Journal of Construction Education
Fall 1999, Vol. 4, No. 3, pp. 260-277

1522-8150/99/$3.00/Educational Practice Manuscript

A Road Map to an effective Graduate Construction Education Program

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This manuscript presents a model for graduate construction education that is responsive to the current issues in the construction industry and the academic environment. It provides a review of literature from the faculty of the Associated Schools of Construction in the form of an historical perspective demonstrating little change over the past decade. Master's and Ph.D. programs are discussed and outlined in response to the suggested graduate education model in conjunction with program coordination and academic rigor.

Key Words: Graduate education, Program model, and Graduate program history

Introduction

The intent of this paper is to provide a historical review of construction's graduate education, to propose a graduate education model that responds to the current and future needs of the construction academic or industry professional, and discuss programmic options available for meeting the requirements of the model. The model being proposed goes beyond the traditional delivery methods currently used by most graduate programs. The paper discusses the options available for graduate programs to affect changes necessary for the implementation of the proposed model.

Over the last twenty years, there has been a significant paradigm shift in the concept that defines a construction professional, within both academia and industry. As early as 1989, there was a call-to-meeting proposed to define the goals and topics for graduate education in the field of construction (Moss, 1989). However, this call was never responded to and over the years since this call, no one has provided consistent leadership in graduate education within the Associated Schools of Construction (ASC). The strategic planning session at the ASC Mid-year Board Meeting identified the need for more Masters and Ph.D. programs and the necessity for expanded involvement by the ASC in graduate program guidance (ASC, 1998). The Board's discussion, concerning faculty development towards tenure and promotion, identified the need for higher academically qualified construction educators as a response to the universities' ever-increasing requirement for research. Support for academic qualification also came from Rogers, and Christensen (1992), who reported that not only was a graduate program a necessary requirement for research productivity, but that the ASC faculty believes a strong graduate program is necessary to be productive in research. Within their survey on inhibitors to research productivity, the lack of a graduate program was ranked second of sixteen questions. It is hoped that this manuscript will create some discussion and leadership in support of the ASC's mission

of enhancing graduate education and faculty development. The discussion below will first give the reader a brief historical review of the literature concerning graduate education within the academic programs aligned with the ASC. Following this, the authors will define the graduate education model and discuss the implications of this model on the design of both Masters and Doctoral programs.

Literature Review

This review is limited to works published within the ASC Annual Meeting Proceedings and The Journal of Construction Education. A listing of ASC graduate programs is provided first to give the reader an understanding of graduate program growth over the past ten years. An in-depth literature review, spanning the same period, found four major categories of work concerning graduate education. The earliest writings centered on program development and program identification, the second major grouping involved course content descriptions, the third discusses the tie between graduates and research, and finally the fourth, academic justification and industry acceptance.

Programs

Construction undergraduate programs have historically emerged from or have been affiliated with Colleges of Agriculture, Industrial Technology, Architecture, Engineering and Business. A current analysis of program orientation finds that this is still the case even at the graduate programs level, i.e., Agriculture – two, Industrial Technology – fourteen, Architecture – six, Engineering – eight and Business – one. Fifty-two percent of construction education undergraduate programs are affiliated with the Applied Science and Industrial Technology colleges, as well as, forty-six percent of the graduate programs. These facts are quite counter to the common thinking of construction educators as reported by Hauck (1998) and has not changed since 1992, as reported to the ASC Board of Directors (Williamson, 1993). Marshall (1990) provides us with an historical snapshot of construction programs and related curriculums offering graduate construction education. These included: Colorado State University, University of Florida, Purdue University, University of Northern Iowa, Pittsburgh State University, Worcester Polytechnic Institute, Michigan State University, Polytechnic Institute of New York, State University of New York, East Carolina University, University of Oklahoma, Clemson University, and Texas A&M University. Marshall's work, however, did not provide information such as program level or degree title/emphases. Table 1 represents the current status of ASC programs in graduate education. Of the thirty-four member schools reporting masters degrees, seven are technology, and twelve are engineering, thirteen are construction management, and one is business. Four Doctoral degrees are reported as being engineering, three are technology, one is education, two are architecture and one building construction. While the above information demonstrates diversity of location and program emphases there is still a significant lack of construction programs identifying their degree as being separate and uniquly different than the allied discipline in which they reside.

Table 1

1998 Survey of ASC Graduate Programs

University	Masters Degree	Doctoral Degree
Arizona State University	M.S. in Construction	
Auburn University	Master of Building Science	
Bowling Green State University	Masters of Industrial Technology	Ph.D. in Technology Management
Bradley University	M.S.C.E. (Construction Management option)	
Brigham Young University	M.S. in Construction Management Pending	
California State University - CHICO	M.S. Construction Management	
Central Connecticut State University	M.S. In Industrial Technical Management	Ph. D. in Technology Management
Central Missouri State University	M.S. in Industrial Technology, M.S. in Industrial Management	
Clarkson University	M.S. in Civil Engineering, M.E. in Civil Engineering	Ph.D. Civil and Environmental Engineering
Clemson University	Master of Construction Science and Management	
Colorado State University	Master in Manufacturing Technology and Construction Management	Ph.D. School of Education
Eastern Michigan University	M.S. in Construction Management	
Fairleigh Dickinson University	M.S. Pollution Studies, M.S. in Electrical Engineering	
Georgia Institute of Technology	M.S. in Building Construction	Ph.D. in Building Construction
Iowa State University	M.S. Civil Engineering - Construction Engrg & Management	Civil Engineering - Const. Engrg & Management
Michigan State University	M.S. in Construction Management	
Montana State University	M.S. Construction Engineering Management	
Oregon State University	M.S. Construction Engineering Management	
Purdue University - BCM	M.S. School of Technology	Ph.D. School of Education
Southern Polytechnic State University	M.S. in Construction	
Stanford University	M.S. in Construction Engineering & Management	Ph.D. in Civil and Environmental Engineering - Construction
Temple University	M.S.E. Civil Engineering, M.S. Environmental Health	Ph.D. Engineering
Texas A&M University	M.S. Construction Management	Ph.D. in Architecture
Texas Tech University	M.S. in Civil Engineering, M.S. Engineering	
University of Denver	Masters in Real Estate & Construction Management, M.B.A. with specialization in RE/CM/RECM	
University of Florida	Master of Building Construction, M.S. in Building Construction	Ph.D. in Architecture (Building Construction)
University of Nebraska - Lincoln	Masters of Engineering (start Spring 1999)	
University of Nevada - Las Vegas	M.S. Engineering - Construction	
University of New Mexico	M.S. Civil Engineering, M.S. Construction Engineering & Mgmt.	
University of Northern Iowa	M.A. in Technology	Doctor of Industrial Technology (DIT)
University of Oklahoma	M.S. in Construction Administration	
University of Southern Mississippi	M.S. in Engineering Technology	
University of Washington	M.S. in Construction Management	

Curriculum Development Philosophy

Considering that graduate education has been included within our curriculums for more than twenty years, little writing has occurred in this area. Most curriculums were developed and organized based on the educational philosophy and technical experience of the person developing the academic curriculum. "Typically the graduate curriculum was not validated, either within academia or industry because the developers of the coursework did not know how nor have time to do this important task" (Newitt, 1987, 23). In 1988 an industry survey was conducted by Arizona State University to determine the viability of a new graduate program at ASU and to validate the existing graduate program at Texas A&M University. The survey included clientele identification, academic background accommodation, curriculum development, industry acceptance, academic viability, research identification, and employment prospects for graduates. Interestingly, it was found that thirty-six percent of the firms were not aware of a graduate program in construction and seventy-one percent expressed the opinion that a graduate program was needed (Badger & Segner, 1989). At the same time, the University of Oklahoma provided insight into their development of a second graduate degree offering, the MBA/MS degree in Construction Management. Their existing graduate degree, initiated in 1986, was a Master of Science in Construction Science. The MBA/MS dual degree was an integration between the College of Architecture and the College of Business (Conner & McManus, 1989). In 1989 Purdue University proposed a master's degree program that would be an extension of an undergraduate degree in construction (Moss, 1989). However, this proposed degree program within the Department of Building Construction and Contracting never came to fruition.

Most existing graduate degree programs were reported to be lateral programs that offer few courses in advanced construction concepts. A lateral program is defined as one in which the student pursues a graduate degree in a different field than the undergraduate degree (Moss, 1989). Some graduate courses at varying instutions are nothing more than an undergraduate course with a term paper requirement to differentiate the graduate from the undergraduate, i.e., the University of Oklahoma. The current thinking at that time was to steer away from both the lateral program and the term paper requirement coursework by instituting more of a specialty graduate program which includes a separate group of leveling coursework and credit for practical experience. Roger Killingsworth (1990) conducted a survey to look at population trends and education. Several adaptive strategies were suggested: 1) developing accredited degree programs for the older, part-time student interested in career enhancement, 2) development of business oriented masters programs to meet industry desires for more training in business, management, and communications that cannot be included in already crowded undergraduate curricula, 3) the development of a few Doctoral programs to fill the demand for personnel trained to perform research activities. Further support for program specialization comes from Feigenbaum, & Pedulla (1991). Their work provides a differentiation between program objectives when preparing construction professionals and construction educators for their personal success. It was suggested that in the construction professional program, efforts should be made to target a construction specialization. Oppenheim (1993), indicated that graduate program should provide these three objectives: 1) provide management training so that the graduate can advance more rapidly in the profession, 2) provide students with appropriate experience and inclination for teaching, and 3) provide innovators to a changing industry.

Coursework

Feigenbaum and Pedulla (1991), were the first to use of the term “Essential Elements” of a profession in describing an educational curriculum within our literature. To date there has been no effort to define a core curriculum in construction's graduate education. Essential to the instructional design and concepts taught at the graduate level are the difficulties encountered by graduate professors when considering the personal differences of graduate students, including educational background, industrial background, and level of technical or practical experience. This is central to offering meaningful instruction that is not merely an extension of undergraduate coursework. The instructor must carefully analyze what is appropriate substantive coursework and determine the level of difficulty needed to furnish meaningful instruction (Maher, 1990). Several papers have been presented on graduate coursework at the annual ASC conferences. The first by Marchman, (1991) concerns scope definition and control within conceptual estimating. Marchman's work suggest that because of concept complexity it is best taught at the graduate level. The faculty at Colorado State University, working with the Center for the Stabilization and Reuse of Important Structures explored the integration of historic preservation with graduate studies at both the master’s and Ph.D. levels. Successful ventures as of 1995 included consultation, reuse studies, facility evaluation, historic nominations, and experiential applications. "Beyond traditional educational benefits, these activities build community support and provide funding for research and a growing number of graduate assistantships" (Griffin, Hauck, & Reidhead, 1995, 95). Finally, Nobe and Berryman (1996, 1) reported that "reserve fund analysis was a logical extension of services for construction management professionals and that there is a growing and untapped market that could be filled by properly trained construction management graduate students."

Research Integration

Segner (1990), began the discussion concerning the connection between graduate education and research. Segner stated that the graduate education programs must integrate a research component. This component would generate and disseminate new knowledge and assist in the establishment of academic credibility. It was hoped that the construction industry would finance graduate research and that this support would assist in the recruitment of top-quality graduate students. It would be difficult to argue that graduate education and research do not go hand-in-hand in today's academic climate. Rounds (1992) argued that research funding is going to the researchers converted from the design disciplines who are experienced and highly qualified researchers, rather than to constructors who may have a better understanding of construction, but are simply not qualified in the research area and do not have a track record to demonstrate competence in research. We must develop construction terminal degree programs that will produce the professional construction educator and who is highly trained in research.

Industry Justification

Construction graduate programs have not observed a noticable change in the problems described above and many would argue that a change must occur for our graduate programs to remain viable and to experience professional growth. Graduate construction education is still an anomaly. The industry has yet to accept that graduate students are more valuable than

undergraduates. Most graduate students are considered “retreads” from other disciplines who want to gain the competencies our undergraduates have, but without getting another undergraduate degree. "The ‘90’s must see the growth of true graduate level construction education programs that enable us to feel good about sending our own undergraduates to them" (Rounds, 1992, 145). Moss (1989, 84) stated, "unfortunately, most construction employers are very skeptical. But we should not let their skepticism deter progress. We did not let their skepticism deter us two decades ago (in the formal establishment of the undergraduate degree programs and accreditation process), and we should not now". The expansion of graduate education is necessary for construction education to progress as an academic discipline. Graduate education, research and the expansion of knowledge are part of all other disciplines. "Construction education cannot expect to be accepted as a legitimate academic discipline if it continues to be an exception to the rule. Graduate education is essential to our construction educators" (Moss, 1989, 84). "For construction education to be accepted as an academic discipline it will be necessary for it to exhibit the characteristics found in other traditional university level academic disciplines" (Bilbo & Yeager, 1990, 5).

Graduate Education Model

Even though many of the statements discovered in the review of literature were true ten years ago, sadly, they are accurate today and we within must change not only industry’s perception, but the perception of the academic community. As a result, we submit the following rationale and graduate education model.

Model Rationale

The construction industry and the academic environment have changed markedly since the seventies, both in terms of what is expected of construction education graduates and what is expected of construction educators. The emergence of construction education at universities throughout the nation has resulted in over fifty accredited programs recognized by the American Council for Construction Education (ACCE), and Accrediting Board for Engineering and Technology (ABET). Construction firms now demand that graduates have knowledge, skills, and abilities beyond the traditional technology areas of materials, methods, estimating, scheduling, the architectural areas of design, computer aided drafting, and the engineering areas of mechanical, electrical, geology, and structures. Today’s graduate is expected to have at least an introductory level of knowledge in the legal aspects of construction contracting, alternative contractual delivery methods, financial and economic management, systems communication and integration, and human resource management. Long gone is the expectation that a construction education graduate don a hard hat, steel toed shoes, overalls, and proceed to the field where he or she spends the day toiling in the sun, sleet, rain or snow. Today’s graduate is viewed as a professional manager who enters the industry at a mid-level management position, i.e., project manager, more frequently in shirt and tie than in overalls and hard hat. More emphasis is placed on administrating the construction technologies and the design/construct/manage interface than performing them. Indications are that graduates are gaining acceptance in the industry as professional managers rather than skilled technologists.

As a result of the emergence of construction education as an appropriate collegiate offering, the profile of the construction educator has also undergone changes. No longer will it suffice for a tenure track educator to be engaged solely in the realms of teaching and service to industry. While construction programs will always need to maintain strong ties with the construction industry, this will be best accomplished by the use of adjunct and visiting faculty which bring recent industry experience to curricula. Professional construction educators, in seeking to be recognized by their academic peers, must perform in the realm that their academic peers recognize and respect, specifically research and publication. The thought that construction educators can claim immunity from these expectations because construction education is "different" is not a viable option. In our emerging discipline, with its associated body of knowledge in a seminal stage, academic recognition is essential for continued success. This simply means that to gain academic recognition and respect, construction educators must face the same processes that lead to tenure and recognition of their academic peers in established disciplines. The day is past where Deans should be expected to go to university administration with "hats in hand" to try to explain why the construction educator should not be held to the given standards for tenure and promotion. One of the most important keys to achieve this academic recognition and acceptance is a viable and rigorous graduate program.

Three major facets of concern for graduate education should be addressed by construction programs whether the student holds an undergraduate degree in construction, holds undergraduate or graduate degree from one of the allied disciplines (e.g., Architecture, Engineering, Industrial Technology and Business), or holds a degree from a non-allied discipline. First, there should be a program directed toward career change which would address the needs of students desiring improved ability for: (1) vertical advancement within the industry and (2) the needs of students desiring to move from industry to academia. Second, programs must be able to provide graduate instruction through innovative and non-traditional methodologies. Finally, the emphasis of these innovative career change programs should be the enhancement of existing content knowledge to meet the challenges of a dynamic industry. Advanced knowledge should be provided in construction management concepts and problem solving through investigative research practices.

Model Statement

Graduate programs in construction education should provide students with the opportunity for advanced study in the principles of construction management, science, and technology beyond the level of study within construction baccalaureate degrees. The graduate degree should offer a program of study that is succinctly different in content and methodology from current undergraduate curriculums. In addition to providing study in the management and technical content areas, the graduate program should emphasize experiences in basic and applied research methodology in both scientific and social inquiry. Concurrently, emphasis should be placed on the development and refinement of systems communication and integration as well as the use of current technology in the realm of information management. Skills in inquiry and communication are essential for both academic and industry professionals and will serve to enhance their advancement within their respective vocations.

Career Change Program

There is a definite need to have a graduate program that adequately addresses the needs of students who hold aligned and non-aligned degrees. These students may desire a career move to the construction industry, enhanced advancement mobility, or a move from the construction industry to the academic environment. In trying to develop a sustainable growth pattern for graduate programs, the accommodation of these career change needs should be an integral part of the graduate program. Academic preparation for these students has always been a strong issue of debate - just what content knowledge should be required and what is the best way to enable these students to function and compete with students prepared in the construction discipline? The leveling sequence logic that follows is inherently dependent upon the concept that the graduate program is succinctly different in methodology and content than the undergraduate program. Specifically, this implies that the knowledge, skills, and abilities taught in the graduate program may built upon, but are clearly different from, the knowledges, skills, and abilities taught in the undergraduate program. It is incumbent upon a viable program to move in this direction, whether for a "thesis" option or a "non-thesis" option at the master's level, or a "dissertation" option or a "project" option at the doctoral level. To do less, virtually assures that the graduate program will remain status quo and not achieve the pre-eminent status sought by construction graduate programs.

Career change students will always face the reality of entering a graduate program with less preparation than their counterparts who hold a baccalaureate degree from the construction or closely allied disciplines. The question that has to be addressed is that of "pre-requisites" and "minimal academic preparation." The most desirable and efficient circumstance is for students to have graduated from a construction undergraduate program, however with career change students their lack of academic preparation often presents unique problems. For example, what program options are available to the career change student with five to ten years of construction management field experience? Does the program require them to take remedial coursework that is of lesser quality than their field experience? Some programs require graduate applicants to satisfy academic deficiencies by taking undergraduate courses. The use of existing undergraduate coursework is probably the most efficient programmatic method for students to meet prerequisite requirements. It requires less of the usually over-extended departmental resources. This undergraduate course option could also provide an efficient deterrent to an industry professional seeking a graduate degree. In the recent past a "leveling" option has surfaced. Currently two construction graduate programs are known to be offering leveling coursework, i.e., Texas A&M University and Colorado State University. Colorado State University offers graduate leveling courses during the summer semester and advertises them nationally.

It can be argued that it is in the best interest of both the departments (graduate funding formulas) and the students to accomplish this through a series of not-for-credit "leveling" courses offered by the graduate program. Only in rare circumstances should a graduate student from a closely allied discipline be forced into an undergraduate course to provide pre-requisite knowledge and skill. It should be incumbent upon the student's advisor to assess the academic needs of each graduate applicant that are unique to that student's academic and experience background.

The coordinator of each course sequence/content area of the undergraduate program should be responsible for the development, monitoring, and evaluation of leveling coursework. If evaluation leads to the conclusion that one leveling course is not enough, as may be the case in structures, methods and materials, or any undergraduate course sequence, then the course sequence coordinator should make recommendations regarding expanding the leveling courses for that sequence/content area. It should be noted that this does not automatically dictate another course, but may involve adding a lab, increasing the semester credit hours from three to four, etc. Even a comprehensive reading list might suffice to alleviate the deficiency. Self-study courses could be offered "on the web" or in similar individually paced programs. Endeavors to provide "pre-requisite knowledge and skills" should be developed at the graduate course level and avoid undergraduate course work (with rare exception). Efforts must be made to maintain a balance between the number of required hours in leveling course work and the needs of the student to complete their advanced education and either enter the job market or realize timely advancement benefit. Regardless of the method, the required outcome of the leveling sequence is certain: the students must be prepared to enter subsequent graduate work in the same courses with the same requirements as their counterparts.

Because of the logistic problems created with continually offering the leveling sequence, thought should be given to teaching these courses sequentially on an annual basis beginning in the fall semester of each year. Essentially this means that all "career change" students would enter a leveling program at the same time each year and complete their pre-requisite program together. This leveling sequence might cause the graduate program to lose a few career change students. However, in order to maintain a sustainable growth pattern and with limited faculty teaching resources this is should be the best option. Advertising these courses internally where the undergraduate program is offered and across the campus would likely provide students from a variety of disciplines needing elective enrollment. This inter-disciplinary approach will increase the visibility of the program as well as keep unprepared students out of the advanced courses contained in the core construction curriculum. Another benefit of having a comprehensive set of "leveling courses" is the opportunity to get more faculty involved in the graduate program. It would be extremely valuable to have all tenured and tenure track faculty teaching a minimum of one graduate course per academic year. The emphasis would be to provide graduate students with more research options on a more dynamic variety of issues. Faculty would benefit by having graduate students directly involved with their research and writing which is necessary for their tenure and post-tenure reviews.

It is in the "career change" program that the optional professional internship requirement could provide further knowledge and skills to "close the gap" between graduates of construction education programs and those from allied and non-allied disciplines. From this perspective, the professional internship would be required of all students, not in the "thesis" or "dissertation" option, who have no meaningful practical experience in construction management. Although an administrative headache, the internship requirement would help alleviate the concerns of many faculty, who accurately voice the fact that a student could graduate with graduate degree in construction without having any work experience in the construction industry. Uniform enforcement of the internship requirements, with clear guidelines for exceptions, would be paramount in the success of the graduate internship program.

Non-Traditional Approaches

One thing is certain; higher education is under pressure to expand the offerings beyond the traditional classroom. Questions to be addressed regarding non-traditional degree programs include residency requirements, faculty commitment to teaching assignments and course loads, travel compensation, fiscal considerations, inter-system agreements, and the level of enrollment necessary to maintain the offerings. While offering continuing graduate education courses through non-traditional approaches is in most cases feasible, the establishment of a non-traditional graduate degree program would require a substantial commitment of departmental and college resources. The guiding tenets and university commitment for this endeavor should be embraced by the college and outlined in the departmental strategic plan. Three instructional delivery strategies are offered for going beyond what has been considered a traditional offering of construction graduate education; (1) distance education through the electronically broadcast classroom and Internet coursework, (2) off-campus training programs for graduate credit using various corporate facilities and satellite system campuses, and (3) consistent evening and weekend course offerings.

Perhaps the best entry into non-traditional offerings is through the delivery medium of the graduate program. Clearly, new instructional media technologies have given providers of higher education unique options for the delivery of course work and instruction that wasn't commonly available five years ago. One of the tenants of distance education is to reach a more diverse and geographically dispersed audience not accessible through traditional classroom instruction. The key to embracing the new technologies of instruction is the systematic planning and design of instructional objectives that fit into the overall strategy and philosophy of the university's graduate program.

The electronic classroom and Internet course offerings are no longer a thing of the future, innovative educational technology is here and available. "If the nation is to benefit from the scientific and technological advances predicted for the 21st century, the educational systems in place must be retooled, according to the presidents of the National Academy of Sciences (NAS), and the National Academy of Engineering (NAE). And the Internet sits at the center of that process" (Citing online document, URL http://www2.nas.edu/whatsnew/2842.html). And at the graduate level, the Internet will provide students with access to the best faculty, no matter where in the world students or faculty are located (Alberts, 1998). The College of Engineering's Center for Distance Learning (ECDL), at the University of Texas at Arlington, provides educational opportunities for graduate students in several disciplines, currently offering programs in Aerospace Engineering, Computer Science & Engineering, Electrical Engineering, and Mechanical Engineering. Since 1977, ECDL has offered 1231 courses to 10,920 students and is currently delivering graduate classes to students electronically in three formats: videotape, closed-circuit television, and via the Internet (Citing online document, URL http://engineering.uta.edu/).

The electronic classroom is much like an ordinary traditional classroom. Students and professors interact through the spoken word, see each other and may interact by employing audio, video and computer technology (e.g., whiteboards) in the classroom which are linked over the Internet or uplink system. The essential difference between ordinary classrooms and electronic classrooms

for the users is the students and the instructor may be at different locations; e.g., the professor and one group of students may be in one classroom while another group of students is in another classroom - perhaps on the other side of the country (Pedersen, 1998). The students participating at those distant sites can both see and hear the professor or presenter and the people in classrooms other than theirs. The electronic classroom is designed with the goal of allowing users to communicate much as they would have done had they been in the same room. The electronic classroom and Internet coursework will require a substantial startup effort and will possibly require the retraining of faculty. A concerted effort in marketing a distance education program through these non-traditional strategies would be essential if this approach was to become an integral part of the "sustainable growth" for the graduate programs.

The off-campus program offers the easiest opportunity to enter into a "non-traditional" approach to graduate education. Certainly, in today's market, it makes more sense to have one professor travel to teach a course, rather than twenty students travel to take a course. This involves changing not only the existing mindset that the graduate program is only for full-time students, but also that graduate coursework should be offered only at the major university campuses. It should be noted that an evening and Saturday masters curriculum has been developed and implemented at Southern Polytechnic State University. Quickly, the question of "Where do we offer the program?" enters the equation. There has been much discussion of using various corporate facilities to teach off-campus courses for graduate credit. In keeping with the tenet of "sustainable growth", an off-campus program would be better served if the program was offered at a college or junior college campus rather than a corporate facility. In the corporate environment, it is inherent that the program could become identified with the specific company rather than the host department's program. If a major construction company wants to offer their facilities for a graduate course, it can be done; however, it should be done to include students external to their organization. In the large metropolitan markets, there will be several corporate office locations available of suitable size and adequate facilities.

The graduate program, if offered on another campus, could serve the same corporate needs and would appeal to a broader market. This could easily be done at satellite campuses. The graduate program could easily be offered on the campus where the residency requirement could be met, and through their established contact in the junior college venue. Graduate programs at these satellite campuses are already established to meet the needs of the full-time employees in the large metropolitan markets. Some of these campuses are known to have indicated a strong interest in having a construction graduate program offered in conjunction with their own undergraduate program. Faculty have indicated that potential students have requested graduate courses in construction, but the current departments do not have the resources to offer them.

The simple act of reaching out to potential students that are full time employees would add an aspect to the graduate program that has generally been ignored. Little effort has been made to provide industry practitioners, who must remain gainfully employed, with an opportunity to pursue advanced graduate work. If the program is within a large metropolitan area, course scheduling can be one possible solution. A simple shift from morning to late afternoon or evening scheduling would be sufficient. Another strategy would be to offer weekend courses. A weekend course offering could begin with three hours on Friday evening and include all day Saturday. The major concern with this option as well as the off-campus strategy, would be

course rotation. Courses would have to be rotated in such a manner that a student could eventually receive all the required coursework.

Graduate Programs

The remainder of this manuscript is dedicated to a description of how the proposed graduate education model can be integrated into the Master's and Doctoral programs in construction education. In addition, attention is drawn to the activities of a Program Coordinator and finally, academic rigor.

Masters Program

It is expected that students would be entering the Masters program from the construction industry, construction baccalaureate programs, other closely aligned disciplines and non-aligned disciplines. In the case of the first two sources, very little, if any, pre-requisite or leveling coursework would be required. However, this is not the case with students from the aligned and non-aligned disciplines. Many of these students will have limited content knowledge in construction management and will most likely require additional coursework to bring them up to the same level as their industry or construction graduate counterparts. Evaluation of their content knowledge could be conducted by the graduate advisor on an individual-by-individual bases or simply requiring the passage of the Certified Professional Constructor (CPC) exam as a prerequisite for entry into the core graduate curriculum from the leveling coursework.

All Master's programs, whether career change or not, should require the mastery of a "core of knowledge" for the graduate level of construction education. This core should be twelve to fifteen hours and be required of all students in the graduate program. It should be unique enough that students coming directly from undergraduate study discover new knowledge, skills, and abilities, without repetition of the content of the undergraduate course-work. There has been much discussion over the years of the necessity of requiring that students entering the Master's program have significant work experience in the construction industry. While the value of such experience is evident, this should not be a requirement for entrance into the program. As part of the sustainable growth, entrance from undergraduate programs should be encouraged. These inquiring minds should be welcomed as part of a viable Master's program.

Beyond the "core of knowledge," the program should be structured to allow students to seek a "specialty area" of interest such as facility management, project controls, information management, project finance and development, etc. These specialty areas should meet the objectives of the departmental strategic plan and be compatible with the expertise of the major professor(s) who will provide guidance to the graduate student. However, the committee chair should determine each student’s specific curriculum content or degree plan. Complementary course-work from outside the department should remain an integral part of the Master's program.

The Master's program should offer both a thesis option and a non-thesis option. Regardless of the option undertaken, methods of scientific and social inquiry should be an integral part of any

degree-awarding curriculum. A research methods course specifically developed to address research design and methods, population parameters, sampling techniques, data collection, proposal writing, and academic publications in the construction industry, should be required of all students seeking a graduate degree. This research core course should be taught as a method of assisting students in identifying a specific construction industry problem and establishing a systematic plan for investigation. Coupled with the research methods course, all graduate students should be required to complete a minimum of three additional hours in quantitative research statistics. Students taking the thesis option should also be required to take six hours of research statistics from a statistics department, three of which should be a course in qualitative research methods and data analysis. This emphasis on problem identification, information collection, data analysis, and solution communication will be beneficial to all graduate students whether they are industry or academia bound, regardless of thesis or non-thesis option.

For the non-thesis students with no prior extended period of construction management experience, a professional internship option would be an excellent way to assure that all students, upon graduating with a Master's degree, have at least some exposure to work in the construction industry. As long as the non-thesis option is clearly the easiest path to graduation, few students will choose the thesis option unless the student has entered the doctoral path. The internship, if required for the non-thesis option, would help to alleviate the discrepancy in effort required between the two options. In concept, the internship would require a full semester, or full summer term, working within the construction industry, or a closely allied industry. Before the internship, the student would be required to complete the “research core” and establish their graduate advisory committee. With direct guidance from the committee chair and approval of a majority of the committee, a proposal is written outlining the internship criteria, i.e., the sponsoring firm, the problem statement, the method of investigation, and data collection. While serving the internship, the student would be responsible for gathering the data necessary to analyze the proposed problem and support its conclusion. Upon returning to campus the student would complete the remaining coursework, analyze the data, and write a journal-ready manuscript ready for submission. This would enable the non-thesis graduate student to address "actual construction management" problems, validate time spent in the construction work environment, and demonstrate that they have developed effective analytical problem solving and communication skills; all of which will serve as program-marketing tools to promote graduate education in the construction industry and academia.

Doctoral Program

It is unlikely a construction Ph.D. program would receive approval without a Master's program that was flourishing. If the needs are such that a Ph.D. program cannot wait for the three to five years it would take to develop a departmental program from the ground up, then the obvious strategy is a collaborative effort with an established Ph.D. program. As found in the literature review for this manuscript, it is quite apparent that the construction industry sees very little "value added" in the Master's program for employment purposes. It is also unlikely that a great deal of support can be expected from the industry for a Ph.D. program.

The demand for construction Ph.D. graduates is in academia, and it should be noted that this demand has been extremely high for several years. Given the nature of expanding construction

education programs across the nation, this demand will likely remain steady for many years. It is this demand, and the corresponding opportunity for construction graduate programs to take the lead in preparing the next generation of construction educators, that prompts the immediate call for a "collaborative" program. Given the demands of higher education, a program that jointly produced Ph.D. graduates with a technical content base from a construction program and the educational preparation from a education program would be well received by the institutions which have faculty openings that require or prefer candidates with an earned doctorate. This type of program would also enable departments to provide a Ph.D. with minimal added resources. To begin from scratch to establish a Ph.D. program for many construction education programs would take far too long to take advantage of the current opportunity and demand.

Program Coordination

Uncontrolled growth which stretches faculty resources beyond a suggested ratio of one full time equivalent (FTE) per ten graduate students should be avoided, if possible. When the ratio of graduate students begins to exceed this figure, it is unlikely that a quality program can be sustained without additional resources. Out of necessity, a large part of a graduate student's degree program is the responsibility of graduate student. The individual graduate student must assume the responsibility for their degree program (Oppenheim, 1993).

Comprehensive coordination of the graduate program is essential, especially in a period where increased enrollment and changes in the scope and offerings of the graduate program is expected. The very nature of the Master's degree is one of "time compression"; that is a student may expect to graduate from 1.5 to 2.0 years from the time he or she enters the program. This places a great deal of emphasis on the guidance, counseling and coordination of each student. Specific guidelines established in a "Graduate Procedures Manual" should be provided each student upon their beginning the graduate program. In this manual, specific information, including timing, should be covered for:

- selecting a graduate committee
- degree requirements
- residency requirements
- filing a degree plan
- changes to degree plans
- petitions
- final examinations
- applying for graduation

Information and guidelines for the non-thesis option should be included, as well as information regarding internship requirements. Thesis options should be addressed as well as information about core requirements and selection of electives. In short the graduate manual should be a handbook of standard procedures for all aspects of the Master's degree program, a self-help guide for students.

One of the major services that the Program Coordinator should provide is assistance in selection of committee members and committee chairs. Students should have their committee chair

selected before entering their second semester of coursework. A concerted effort needs to be made to involve more faculty in graduate programs, both through teaching and through mentoring/chairing of student graduate committees. The graduate curriculum needs constant evaluation and tweaking as a dynamic entity, not as a static entity. The program coordinator should see that this is accomplished, while ensuring that curriculum matters remain the purview of the faculty. This is not always an easy task. It could be argued that the more actively involved faculty is in teaching graduate courses, the easier this will become.

Beyond these matters, the Program Coordinator should focus on student recruitment and admissions, marketing strategies, evaluation and feasibility analyses of expanded and non-traditional graduate offerings, and maintain the effort toward developing a Ph.D. in construction while maintaining a customer focus necessary for the development an effective graduate program strategy (Feigenbaum,1993). Perhaps the key word here is "coordinator". Delegation of responsibility and authority is a vital element of the "Coordinator" position. No one person can accomplish all that needs to be done and remain active in teaching and research. As the program expands and new options are offered, the graduate program cannot be a "one-person" show. A shift in the commitment of resources is essential in moving the program to "pre-eminent" status. Expanded involvement of existing and new faculty is imperative in developing a successful team of graduate educators.

Quality and Academic Rigor

And finally, a word about quality and academic rigor. Programs where there is a substantial differential in the amount of effort required of students enrolled in the graduate programs should be avoided. The line of "academic freedom" for professors should never be breached. However, all professors should insist on a standard of quality that has been endorsed by the graduate faculty for all graduate students. Standards for the non-thesis option should be consistent and applied uniformly to avoid inequities. All theses or professional papers should require a proposal, submitted and approved by the student's graduate committee, before the research is conducted. All research papers, whether a thesis or professional paper, must be more than a regurgitation of previous research; each should include a unique contribution to the body of knowledge in construction education. Academic rigor, proper documentation and format, should be an integral part of the research component of all graduate programs. Each department's graduate faculty should develop and implement guidelines, with appropriate standards of rigor and quality. Research and inquiry as presented in non-thesis papers need to focus on the creation of new knowledge or the solution of a specific problem. Research efforts, whether they are theses or professional papers need to use appropriate methods of inquiry and be presented using proper academic format. Traditional graduate programs, non-traditional approaches, and all offerings by graduate construction education should be characterized by standards of high quality and academic rigor as benchmarks of performance.

Conclusions

There is a lack of direction and leadership concerning graduate education programs identified by the review of literature within this manuscript. The model presented here is intended to provide

a general framework for graduate construction education that is responsive to the current issues in the construction industry and the academic environment. However, additional work needs to be undertaken to establish not only the current state of construction graduate education, but where specifically graduate education needs to adapt to be responsive to the identified needs. First, an in-depth survey and accounting of current construction graduate programs including their history and current curriculum must be identified. Second, the ASC graduate education committee and graduate education providers need to identify and establish a consensus concerning the essential elements of instruction (EEI) for the core of a construction graduate program with specific outcome designs adapted to both industry and academic. Finally, this group must identify construction-related specializations that industry and academics would recognize as value-added graduate education.

References

Alberts, B. (February, 1998). *Presidents opening address to the National Academy of Sciences.* [WWW document]. Presented at the Annual Meeting of the American Association for the Advancement of Science, Philadelphia, PA. URL http://www2.nas.edu/new/217a.html.

Associated schools of construction. (1998, October). *Strategic planning session.* Estes Park, CO.: Author. URL http://ascweb.org/dironly/strategic_plan/plan_report.htm.

Badger, W. W. & Segner Jr., R. O. (1989). The challenges in establishing a master's degree program in construction. *Proceedings of the 25th Annual Conference of the Associated Schools of Construction, Lincoln, NB,* 1-8.

Bilbo, D. L. & Yeager, L. D. (1990). Is construction education a university level academic discipline? *Proceedings of the 26th Annual Conference of the Associated Schools of Construction, Clemson, SC,* 5-7.

Conner, H. C. & McManus, B. (1989). A dual degree MBA/MS in construction management. *Proceedings of the 25th Annual Conference of the Associated Schools of Construction, Lincoln, NB,* 23-28.

Feigenbaum, L. (1993). Using TQM concepts in the recruitment of graduate students. *Proceedings of the 29th Annual Conference of the Associated Schools of Construction, Fort Collins, CO,* 83-87.

Feigenbaum, L. & Pedulla, A. (1991). The dual function of graduate construction education. *Proceedings of the 27th Annual Conference of the Associated Schools of Construction, Provo, UT,* 1-5.

Griffin, S., Hauck, A. J. & Reidhead, J. D. (1995). Historic preservation: New opportunities in graduate education. *Proceedings of the 31st Annual Conference of the Associated Schools of Construction, Tempe, AZ,* 95-99.

Hauck, A. J. (1998). Construction management curriculum reform and integration with a broader discipline: A case study. *Journal of Construction Education, 2*(2), 127-140.

Killingsworth, R. (1990). The effects of population trends on construction and construction education. *Proceedings of the 26th Annual Conference of the Associated Schools of Construction, Clemson, SC,* 27-33.

Maher, R. P. (1990). The problem of 'leveling' instruction in construction management education. *Proceedings of the 26th Annual Conference of the Associated Schools of Construction, Clemson, SC,* 1-3.

Marchman, D. (1991). Conceptual estimating as a topic in a graduate construction curriculum. *Proceedings of the 27th Annual Conference of the Associated Schools of Construction, Provo, UT,* 7-10.

Marshall, J. A. (1990). The growth of graduate education in construction management. *Proceedings of the 26th Annual Conference of the Associated Schools of Construction, Clemson, SC,* 19-21.

Moss, D. D. (1989). Proposed master's degree program for constructors. *Proceedings of the 24th Annual Conference of the Associated Schools of Construction, West Lafayette, IN,* 84-85.

Newitt, J. (1987). Validation of construction management curriculum. *Proceedings of the 23rd Annual Conference of the Associated Schools of Construction, West Lafayette, IN,* 23-27.

Nobe, M. D. & Berryman, C. W. (1996). Incorporating reserve fund analysis into graduate construction education. *Journal of Construction Education, 1*(2), 10-14.

Oppenheim, P. (1993). A student manual for a construction masters program. *Proceedings of the 29th Annual Conference of the Associated Schools of Construction, Fort Collins, CO,* 69-75.

Pedersen, G. (October, 1998). *Distributed Electronic Classrooms.* [WWW document]. URL http://munin.uio.no/English/intro.html.

Rogers, L. & Christensen, K. (1992). Perceptions of construction management faculty regarding factors which impact their research productivity. *Proceedings of the 28th Annual Conference of the Associated Schools of Construction, Auburn, AL,* 123-128.

Rounds, J. (1992). Construction education: On the brink. *Proceedings of the 28th Annual Conference of the Associated Schools of Construction, Auburn, AL,* 145-150.

Segner, R. O. (1990). Graduate construction education: A means to construction research. *Proceedings of the 26th Annual Conference of the Associated Schools of Construction, Clemson, SC,* 13-17.

Williamson III, K. C. (April, 1993). Unpublished report to the ASC Board of Directors. *ASC support for a journal of construction education.* 29th Annual Conference of the Associated Schools of Construction, Fort Collins, CO.