are the actual transaction costs to process a change order or a purchase order through an organization? One contractor tracked the costs of purchase orders from inception and found the paperwork costs to average slightly over $100 per purchase order (Barton, 1996). Intranet implementation reduced the cost per purchase order to less than $1.

This cost per purchase order can be multiplied by the number of P.O.'s on a typical project to extrapolate the potential savings from just this one item. The cost of passing paper around a construction company is one of those hidden costs that tend to become absorbed in general overhead. Even though these transaction costs may not show up in executive reports, they are still real costs.

Intranets provide a strategic weapon for contractors. What is the time value of information to the project? Intranets help contractors manage things more efficiently and effectively. Intranets enable contractors to manage information and access information in an easier fashion. They can improve the quality and reduce the costs of the contractor's internal infrastructure.

IDC Corp. in a survey of corporations that adopted intranets found that the return on investment was 1000% that meant the payback period for this tool was less than one quarter (IDC, 1996). Thus the actual cost to develop and deploy these Intranet solutions is very low.

Hardware Considerations

Software is one part of the Intranet with hardware, of course, being the other half. Some contractors considering Intranets may feel that these applications are only for larger contractors. However, many hardware vendors are making available web platform servers that are implemented in relatively inexpensive and uncomplicated manner. One firm has what they term a "shrink-wrapped Internet server" that they claim can be set up in an hour on site (Morris, 14). An important consideration in hardware selection is that of availability and reliability. A contractor can not have project business stop because the server site is out of commission. Security considerations from both a hardware and software perspective are essential.

Hardware configuration is important in the sense that an Intranet differs from many typical web sites. The standard web site is a relatively static site and essentially only displays information. Construction projects comprise substantial amounts of data and personnel need to search through large amounts of data to be productive. Data base mining takes a large amount of central processing unit (CPU) power as can be attested to by those familiar with data base and spreadsheet applications. A 150 megahertz-plus Pentium Pro box (or equal) with 24-32 megabytes of random-access memory and a hard drive sufficient to contain the project data should suffice for most contractor intranets. These Intranets are random-access memory-intensive applications. Given the cost-tradeoff choice between faster processor speed above the 150 megahertz threshold or more random-access memory, the decision should be for more memory. A Fortune 500 firm web site requires the power inherent in 64-bit specialty servers since they may receive 100,000 to 1,000,000 hits per day. These large web sites need significant computing capacity to deliver information to people simultaneously. A construction Intranet would never generate this amount of traffic volume therefore computing capacity requirements are not nearly as severe.

Higher-level personnel such as a project manager or operations manager obviously need to access more than one project. If a set of projects outgrows the capacity of one box, other boxes can be added on a low-cost basis to take care of this. This is transparent to the user. They tie into the intranet site and choose a search path for a certain project and they may be switched to another box. As projects are completed, space on servers can be freed up for additional projects with the outdated project's files saved in an archival state.

Client Relations

Intranets not only provide direct benefits to the contractor but subsidiary benefits to client relations. Intranets level the playing field enabling a small and medium-sized contractors to have the same high-tech profile as larger contractors. This can improve client satisfaction with the benefit of possible repeat projects. Currently, contractors utilizing Intranets to help keep clients and their resident project staffs informed can project a more progressive image than most of the competition. Client questions can often consume project staff time better devoted to more productive project issues. The project Intranet allows the client to access this information and reduces the burden of this task on the contractor's personnel. Thus an Intranet can be both an information tool and a marketing tool.

The decision-making process for a client selecting a contractor is a complicated process and can be an emotional one. Clients using an Intranet connection to get immediate answers to their questions can tend to have a more favorable view of the particular contractor. There also tend to be barriers created between contractor and client which Intranets can assist in overcoming.

A non-construction example of better client relations is Federal Express or FedEx. FedEx has placed a front-end on its databases that enables customers to track their packages around the world, day and night, every step of the way. This customer Intranet gets information to FedEx customers in a secure way while providing a means of differentiation and competitive advantage for FedEx (Gerstner, 1995).

Consultants

There are also a number of consulting organizations which for a nominal fee will assist in setting up Intranets and initial programming for contractors. Ultimately, the goal is to have a system that requires no consultants and can be updated by the contractor's employees. The best way to evaluate a consultant is to have an actual demonstration of what they have done for other companies. If the contractor has the necessary computer expertise in-house, consultants may not be necessary. However, this is usually the exception rather than the rule. What consultants bring to the table is expertise gained from the installation of many systems plus special expertise in areas such as Intranet security. Security protections, as detailed in due course, can not be ignored in Intranet implementation. Creating a sound Intranet means a strong focus on content. The consultant can help assist in this content creation process.

A caveat with consultants is that they have to be educated to the construction project model. Many consultants have substantial business experience but not with construction organizations. In order for the Intranet to deliver value to construction project personnel, consultants must be educated as to what are the information requirements. To achieve full value, the Intranet site must be seen as a valuable tool and a comprehensive information source by project users. Contractors and consultants need to collaborate on a content perspective from the project user viewpoint rather than how the contractor may be organized internally.

Contractor Intranet Possibilities

Already discussed have been certain applications for the contractor's project Intranet. Essentially all information about a project can be posted to a project Intranet with proper password protections. Any item on a project that involves paper can be converted to use on an Intranet. Items such as safety plans, project schedules, field change orders, and project meeting minutes can all have an Intranet presence. Tool box safety talks are required by contractors and these safety contacts are mandated by law in some states. A carpenter supervisor starting a scaffolding project could with a web browser set the search engine to find the talk on scaffolding safety for the crew. This example of a carpenter supervisor utilizing a web browser on a computer may seem unrealistic. However, if user-friendly Intranet design is implemented with understandable point-and-click interfaces along with adequate training this concept is possible. Similarly, a superintendent remembers that about two months ago, there was some discussion on curtain walls for the project. Utilizing the browser and a key word search through the search engine, the superintendent could easily find the reference information related to curtain walls.

Other information contractors should consider postings to an Intranet include the company personnel policy manual, safety manual, benefits information, and general company information. Methods' improvements or a problem solution with a concrete forming system can be quickly sent company-wide. When a contractor gets new projects or other newsworthy events occur, employees generally want to know this information. A contractor's Intranet makes this possible in a very low cost fashion. Newsletters can be costly to produce, become outdated, or lost by employees. Intranet information can be posted, readily available, and continually updated. One of the management trends is to make employees feel they are a part of the company. Intranets, through providing relevant information, can foster this.

Training is a key issue in the construction industry. Particularly problematic is employees working at remote locations. A contractor Intranet can provide for on-line training. Project personnel can share various ideas on issues they encounter on projects which is another training methodology. Intranets can make experience easier to learn, to use, and to maintain.

Disadvantages

There are certain potential and real disadvantages to the use of Intranets. In general it is a sound concept but there is still a requirement for improvements. One area is in terms of web authoring tools that allow non-programmers to be able to create applications without programming. A project engineer may want to create a hyperlinks to related information such as costs and schedules. The lack of practical web authoring software is one of the most critical factors in the enhancement and advancement of Intranets (Machrone, 1996). Continuing advances in web-page authoring software are making it easier for non-programmers. Code-based web tools are giving way to graphics-based editors much as the way graphical user interfaces have done in other software areas (Mendelson, 1997).

Intranets also need constant updating. Intranets are about information and for that information to be useful, it must be kept current on a continual basis. How often should a project Intranet be updated is one question asked by contractors. The answer is that updating should occur when new information becomes available. Those contractors who decide to update a project Intranet like their network schedules on a once a month basis will not derive the advantages that this tool can offer. A contractor can not realistically expect someone who has a full-time job doing something else to manage this because it will not happen. Either one of the jobs or the other will suffer from time constraints. It could certainly be part-time such as a quarter-time allocation but the contractor has to book this time into the person's job. Maintenance of project Intranet databases just as with project schedules currently requires a significant time commitment by the contractor.

The advent of powerful browsers allows information viewing in a very user-friendly way. What is needed is a way to update and create content in a very user-friendly way. Intranets are not the whole solution. Those contractors employing various groupware software packages in proprietary client-server configurations should still retain it but attempt to retarget it to the Intranet. Groupware applications that strongly support Intranets still require further development (Mitchell, 1996).

To achieve full cost and time advantages with the Intranet tool, there should be an avoidance of dual information streams, paper and electronic. Even signatures can be captured electronically for such items as authorizations and change orders. Having a separate paper-based system concurrent with the electronic system will only partially realize the true benefits. Contractors in a paper-based world usually never have to worry about document editing. A document in two-column format has to move to one-column format for obvious scrolling reasons. Documents on paper can look different on a computer screen. This may require a simple change such as with a color palette selection due to monitor viewing problems or a more substantial change.

All information about a project may not be suitable for a project Intranet. Drawings constitute a significant amount of project information yet data transmission rates for this type of graphic information may not be practicable for Intranet application. Even with transmission rate improvements through faster modems, the viewing an “E-size” (thirty-six inches by forty-eight inches) drawing on the typical computer screen is difficult. A $2 million project may be comprised of twenty primary drawings. Often project personnel view these drawings together such as referencing a section view from one sheet to a general arrangements floor plan on another sheet. Scrolling between these drawings on a computer screen may not make sense. Therefore, certain documents such as large format plans should probably remain in hard copy form at present. Small drawings such as “A-size” (eight-and-one-half inches by eleven inches) shop drawings and sketches would be more practical for Intranet posting. Yet graphical information still requires significant downloading time.

Two other problems are transaction processing time due to translation and fidelity loss. Moving information between different-branded like applications requires translations that slow Intranet traffic down. Moreover there can be a loss of fidelity meaning that gibberish will show up at times in these translated documents. The loss of speed and/or the loss of fidelity hampers effective Intranet application. At present there is movement towards open standards that can be supported seamlessly over Intranets but problems still remain. Construction project personnel need to have the ability to share all data seamlessly rather than having “islands of data” that currently comprise most projects.

Some training is necessary for project personnel to show them how to find project information on the Intranet. With intelligent search engines available through web browsers, trained Intranet users can delegate information gathering tasks to these tools. However, users have to know and understand the applicability of these tools. Additionally, information posted to a project Intranet must be reliable. Information is only as valuable as it is reliable. Bad information follows the old cliché of “garbage-in, garbage-out.”

There has been a great deal of attention regarding the advent of network computers (Gerstner, 1995). These are essentially the reincarnation of “dumb terminals” that used to be for access to mainframes and mini-computers. The argument for network computers is that with Intranets, it doesn’t matter to users where processing, storage, data movement, and other factors take place whether on the network or in their own computer. The supposed benefit with network computers is that acquisition, use, and updating costs will be less than with personal computers. Contractors considering the utilization of network computers need to be skeptical of true cost savings given constantly lower prices for personal computers. One key factor that has led to the widespread acceptance of personal computers is their ready availability to individuals in various locations.

Intranets should be viewed as a supplement to rather than a substitute for personal computers in field and office locations.

A final potential disadvantage to Intranets is that construction is essentially a people business. In addition, contractor personnel need to get out on sites and personally view the work activity. Reported data by the time it becomes compiled tends to be filtered in sometimes unintended ways. Some contractor personnel tend to try to manage projects by remote control and avoid interaction with the work actually taking place. It is hoped that Intranets will not be a crutch to promote these remote control management styles. Instead, the potential of Intranets should enable project personnel to avoid being buried in paper and spend more time interacting with project activities.

Personnel Abuse

Contractors may be reticent to distribute web browsers and adopt Intranets because of the stories about employees abusing the Internet for web surfing and other time-wasting activity. Certainly there is the potential for employee abuse. Despite the best controls, it will still occur with Intranets. Any tool can be abused by employees from copiers to computers with a golf software game to company pickup trucks. Because employees abuse these items doesn't mean that a contractor eliminates them. The advantages and time savings of Intranets are so powerful that even if some abuse occurs, the contractor will still realize important savings. Contractors do not eliminate copy machines simply because they might be used by employees for personal business.

Security

Security is a very common concern about the Internet and thus it follows that Intranets create the same concern. A number of true and dramatization-type stories have been publicized by the media about the potential for abuse (Brancato, 1995, Shimomura, 1996). No one wants unauthorized individuals accessing sensitive data. The typical construction project creates additional cautions. Due to the fragmented nature of a typical project, a number of subcontractors and suppliers are participants. They need access to at least a portion of the project database. Security concerns can not be minimized with Intranets. Security systems with firewalls that prohibit unauthorized entry are essential. Firewall software has been more prevalent for larger web sites. Lower-cost firewall packages costing a few thousand dollars make this solution practical for contractors. The Internet was developed to make communications easy and not with security considerations a concern. If someone gains unauthorized access, what information is available? Due to the proliferation of paper at a job site with little or no security, there is some exaggeration of security problems with an Intranet. Sensitive project information should be kept off of the project Intranet.

One potential scenario is to create a commonly available web site about a project. The commonly available information might entail project owner, designers, and contractors along with general project information such as general floor plan, square footage's, completion time frame, along with features including covered parking, fountains, and finishes. These files would be read-onlyuploadable to prevent hackers from altering the project information. A web server could be set up for all of the projects that a developer or general contractor has in progress. A developer with completed projects still needing leasing tenants or having upcoming vacancies could also place these on the web server along with lease rates. Onto this web server that is actually Internet available could also be a guest log. Those desiring more specific information on lease areas can sign the guest log for further follow-up by the marketing segment of the developer's organization.

A separate web server would be set up for sensitive information on various projects. Access to this web server would be password restricted with various levels of access depending on password. A contractor's project engineer could function as the "web master" who would be in charge of all documents for the project. Commonly available information such as project meeting minutes and project schedule would be available at the lowest password level. To get to certain areas such as unit costs might be restricted only to the superintendent-project manager level.

Password encryption programs commercially available at low cost mean that Intranets can be protected easily. These encryption keys mean that due to their length, even the world's best intelligence agencies with supercomputers could not gain access by cracking the encryption code in anything resembling a timely fashion.

Security threats to Intranets come essentially in three forms:

- unauthorized access to Intranet transactions
- unauthorized access by outside hackers to the Intranet server
- unauthorized access by inside hackers to the Intranet server

The Federal Bureau of Investigation (FBI) has stated that 80% of unauthorized access cases are from inside hackers that are overstepping their bounds or using their access privileges illegally (Summers, 1996). There are a number of architectures to choose from in configuring a system. Users from web browsers travel over the Internet to the project Intranet. Before they can get into the web server and Intranet they must pass through filtering router and firewall security software (refer to Figure 1). These systems check for user authentication before allowing access to the system. The primary concern in security is user authentication. Is the person who they say they are to allow access at the particular Intranet desired level? Security concerns raised by firms have meant that software authentication tools are available with most widely available web browsers on the market. Between hardware and software, a project Intranet can keep out even determined hackers. Suffice to say that Intranet security solutions at relatively low cost are available. Monitoring software can also point to unauthorized cases of access.

Another sensitive security concern for contractors should not be outside hackers or inside hackers trying to subvert an Intranet but instead what happens inside the contractor's organization. A mistake by a clerical staffer for the business development manager could result in a document such as a client lead list or strategic marketing plan being sent out for anyone to view on the network.

The issue of security is somewhat of a non-starter in many cases. Most information on an Intranet came off a piece of paper or is easily converted to a piece of paper. Virtually all contractors have facsimile machines in their offices. A fax machine can transmit all project information to anyone. Copiers can reproduce information just as well and be carried out by employees. The same example could be used with people who will give their credit card number to a perfect stranger over the phone but avoid electronic commerce on the Internet. What happens to a contractor when an estimator quits and takes cost data out the door? The only caveat with an Intranet is that the transmission of information is made much easier.

Impetus for Implementing Intranets

Construction organizations as aforementioned are traditionally slow adopters of new technology. There are many examples of new technology common to the construction project such as lasers, hydraulic cranes, and improved materials. The important key to these technologies is that they came from vendors developing products to sell into the industry in more of a "supply-push" function. This technology adoption did not typically result in a "demand-pull" function from contractors. Lasers, as an example, took a number of years before they became a common sight on construction projects.

The cost savings from Intranet application are obvious. Like many innovations, conservative contractors tend to be suspicious of promised benefits. The slow adoption of critical path method scheduling techniques was only accelerated by owners making this a requirement of their specifications. A demand by increasingly sophisticated owners for more project information may lead to project specifications requiring that a project be displayed on its own Intranet. Some far-sighted owners have required contractors to implement document-tracking contract administration software on certain projects (Kern, 1987) and the next step up would be a project Intranet.

Construction program graduates schooled in Intranet techniques can provide an internal impetus for implementation of these systems (Walsh, 1996). In part contractors have adopted computerized cost estimating and other systems due to the fact that college-educated construction graduates were familiar with these tools.

The project cycle in construction is constant based on the familiar steps of planning, organizing, staffing, directing, and controlling (Barrie, Paulson, 1992). The essential element in every step is internal information and external information. Internal information integrated with external information. The growing merger of computers and communications capabilities affords direct access to construction personnel who heretofore depended on chains of human intermediaries.

Summary

Continual decreases in the price of communications and personal computers with very high speed data transmission rates combined with decentralized construction operations make Intranets a sound solution for the construction industry. Work flow on a construction project not only depends on tools, personnel, and materials but information. Intranets allow contractors to break down the barriers between itself, clients, vendors, and subcontractors. Construction projects are a team effort. With Intranets providing all information in an readily-viewable form, cross-firm collaboration is fostered on the project. The return on investment from Intranets makes it one of the soundest investments that contractors can make in today's competitive marketplace.

Contractors avoiding Intranets should consider the debate about telephones back in 1915. In 1915 many saw the telephone as just a gadget or toy with no practical value. The telephone is obviously an important communications tool and so too with Intranets. The computer revolution was supposed to usher in the era of the paperless office. Thus far it has not happened in construction due to the many separate systems controlled by project participants. Intranets offer a solution to help reduce the paperwork burden inherent in construction projects. Project personnel can then use their time where it has the most value.

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Development of the Job Order Contracting (JOC) Process for the 21st Century

Dean T. Kashiwagi and Ziad Al Sharmani
Arizona State University
Tempe, Arizona

This research describes the concept of "Job Order Contracting" (JOC). It defines the "theoretical" advantages and disadvantages of the JOC (also known as "Delivery Order Contract" (DOC) and "SABER"). The article introduces the Center for Job Order Contracting Excellence (CJE) and the first documented performance of JOCs. The article also introduces the use of Performance Based Procurement System (PBPS) to set a "minimum performance" requirement and improving the performance of the JOC process.

Key Words: Job Order Contract, Delivery Order Contract, Indefinite Delivery Indefinite Quantity (IDIQ) Contract, Performance Based Procurement System (PBPS)

Introduction

With the competitive worldwide marketplace forcing facility owners to minimize operation and maintenance costs, many facility owners are moving to modular construction to reduce the need for complex engineering design. The renovation of existing facilities has become a viable option for facility owners. "At present, almost half of the money spent on building construction in the US is spent on renovations, additions, or replacements of major systems in existing buildings ($55 billion). Over the past 15 years, renovation spending has increased an average of almost 7 percent per year and only declined one year (1991)." (1) The traditional specification, design, and low bid award delivery system for minor construction or facility modification has the following deficiencies:

1. Specifications and drawings are compiled by designers who often do not have the best construction experience.
2. The delivery system is a time consuming process requiring time for each step of the process: design (three months), advertisement (three weeks), bidding, award (three weeks), and mobilization (three weeks).
3. The competitive low-bid award system motivates contractors to do minimal quality work that meets the minimal requirements of the specifications.
4. Lack of motivation for the contractor to increase performance, training, or safety.
5. Contractors are not rewarded for high performance construction.

Facility owners who are trying to keep up with changing operations requirements and operation line optimization may wait for six months for facility modifications with the current specification, design, low-bid award procurement process. Thousands of dollars could be saved by delivering construction modifications sooner. The Job Order Contracting (JOC) process is a delivery system that was developed to meet this need.

Facility engineers at the U.S. Military Academy, West Point, realized the disadvantages of the design-bid-build delivery system in the early 1980's. A process that could provide timely construction to meet the facility requirements of an aging facility was needed. They decided to implement an experimental indefinite delivery- indefinite quantity (IDIQ) facility maintenance contract which was first used by the Supreme Headquarters Allied Powers Europe (SHAPE) in Belgium. This new delivery system resembles the just-in-time and partnering contracting delivery system used by the Japanese automobile makers to meet the rapidly changing needs of the worldwide competitive marketplace. By implementing the new delivery system, the facility engineers at West Point managed to accomplish the following:

1. Minimized the response time for facility construction.
2. Reduced the workload on in-house design staff.
3. Enhanced quality control.
4. Lowered the contract administration costs.
5. Reduced construction costs.
6. Reduced the backlog of maintenance and repair.

JOC is used in nearly every US military site in the world. There are over 200 JOCs in place in the public and private sectors, ranging from one to five million dollars of construction per year.

Job Order Contracting Process

A JOC system is based on a competitively bid, indefinite delivery - indefinite quantity (IDIQ) contract between a facility owner and a construction general contractor. The contract predefines basic construction units of work in a unit price book (UPB). This book defines a unit price to be paid for each of the construction line items. Over 40,000 line items are included in the UPB. The JOC on a site usually competes against the in-house construction capability and the traditional design, advertise, and low-bid award delivery system.

A JOC includes the following conditions:

1. Design and construction by the JOC contractor.
2. A minimum and maximum amount of work per year per site.
3. A maximum limit on the size of a job order (usually $300,000 for the federal government).
4. Construction tasks not included in the unit price book may be negotiated.
5. A facility owner may award more work to a performing JOC.
6. A facility owner may exercise "option years" to extend a performing JOC.

A JOC is awarded on a low-bid, competitive award basis. The facility owner uses a UPB to identify a cost of doing business. To bid on a JOC, contractors will do the following:

1. Estimate what types of construction work will be required at the site during the year.
2. Using the UPB unit prices, estimate the facility owner's cost of construction.
3. Estimate the contractor's cost of construction. The difference between the facility owner's cost based on the UPB and the contractor's cost is represented as a coefficient which is used as a multiplier that covers the contractor's overhead and profit as well as any adjustment between the UPB and the local prices. The coefficient is then submitted as the bid submittal price.
4. Submit the bid.

The JOC is usually awarded on a "low-bid" basis. As soon as the contract is awarded, the JOC contractor mobilizes and establishes a site office adjacent to the facility management staff. The JOC contractor's representative becomes a member of the facility management staff. When a facility owner or user has a construction requirement the contractor's representative arranges for a site visit and prepares a simplified design and preliminary cost estimate. After design approval, the contractor and the facility manager establish a detailed cost estimate using the UPB. By using estimating software that computerizes the UPB data, the estimating process is completed quickly. After approval, a job order is issued and the contractor begins construction.

Theoretical Advantages of JOC

Major theoretical advantages of the JOC process over the traditional design and low-bid award delivery system should include:

1. Higher quality of construction and service due to the partnering and performance incentives.
2. Construction starts approximately 30 days from the identification of construction requirement.
3. The simplified design documents and acquisition process eliminates the need for complicated and repetitive contract documents for similar or standard type construction.
4. In case of unsatisfactory performance, the facility owner can unilaterally decide to stop using the contract once the guaranteed minimum amount is awarded and can use the traditional design/specification process or in-house construction capability.
5. A procurement process that legally allows government entities to raise the level of performance, eliminate redundant "boiler plate" documentation and other procurement functions, and allow contractors to partner with the facility users.

Theoretical Disadvantages of the JOC

The following are the "theoretical" disadvantages or problems with the JOC process:

1. Facility owners were using multiple JOC contractors at a site. The motivation was to force JOC contractors to compete and increase the level of performance. The problem with this philosophy is that JOC requires a minimum mobilization at a site. The "sunk cost" of this mobilization is a win-win situation only if the JOC contractor

is able to do a large volume of work. Multiple contractors with mobilization costs negates the win-win philosophy of the JOC.

2. The awarding of JOCs to low bids motivates low performing contractors to bid low to win bids. These contractors then deliver a low level of performance to attempt to break even. The low-bid award process can negate the advantages of JOC.

Center for Job Order Contracting Excellence (CJE)

In 1994, a group of JOC/SABER/DOC contractors gathered at Arizona State University (ASU) to address the successes, failures, and future of the JOC industry. They were presented with the concepts of industry stability, differentiation by the performance, the shortcomings of the low-bid procurement system, information systems, and the unstable structure of the construction industry. The result of the meeting was the establishment of the Center for Job Order Contracting Excellence (CJE). The objectives of the CJE are to:

1. Collect performance information on Job Order Contractors.
2. Disseminate the performance information to assist facility owners in reducing risk and life cycle costs and to motivate contractors to perform.
3. Research JOC issues and assist the industry in stabilizing and improving its performance.
4. Educate facility owners on the advantage of using the JOC process.
5. Act as an interface between the academic community, the Job Order Contracting industry, and potential clients.
6. Provide owners with a reliable means of performance based evaluation and competitive selection between JOC and more conventional methods.

Job Order Contracting Performance

The CJE has been conducting a yearly JOC performance survey since 1994 in order to:

1. Quantify the JOC contractors' performance.
2. Verify theoretical strengths and weaknesses of the JOC process.
3. Improve the JOC process.

Public agencies have begun to recognize that the increased use of past performance information as an evaluation factor in the contract award process can improve the procurement system's ability to select quality contractors at a better price. The 1996 JOC/SABER/DOC questionnaire consists of 31 questions. Performance criteria were developed by the CJE, facility managers, and ASU researchers. The performance information addresses such factors as customer satisfaction, number of complaints, number of job orders completed on time, and percentage of dissatisfied work. The following JOC contractors (who account for $360 million of construction per year) participated in the 1996 survey:

1. Beneco Enterprises
2. Brown & Root Services Corporation.

3. Centennial Contractors Enterprises, Inc.
4. DEL-JEN, Inc.
5. FKW, Inc.
6. Gracon Corporation.
7. MCC Construction Corporation.

Table 1

Performance Trends of JOC

S. No.	Description	Units	Year 1994	1995	1996
1	Average contract duration.	Years	3.71	3.55	3.95
2	Percentage of delivery orders that the customer is dissatisfied with.	%	13.37	13.8	12.59
3	Average response time for estimate and working drawings.	Days	11.46	15.2	14.46
4	Customer rating of quality of drawings.	(1-10)	5.69	7.89	7.42
5	Average response time for emergency/urgent delivery orders.	Days	4.31	6.11	5.07
6	Average percentage of delivery orders completed on time.	%	75.94	78.35	80.33
7	Average Customer rating of quality of construction	(1-10)	7.32	7.75	8.08
8	Average rating of the professional level of the contractor.	(1-10)	7.05	8.2	8.55
9	Average rating of the housekeeping level of the contractor.	(1-10)	7	7.9	8.16
10	Average rating of the management capability of contractor's on-site personnel.	(1-10)	6.91	7.73	8.08
11	Average rating of the of the contractor's engineering support capabilities.	(1-10)	5.54	7.32	7.44
12	Average rating of the contractor's public relations.	(1-10)	6.92	8.55	8.38
13	Average number of delivery orders JOC handles simultaneously.	#	19.66	15.68	22.96

The 1996 survey results include the following:

1. Number of sites surveyed: 83
2. Number of sites responding: 55 (60%)
3. Number of Contractor’s full time staff on site: 6.84 persons
4. Comparing JOC performance to traditional process:
   - Better than: 75%
   - Same as: 20%
   - Worse than: 5%
5. Percentage of work that facility owner is satisfied with: 87%
6. Response time for routine construction (drawings and cost estimate): 14.5 days
7. Response time for emergency construction (drawings and cost estimate): 5 days
8. Construction completed on time: 80%
9. Customer rating of construction (0-10): 8
10. Professional level of contractor (0-10): 8.6
11. Contractor’s safety performance (0-10): 8.7

The initial survey in 1994 asked three questions not asked in 1996. The results are shown below:

1. JOC is more efficient than previous procurement processes: 93%
2. JOC is more timely than previous procurement processes: 91%
3. JOC is more cost effective than previous methods: 62%

Table 1 is a summary of the 1994/95/96 survey results (Kashiwagi, Anderson and Sharmani). It shows trends in performance of the JOC contractor performance over the last three years.

The above results indicates that JOC is more efficient and effective than traditional construction delivery systems. It shows that the seven contractors surveyed are performing at a high level of performance. The majority of these sites have only one JOC and have a performing contractor. To ensure this level of performance, the "low-bid" award system requires enhancement. Deming states that individuals and entities are constrained by who they are. Deming encourages performing owners to hire the "best" available and then educate and partner with them (Deming, 1985).

Performance Based Procurement of JOC Service

The Performance Based Procurement System (PBPS), was first introduced in 1991 (Kashiwagi, 1991). It uses computer technology, "fuzzy logic," and Information Theory (IT) to transform construction data into performance information. The PBPS model is a modified relative distancing model of the "Displaced Ideal Model" introduced by Zeleny (1985). It mimics the human mind by differentiating between information and non-informational data by using relativity to compare cost and performance at the same time.

For example, Table 2 lists three contractors and three performance criteria. Column A, Rows 1, 2, and 3 represent the contractors bidding on the contract. Column B, Rows 1, 2, and 3 represent the different contractors' coefficient (cost plus profit). Since all the coefficients are exactly the same, there is no differentiation and the selection cannot be made based on price. The price data is therefore non-informational data and is not considered by the model. Columns C and D are the ratings given to the contractors by the survey. The numbers in Row 4 represent a "theoretical best" system performance. This "best" system will now be used as the baseline against which all available system will be compared. Contractors and their proposals are compared relatively to what actually exists, not to what a facility owner perceives is available. Row 5 represents the facility owner's weighting scheme, which is how he/she ranks priorities and needs. Assuming that the facility owner is not planning to do multiple projects at the same time (Column D), for example, the contractor's ability to process multiple delivery orders at the same time is not critical. However, if it is a large facility with rapidly changing facility requirements, that capability becomes important (information). It is important to recognize that, based on the requirement, what is considered as "non-informational data" in one situation may be considered as "information" in another requirement.

Table 2

Sample Calculation Showing Procedure of Relative Distancing Model

	A	B	C	D	E
S. No.	**Options**	**Coefficient**	**Construction Performance**	**Multiple Delivery Order Performance**	**Total Relative Distance**
1	Contractor 1	1.25	10	9.5	0.1
2	Contractor 2	1.25	9.5	8	0.15
3	Contractor 3	1.25	9	9	0.12
4	Best Line	1.25	10	9.5	-
5	Requirement	0.2	0.6	0.2	-

The model uses the performance information obtained from the surveys (Columns C and D), the requirement factor (weight scheme, Row 5), and the relative best distance from each alternatives data point (Rows 1, 2, 3) to the best possible data point (Row 4), to produce a "total relative distance" of each option to the "ideal option" (Column E). The option (contractor, for example) that has the smallest number in Column E is closest to the theoretical best. In the example in Figure 1, the best option is "option 1."

There are two methods to implement the Performance Based Procurement System (PBPS):

1. To award the contract on a one-step, competitive bid process which considers price and performance.
2. To set the level of performance requirement based on documented performance of contractors by using a relative performance.

In implementing the JOC process in 1996, Arizona State University (ASU) decided that method 2 would be the more "acceptable" process to procure a performing DOC to meet the strict state of Arizona procurement laws.

The criteria shown in Table 3 does not include one critical component of the JOC, the site manager performance for the contractors. This data is not available until after the bids are submitted. Using the performance information of the CJE participants (except for the site manager's performance), the PBPS gave the following relative distances for the performing JOCs:

1. Best option relative distance: 0.1075
2. Second best option relative distance: 0.1292
3. Third best option relative distance: 0.2171
4. Fourth best option relative distance: 0.2254
5. Fifth best option relative distance: 0.2480

If 0.2 is used as the maximum possible distance from the best line, only two options would meet the prequalification. The following factors were considered in setting the minimum requirement:

1. The five CJE participants are performing contractors.
2. If the site manager of the fifth best option was a high performer, the distance from the best line would be less (better performance).

Table 3

Weighting scheme used by ASU on the JOC performance criteria.

S. No.	Criteria	N Weights
1	Max. Duration (Base & Option Years)	0.0026
2	Total number of current contracts	0.0360
3	Number of JOC/SABER/DOC on site	0.0067
4	Number of job orders to date	0.0283
5	Cost per job orders to date	0.0221
6	Number of contractor personnel on site	0.0051
7	Dollar / Person	0.0026
8	Efficiency of JOC compared to other methods % Better Than	0.0452
9	Efficiency of JOC compared to other methods % Worse Than	0.0452
10	Customer satisfaction with JOC	0.0488
11	Percentage of delivery orders that the customer is dissatisfied with	0.0463
12	Response time for estimate and working drawings	0.0437
13	Response time for emergency/urgent delivery orders	0.0463
14	Customer rating of quality of drawings	0.0324
15	Percentage of delivery orders completed on time	0.0504
16	Customer rating of quality of construction	0.0488
17	Rating of the professional level of the contractor	0.0427
18	Rating of the housekeeping level of the contractor	0.0437
19	Management capability of contractor's on-site personnel	0.0324
20	Rating of the contractor's engineering support capabilities	0.0298
21	Rating of the contractor's public relations	0.0308
22	Performance level of subcontractors	0.0437
23	Ability to manage multiple subcontractors	0.0452
24	Rating of contractor's ability to handle multiple projects	0.0463
25	Number of delivery orders JOC handles simultaneously	0.0411
26	Contractor's safety performance	0.0411
27	Site Manager	0.0514
28	% Responses for Survey	0.0411

The ASU facility management personnel used 0.24 as the prequalification requirement. The Performance Based Procurement of a performing JOC contractor at ASU will have the following steps:

1. A specification and accompanying UPB is constructed.
2. Contractors bid a price and give previous JOC point of contacts at past or current sites.
3. The performance information is collected on each contractor.
4. Performance lines are constructed, and the PBPS is used to prioritize the contractors using the same weights as shown in Table 3.
5. All contractors who have a "relative distance" away from the best line that is less than .2400 will be qualified to bid on the project.
6. The bid prices of the qualified contractors will then be opened and the lowest qualified bid will be awarded the DOC.

This process ensures that the JOC contractor is a performing contractor of "equal" performance with the other performing contractors and the price is a competitive price of a performing contractor.

Conclusion

The JOC process is a high performance delivery system for facility renovation and minor construction. The process is more efficient and timely. It has not been documented that the JOC process delivers construction at a lower price. High performing JOC contractors combined with the JOC delivery process has provided customer satisfaction, quality construction, and timely delivery. To raise the level of JOC contractor performance, a performance based prequalification can be implemented. The CJE and the PBSRG will continue to monitor the performance of JOC contractors and assist the contractors to continually improve as well as to continue to experiment with implementing the PBPS to raise the level of JOC contractor performance.

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The Development of the Performance Based Procurement System (PBPS)

Dean T. Kashiwagi
Arizona State University
Tempe, Arizona

The Performance-Based Studies Research Group (PBSRG) at the Del E. Webb School of Construction has developed a methodology to reduce facility system life-cycle cost. The methodology reshapes the current construction industry model from a "low-bid" industry, in which facility owners assume that all bidding contractors performs at the same level, into a value added performance-based industry in which facility owners make purchase decisions based on actual contractor/system performance data as well as bid price. The new information-regulated industry changes roles and partnerships between the construction industry and facility owners and facilitates an environment in which performing contractors are rewarded and contractors can continuously improve. The research group is concern with the identification of performance levels in the industrial sector, the design of a performance-based structure for manufacturers and contractors in the commercial sector, and the education of the construction industry. The PBSRG research efforts ($ 1,200K, 1994-present) includes the design and improvement of the Performance-Based Procurement System (PBPS); performance data collection on general, mechanical, and electrical contractors; landscaping and janitorial services; and design services in the public and private commercial sectors.

Key Words: Performance Based Procurement System (PBPS), Design-Build, Displaced Ideal Model, Low-Bid construction delivery system.

Introduction

The Performance-Based Studies Research Group (PBSRG) at the Del E. Webb School of Construction has developed a methodology to reduce facility system life-cycle cost. The methodology reshapes the current construction industry model from a "low-bid" industry, in which facility owners assume that all bidding contractors performs at the same level, into a value added performance-based industry in which facility owners make purchase decisions based on actual contractor/system performance data as well as bid price. The new information-regulated industry changes roles and partnerships between the construction industry and facility owners and facilitates an environment in which performing contractors are rewarded and contractors can continuously improve. The research group is concern with the identification of performance levels in the industrial sector, the design of a performance-based structure for manufacturers and contractors in the commercial sector, and the education of the construction industry. The PBSRG research efforts ($ 1,200K, 1994-present) includes the design and improvement of the Performance-Based Procurement System (PBPS); performance data collection on general, mechanical, and electrical contractors; landscaping and janitorial services; and design services in the public and private commercial sectors.

The Development of the Performance-Based Procurement System

Background

Performance information on roofing systems has been collected and analyzed since 1983 (Kashiwagi, 1991), leading to the following definitions:

1. *Performance* is "the value and level of service provided to meet the requirement of the end user as defined by the end user" (Kashiwagi, 1996a).
2. *Performance information* is "data that assists in differentiating and assigning value to contractors, facility systems or product performance in relation to the end user's requirements" (Kashiwagi, 1996b).
3. *Non-informational data* are numbers or explanations that do not assist in assigning the relative value of performance.

Non-informational data can be found where the following exist:

1. Alternatives (contractors, suppliers, materials) are perceived as "all the same." This is a major assumption of the predominate specification and competitive low-bid award delivery system. When a contract is awarded on price alone, the facility owner assumes that all the bidders will perform at the same level, and the only differentiating factor among the bidders is their price.
2. Environments with a multitude of factors or combination of factors that govern performance. This situation makes it very difficult to identify performance information using the stochastic or probabilistic analysis approach.
3. Environments in which the training of personnel is difficult to justify. It is a need but not a requirement; facility owners would like contractors to train their personnel but are not willing to pay the extra cost for doing so. Thus, skill levels degrade over time, risk is high, and profits are low (all manifestations of the construction industry) (Kashiwagi, 1995a, Spratt, 1996).
4. Proliferation of rules and regulations, specifications, and standards. These tools are an attempt to reduce risk because all the construction options "look the same."
5. Environments in which experts, lawyers, and sales people are found in great numbers. Litigation is a manifestation of confusion and a lack of communication.
6. Environments in which research is difficult to finance, conduct, and implement.

Construction Industry Structure

The construction industry is sectored by two major constraints, competition and performance (Figure 1.). The greater the competition, the lower the price (quadrant I in Figure 1); the greater the performance, the higher the price (quadrant III in Figure 1).

To manage the two constraints, the construction industry has divided into four segments: the low-bid sector (quadrant I); the negotiated bid sector (quadrant III); the performance sector (quadrant II); and an stable sector characterized by low competition and low performance (quadrant IV).

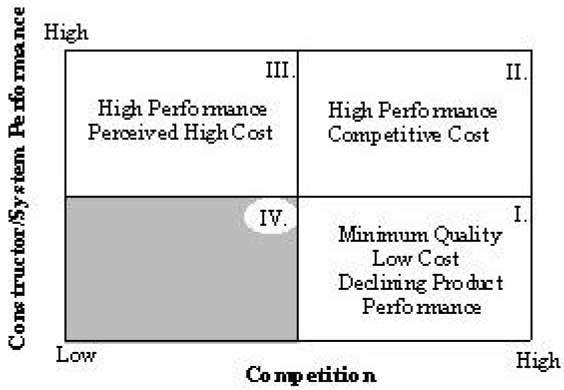

Figure 1. Construction industry structure (Kashiwagi, 1996)

The Low-bid Arena

The low-bid sector (quadrant I in Figure 1) has the following characteristics:

1. Specifications are issued by facility owners and their representatives.
2. Bidders, or "alternatives," are considered "all-the-same." Thus, facility owners cannot give credit to higher performing options.
3. The project is awarded to the lowest price alternative that is perceived to meet the minimum level of the specification.
4. Lack of incentive for contractors to continuously improve and provide higher performing facility systems.
5. The risk of constructed systems not meeting expectations is high due to the emphasis on meeting minimum requirements at the lowest possible cost.
6. A lack of entry/exit barriers, leading to a proliferation of "low cost" contractors, material, product, and services.
7. Marketing (promotion, sales, advertisements) becomes the differentiator. Marketing uses non-informational data that may confuse owners as to the difference between performance and marketing data.
8. The size of the contractor becomes more important than the profit of the contractor (the only differentiator becomes a lower price that is due to high volume). Success is measured in terms of size and not profitability.
9. Work is centered on non-informational data that is generated by the manufacturer's sales and marketing groups. A verification of this concept is the realization that there exists, except for the information collected by the Performance-Based Studies Research Group (PBSRG) at the Del E. Webb School of Construction, no performance information that differentiates the performance of a facility or facility systems by constructors of different skills levels.
10. The amount of regulations, specifications, standards, and data increases but does not differentiate performance.

Standards proliferate in the low-bid arena. Standards usually allow the majority of manufacturers and contractors to operate, resulting in an "all-the-same" environment that encourage minimal performance. When all the participants meet the standard, the standard has no value in differentiating the contractors/systems.

The Negotiated Bid Arena

Facility owners attempt to reduce risk by limiting competition in the negotiated bid sector. Facility owners award projects by "best value" and negotiation. However, the relative worth of the selected alternative is difficult to identify due to a lack of performance information and a lack of competition. The worldwide competitive marketplace's influence to reduce costs may lead to the perception by facility owners that they are paying "too much." Facility managers are pressured to lower costs by using more competition. More competition may bring lower quality. In this arena the following problems exist:

1. How does the facility owner maintain performance but yet get a more competitive price?
2. How does the owner identify a "fair" price for a performing service?
3. How does the facility owner motivate the constructor to continuously improve?

Performance-Based Sector

The performance or information based sector must have all five of the characteristics of a stable industry. The conflict between full and open competition and entry/exit barriers must be overcome. Performance information and the Performance-Based Procurement System (PBPS) fulfill all five requirements. Taking advantage of computer technology to store huge amounts of data and process the data into information by mimicking the human mind, the PBPS and the resulting performance information have increased the level of competition and performance of constructors in the commercial roofing sector of the construction industry. The performance-based sector is defined by the Information Theory (IT) developed at the PBSRG (Kashiwagi, 1996b). The theory includes:

1. A construction manufacturer or contractor is constrained by unique characteristics that limit his/her rate of improvement and information application. No two contractors can perform at the exact same level.
2. Participants must use performance information to maximize continuous improvement. A contractor cannot improve unless he/she first knows what his/her performance is relative to others in the industry.
3. Performance information has to be shared with competitors and end users.

Construction Industry Stability

Porter (1985) and Kashiwagi (1991) define a stable industry as an industry that can continually provide a performing product regardless of demand and is continuously improving the industry performance. The following characteristics are necessary for the creation of a stable industry (Kashiwagi, 1991).

1. Differentiation by performance.
2. A fair profit to participants.
3. Full and open competition.
4. Buyer protection (reduction of risk).
5. Entry/Exit barriers (prequalification and specification).

Factors 3 and 5 are in conflict. The conflict is also seen in Figure 1, as facility managers who limit competition to increase performance are also pressured to increase competition to reduce cost.

1. Construction participants can utilize performance information to:
2. Design company structure and operations.
3. Design strategic plan.
4. Cause continuous improvement.
5. Identify markets of opportunity.
6. Select partners in the value chain to provide performance to the end-users.

Facility managers can use performance information to:

1. Procure the best option.
2. Outsource all facility services and systems while maintaining total control.
3. Reduce facility management requirements (design, inspection, renovation, and maintenance).

Construction Delivery System

The construction industry presently uses three delivery systems, the conventional, the design-build, and performance-based procurement, to deliver its product.

Conventional Delivery System

The most conventional delivery system for construction systems is shown in Figure 2.

Several factors create problems in the conventional delivery process.

1. Lack of communication between facility owner, designer, constructor, and inspector creates an inability for each to understand the other's problems that are due to different perceptions.
2. Lack of incentive to increase performance of the construction process. Current performance incentives have no correlation with relative performance that is usually oriented toward one contractor's performance under "unique conditions," finishing early (relative to some engineer's estimate) or within budget.

3. A secondary inspection (a duplication of the contractor's inspection) is performed by the facility owner's representative after the construction is completed. The representative has less expertise in construction, has no impact on the continuous improvement of the contractor's skill level, and is in an adversarial role. The initial inspection performed by the constructor may lose its effectiveness or not be conducted at all.

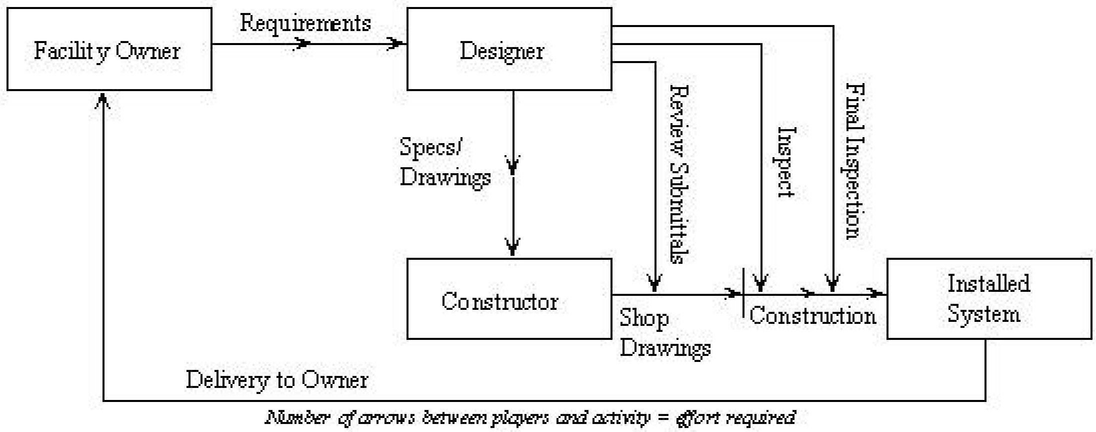

Figure 2. Conventional delivery process

Design-Build Delivery System

A delivery system that is gaining in popularity in the construction industry is the Design-Build process shown in Figure 3.

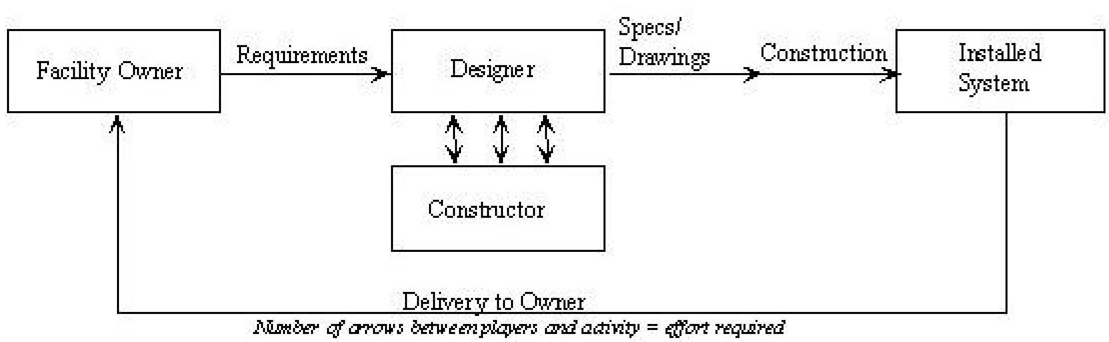

Figure 3. Design-Build model.

Communication problems are reduced in the design-build process because the number of communication links is reduced. Liability, responsibility, and problem solving lie one entity, the design-build constructor. The following questions exist with the design-build delivery system:

1. What is the value of the design-build effort, or exactly what is the quality of the constructed facility system? (This consideration limits trust and communication with the owner.)
2. How does the design-build team determinate the right level of performance and continuous improvement to maximize the facility owner's perception?

Performance-Based Delivery System

The Performance Information structure delivery system identifies the facility owner's perception of performance and matches that perception with the best available contractor and designers (using performance information). The facility owners uses the following types of contractor/designer/ performance information to make his selection:

1. Expertise and experience.
2. Price.
3. Contractor margins, financial stability, and payment of subcontractors.
4. Previous size of jobs.
5. Previous types of jobs.
6. Completion rates on time and below budget.
7. Performance of previously constructed facilities or facility systems.
8. Personnel proposed for construction management.

The facility owner determines the requirement in terms of the relative worth of performance criteria and then uses the performance information to select the constructor and designers that who match the owner's perception of performance. The facility owner becomes a player on the teams of the constructor's, the constructor, and designer. Each party adds information (instead of data) based on their experience. The system is shown in Figure 4.

Performance information brings trust between parties. The more information, the less distrust. It allows all parties to understand who and what all other parties bring to the partnership including positive and negative characteristics. The information system brings about partnerships of facility owners, constructors, and designers with common understandings of the objectives and limitations of the projects. The partnership uses the performance information to select systems, improve construction performance, and determine the price and worth of the construction and design efforts. The number of communications is reduced and tasks are streamlined due to a full understanding and availability of information between partners. The information system helps the design and construction components to continuously improve.

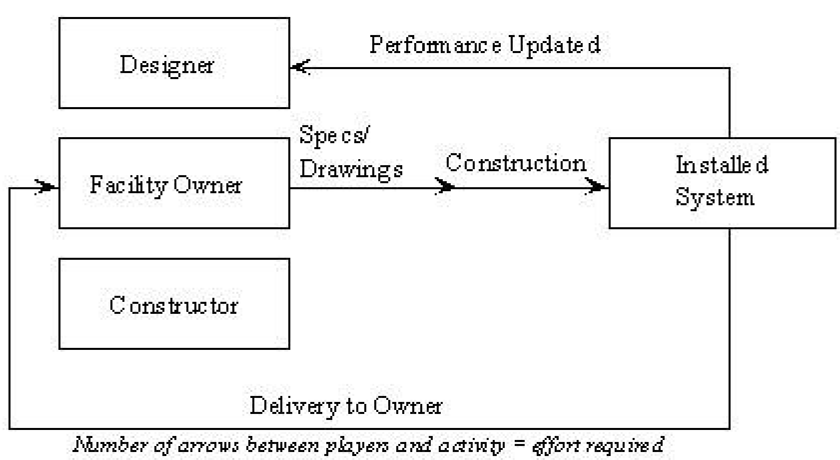

Figure 4. Performance-Based delivery model

Performance Based Procurement System

The Performance Based Procurement System (PBPS) is the centerpiece of the new construction environment. It collects information, it gives relative "worth" of different systems under different conditions, and selects the best performing contractor. The process of the PBPS is shown in Figure 5.

The decision making model is a "modified" relative distancing model of the "Displaced Ideal Model," (Zeleny, 1982) which uses the natural log function to measure information. The model's math was modified by Kashiwagi in 1995 to give more accurate information. The use of the model in the PBPS makes the following assumptions (Kashiwagi, 1996b).

1. All factors are related. There are no factors that do not have an impact on every other factor. Therefore, the problem of dependency is eliminated, and no effort is wasted on determining the impact of dependency or ensuring that the criteria are independent.
2. Everything is relative and every decision maker has a different perception of performance.
3. Performance is defined by available options as well as end user requirements. These two are dependent. All models that separate the two do not meet the requirements of a performance-based decision making tool in the procurement of construction systems (such as Analytic Hierarchy Process, also known as AHP).
4. The decision maker defines the performance requirement in his/her own terms. The model must be able to easily match the facility owner's prioritization with relative choices.

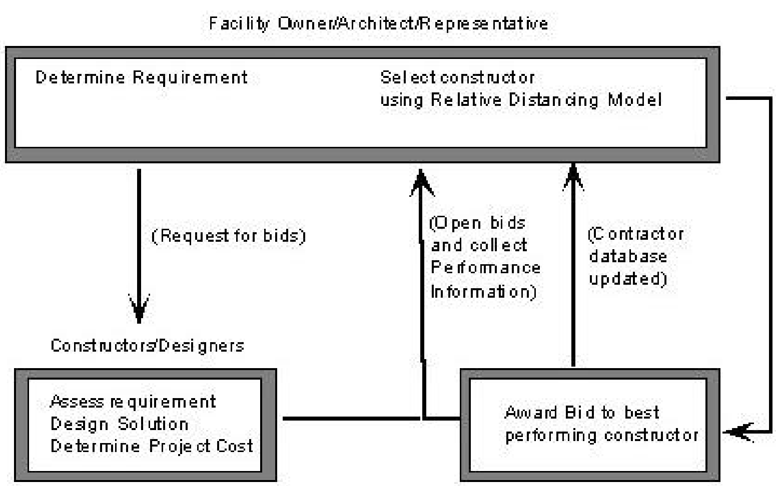

Figure 5. Performance-Based procurement process.

All information exists (Kashiwagi, 1996a). The problem in acquiring the information is the ability to perceive the information. The PBPS provides a tool for individuals to collect and analyze performance information to make intelligent decisions. Facility owners, including Motorola, Honeywell, IBM, McDonnell Douglas, Phelps Dodge, the State of Wyoming, the USA Army Medical Command, and the Fresno Unified School District, have participated in refining the PBPS. The Federal Aviation Administration Western Region will be the first United States

Federal Agency to implement the PBPS in the regular contracting format. They will be the first entity (public or private) to use the system to select a general contractor on complex construction projects.

Requirements of the Performance-Based Information Environment

The following are requirements of the information requirement:

1. The technology to process data into information. The technology must have the capability to handle a changing database without requiring redesign of the technology. This eliminates systems that have a set order of options and decision processes.
2. Performance information databases that are shared between facility owners, constructors, and designers.
3. Education of the construction industry participants.

The PBSRG at Arizona State University has adopted the above objectives. Started in 1994, the PBSRG has performed and planned research (over $1200K) to meet the above objectives. The long-term objective is to construct a performance-based construction sector regulated entirely by performance information (and not minimum standards). This environment would have the following advantages:

1. Eliminate all non-value added construction/design activities and functions.
2. Identify performing facilities systems that leads to a reduction of risk.
3. Allow total competition (prequalification in the same step using performance information) and allow performing constructors to receive a fair profit.
4. Motivate constructors to continuously improve.

The PBSRG has tested the PBPS twenty-five times in the public and private sector to purchase roofing systems, janitorial and landscaping services, and copy machine service. Performance information databases are currently being compiled for general, electrical, mechanical, roofing, and JOC contractors and systems. It has also been used to quantify the performance of roofing designers and will be used to quantify the performance of architects and engineers. The PBPS has also been tested by procuring five years of copy machine service for the State of Wyoming through one vendor (or joint venture group). In 1996 the State of Wyoming copy machine service had the following problems, which are shared by the construction industry and which led the State to seek the help of PBPS.

1. Many different vendors with different machines, different prices, different services.
2. An unclear objective of the highest possible level of performance at the best price.
3. The potential joint venturing of contractors who did not known each other before the bid opening.
4. The option for contractors to bid a part of the job, instead of the entire job.
5. The procurement of a “level of service” rather than the “installed system.”

Organizations that have used the PBPS system report satisfaction with the value received.

Future Research and Recommendations

The PBSRG is undertaking a project to design a performance-based structure for a major manufacturer of a facility system that includes the following areas:

1. Re-education of personnel.
2. Restructuring the company's marketing, organizations, and information system based on performance theory.
3. Designing the interface between contractors, facility owners, and manufacturers based on performance theory.
4. Identifying performing facility owners.

The PBSRG is also working with design consultants to transform their services from being centered around manufacturer generated "data" to performance information. Performance information and theory are also being used to redefine construction industry segment structure.

The PBSRG's five major objectives of 1997 include:

1. Complete the performance-based structure for a major manufacturing company of construction materials that will give the manufacturer the competitive advantage based on performance.
2. Implement and document the PBPS for the US Federal government.
3. Implement the performance environment on an industrial plan application.
4. Form a complex database for a complex construction craft, which can be used by the craft to design a strategic plan, drive training requirements, and educate end users on the cost of performance.
5. Implement the PBPS on general construction.

The following are the author's recommendations for the industry:

1. Move from an industry regulated by standards to one regulated by performance information. Reduce the number of standards.
2. Increase performance information databases.
3. Move from data based, problematic research to information based research.
4. Reduce the number of non-value added activities and participants in construction.
5. Reduce marketing efforts of construction manufacturers and contractors and use the funding to improve construction performance.
6. Move from rule based expert systems, which cannot be easily applied to different cases, to "AI rule generation" tools that are flexible and transform data into information.

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Building Code Amendment Justification Research: Poor Indoor Air Quality Mitigation Relative to Attached Garages in a Single Family Residence Scenario

John D. Murphy Jr. and Joe Beebe
Colorado State University
Fort Collins, Colorado

This paper reports on research that utilized the Sealed Housing for Evaporation Determination (SHED) method for measuring auto emissions in a confined space to facilitate measurement of "off-gassing" of automobiles in a simulated garage space. Results show there is adequate evidence that a pollutant source is likely to exist in the garage space, to the extent that migration of the pollutant into the living space needs to be mitigated. This data is used to justify the statement that building codes should require a dedicated exhaust vent (passive minimum) for any garage attached to a residential family unit.

Key Words: Indoor Air Quality, Residential Building Codes, Space Ventilation Requirements

Introduction

Indoor air quality is becoming a phrase that is more widely heard; yet standards and governmental intervention are yet to be widely instituted. The term indoor air quality can be thought of as a general term referencing the need for air that is of the quality to support healthy, comfortable, and productive occupation of indoor spaces. While there are many facets of air quality that cross over the indoor vs. outdoor line, the literature, and thus research, has focused mostly on outdoor air quality in the past. Although there is justification for this in that our indoor air can always be traced back to an outdoor air source, a majority of United States population spends approximately 21 hours of the day in some type of indoor environment (Warsco, 1992). Research has shown that average levels for many air pollutants may be two to five times higher in buildings than for ambient levels (those levels of pollutants found in outside air at the same building sample)(Committee on Environment and Public Works, 1989). With this being the case, there is justified argument for creation of some governmental standards to lead society in the direction of healthier indoor environments (Murphy, Jensen, and O'Marra, 1994). While many would be of the opinion that we do not need more government intervention, building code usage/reference has proven to be a worthwhile avenue by which to set minimum, standards for health and safety in the design and construction of buildings and space. This paper argues that building codes may be the most effective point to begin protecting the public in a residential setting regarding the ill effects of poor indoor air quality.

Further supporting the need for standards are the legal issues regarding liabilities of poor indoor air quality. These litigation issues have become more of a concern to designers and constructors specifically related to products liability and owners premises liability, among other aspects

(Murphy et al., 1994) (Murphy, O'Marra, Jensen, 1995). Most legal cases can be shown to be complicated by the lace of standards for indoor air quality.

One indoor air pollutant that is commonly accepted as dangerous to ones health, is the existence of hydrocarbons in occupied spaces. In addition, those that are very learned in the area of indoor air pollutants would agree that there is some level of concern from off-gassing volatile organic compounds, ozone, insulation products, formaldehyde, etc. that are common from certain plastics, finishes, and other products. In the United States, an attached garage for a single-family unit, supporting one or more vehicles, has become the norm. It can be argued that the garage is a common source for many of the pollutant sources mentioned above. After reviewing the Building Code (UBC) 1994, the National Building Code (BOCA) 1996, and the Standard Building Code (SBC) 1994, the authors found no references to requirements that would mitigate the possible migration of indoor air pollutants from the garage space to the living spaces. The typical reference in all three of these codes, regarding the garage, dealt with fire protection separation from the living space.

This paper reports on research that focuses on just one physical source of possible pollutants located in the garage – that being the automobile itself. In isolating on the automobile as a specific pollutant source, the researchers hope to validate the need for building code change that will apply a simple solution to mitigating the garage as a point source of possible indoor air pollution. The suggested amendment to building code is to require a minimum ventilation mechanism specifically for the garage. This, in conjunction with present fire rating separation requirements, would create an isolated air exchange scenario for the garage space.

Methodology

A laboratory study was conducted to measure evaporation emissions from in-use vehicles using the Sealed Housing for Evaporation Determination (SHED) method. This SHED method utilized a sealed metal chamber of approximate dimensions 8 feet tall by 10 feet wide by 22 feet long. Twenty light duty cars and trucks were obtained for the study. A graphic of study methodology is shown in Figure 1.

As one can see, each automobile underwent the "hot soak test" which includes allowing each subject vehicle to "outgas" inside the chamber immediately following an emissions dynomometer test of 41 minutes (Environmental Protection Agency, 1996). This provided a standard level of "warm up" for each subject vehicle, resulting in a high level of comparability with this data. Evaporation emissions were measured using the same analysis equipment for all subject vehicles. A limitation of this study is that the concentration analyzer equipment utilized did not differentiate between types of hydrocarbons, instead calculating total hydrocarbons (THC). Calculations for total mass of THC were completed as follows:

$$\text{MASSTHC} = \text{Volume } (\text{ft}^3\text{STD}) \text{ X Denisty}^{\text{gms}}/\text{ft}^3\text{STD X concent.THC } (\text{parts}/10^6\text{parts})$$

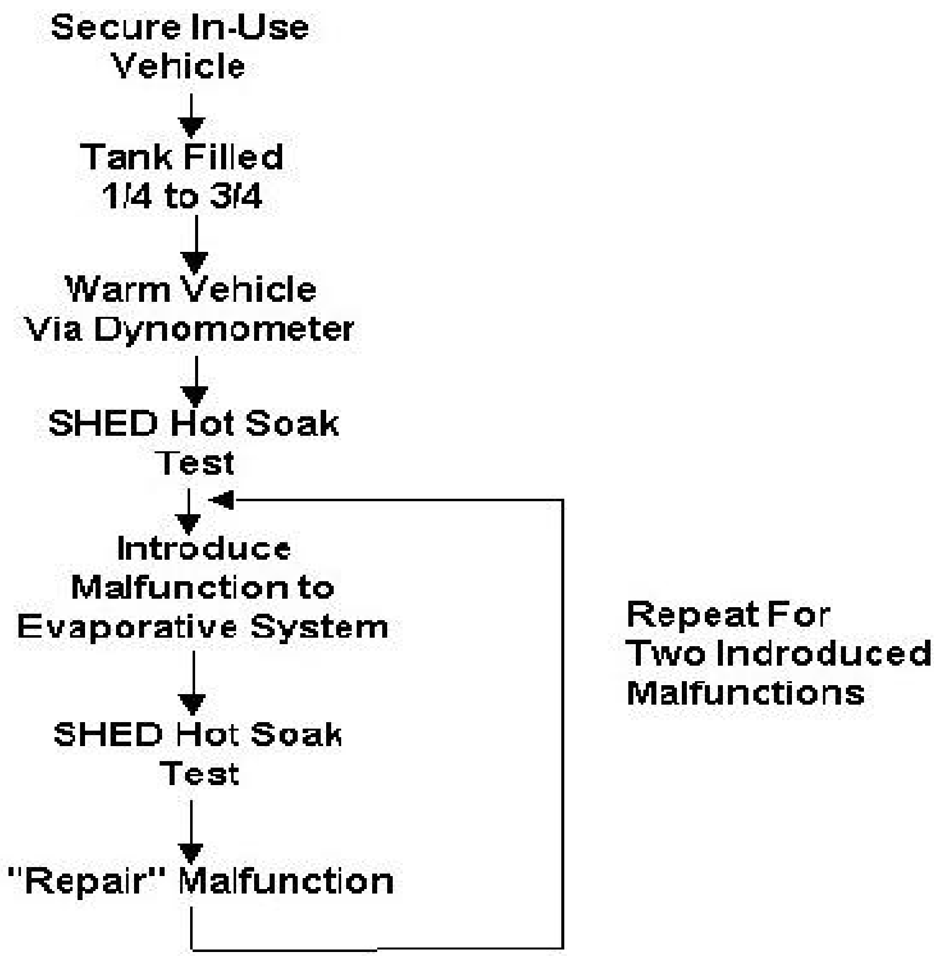

Figure 1. Methodology of emissions evaporation measurement testing.

From a reading taken from the concentration analyzer, parts per million (ppm) can be read with a published density. From this point the formula can be utilized after adjustments have been made for the altitude (pressure adjustment) and the exact size of the SHED (volume adjustment). These adjustments were made for all calculations for all subject vehicles. To show an example of these completed calculations, a reading for subject vehicle is found to be 200 ppm of THC and a published density of 14.2 grams ft^3STD in our SHED which has a standard volume is 1385 cubic feet.

$$\text{MASSTHC} = 1385\text{ft}^3\text{STD X } 14.2^{\text{gms}}/\text{ft}^3\text{STD X } 200 \text{ THC (parts}/10^6)$$

$$\text{MASSTHC} = 3.93 \text{ grams of THC}$$

Another aspect of this study was to address the differing states of maintenance found in vehicles. Automotive designs today typically have vapor saving devices intended to lower rates of evaporative emissions. Under varying degrees of disrepair, vehicles may have some of these devised in non-working order. To simulate/allow for these occurrences, malfunctions were introduces to the subject vehicles prior to running the vehicle through a hot soak test again.

Figure 1 shows this sequence. The two malfunctions introduced individually were 1) removing the fuel cap and 2) removing carbon canister fuel tank vapor hose. In the cases where the THC emissions were found to be unusually high in the first soak test, the vehicle may not have been re-tested again. The reason for this is the suspicion that a vapor leak already existed in the vapor saver system and a comparison with an induced defect would be limited in meaning.

Results

The results of the research can be summarized as shown in Table 1.

Table 1

Summary of study results

With CAP "Defect" (Avg) 1.58 gms (12)
With HOSE "Defect" (Avg) 3.29 gms (11)
With UNKNOWN "Defect" (Avg) 8.25 gms (4)
With DEFECTS "Corrected" (Avg) 0.53 gms (19

As can be seen in Table 1, the average SHED THC evaporation loss was 1.58 grams with the fuel cap removed. The average with (only) the carbon canister fuel tank vapor hose disconnected was 3.29 grams. The average for an unknown defect was 8.25 grams. The average for a system "ok" condition was 0.527 grams. The numbers in parenthesis indicate the number of tests with the stated condition of the vapor saver system. To give some sense of scale on these readings, the Environmental Protection Agency (EPA) allows 2 grams total THC evaporation for vehicle design, calculated by the hot soak test and a procedure called the diurnal breathing loss (DBL) test. The EPA does not have a standard for the hot soak test alone. While the DBL test was not applied in this research, the results from only one of the tests included within the allowed vapor emissions standard can be seen as a statement of emissions greater than or equal to the results obtained in the study.

The results shown in Table 1 do not tell the whole story, however, as some surprising results can be seen in the raw data contained in Appendix A. For example, in several cases, the removal of the fuel cap or canister hose resulted in very little increase in THC evaporation loss compared to "system OK" tests. The reasons for this are not clear. Preliminary information obtained by the researchers suggests that pressure threshold or "head valve" devices can affect initial hydrocarbon losses when vapor saver systems are first vented. The "whoosh" heard when some fuel caps are removed for vehicle refueling is a manifestation of these threshold devices. Obviously, variations in the fuel volatility of the vehicles under test in this study can cause large differences in evaporation losses as well.

Nevertheless, the averages do suggest real differences among vehicle vapor saver "conditions." That is, a missing fuel cap, or broken or disconnected vapor hose at the canister results in a large increase evaporation losses of THC.

Conclusions and Recommendation

The data obtained in this study and related observations indicate real differences in hydrocarbon evaporation emissions between vehicles with *intact* and *functional* vapor saver systems and vehicles with defective vapor saver systems. But, in line with the contention of this paper, what do these results mean with regard to making a judgment as to whether or not to ventilate a garage space. With the understanding that it would be very difficult, and quite possibly invalid, to estimate the state of disrepair of vehicles in a "typical" attached garage, one can still conclude that vehicles parked in a garage are a source of hydrocarbons that are in close proximity to living spaces when the garage is attached . With this in mind, it is the recommendation of the researchers that the building code be amended to include requirements for all garages attached to residential housing units to have a dedicated exhaust system for the garage space(s). This research shows that there is a need for ventilation of garages based solely on comparison between what the EPA allows regarding vehicle design and the rates of evaporative emissions for many different vehicles. This does not take into account the fact that science has not yet shown with any degree of certainty at what level of exposure to hydrocarbons, an other pollutants, human tissue is damaged or disease initiates (ie. threshold of carcinogenicity) (Murphy and Grosse, 1993). This uncertainty strengthens the argument to protect the public from the possibility of harm. Also, differentiating between types of hydrocarbons is not a major issue in that most proponents for better indoor air quality would agree that many of the sources of out-gassing hydrocarbons from an automobile would be considered as not healthy for breathing. The reader should also be cognizant of the fact that this research did not address any of the many other possible pollutant sources typically sound in garage (paint, solvents, gasoline cans, etc.).

Future Research

The above referenced recommended change to building codes assumes a functionality of the required system. With that in mind, there is a need for further research to become more specific with the requirements. This is necessary to facilitate the proposed change. The next aspects of research to support and detail this recommended amendment to code is to complete research that addresses the following:

1. Formulate a way to specify the proper number of air changes for the garage per day.
2. Formulate an associated required number of air intake grills.
3. Specify the means by which an envelope will be maintained to facilitate required air changes
4. per day.
5. Specify the minimum means by which the garage space can be ventilated.

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Appendix A

				Result (HC gms)			
No	Vehicle	Condition	Avg. Temp	System OK	Cap Off	Hose Off	Comment
1	’73 Ford PU	Leak fuel guage	81.0			2.69	
2	’93 Chev. PU	Syst. OK	81.5	0.034			
3	‘93 Chev. PU	Syst. OK	85.0	0.196			
4	’93 Chev. PU	Cap removed	88.0		1.50		
5	’86 Chev. Sedan	Syst. OK	91.0	0.304			
6	’86 Chev. Sedan	Cap removed	91.0		0.553		
7	’92 Saturn SL	Syst. OK	80.0	0.242			
8	’92 Saturn SL	Cap removed	82.0		0.299		
9	’92 Toyota Sedan	Syst. OK	82.0	0.202			
10	’92 Toyota Sedan	Cap removed	82.5		4.78		
11	’93 Lumina APV	Cap removed	81.0		2.43		
12	’93 Lumina APV	Syst. OK	84.5	1.15			
13	’93 Lumina APV	Cap removed	87.0		2.595		
14	’93 Lumina APV	Hose off canister	86.0			4.714	
15	’93 Lumina APV	Repeat test #14	88.0			6.943	
16	’93 Lumina APV	With EtoH added	87.5			3.612	
17	’92 Saturn SL	Hose off canister	81.5			0.642	
18	’92 Toyota Sedan	Hose off canister	82.5			1.192	
19	’92 Toyota Sedan	Hose off canister	80.0			1.197	
20	’80 Chev. Caprice	Syst. OK	83.0	6.394			
21	’92 Chry. New Yorker	Syst. OK	80.0	0.120			
22	’92 Chry. New Yorker	Hose off canister	83.0	0.124			
23	’89 Ford Escort	Syst. OK	79.0	0.092			
24	Chev. Astro Van	Syst. OK	83.5	0.449			
25	’89 Toyota PU	Hose off canister				0.132	
26	’84 Range Rover	Syst. OK		10.660			Grey Mkt.
27	’92 Saturn SLI	Cap removed			0.609		
28	’81 Ford Escort	Hose off canister	77.5			9.288	
29	“93 Dodge Caravan	Syst. OK	79.5	0.136			
30	’93 Dodge Caravan	Hose off canister	82.5			1.176	
31	’81 Ford Escort	Syst. OK	82.5	1.514			
32	’85 Jeep Cherokee	Syst. OK	82.5	12.921			Canister broken
33	’81 Datsun 210	Syst. OK	82.0	0.49			
34	’81 Datsun 210	Cap removed	84.0		1.061		
35	’92 Saturn SL	Syst. OK	85.5	0.202			
36	’81 Ford Escort	Syst. OK	86.0	2.435			New canister
37	’88 Chev. Corsica	Syst. OK	8..5	0.153			MtoH/EtoH
38	’88 Chev. Corsica	Cap removed	83.5		0.095		MtoH/EtoH
39	’73 Ford PU	Leak fuel gauge	82.5			3.367	
40	’90 Chev. Lumina	Syst. OK	79.5	0.153			
41	’90 Chev. Lumina	Cap removed	78.0		0.305		
42	’81 Ford Escort	Syst. OK	81.5	1.922			
43	’80 Arrow PU	Syst.OK	83.0	3.041			
44	’80 Arrow PU	Cap removed	83.5		3.502		
45	’91 Honda Accord	Syst. OK		0.088			
46	’91 Honda Accord	Cap removed			1.195		

“Syst. OK” refers to a visual inspection only

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