OVERVIEW OF SUMMER RESEARCH PROGRAM FOR UNDERGRADUATE STUDENTS IN CONSTRUCTION

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Abstract

The Del E. Webb School of Construction (DEWSC) at Arizona State University (ASU) received funding to develop a site to provide research experiences for undergraduate students in the field of construction management. The site attracted thirteen high caliber undergraduate students from civil engineering, construction engineering/management, and architectural engineering programs from across the nation and imparted research training to them through a focused and well-supported ten-week on-site research program. The Research Experience of Undergraduates (REU) included an orientation workshop, participating faculty presentations, nine week individual research program, interaction with current graduate students, workshops on construction management, bimonthly research seminars, final research presentation, and final technical report. In addition the students participated in two construction project site visits, and a panel discussion of construction industry experts describing the current status of the industry and its research needs. Through well-designed group and individual research training, the participating undergraduate students were exposed to research opportunities in the construction industry intended to motivate them to consider graduate education. The purpose of this paper, with its supporting research analysis is to present the statistical data evaluating the quantitative and qualitative aspects of the program. During the evaluative phase of the program, all participating students completed an in-depth analysis that focused on the structure of the program, the curriculum, the content, program implementation, quality and research opportunities availed them. Presentation of this paper illustrates these findings and projects revisions to be considered for subsequent programs at Arizona State University, for funding years 2002 to 2003.

Overview

Success of a nation is determined by the quality of its workforce. The nation needs a workforce for the future with the kind of skills learned through a rigorous encounter with science, engineering, and mathematics that will prepare them to make decisions about issues with scientific and

technological dimensions (NSF 1997). Universities across the nation must strive hard to actively engage those students preparing to become K-12 teachers; technicians; professional scientists, mathematicians, or engineers; business or public leaders; and other types of "knowledge workers" and knowledgeable citizens (NSF 1996). American's business and industry, governments and foundations must provide active assistance and support to accomplish this important task (NSF 1996).

Over the past few years national organizations such as the American Society of Civil Engineers (ASCE), American Society for Engineering Education (ASEE), National Science Foundation (NSF), Accreditation Board of Engineering and Technology (ABET), and National Research Council (NRC) have sponsored numerous studies to gauge the current status of undergraduate engineering education and to develop an agenda of improvement (ABET 1993, ASCE 1995, NSF 1995). One of the themes of improvement that has developed from these studies encourages dual emphasis on teaching and research at the undergraduate level (Coppula 1997). Rather than viewing teaching and research as opposite ends of the spectrum of undergraduate education, integrative strategies can be adopted to benefit the student's educational process. Synergism between teaching and research can be beneficial for the undergraduate engineering student (Sabatini 1997). Involving undergraduate students in the research process enables them to learn the methods and processes of research, i.e. what scientists and engineers do, how to make informed judgments about technical matters, and how to communicate and work in teams to solve complex problems (NSF 1996).

Motivated by these findings the Del E. Webb School of Construction (DEWSC) in the College of Engineering and Applied Sciences at Arizona State University (ASU) submitted a proposal to develop a site for Research Experience of Undergraduates (REU) that focused on these issues and other interests pertinent to the United States construction industry. With the award of the first REU grant, ASU was able to successfully launch the first REU Site, during the summer of 2001, from May 29th to August 2nd.

The Construction Industry and Its Research Needs

The construction industry is a dynamic and important portion of the United States economy. It is a very large and complex industry. Growth and replacement of people leaving the work force will add more than 68,000 new positions for civil and construction engineers by the year 2005 according to a forecast of employment trends (ASCE 1996). The construction industry is growing at a fast pace—newer project delivery methodologies are being adopted; design of facilities is continuously improving; newer means, methods and materials of construction are being produced. Additional market forces due to specialization, fragmentation, litigation and globalization are putting more pressure on the industry (Tommelein and Fischer 1999). These forces have led to the high complexity and uncertainty so characteristic of most current construction projects. Further, due to a shift in thinking regarding the engineering and construction process, as well as the availability of new information technologies, an emergence of new organizational and contractual structures has developed. These activities coupled with new construction means, methods, and materials have caused new opportunities to pulsate throughout the construction industry

(Tommelein and Fischer 1999). Agencies involved in the construction business have to implement strategic plans to adapt to these changing forces and to prepare themselves for new opportunities.

One of the resulting developments from the above-described forces is the growing attention to a relatively new discipline in the construction industry, namely construction management. The Construction Management Associate of America (CMAA) defines Construction Management as a profession that provides a comprehensive array of services spanning all phases—design, construction, operation, and maintenance—of the constructed facility. The principle objective of this discipline is to facilitate completion of each construction project on time and within budget while maintaining an acceptable level of quality, safety, efficiency, and workmanship. The construction management discipline will definitely play a strong role in determining the future growth of the construction industry. Owners, constructors, construction management consultants, federal agencies, state agencies, and universities that form the core of the discipline will have to join hands with other agencies of the construction industry to develop strategies for continuous improvement of the industry. Numerous areas of study, research, and scholarship need to be identified.

In order to determine the research needs of the construction industry, the National Science Foundation (NSF) sponsored a workshop entitled Berkeley-Stanford CE&M Workshop: Defining a Research Agenda for AEC Process/Product Development in 2000 and Beyond (Tommelein and Fischer 1999). Numerous research topics of significance to the U.S. construction industry were debated under the auspices of this workshop.
A crucial conclusion that results from the current status of the construction industry, and initiatives such as the one described above, is the importance of improving and enhancing the research program that benefits the construction industry. In addition to conducting research, there is clearly a need to train undergraduate civil engineering, construction engineering/management, and architectural engineering students to handle the challenges being faced by the construction industry. Also there is a need to encourage these students to pursue graduate study and develop a research program in construction. The industry can benefit from the end product of the research, and additionally can also benefit from the graduates who have first hand knowledge—through involvement in research—of the issues facing the construction industry.

Objectives and Impacts of the REU Site

The intellectual focus of the REU site was to study innovative technologies that can provide long-term benefits to the construction industry. Successful development and implementation of the REU site produced the following impacts:

1. Provided civil engineering, construction engineering/management, and architectural engineering undergraduate students an opportunity to actively participate in research that benefits the construction industry
2. Made student participants aware of the research needs of the construction industry
3. Provided much needed research training in the field of construction management
4. Motivated and encouraged undergraduate student participants to consider graduate

study in the area of construction management

5. Served as an inspiration for student participants to seek research positions in the construction industry
6. Demonstrated to the student participants the complexities and dynamics of the construction industry
7. Demonstrated to the construction industry benefits of university-industry partnerships
8. Created synergism between teaching and research
9. Provided opportunities to faculty members and graduate students to serve as undergraduate student mentors

Organizational Structure, Timetable and Institutional Commitment

Dr. Sawhney, Dr. Badger and Geraldine Peten jointly managed the REU site. Dr. Sawhney provided the day-to-day support for the site. Geraldine Peten, Director of REU Program, provided the necessary guidance and leadership for the management of the site. Ms. Peten played a critical role in overseeing the efficacy of the entire program as well as facilitating the major events, project evaluation and reporting tasks. Support of other graduate students during the summer months provided further management assistance to the team.

A preliminary timetable for the REU site is provided in Figure 1. After the completion of the summer program, the evaluation task was completed and recommendations for improvement were incorporated for the summer program next year. Shortly after the conclusion of the first REU session, the advertising and student recruitment efforts for the next year program began. Actual details of the summer research program activities are provided in the next section.

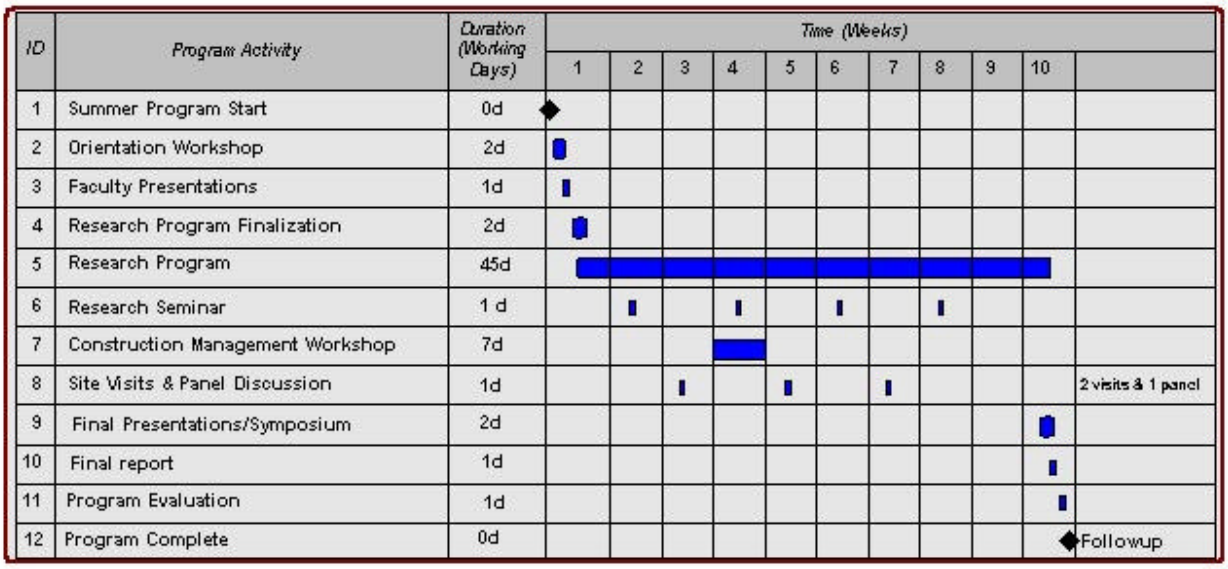

Figure 1.

1. Orientation Workshop: The initial task of the REU staff at ASU was to acclimate the out-of-state students to Arizona and its hot and dry climate with a cool and refreshing welcome. The first day of the program was designated as a travel day, whereby students were greeted at the airport, treated to lunch and given a brief tour of the ASU campus before being escorted to their dorms to unpack and prepare for the first formal days of the REU program orientation. May 30th and 31st consisted of two full days of the summer research program orientation, which included all meals. Student participants were familiarized with the objectives of the program, provided with administrative and logistical information, an overview of the construction management discipline and formal presentations of all on-going research projects by ASU faculty and graduate research mentors.

2. Faculty Presentations: Each faculty mentor, from the Del E. Webb School of Construction, presented a persuasive synopsis of their research for the purpose of motivating REU students to participant in their research activities during the remainder nine-weeks of the program. The presentations provided information about the current research projects that each faculty member was conducting, encompassing the general ideas, concepts, hypothesis, significance of research, current status and projected timelines and critical events.

3. Research Program Finalization: Student participants were allowed to review and discuss the research opportunities available during the orientation presentations and the two subsequent days. A deadline of Monday, June 4, 2001 was issued for the students to select a research area of their interest and submit a one-page proposal to guide their research. The principal coordinator and the selected faculty mentor worked with students on a one-on-one basis. Specified objectives and the scope of work were given time frame commitments.

4.Research Program: Each student participated in a research project being undertaken by one of the faculty mentors. This task was assigned a nine-week duration. Student-faculty interaction during this nine-week period was crucial. Involvement of the student participants in the research team for each research project was required. A balanced approach between guided research effort and independent research effort was followed. In addition to the actual research activities, the research program involved individual meetings with faculty mentor, meetings with graduate research assistants, research group meetings, progress reports and progress PowerPoint presentations.

5. Research Seminar: A bimonthly seminars were organized. The project coordinator facilitated four of these seminars during the nine-week duration of the program. The seminars were used as a medium for exchange of research ideas between student participants. Other faculty members and graduate students were also invited to these seminars. Student research projects were used as a mechanism for discussion. The primary objective was to provide student participants with the experience developing an understanding for the given research topic.

6. Construction Management Workshop: The construction management workshop was conducted from June 4th to June 6th consisting of nine hours of instruction by André Mund, an ASU doctoral candidate and graduate research assistant. The concepts and objectives covered included the design

and analysis of construction operations, planning and scheduling, cost controls, information technology in construction, and quality, safety, and communication management. The three-day agenda also included guest speakers and hands-on activities

7. Site Visits and Panel Discussion: The REU student participated in two-construction project site visits (half-day duration), (i.e. Maracay Homes Development and the Aerated Autoclave Concrete manufacturing facility); a clean-room manufacturer (i.e. Intel Facility) and a panel discussion (two-hour duration) of construction industry experts discussing **Reversing the Degenerating Image of the Construction Industry** facilitated by Dr. Tom Scleifer, with visiting researcher, Michael Schleipfer. This part of the summer research program was supported by the Alliance for Construction Excellence (ACE)—the outreach arm of the Del E. Webb School of Construction.

8. Final Presentation/Symposium: During the last week of the summer research program a two-day long symposium was conducted. All student participants were required to give a final presentation describing their research program during this symposium. Faculty members were present and evaluated the work performed by the student participants. A poster session at the end of the symposium was used to showcase the work performed by the student participants. Members of the regional construction industry, other graduate and undergraduate students, and faculty were invited to this event.

9. Final Report: Each of the student participants were required to submit a final report, which is outlined in Figure 2. of this paper.

10. Program Evaluation: The summer research program was concluded with program evaluation. Each student participant was required to evaluate the summer research program. More information about evaluation is provided in a section titled "Project Evaluation".
In addition to the above listed activities, numerous social events were organized. These events provided an opportunity for everyone involved in the REU site to develop social ties with each other and to promote collegial relationships.

Student Profiles

- **Stephanie Barta –** A junior at the University of Houston in Texas, with a double major in Architecture and Civil Engineering.
- **Benson V. Bashford –** A junior at Arizona State University majoring in Construction Management.
- **Gabriel Buttram –** A sophomore at Northern Arizona University majoring in Construction Management with a minor in Business Administration.
- **Martin Cruise, III –** A junior at Morgan State University in Baltimore, Maryland; majoring in Civil Engineering.
- **Sarah Field** – A sophomore at the University of Detroit Mercy, in Detroit, Michigan; majoring in Architecture.
- **Travis Fults** – A junior at the University of Texas, in Austin, Texas; majoring in Architectural Engineering.

- **Matt Lulling** – A sophomore at Arizona State University majoring in Construction.
- **George Miguel** - A junior at Arizona State University majoring in Construction.
- **Aaron Moore –** A junior at Morgan State University, majoring in Civil Engineering.
- **Brad Payne** – A junior at Purdue University in West Lafayette, Indiana; majoring in Building Construction Management.
- **Cynthia Turenne** – A junior at Morgan State University in Baltimore, Maryland; majoring in Civil Engineering.
- **Michael Watson** – A sophomore at Arizona State University in Tempe, Arizona; majoring in Construction.
- **CarmaLisa Washington** – A freshman at El Paso Community College in El Paso, Texas; majoring in Architecture

REU STUDENT(S)	RESEARCH PROJECT	FACULTY MENTOR/ PRINCIPAL INVESTIGATOR
Stephanie Barta and Gabriel Buttram	The Applicability of Autoclaved Aerated Cellular Concrete in Residential Construction	Dr. Anil Sawhney
Benson V. Bashford	A Study on the Effectiveness of Job Ready/Job Complete^{SM} (JRJC^{SM})as a Management Tool in Residential Construction	Dr.Howard Bashford
Martin Cruise	DFMA as it pertains to Pre-cast Concrete Slabs for use in Residential Foundation	Dr. Howard Bashford
Sarah Field and Aaron Moore	Investigation of Construction Defects in the Arizona Housing Industry	Dr. Howard Bashford
Travis Fults	Benchmarking	Dr. Allan Chasey
Matt Lulling	A Study of Alternative Project Delivery Methods in the Non-Residential Private Sector	Dr. Jim Ernzen
George Miguel	Spatial Arrangement of Measurements of Residential Floor Flatness	Dr. Ken Walsh
Brad Payne and Cynthia Turenne	Use of Global Positioning System as a Layout Tool in Residential Construction	Dr. Howard Bashford
CarmaLisa Washington	Mail-Order Houses to Suit the Need of Contemporary Buyers: Using the Past for the Future	Dr. Howard Bashford
Michael Watson	Two Key Supply Chains in Residential Construction: Lumber and Roof Tile	Dr. Ken Walsh

Figure 2. - Table of REU Research Projects

The Research Environment

Eleven full-time faculty members (including the Primary Investigators - PIs) at the Del E. Webb School of Construction participated in the summer research program. They provided access to their on-going research projects and guided the student participants in their research programs. In addition, the Del E. Webb Foundation, Eminent Scholar was also involved in the student activities. Figure 3 shows the name, rank, and research interests of the participating faculty.

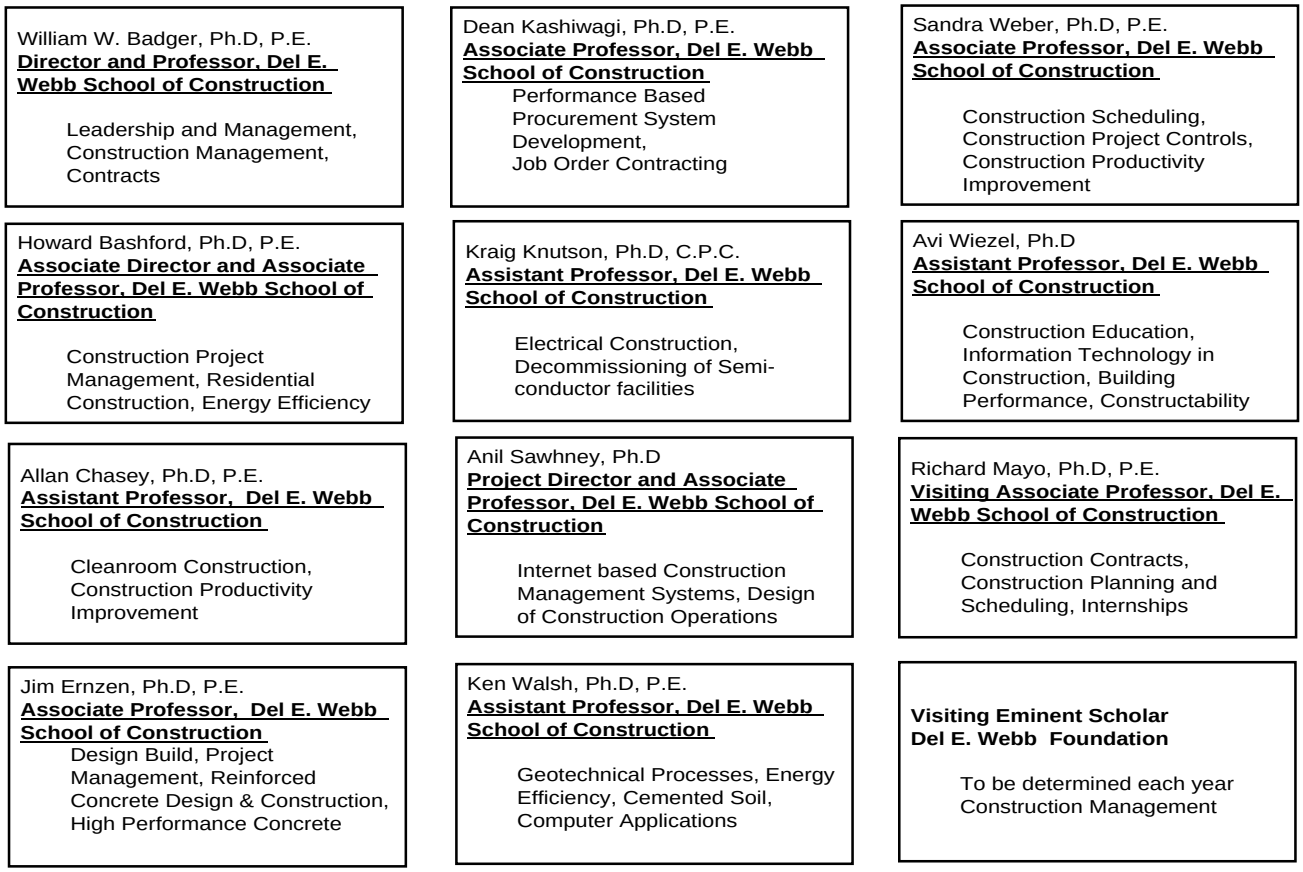

FIGURE 3: FACULTY MENTORS

Undergraduate Education

The Del E. Webb School of Construction is a student-centered department. It has offered an undergraduate degree in construction for more than 40 years. The enrollment has grown from 209 students in 1989 to the present enrollment of approximately 400, including 60 graduate students. The enrollment of women has increased from 6 % to 13.2 %. Currently 12.3 % belong to minority groups. The support for the undergraduate scholarship program is outstanding, with more than $150,000 distributed to 44 students for the 1999/00 academic year. The School consistently experiences a 100% placement of its graduates, who receive an average starting salary of $38,000-$40,000. DEWSC provided $500 (in addition to the NSF stipend) to each student participant as a commitment to the continuous improvement of undergraduate education.

Research

The DEWSC has a strong research program that has been strongly supported by the federal and state agencies. In fiscal year 1999, the Del E. Webb School of Construction was successful in obtaining $1,144,732 in external awards. Support of the construction industry is also very high.

The outreach arm of the school called the Alliance for Construction Excellence (ACE) coordinates the industrial support. Currently ACE has over 190 industrial members that provide funds for research activities in the school. Figure 4 shows the link between ACE and the proposed REU site.

Facilities and Resources

The REU program utilized the facilities and resources that exist in the Del E. Webb School of Construction. Student participants utilized two main resources. First, the construction project room that was designed for collaborative learning was used as the office space for the REU students. Second, the student participants were given access to the DEWSC computer laboratory. The School of Construction is one of the few programs at ASU that has its own computer laboratory conveniently located in the same building where the core courses are taught. The laboratory consists of 31 Pentium III personal computers. The laboratory also has a ceiling mounted data projector that can be used for demonstrations. The school has two portable presentation stations that consist of a Pentium notebook and a data projector. The computer hardware in the laboratory supports numerous general purpose and construction industry specific software. These computer hardware and software resources are in addition to the college and university wide infrastructure.

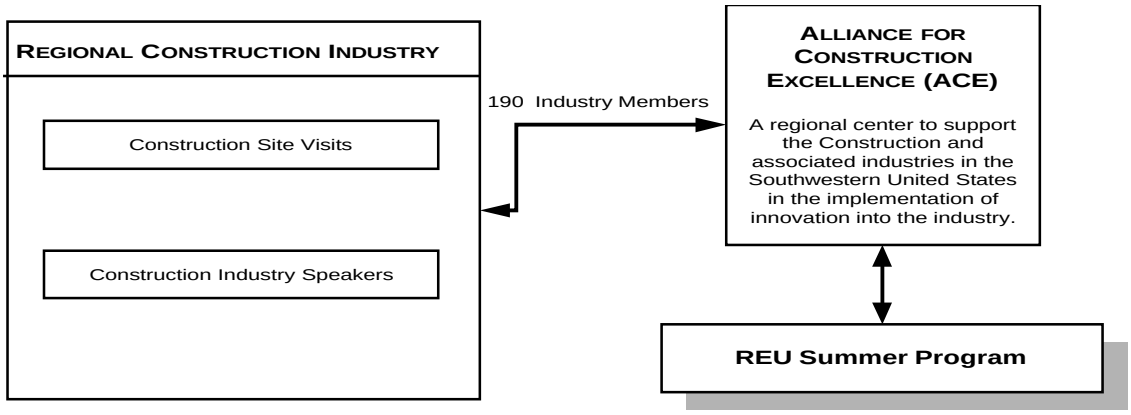

Figure 4: Alliance for Student Recruitment and Selection

The announcement of the Del E. Web School of Construction being selected as one of the successful recipients of a 2001 REU Site, immediately prompted the broadcasting of available grants via advertisements, creating a website, and contact educational institutions outline in Figure 5, which shows four-year and two-year programs that were targeted to recruit and select interested students.

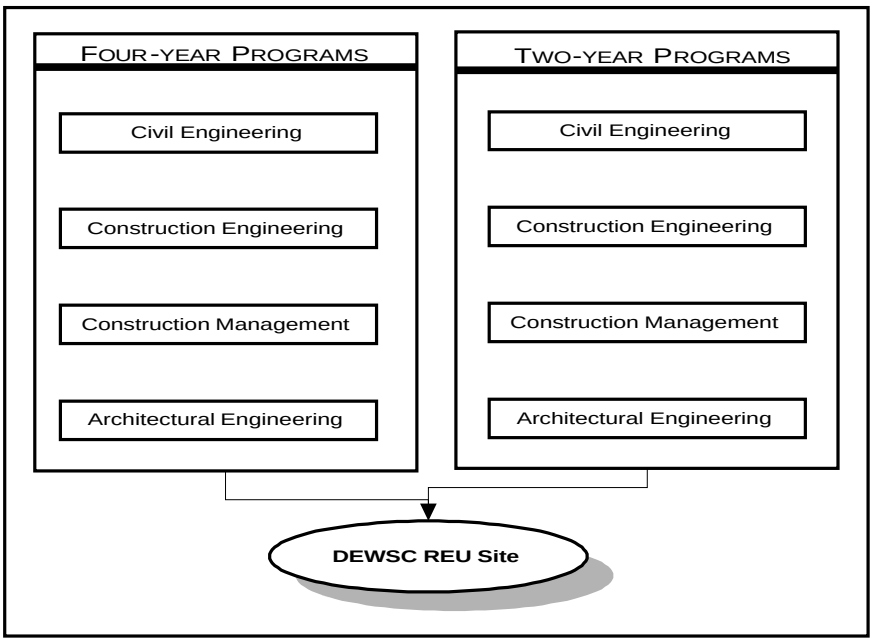

Figure 5: Target Four-year and Two-Year Programs

A key focus of the Research Experiences for Undergraduates (REU) site was to attract women and minority students and to train and motivate them to undertake graduate studies and research in areas that are of significance to the construction industry. Support of external and internal agencies was available to attract students from these underrepresented groups. Figure 6 shows the framework of external and internal agencies that was used to attract members of the underrepresented groups. With the help of external organizations such as Advancing Minorities' Interest in Engineering (AMIE), National Association of Women in Construction (NAWIC), Society of Hispanic Professional Engineers (SHPE), American Indian Science and Engineering Society (AISES) student diversity was accomplished. Additionally, the Arizona State University Office of Minority Engineering Programs (OMEP) provided internal support to attract students from diverse backgrounds. Student recruitment efforts were also be directed at universities that have existing ties with Del E. Webb School of Construction that include Morgan State University, Texas A & M University, University of Florida, Prude University, Auburn University, California State University Chico, California State University Sacramento, Cal Poly San Louis Obispo, Northern Arizona University, Oregon State University, University of Nebraska Lincoln, University of Nebraska Omaha, University of Cincinnati, University of Nevada Las Vegas, and University of Washington.

A well-designed selection process followed the well-directed recruitment effort. As part of the application process interested students were required to submit a completed application form, official transcripts from all the educational institutions attended, three letters of reference, and a statement of interest describing past experience and background as well as future directions.

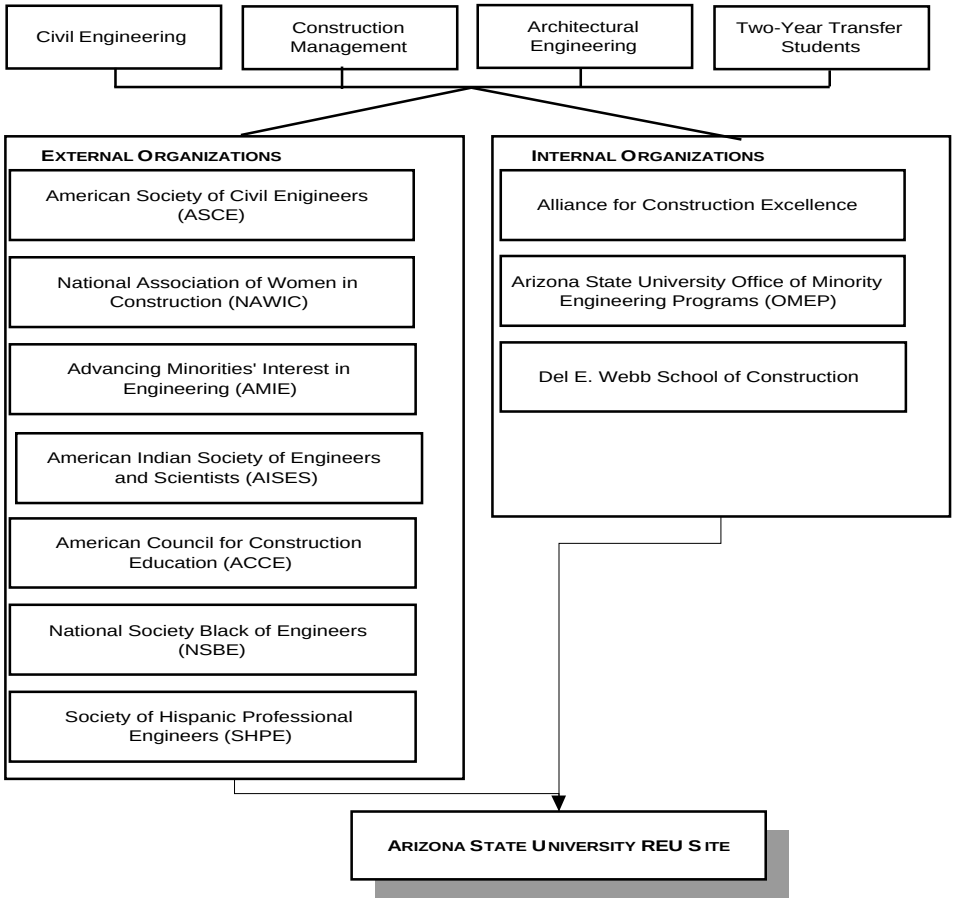

FIGURE 6: EXTERNAL AND INTERNAL AGENCIES

All the applications received went through an initial screening process that was coordinated by the PI. The final pool of applicants was reviewed by the faculty members. Applicants in the final pool were contacted by telephone and e-mail before the final selection is made. Upon formal offer and acceptance of the REU scholarship, each student was sent, via registered mail, an official offer letter, the contractual scholarship award, a Participant Certification statement, Consent to Medical Treatment form, housing application, and travel and program itinerary.

The demographics of the successful REU recipients included:

- 4 female students
  - 2 African American
  - 2 Caucasians
- 9 Male students
  - 2 African American
  - 1 Native American
  - 6 Caucasian
- Geographical Location of Educational Institutions
  - University of Houston – Texas (One student)

- University of Texas – Austin (One student)
- El Paso Community College – Texas (One Student)
- Morgan State University, Baltimore, Maryland (3 students)
- University of Detroit Mercy (One student)
- Purdue University, Indiana (One student)
- Northern Arizona University – Flagstaff (One student)
- Arizona State University – Tempe (4 students)

Project Evaluation and Reporting

Gauging the effectiveness of the proposed Summer Research Program was an important undertaking. A number of project evaluation instruments were developed to record the effectiveness of the program. The development of these instruments was guided by the National Science Foundation publication, "User-Friendly Handbook For Mixed Method Evaluations" (Frechtling and Sharp 1997). As recommended by this handbook the project evaluation was designed to:

1. Gain direction for improving the project as it develops (formative evaluations)
2. Determine project effectiveness after the completion of each year (summative evaluations)

Significant effort was expended on the completion of the formative and summative evaluations. The data collected through these evaluations was used to continuously refine and improve the summer research program.

Evaluation Techniques

Both quantitative and qualitative techniques were employed to conduct the project evaluation. Under the quantitative category, the questionnaire technique was used and under the qualitative category, the observation and interview technique will was used:

1. Student participant questionnaires
2. Faculty questionnaires

The following two sets of interviews will be conducted:

1. Student participant interviews
2. Selected faculty interviews

Dr. Badger served as the administrative observer for the project and assisted in the evaluation tasks.

Measures Employed to Gauge Project Success

The following measures were used to measure the project success and achieve improvements (Frechtling and Sharp 1997):

1. Did program activities occur as planned?
2. Was the proposed timeline appropriate?
3. What adjustments in program activities might lead to better attainment of project goals?

4. To what extent do the activities and strategies match those described in the plan? If they do not match, are the changes in the activities justified and described?
5. To what extent are the student participants moving toward the anticipated goals of the project?
6. Which of the activities or strategies are aiding the student participants to move towards the goals?
7. What barriers were encountered? How and to what extent were they overcome?
8. Did development of the project occur as originally planned?
9. To what extent did the project meet its overall goals?
10. Was the project equally effective for all student participants?
11. What components were most effective?
12. How effective is the project in increasing the benefits to the construction industry?
13. What has been learned from the project that will be helpful to students in other branches of engineering and non-engineering fields?

The above listed measures were used in the development of the questionnaires, and strategies for the administrative observation and interviews. In addition, the PI also maintained a database on project participants that included the name of the home institutions of the student participants and other demographic data.

Follow Through Procedures

The continued success of the program stems from the ability to track the student participants as they completed their REU experience at the Del E. Webb School of Construction. The project deployed the following techniques to accomplish this:

1. The PI will invite one past student participant to the orientation workshop each year (Year 2 through Year 3)
2. The PI will send a list of graduate programs that closely match each student participant's interest and encourage him or her to apply to those programs
3. Distribute any research position openings that the PI becomes aware of
4. Distribute any graduate fellowship or scholarship program that the PI becomes aware of
5. Maintain an e-mail based mailing list of the past student participants and encourage exchange of e-mails amongst the past student participants

Annual Reporting

Annual progress reports will be submitted through the NSF project reporting system in FastLane. The progress report will provide information on project participants, faculty participants, on the research training provided, on publications and products, and most importantly on contributions to education and human resource development. Data for the progress report will feed into the project evaluation plan, which in turn will enable informed statements about contributions and success in meeting project goals.

Conclusion

Overall, the first REU Site sponsored at ASU in the Del E. Webb School of Construction was a major success. This initial launching of the program revealed several areas that had to be monitored and adjusted while the program was progressing. Primarily, a more in-depth academic research workshop had to be initiated, than was originally planned. The Learning Resource Center conducted a nine-hour workshop that all students thoroughly needed and appreciated. Most students suggested that this type of instruction be included in the first week of orientation instead of later in the program.

Fulfilling the objectives of the program entailed that students develop and continuously demonstrate their oral and written communication skills, simultaneous to working effectively in teams. Students were reluctant about presenting their work and developing PowerPoint presentations, but all agreed in the evaluative stage that this activity forced them to create new marketable skills that will a permanent asset in their career. Interpersonal skills were greatly improved by working with team members, faculty mentor, graduate assistants and interfacing with construction industry professionals.

Successful alumnae of the first REU Site collectively agree that Arizona State University is a recognized leader in construction education and strategically completed the first program by exceeding their expectations. Much of this success is due to the strong industry support for the school, which validates the nature of research being conducted by the faculty members and also shows that the role the school plays in undergraduate and graduate education is significant. The unique experience and the capabilities of the Del E Webb School of Construction provided the REU students with learning opportunities and outcomes that will be a significant factor in their success throughout their career. The majority of the students requested that the program be extended from one to two weeks.

Acknowledgements

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BIBLIOGRAPHIC INFORMATION

ABET (1993) "Criteria for accrediting programs in engineering in the United States" Engineering Accreditation Commission, Accreditation Board for Engineering and Technology, New York, NY.

AbouRizk S. M. and Sawhney, A. (1994) "Simulation and Gaming in Construction Engineering Education" ASEE/C^{2}E^2/C^{2}EI Conference, Edmonton, Alberta, June 1994.

ASCE (1995) “Summary Report-1995 Civil Engineering Education Conference (CEEC ’95), American Society of Civil Engineers, Denver, Colorado.

ASCE (1996) “ASCE News” Vol. 21, No. 5 pp. 5, American Society of Civil Engineers, New York, NY.

Coppula, D. (1997) “Integrating Teaching and Research” PRISM December 1997, American Society of Engineering Education.

Halpin, D. W. (1977) “CYCLONE: Method for Modeling of Job Site Processes” Journal of the Construction Division, American Society of Civil Engineers, Vol. 103, No. 3, p.p. 489-499.

NSF (1995) “Restructuring Engineering Education: A Focus on Change, Report of an (1994) NSF Workshop on Engineering Education, Division of Undergraduate Education, Directorate for Education and Human Resources, National Science Foundation, Arlington, VA.

NSF (1996) “Shaping the Future: New Expectations for Undergraduate Education in Science, Mathematics, Engineering and Technology” Division of Undergraduate Education, Directorate for Education and Human Resources, National Science Foundation, Arlington, VA.

NSF (1997) “Shaping the Future: Volume II Perspective on Undergraduate Education in Science, Mathematics, Engineering and Technology” Division of Undergraduate Education, Directorate for Education and Human Resources, National Science Foundation, Arlington, VA.

Sabatini, D. A. (1997) “Teaching and Research Synergism: The Undergraduate Research Experience” American Society of Civil Engineering, Journal of Professional Issues in Engineering Education and Practice, Vol. 123, No. 3, July 1997.

Tommelein, I, and Fischer, M. (1999) “Berkeley-Stanford CE&M Workshop: Defining a Research Agenda for AEC Process/Product Development in 2000 and Beyond” University of California, Berkeley, Berkeley.

BIOGRAPHICAL INFORMATION

Geraldine Peten is currently a graduate student and graduate research assistant at Arizona State University in the Del E. Webb School of Construction. She received her Bachelor of Arts degree from Montclair State University, in Montclair, NJ and a Master of Arts degree from Seton Hall University in South Orange, NJ. Her career has encompassed that of a vocational educator, educational administrator, construction entrepreneur and a construction manager for a public school district. Ms. Peten is also in the final phase of completing her doctorate in curriculum and instruction from Northern Arizona University in order to reach the pinnacle of her career as a college professor

Dr. Anil Sawhney is currently an Associate Professor at Arizona State University in the Del E. Webb School of Construction. He received his Bachelor of Engineering degree from India in 1987 and a Master of Building Engineering and Management degree from the School of Planning and Architecture, New Delhi in 1990. He completed his Ph.D. at the University of Alberta in June 1994. Before ASU, he was an Assistant Professor at Western Michigan University. His research interests are mainly focused on construction simulation techniques and use of computers in education.

Dr. Bill Badger joined Arizona State University in 1985 where he has been serving as Professor and Director of the School of Construction since 1987. Dr. Badger was instrumental in bringing industry endowment to the School of Construction. Prior to joining the ASU faculty, Dr. Badger spent 26 years in the Army Corps of Engineers. His last position in the Army was as the Engineer for the United States Military Academy at West He was inducted to the National Academy of Construction in 2000.