2006-1175: A CAREER IN BUILDING DESIGN - EDUCATION IN CIVIL ENGINEERING VERSUS ARCHITECTURE

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A Career in Building Design:
Education in Civil Engineering versus Architecture

Abstract

In the construction profession, the trend in "transprofessional" discipline practice that combines structural engineering and architecture has gained prominence and the line that separates the different roles in the construction industry has already become blurred. The two professions are so interrelated that the industry values a background in both fields. Increasingly more universities across the country and the world have an Architectural Engineering curriculum. However, most existing programs emphasize training in Architectural Engineering with significantly less emphasis placed on structural engineering. In this report, I devised an undergraduate curriculum(s) at NC State University to build a professional career in building/bridge design with strong emphasis in both the structural as well as the architectural aspects. This plan may serve as a model for programs interested in a similar training path.

NC State University provides a unique opportunity with a strong faculty and testing facilities through a nationally ranked structural engineering and architectural programs. Many of the students with interest in both architecture and civil engineering are usually forced to choose one over the other. Without proper guidance, these students often lose valuable time and graduate with a single degree in either civil engineering or architecture. Therefore, I decided to explore and create a curriculum with an emphasis in civil engineering and substantial training in architecture. To accomplish this, I explored the undergraduate program content of the civil engineering and architecture degrees to discover fundamentals that are essential to making a substantial contribution to the professional field of building and bridge design. The backgrounds of existing architectural engineering educational programs, both national and international, were studied to gain a better understanding of the basic knowledge necessary for an architectural engineer. I researched the educational backgrounds of present leaders in the field of architecture, engineering, or architectural engineering to try and formulate an academic plan for success in a technical career. From all of the aforementioned actions, I formulated a program for my university using existing classes that could potentially become a curriculum for architectural engineering at NC State. In conclusion, I propose a plan for a five year dual-training program. I expect that this program would help future students who are interested in such a career.

Introduction

Conventionally, construction professionals like architects and engineers occupy segregated roles in industry. However, it has been recognized that civil engineering and architecture are career paths that continually intertwine. Although the two professions are combined to achieve a single goal, a structure, the different aspects of the unifying goal are extremely separate, i.e. structure design and the mechanics of the structure. Very similar to the real world industry, undergraduate studies in civil engineering with a

structural emphasis and architecture are both focused on structures, just from different perspectives.

Objective and motivation

The purpose of this investigation is to find a mix of education in the two degree programs that would best help me to make a significant contribution to the future of structure design. Additionally, this research is aimed to explore the program content of civil engineering and architecture degrees to discover fundamentals that are essential to obtaining a leadership position in a professional field. Leadership is the birthplace of innovation; this idea of leadership and innovation is perpetuated by a strong background in education, however, which type of training is the question. My motivation for this study is to determine a path of study for myself, and possibly other students in the same situation, that will perpetuate a leadership role in the professional world through a certain and specific educational route.

After researching programs from other institutions, both national and international, and investigating the course requirements of the architecture program and the civil engineering program here at North Carolina State University, I have realized that although it is near impossible to double major in two such demanding fields, degrees in both are attainable and beneficial to a person interested in the civil engineering aspect as well as architectural aspects of structural design. In researching the trans-professional aspect of education in civil engineering and architecture, a question arises; how should some one proceed with their higher education when interested in a career that encompasses both these fields.

Existing programs

The trend in "transprofessional" discipline practice has become obvious, and the line that draws the separation between different roles in the construction industry has already become blurred. Because of this, "it would be expedient to design and to implement common courses and curricula for all construction disciplines in order to promote unity and common objectives among professionals in the construction industry"[6]. Construction professionals of today's industry are calling for a "multidisciplinary and integrative-professional approach to professional education"[6].

There are a handful of universities that are developing or have developed programs that are considered to be hybrids of the civil engineering and the architecture curriculum. Often referred to as architectural engineering, this degree is offered at such universities as Princeton and Penn State, and foreign institutes like King Fahd University of Petroleum and Minerals in Saudi Arabia.

The program at the King Fahd University of Petroleum and Minerals lists its objectives in teaching architectural engineering as teaching engineering from a scientific and analytical aspect, yet at the same time emphasizing the architectural concepts. The professors of the university describe the program as "well balanced in theory, analysis,

and design"[1]. The architectural engineering curriculum that the university offers is accredited by both the Accreditation Board for Engineering and Technology (ABET) and meets guidelines set out by the American Society of Civil Engineers (ASCE) for accreditation. However, there are drawbacks with respect to time when considering the program. The degree that KFUPM offers requires 139 credit hours plus a two month internships. Instead of the typical four year undergraduate program, this program also requires an additional fifth year [1]. See Table 1 for the five year degree plan for KFUPM.

As early as 1973, programs were already developing for a joint education between civil engineering and architecture. During the 1970's, Robert Mark, Professor of Civil Engineering at Princeton University formulated a "joint faculty appointment between the School of Architecture and the Department of Civil Engineering" [9]. Despite this innovational development, earlier programs offered no accredited degree. However, the graduating class of 2008 was able to enroll in a program entitled "Civil and Environmental Engineering, Architecture and Engineering-Structures Focus" which is ABET accredited [13]. This curriculum is offered on Table 2. Program development such as the aforementioned is evidence of the necessity for changing curriculum to accommodate the rise trans-professional oriented students.

By 1995, an average of 10 students a year enrolled in the matured program which offered an accredited degree in engineering only [9]. Much like the program at KFUPM, the dual career oriented curriculum at Princeton focuses on "core engineering courses in math, science, and engineering science … [and] core program courses in architecture" [9]. A large difference between the KFUPM program and the Princeton program is that KFUPM actually developed a new department specifically for "architectural engineering" while Princeton's students enrolled in the curriculum simply take courses from two different departments, in fact, "most of the courses are part of regular non-program offerings" [9]. This could be the reason why the program only accredits the engineering portion of the curriculum. The four year architecture program at Princeton awards an A.B degree, which is not a professional degree [9]. As explained by the writers, a graduate program is required for certification. The four year curriculum can be located in Table 2. The curriculum is an updated version of the program originally established. The four year plan is accredited, and the current curriculum is an example of a course load for enrolled students.

Another extensive and accredited four year plan for architectural engineering is offered by Penn State. The degree plan for Penn State's AE program is a good example because contains classes essential to both fields of architecture and engineering. The ten semester plan includes a total of 168 credits. Their five year degree program is provided on the Table 3.

In comparing the curriculums for NC State's Civil Engineering Program (also provided in the following) with Penn State (only one out of four possible curriculums are shown), an observer can realize the similarities in certain course requirements. There are 29 courses offered (but not mandatory) in Penn State's degree plan that are designated as architectural engineering courses, however most of these courses are offered at NC State

in other departments of engineering or in the design school's architecture program. Almost all of the general requirements (calculus, physics, economics, etc.) are the same for both programs (Penn State and NC State; Table 3, Table 4) and many of the fundamental classes for civil engineering are present in both are drawn out on Table 5.

A dual program at NC State and other paths of education?

It is possible for NC State to devise its own Architectural Engineering Program using the core classes essential to both architecture and civil engineering. The problem in this plan of action for an NC State student is primarily where to find all the courses necessary for a BS in Architectural Engineering. Another query arises when these courses are found at NC State in either the College of Engineering or in the curriculum of the Department of Architecture; how important are certain classes? Is it possible to finish this degree in four years by eliminating certain classes that can are considered to be extraneous? To determine this, it is necessary to attain the objective assessment of members from both engineering and architecture representatives of NC State on which courses are fundamental to a dual education.

Using courses presently offered at NC State in both civil engineering and architecture, I have devised a four year program that could potentially become Architectural Engineering at the university. I did this by substituting the technical electives of the civil engineering curriculum with courses essential to the basic concepts and understanding of architecture from the architecture curriculum. The engineering science electives were replaced with a studio class. I also found that many courses essential to the understanding of structure design and architecture were existing CE classes that are required for a CE concentration in structures and could also be easily used for a program in architectural engineering. The potential plan for a four year program is in Table 6. Table 4 and 6 do not show the humanities social science requirements. It is anticipated that the number of credit hours proposed would go up by approximately 15 or more hours to account for these requirements

In creating a dual program, the question of necessity arises. Why is it important to implement architectural engineering, a trans-professional degree program, not just at NC State, but at any higher educational institution? Also, many combinations of different degree programs can create a trans-professional program; what differentiates architectural engineering from the rest?

The necessity of a joint architecture and civil engineering curriculum is apparent in the rising demand for professionals in the construction and structure design industry. The U.S Department of Labor predicts that from present to 2014, architects will realize "employment growth" and a large increase in commercial construction as well as residential construction. These factors coupled with a significant amount of retiring architects show the need for more individuals trained in the structure industry [3]. Additionally, civil engineering is a career on the rise. The U.S. Department of Labor shows that the United States should experience an increasing demand for civil engineers. Presently, of the twenty seven percent of scientific and engineering professionals, a large

majority work "primarily for firms providing architectural, engineering, and related services" [4]. As evident in Figure 1, construction related industries are expecting a rise in demand, and this fact proves the necessity of a joint architecture and civil engineering program. Overall, with an expected 11.4 percent growth rate, the structure design industry will require more programs such as architectural engineering to supplement an increasing need [5].

A major factor of undergraduate engineering studies and education is the Accreditation Board for Engineering and Technology (ABET). For the proposed four year NC State architectural engineering curriculum to be accredited, it will have to meet requirements of course work and faculty set by the ABET. The proposed curriculum is constituted of courses borrowed from the College of Design's architecture program and various curricula from the College of Engineering. The civil engineering program and architecture program at NC State are ABET accredited and National Architectural Accrediting Board (NAAB) accredited respectively. The faculty of both colleges has already met various requirements for their respective programs to earn accreditation. Table 7 contains a table to illustrate specific courses that may be used to satisfy the various ABET requirements.

In determining which courses or path of education is ideal for a trans-professional career, it is important to look at the industry and what it demands of professionals in the world of dual occupations with civil engineering, architects, and architectural engineers. A quick search on any job locating internet search engine will reveal that there is a wide demand for those with trans-professional skills involving architecture and civil engineering. A sample of job descriptions is listed below:

· "TKDA is a $30M, multi-discipline engineering firm … seeking … person to lead the architectural design of industrial railroad facilities. This position requires a Bachelor of Science Degree in Architectural Engineering …"

· "MRI, Inc. ARCHITECT - ARCHITECTURAL / ENGINEERING BUILDING TECHNOLOGY – CALIFORNIA. Investigation, evaluation, and repair design of contemporary and historic buildings and structures … Assignments both as a Project Engineer and a Project Manager. Licensed architect …"

· "Urban Designer / Land Planner - Visalia, California
About the Position:
Urban Designer position for private engineering firm specializing in site engineering, surveying, land planning, and architectural services …
The ideal candidate will have a high degree of creativity and design skills. A background in planning, architecture, landscape architecture, or urban design is desirable …"

These are just three sample vocational openings out of thousands. The cross education between architecture and civil engineering is essential in today's structure industry. The two professions are so interrelated that the demand for both in a work environment is extremely high. The industry values a background in both fields, regardless of a professional's actual license and technical degree.

Another method of ascertaining the perfect path of education for a career involving architecture and engineering is investigating the educational backgrounds of professionals who have succeeded in a trans-professional field. Some examples of leaders in the industry and their past academia are included. Mario Salvadori, an original partner and Honorary Chairman in the respected Weidlinger Associates inventive structures and civil engineering firm, held a Ph.D in engineering and participated in the Manhattan Project. Although Salvadori received no formal education in the field of architecture, he taught at Columbia's School of Architecture, Planning, and Preservation [2]. Al Oak is the chairman and the CEO of successful Indianapolis based "an architectural, engineering, surveying and consulting firm" [11]. Oak's bachelor's degree was in civil engineering. Michael Scott, the chief operating officer and vice president at the multidisciplinary HTNB, is experienced in both structure and architecture. Scott received a bachelor's degree in architectural engineering and architecture, and a master's degree in civil engineering [8]. All of the aforementioned innovative leaders in the industry have an assorted background in engineering and architecture. Whether learned in civil engineering, architecture, or both, individuals have developed into leaders in the professional world. From this fact, one could deduct that the specific path of education when considering a trans-professional career is not as important as the individual's actions.

Conclusion

After investigating programs which entail aspects of civil engineering and architecture, the recommendation of this study is for a person with interests in both career paths to pursue an undergraduate degree in engineering, specifically civil engineering to ensure proper professional accreditation. To supplement this plan of action, a minor, a double major, or even a masters degree in architecture is suggested. To implement a plan of education in preparation for a dual career, a student at NC State would need to meet the 126 hour credit requirements for a degree in CE as well as an additional 15-18 hours for a minor.

If the plan of action included a double major, depending on cross over credits between the two four year plans, it could take a student anywhere from six to eight years due to the extreme differences in core requirements and emphasis at the undergraduate level of architecture. A double major would include 47 cross over credits (humanities and social science, math natural science, language proficiency, and English general education courses), 80 studio or ARCH designated hours, and 85 hours for CE matriculation courses. The sum of those hours is 212 credits required for a double major; this total tops required hours for a four year degree in ARCH (127) and in CE (126) by about 85 hours,

or when considering time and duration, 5.66 extra semesters (if a student registers for 15 credit hours a semester).

Another option is to pursue two degrees, a Bachelor degree in one field and a Masters degree in the other. With respect to time, it is more convenient to earn an undergraduate degree in CE in four years and a graduate degree in two and a half to three years in ARCH, and both degrees would be accredited.

Future research

Future investigation on this matter includes coordinating cooperation between the College of Design's Architecture Department and the College of Engineering to design an architectural engineering degree at NC State. In order to create a program, input from both respective departments is necessary to develop an efficient and accredited degree program.

It is also vital to the creation of an architectural engineering program to determine whether a four or five year program would be best. The duration of a program is usually a strong determining factor for a student debating between programs. The duration depends on course load and courses essential to both concentrations. Again, the cooperation between departments is imperative.

Table 1: Five Year King Fahd University of Petroleum and Minerals Arch E Curriculum[1]

Preparatory Year

Fall Semester

Course #	Course Name
ENGL 001	Preparatory English I
MATH 001	Preparatory Math I
ME 001	Preparatory Shop I
PE 001	Prep Physical Edu I

Spring Semester

Course #	Course Name
ENGL 002	Preparatory English II
MATH 002	Preparatory Math II
ME 002	Preparatory Shop II
PE 002	Prep Physical Edu II

Freshmen Year

Fall Semester

CE 101	Engineering Graphics
CHEM 101	General Chemistry I
ENGL 101	English Composition I
MATH 101	Calculus I
PE 101	Physical Education I
PHYS 101	General Physics I

Spring Semester

ICS 101	Computer Programming
IAS 111	Islamic Ideology
ENGL 102	English Composition II
MATH 102	Calculus II
PE 102	Physical Education II
PHYS 102	General Physics II

Sophomore Year

Fall Semester

ARC 110	History of Architecture
ARE 201	Architectural Graphics
ARE 211	Construction Materials
CE 201	Statics
IAS 200	Intro to Arabic Essay Etc.
MATH 201	Calculus III
CE 260	Surveying I
PE 201	Physical Education III

Spring Semester

ARE 202	Architectural Design
ARE 212	Construction Systems
CE 203	Structural Mechanics I
CE 204	Structural Mechanics Lab
ARE 221	Computer Graphics
MATH 202	Element Diff Equations
IAS 222	Qur'an & Sunnah
PE 202	Physical Education IV

Junior Year

Fall Semester

ARE 303	Working Drawings
ARE 321	Acoustics & Illumination
CE 305	Structural Analysis I
ME 203	Thermodynamics
IAS 333	The Islamic System
CE 230	Engin. Fluid Mechanics

Spring Semester

ARC 300	Workshop/Summer Intern
ARE 322	Mechanical systems
ENGL 214	Technical Report Writing
CE 315	Reinforced Concrete I
ARE 331	Building Economy
EE 208	Electrical Systems
IAS 300	Arabic Terminology

Summer Session/Summer Internship

Senior Year

Fall Semester

ARE 400	System Design in Bldgs.
ARE 401	Senior Thesis Proposal
ARE 413	Construction Management
ARE ***	ARE Elective I
CE 353	Geotechnical Engineering
IAS 400	Arabic Syntax

Spring Semester

ARE 402	Senior Thesis
ARE 412	Contracts & Specs
ARE ***	ARE Elective II
CE 408	Steel Design I
IAS 4**	IAS Elective
*** ***	Elective

Table 2: Four Year Princeton Architecture and Engineering Program Curriculum[13]

Freshmen Year

Fall Semester

Course #	Course Name
CHM 201/203/207	Chemistry
MAT 104	Calculus
PHY 103	General Physics
** ***	Humanities Elective
** ***	Humanities Elective

Spring Semester

Course #	Course Name
COS126	General Comp. Sci.
MAT 201	Multivariable Calc.
PHY104	General Physics II
** ***	Humanities Elective
** ***	Humanities Elective

Sophomore Year

Fall Semester

CEE 205	Mechanics of Fluids
ARC 203	Intro to Arch. Thinking
MAT 202	Linear Algebra
** ***	Humanities Elective
** ***	Humanities Elective

Spring Semester

CEE 262a	Structures
ARC 204	Intro to Arch. Design
CEE 365	Reinforced Concrete
** ***	Humanities Elective
** ***	Program Elective

Junior Year

Fall Semester

CE 361	Structural Analysis
ARC JIW	Arch Studio
CEE 364	Materials in CE
ORF 245	Engineering Statistics
** ***	Program Elective

Spring Semester

CEE 303	Intro to Environ. Engin.
CE 366	Reinforced Concrete Structures
CEE 362	Structural Dynamics and Earth Quake Engineering
** ***	Program Elective
** ***	Program Elective

Senior Year

Fall Semester

CEE 461	Design of Large Building
ARC 401	Housing and Urbanism
CEE 478	Senior Thesis
** ***	Tech Requirement
** ***	Humanities Elective
** ***	Elective

Spring Semester

CEE 478	Senior Thesis
ARC 462	Structure in Arch History
** ***	Technical Requirement
** ***	Elective
** ***	Elective

Table 3: Five Year Penn State Architectural Engineering Curriculum[12]

Freshmen Year

Fall Semester

Course #	Course Name	Hours
Chem 12	Chemistry	3
Math 140	Calculus I	4
AE 124	Orientation	1
Engl 15	Composition	3
Chem14	Chemistry Lab	1
Econ 2, 4, 14	Economics (GS)	3

Spring Semester

Course #	Course Name	Hours
Phys 211	Mechanics	4
Math141	Calculus II	4
EG130	Arch Graphics/CAD	3
Gen Ed	(GH)	3
	Health & Physical Activities	3

Sophomore Year

Fall Semester

Arch 130A	Basic Design	3
AE 221	Arch Materials	3
AE222	Working Drawings	3
Math 231	Calculus III	2
Phys 212	Electr / Magnetism	4
E Mch 11	Statics	3

Spring Semester

Arch 130A	Basic Design	3
AE202	Envirnmental System	3
ME 23	Thermal Science	3
Math 220	Matrices	2
Phys 213	Waves and Thermo	2
E Mch 13	Strength of Materials	3

Junior Year

Fall Semester

AE 309	Arch Acoustics	3
AE 310	HVAC	3
AE 308	Structural Analysis	4
Math 250	Diferential Equations	3
CompSci 201	Programming	3
Arch 210	Design Theory I	3

Spring Semester

AE 311	Electrical/Lighting	3
AE372	Building Industry	3
AE 401	Steel/Timber Design	3
EE 220	Circuits and Power	3
E Mch 12	Dynamics	3
Arch 211	Design Theory II	3

Senior Year

Fall Semester

AE 402	Concrete	3
Arch 441	Design Analysis	4
AE430	Indeterminate Analysis	3
AE 475	Construction Engin I	3
Stat 401	Experimental Methods	3

Spring Semester

CAS 100A	Effective Speech	3
Arch 443	Design Field Trip	1
AE 403	Adv Steel Design	3
Arch 442	Design Analysis	4
Emch 215/216	Engineering Materials	3
	Department Elective	3

Fifth Year

Fall Semester

AE 481W	Senior Project	4
Engl 202C	Technical Writing	3
AE 431	Adv Concrete Design	3
CE 209	Surveying	2
CE 396A	Geotechnical Elective	4

Spring Semester

** ***	Humanistic Elective (GH)	3
** ***	Social Science Elective (GS)	3
AE 482	Senior Project	4
AE 439	Modern Structure	3
	Department Elective	3

Table 4: Four Year NC State CE Curriculum[10]

Freshmen Year

Fall Semester

Course #	Course Name	Hours
CH 101	Chemistry	3
CH 102	Chemistry Lab	1
E 101	Intro to Engineering	1
E 115	Intro to Comp	1
ENG 101	Academic Writing	4
MA 141	Calculus I	4
GRP 101	Health & Fitness	1

Spring semester

Course #	Course Name	Hours
CSC 116	Java	3
MA 142	Calculus II	4
GRP 102	PE Elective	1
PY205	Physics	4

Sophomore Year

Fall semester

CE 214	Engr. Mech-Stat.	3
GC 120	Foundations o. Graph.	3
PY 208H (L)	Physics	4
MA 242	Calculus III	4

Spring semester

CE 215	Engr Mech Dym	3
CE 313	Mech. Of Solid	3
MA 302	Num Apps DEQ	1
MSE 200	Mech Prop. Stuct	3
MA 341	Differential Equation	3

Junior Year

Fall semester

CE 332	Materials of Constr'n	3
CE 375	Civil Engr Systems	3
CE 382	Hydraulics	3
ST 370	Probability & Stat.	3

Spring semester

CE ***	Tech Elective I	3
CE ***	Tech Elective II	3
CE ***	Tech Elective III	3
CE 324	Structural Behavior	1
GRP 041	Science Elective	4

Senior Year

Fall semester

CE ***	CE Design Elective I	3
CE ***	Tech Elective IV	4
** ***	Engr. Science Elec I	3
ENG 331	Comm. for Engr.	3
MAE 301	Thermodynamics	3

Spring semester

CE ***	CE Design Elective II	3
CE ***	CE Design Elec. III	3
** ***	Engr. Science Elec II	3
** ***	Engr. Science Elec III	3

Table 5: Parallel Courses in the Penn State AE and NC State CE Curriculums[10, 12]

Penn State's AE requirements		Comparable NC State Courses	
Course #	Course Name	Course #	Course Name
E Mch 11	Statics	CE 214	Engineering Mechanics - Statics
Phys 213	Waves and Thermodynamics	MAE 301	Engineering Thermodynamics I
E Mch 12	Strength in Materials	CE 313	Mechanics of Solids
AE 308	Structural Analysis	CE 325	Structural Analysis
EE 220	Circuits and Power	ECE 331	Principles of Electrical Engineering I
E Mch 12	Dynamics	CE 213	Introduction to Mechanics
AE 475	Construction Engineering	CE 324	Structural Behavior Measurement
AE 403	Advanced Steel Design	CE 426	Structural Steel Design
ME 33	Fluid Flow	CE 382	Hydraulics
AE 472	Building Constr Planning	CE 367	Mechanical and Electrical Systems in Buildings
Stat 401	Experimental Methods	ST 370	Probability and Statistics for Engineers
CE 335	Civil Engineering Materials	CE 332	Materials of Construction
CE 396A	Geotechnical Elective	CE 342	Engineering Behavior of Soils and Foundations

Table 6: Potential Four Year NC State Architectural Engineering Curriculum[10]

Freshmen Year

Fall Semester

Course #	Course Name	Hours
CH 101	Chemistry	3
CH 102	Chemistry Lab	1
E 101	Intro to Engineering	1
E 115	Intro to Comp	1
ENG 101	Academic Writing	4
MA 141	Calculus I	4
GRP 101	Health & Fitness	1

Spring semester

Course #	Course Name	Hours
CSC 116	Java	3
MA 142	Calculus II	4
PY205	Physics	4
ARC 162	Intro to Arch	3
ADN 111	2d Design	3

Sophomore Year

Fall semester

CE 214	Engr. Statics	3
GC 120	Foundations o. Graph.	3
PY 208H (L)	Physics	4
MA 242	Calculus III	4
GRP 102	PE Elective	1

Spring semester

CE 215	Engr. Dynamics	3
CE 313	Mech. Of Solid	3
MA 302	Number Application	1
ARC 232	Struct. and Material	3
MA 341	Differential Equation	3

Junior Year

Fall semester

CE 325	Engr. Sci. Elective	3
CE 332	Materials of Constr'n	3
CE 375	Civil Engr Systems	3
CE 382	Hydraulics	3
ST 370	Probability & Stat.	3

Spring semester

ARC 251	Arch Representation	3
ARC 331	Arch Structures I	3
CE 324	Structural Behavior	3
GRP 041	Science Elective	4
ECE 331	Principles of Electrical Engr.	3

Senior Year

Fall semester

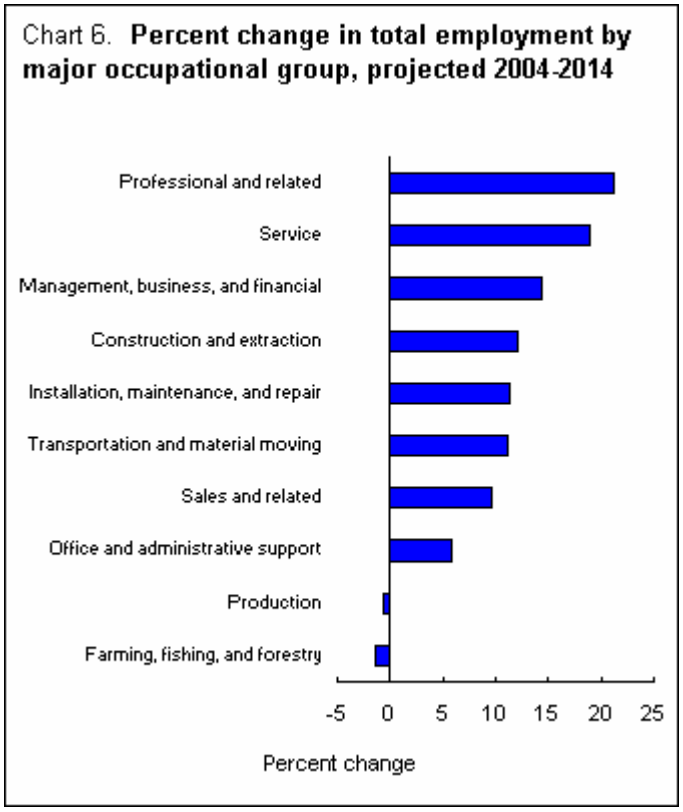
CE 342	Behavior of Soils and Foundations	4
CE ***	CE Design Elective I	3
ARC 332	Arch Structure II	3
** ***	Engr. Sci. Elective	3
MAE 301	Thermodynamics	3

Spring semester

CE ***	CE Design Elective II	3
CE ***	CE Design Elec. III	3
ARC 102	Arch. Design Fundamentals	6

Figure 7: ABET Requirements Fulfilled by Courses in Potential Four Year NC State Architectural Engineering Curriculum[7, 10]

ABET Requirement of Courses	*Proposed NC State Architectural Engineering Courses that Fulfill ABET Requirement*
Mathematics through differential equations	MA 141, MA 142, MA 242, MA 341
Calculus-based physics and general chemistry	CH 101, CH 102, PY205, PY208
Proficiency in statics	CE 214. CE 215
Proficiency in strength of materials	CE 313, CE 332, ARC 232
Proficiency in thermodynamics	MAE 301
Proficiency in fluid mechanics	CE 382
Proficiency in electric circuits	ECE 331
Proficiency in engineering economics	EC 205 (fulfilled by one of the seven humanities requirements mandatory for all engineering majors at NC State)
Proficiency in a minimum of two (2) of the three (3) basic curriculum areas of structures, building mechanical and electrical systems	Achieved through the courses designated as "CE Design Elective"
Design integration throughout breadth of the program	ARC 102, ADN 111, ARC 251,
Proficiency in architectural design and history	ARC 162, ARC 331, ARC 332,
ABET Requirement of Faculty	Engineering faculty already meet the requirements of the ABET for their respective fields. Architecture faculty meet NAAB requirements which are also sufficient for ABET.
"Must demonstrate that faculty teaching courses that are primarily engineering design in content are qualified to teach the subject matter by virtue of professional licensure"	The above engineering courses (CE, MAE, ECE) are all presently ABET accredited and taught by NC State faculty who meet the engineering requirements for accreditation
"The majority of the faculty teaching architectural design courses are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience."	College of Design instructors and professors presently teach in the National Architectural Accrediting Board (NAAB) accredited architecture programs.



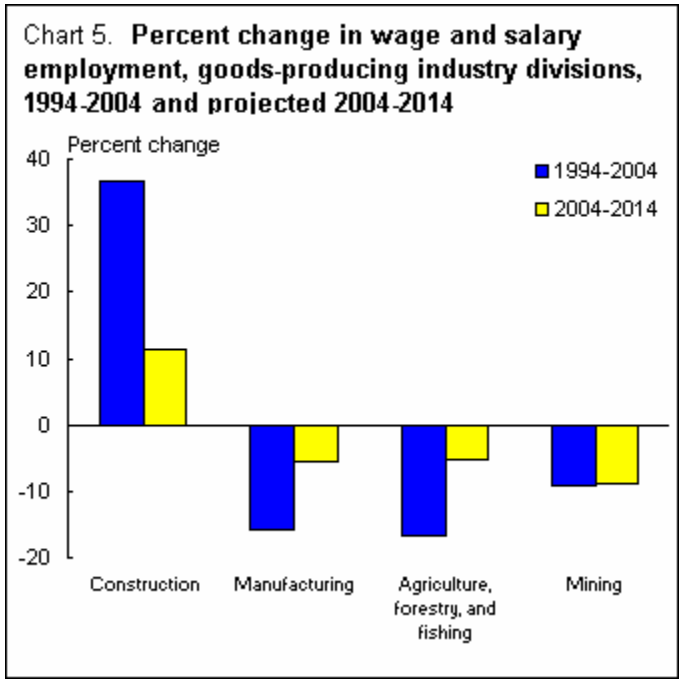


Figure 1: U.S. Department of Labor - Bureau of Labor: Charts Predicting Employment[5]

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