N C A R B

August 2004

Architecture as It Differs From Engineering

Introduction....1
Comparison of Registration Requirements....2
Comparison of Education....4
Comparison of Training....4
Comparison of Examinations....6
Appendix A—Legal Survey....7
Appendix B—Observations From Practice....13
Appendix C—Comparison of Curricula in Six Accredited Architecture and Civil Engineering Programs....17
Appendix D—Outline of Examinations....18

MISSION STATEMENT

The National Council of Architectural Registration Boards (NCARB) is a nonprofit corporation comprising the legally constituted architectural registration boards of the 50 states, the District of Columbia, Guam, the Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands as its members.

The mission of NCARB is to work together as a council of Member Boards to safeguard the health, safety, and welfare of the public and to assist Member Boards in carrying out their duties. Pursuant thereto, the Council shall develop and recommend standards to be required of an applicant for architectural registration; develop and recommend standards regulating the practice of architecture; provide to Member Boards a process for certifying the qualifications of an architect for registration; and represent the interests of Member Boards before public and private agencies, provided that the Council shall not purport to represent the interest of a specific Member Board without that Member Board's approval.

Architecture as It Differs From Engineering
National Council of Architectural Registration Boards
1801 K Street, NW, Suite 1100-K
Washington, DC 20006
202/783-6500
www.ncarb.org

This document was published in August 2004 and supercedes all previous editions of *The Practice of Architecture as It Differs From the Practice of Engineering*.

INTRODUCTION

The National Council of Architectural Registration Boards is a nonprofit corporation, incorporated under the provisions of the Iowa Nonprofit Corporation Act. All legally constituted architectural registration boards of the 50 states, the District of Columbia, Guam, the Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands are its members. They formulate the policies, rules, and regulations of the Council, and elect its officers and directors. All of its officers and directors serve without compensation.

This paper, first published in 1982 and again in 1995, is being reissued by NCARB to assist its Member Boards in their continuing effort to prevent the unlawful practice of architecture by unlicensed persons. In many jurisdictions, chronic problems arise from engineers seeking to use their registration under the engineering registration act as a basis for designing buildings for human habitation.

In almost every state, engineers are registered generically, with no distinction made among electrical, structural, mechanical, and civil engineers, on the one hand, and aeronautical, agricultural, ceramic, electronic, geological, metallurgical, naval, nuclear, petroleum, and surveying engineers, on the other hand. The first group may have some connection to and interest in systems employed in designing buildings for human habitation, while the latter have no such connection. All the disciplines are, however, registered as "engineers."

This paper focuses on the first group of engineering disciplines that, because they are often involved in designing components of buildings, has laid claim to the right to practice architecture. NCARB prepared this paper to demonstrate how the education, training, and examination required of architects for registration differ substantially from that required of structural, mechanical, electrical, and civil engineers. NCARB believes this comparison illustrates why most legislatures have assigned the responsibility for designing buildings for human habitation and occupancy to architects rather than to members of the engineering professions.

Following the section of this paper comparing the requirements for registration, Appendix A surveys court cases and opinions of attorneys general that relate to efforts by engineers to practice architecture.

Appendix B, "Observations from Practice," summarizes interviews by NCARB's Procedures and Documents Committee with six internationally renowned architects and engineers, who discussed the appropriate role for engineers to play with respect to buildings for human habitation and occupancy. One issue that arose in the interviews is the critical responsibility for coordinating the design elements of a building. All six respondents agreed that only the architect has been educated, trained, and examined with respect to the skills and knowledge necessary to act as the coordinating professional.

Appendix C summarizes the architecture and engineering curricula from six representative schools in the United States.

Appendix D outlines the Architect Registration Examination, the Fundamentals of Engineering exam, and the Principles and Practices of Engineering exams.

COMPARISON OF REGISTRATION REQUIREMENTS

In general, the material assembled below demonstrates the substantial difference between architecture and the professions of engineering.

The architect has a more diverse education than does the engineer. A typical architectural curriculum covers a broad scope of subjects, both functional and aesthetic. An engineering curriculum, in contrast, addresses a single technology focused on only one of the many functional systems that a building comprises.

The training required for interns in architecture is prescriptive and translates the knowledge required at the university into an equally broad range of professional skills. For the engineer, the training, like the education, is more narrowly focused. It is not, incidentally, governed by prescribed requirements. NCARB, through its Intern Development Program (IDP), has designated specific areas of training and established appropriate percentages of time to be spent within those areas. Those areas are as wide-ranging as the scope of architectural education. Engineers, in contrast, are expected to gain experience in their specific discipline in preparation for a licensing examination in that discipline. Because training guidelines comparable to IDP do not exist among the engineering professions, there are no guidelines leading an engineering intern into a broad training experience.

The Architect Registration Examination (ARE), prepared by NCARB, tests the applicant's ability to design a building that meets the programmatic requirements of owners and users, and to coordinate and integrate the various technological building systems designed by electrical, mechanical, and structural engineers. No comparable examination exists within any of the engineering disciplines because the practice of engineering does not require such skills, and the training and education of engineers are not designed to produce them. The engineer is typically examined in engineering fundamentals and then tested in narrow areas of knowledge related to the engineer's discipline.

As the following material demonstrates, a registered architect is expected to prove his or her ability to understand, assemble, and coordinate all of the disciplines and specialties that a building comprises. A registered architect must have demonstrated the capacity to act as the "generalist" in the design process. In contrast, the education, training, and examination of a registered professional engineer demonstrate the engineer's competence as a specialist dealing with one branch of engineering knowledge.

On the basis of this study, NCARB has concluded that a registered architect should be involved in the design of all buildings intended for human occupancy and habitation, and that a registered architect is the only design professional prepared to coordinate all the other disciplines required for the project. The practicing architects and engineers interviewed in Appendix B have agreed with this general conclusion. They have further observed that, with respect to projects of any complexity, the architect should engage appropriate engineering consultants to assist in the design.

The eminent structural engineer, Professor Mario Salvadori, has written:

> *A good architect today must be a generalist, well-versed in space distribution, construction techniques and electrical and mechanical systems, but also knowledgeable in financing, real estate, human behavior and social conduct. In addition, he is an artist entitled to the expression of his aesthetic tenets. He must know about so many specialties that he is sometimes said to know nothing about everything. The engineer, on the other hand, is by training and mental makeup a pragmatist. He is an expert in certain specific aspects of engineering and in those aspects only.*[1]

[1]Mario Salvadori, *Why Buildings Stand Up* (McGraw-Hill, 1980) p. 24.

COMPARISON OF EDUCATION

Degree programs in architecture and engineering are accredited by the National Architectural Accrediting Board (NAAB) and the Accrediting Board for Engineering and Technology (ABET), respectively. Curricula summaries for architecture and civil engineering programs are found in Appendix C. These summaries are taken from the web sites of six representative schools located in different regions of the United States.

NAAB accredits two degree programs, the Bachelor of Architecture and the Master of Architecture. The Bachelor of Architecture is a five-year degree program typically requiring completion of 160 semester hours or 240 quarter hours. The Master of Architecture degree is either two years (60 semester hours) or three to three-and-one-half years, depending on the type of bachelor degree previously earned. The ABET-accredited Bachelor of Science in the various engineering disciplines typically requires 122 semester hours or 183 quarter hours over four years.

Engineering curricula offer focused study in a specific engineering discipline. The B.Arch and M.Arch curricula include technical courses that cover engineering disciplines related to the profession of architecture, e.g., civil, structural, electrical, and mechanical. In addition, students in architecture are required to take courses in the humanities, professional practice, and architectural design.

Most architectural registration boards require a degree from an NAAB-accredited program for registration. In addition, NCARB requires such a degree (or equivalent education) for certification.

COMPARISON OF TRAINING

Both engineers and architects must complete a period of internship as a requirement for registration by a U.S. jurisdiction. Most states require a four-year training period for engineers. This training does not have a prescribed structure. All U.S. jurisdictions require approximately three years of training for architects, and almost all require completion of training requirements under the Intern Development Program (IDP). Training for architects is prescriptive, and architectural interns must be trained in the following broad categories: Design and Construction Documents, Construction Contract Administration, Management, and Related Activities.

Training in these categories prepares the architectural intern for the Architect Registration Examination and for entrance into the profession.

IDP Training Requirements

All architectural interns must acquire 700 training units to satisfy the IDP training requirements. One training unit equals eight hours of acceptable activity in a given training area. The chart below lists the IDP training categories and areas, and the minimum required training units for each.

Category A: Design and Construction Documents	
1. Programming	10
2. Site and Environmental Analysis	10
3. Schematic Design	15
4. Engineering Systems Coordination	15
5. Building Cost Analysis	10
6. Code Research	15
7. Design Development	40
8. Construction Documents	135
9. Specifications and Materials Research	15
10. Document Checking and Coordination	10
Total Training Units Required	*350**
Category B: Construction Contract Administration	
11. Bidding and Contract Negotiation	10
12. Construction Phase—Office	15
13. Construction Phase—Observation	15
Total Training Units Required	*70**
Category C: Management	
14. Project Management	15
15. Office Management	10
Total Training Units Required	*35**
Category D: Related Activities	
16. Professional and Community Service	10
Other Related Activities	0
Total Training Units Required	*10*

The required minimum in Categories A, B, C, and D totals 465 training units. The additional 235 training units may be acquired in any of the listed categories. IDP training area descriptions and core competencies within these areas can be found in the current edition of the *IDP Guidelines*.

*The difference between the minimum total training units requested in Categories A, B, and C, and the sum of the minimums required for each training area within the category must be acquired by earning training units from training areas within the same category.

COMPARISON OF EXAMINATIONS

State registration boards register engineers and architects on the basis of examinations that test the minimum knowledge required to protect the public health, safety, and welfare. To assist the state boards, the National Council of Examiners for Engineering and Surveying (NCEES) develops the Fundamentals of Engineering (FE) exam and the Principles and Practices of Engineering exams. NCARB develops the Architect Registration Examination (*see Appendix D*). Engineering candidates may sit for the Fundamentals of Engineering exam during the last year of school, but they must complete a period of internship before being admitted to the Principles and Practice of Engineering exam. Most candidates in architecture must complete the IDP training requirements described above before being admitted to the ARE.

The Fundamentals of Engineering Exam is one day in duration—four hours in the morning and four hours in the afternoon—and comprises 180 problems that test candidates' general knowledge of engineering. All engineering candidates must pass this exam.

The Principles and Practices of Engineering Exams test design, research and development, operations, applications, and modification of systems and processes in a specific engineering discipline (e.g., civil, mechanical, structural, agricultural, petroleum, etc.). This is also a one-day eight-hour exam where candidates have a choice of problems to complete in their discipline.

The Architect Registration Examination comprises eight divisions: Pre-Design; General Structures; Lateral Forces; Mechanical & Electrical Systems; Building Design / Materials & Methods; Construction Documents & Services; Site Planning; Building Planning; and Building Technology. The exam is administered exclusively on computers, and candidates must pass all divisions to complete it. Maximum total testing time is 27.25 hours.

Future architects are tested in technical subjects including structural technology, electrical and mechanical systems, and acoustics. Only in the Fundamentals of Engineering exam, administered in the last year of college, is the future engineer tested in broad engineering subjects. The Principles and Practice of Engineering exams are confined to testing a specific field in which the engineer will practice. Thus, for example, a future mechanical engineer is not tested on his or her knowledge of structural engineering problems. The testing of engineers in these areas may be limited to the Fundamentals of Engineering exam, depending on their disciplines and their choice of Principles and Practices of Engineering exam(s). The act of taking a Principles and Practice exam does not guarantee that professional engineers have demonstrated knowledge of how their discipline relates to buildings for human occupancy.

Conversely, the Site Planning and Building Planning divisions of the ARE demonstrate the ability of future architects to synthesize programmatic and environmental requirements into a coherent and aesthetic concept for the design of buildings and their placement on the site. Engineers are neither educated nor trained to perform these tasks, and these topics are not tested in any of the engineering exams. Architects are further tested in humanities, professional practice, contract law, construction industry operations, office procedures, construction contract administration, and other practice-related topics. Engineers are not required to demonstrate knowledge in these areas.

APPENDIX A – LEGAL SURVEY

Any analysis of how the courts and other enforcement authorities have construed the respective provinces of architects and engineers must begin with a careful reading of the registration statutes of the jurisdiction. Nevada, for example, explicitly exempts a registered engineer from the requirements of its architectural registration law. [Ch. 623.330, Nevada Revised Statutes.] In the small number of jurisdictions like Nevada where legislatures have made the judgment that engineers may practice architecture, the courts cannot be expected to rule otherwise. See, for example, *Sardis v. State of Nevada,* 85 Nev. 585 (1969). The public will only be protected in those jurisdictions by engineering professionals who are willing to limit their practice to their areas of competence.

By far the great majority of state legislatures have demonstrated their statutory intent to distinguish between the practice of architecture and the practice of engineering. This legislative intent is evidenced either by distinctive language describing the practice of each profession or by language permitting an engineer to engage only in such architectural practice as is incidental to the engineering practice. In either circumstance, the courts and enforcement officers have construed the two practices as distinct and, with only a few exceptions,[2] have barred engineers from engaging in the practice of architecture. The great majority of court decisions, summarized here, also distinguish the practice of architecture from the practice of engineering.

An Arizona engineer was charged by the state registration board with engaging in the practice of architecture. He asked the Arizona court to intervene and prohibit the board from proceeding against him. While the two registration statutes had nearly identical definitional language, the Supreme Court of Arizona ruled that the legislative framework, including references to incidental practice, made clear the intent that the two disciplines required separate registration, and the court deferred to the board to decide if the engineer was illegally engaged in architectural practice. *State Board of Technical Registration v. MacDaniel*, 84 Ariz. 223 (1958)

[2]See, *Varich v. Florida State Board of Architecture*, 239 So.2d 29 (Florida, 1970), where an intermediate Florida court declined the state board's invitation to examine the historical differences between the two professions and rendered its decision in favor of engineer Varich on the basis of a literal reading of the two statutes, and *Georgia Association of the American Institute of Architects v. Gwinnett County*, 233 S.E.2d 142 (Georgia, 1977), where the Supreme Court of Georgia declined to enjoin a county employee, qualified only as a professional engineer, from designing a fire station on behalf of the county. Both statutes permitted engineers to engage in incidental architectural practice. Neither statute included any reference to human habitation or other language that might distinguish the practice of architecture from the practice of engineering. See also *Schmidt v. Kansas State Board of Technical Professions*, 21 P.3d 542 (Kansas, 2001), where the Kansas Supreme Court found that due to an ambiguity in the board's regulations, engineers were permitted "to prepare and seal those documents that the engineer is qualified by education, training, and experience to seal, not merely those documents an engineer is licensed to seal." Following this decision, the regulations of the Kansas State Board of Technical Professions were amended effective November 2, 2001, to eliminate the provision that the Court had said permitted engineers to prepare architectural plans they were not licensed to prepare.

Architecture as It Differs From Engineering

In Maine, a registered engineer masquerading as an architect was charged criminally for violating Maine's architectural registration law. He defended on the ground that there was no distinction between the two practices as defined in the statutes. The Supreme Judicial Court of Maine upheld the engineers conviction, observing:

> "While the respective functions of an engineer and those of an architect as recited in the two statutes superficially appear parallel and equivalent . . . they are designed not so . . . Architects are commonly engaged to project and supervise the erection of costly residences, schools, hospitals, factories, office and industrial buildings, and to plan and contain urban and suburban development. Health, safety, utility, efficiency, stabilization of property values, sociology and psychology are only some of the integrants (of architectural practice). Banking quarters, commercial office suites, building lobbies, store merchandising salons and display atmospheres, motels, restaurants and hotels, eloquently and universally attest the decisive importance in competitive business of architectural science, skill and taste." *State v. Beck*, 156 Me. 403 (1960)

In Ohio, a college defended against the fee claim of an engineer on the ground that the engineer was not registered as an architect and was, therefore, illegally performing architectural services when he undertook the design of campus buildings. The statute allowed the engineer to perform incidental architectural services. The court held that:

> "The legislature in establishing each of these professions recognized that they required a different educational background. The legislature also recognized that they have some things in common and provided for this and still recognized that each profession must be protected in its primary field of endeavor . . . In the instant case, the contract calls for the building and construction of college buildings which primarily and predominately call for the services of an architect and not such as are incidental to engineering." *Fanning v. College of Steubenville*, 197 N.E.2d 422 (Ohio, 1961)

The Kentucky Court of Appeals held that an engineer violated the architectural practice act when he designed a nursing home. Despite similar language in the two statutes, the court focused on the language in the architectural act that referred to "buildings . . . erected as a shelter for human beings, their activities and possessions," and concluded that such buildings were the exclusive province of architects. *Dahlem Construction Co. v. State Board of Examiners and Registration of Architects*, 459 S.W.2d 169 (Kentucky, 1970). Seven years later, the same court upheld the state fire marshall's refusal to issue a permit to an engineer who presented his plans for an industrial building having a capacity for in excess of 100 persons. The court cited approvingly an agreement between the Kentucky Architectural Board and the Kentucky Engineering Board, stating that because of differences in education, the architect is not competent to practice engineering, nor the engineer to practice architecture. *Roggenkamp v. State Fire Marshall*, 559 S.W.2d 514 (Kentucky, 1977)

The Attorney General of South Dakota ruled that building inspectors may only issue permits on buildings exceeding $200,000 in total cost if the plans and specifications have been signed by a registered architect. He ruled that an engineer may not submit such plans as an incident to his engineering practice. Op. Atty. Gen. No. 82-13 (1982)

A licensed engineer who designed a duplex beach house was fined by the New Jersey Board of Architects. He argued in court that there was no difference between the practice of architecture and the practice of engineering as defined in the two New Jersey statutes. The court, rejecting his argument, found that he had illicitly engaged in the practice of architecture. *State of New Jersey Board of Architects v. North*, 484 A.2d 1297 (New Jersey, 1984)

The Arkansas Attorney General was asked for his opinion as to whether an engineer may design a building for human occupancy or habitation. Arkansas had adopted the NCARB Model Law definition of the practice of architecture: services with respect to buildings which are *designed for human occupancy or habitation*. The Attorney General read the italicized language as distinguishing architecture from the practice of engineering, and concluded that the practice of engineering in Arkansas cannot be "construed to include the planning and design of buildings for 'human occupancy or habitation.'" Opinion No. 94-378; November 22, 1994

An Arkansas licensed engineer was charged with practicing architecture without a license by the state registration board in connection with the engineer's involvement in a proposal to provide "architectural/ engineering design services" for a new county courthouse. He appealed, and a lower court overturned the fine, but the state Court of Appeals reversed and upheld the sanction. The engineer argued that, in participating in the proposal to provide "architectural/engineering design services," he never intended to perform the architectural work himself; rather, he intended that the architectural work be performed by a licensed architect. The Board of Architects rejected this argument and the Appeals Court upheld the board's decision, finding that the engineer had no firm agreement to associate with an architect at the time he proposed to offer design services. In addition, the Appeals Court found that the courthouse design project was "essentially an architectural one," and thus did not qualify for an exception in Arkansas law permitting the practice of architecture incidental to engineering practice. A*rkansas State Board of Architects v. Hawkins*, 12 S.W.3d 253 (Court of Appeals, 2000)

Unpublished trial court decisions may not be cited as precedent; nonetheless, the language used by a Florida Circuit Court in issuing a final judgment and injunction prohibiting the practice of architecture by a registered engineer aptly summarizes the view of most courts dealing with this question:

> "A review of the requirements for admission to practice of architecture and engineering, and of the academic curriculum of the various institutions teaching the foundation courses for both professions, reinforces the concept that buildings which involve primarily esthetic considerations and the creation and adaptation of space primarily for the use and occupancy by human beings are architecture, as opposed to the essentially mechanical process of applying mathematics and paraphernalia of industry and transportation which is clearly part of professional engineering.

> Only the architect studies man and his environment in this sense, and the state properly recognizes this distinction for the protection of the health and welfare of the people under the police power.
>
> It may be, as contended here, that the current philosophy of design that form follows function has brought the architectural result closer to the end product of the engineer. Yet this cannot erase the ultimate distinction that the architect is trained and conditioned to begin the process of design with the requirements of the human being, while the engineer is trained and conditioned to achieve a result almost entirely by the application of the principles of mathematics and engineering to problems similarly dimensioned, a process which can in fact suppress the requirements of the human in favor of those of the machine." *The Florida State Board of Architecture v. Dugger*, Circuit Court, 7th Judicial Circuit, Chancery No. 40,424, Div. D (Florida, 1968)

A recent opinion from the Attorney General of Oklahoma discussed the phrase "incidental practice" found in many states regulating both engineers and architects. The question addressed to the Oklahoma Attorney General was, "May an individual not licensed as an architect under the Act provide architectural services?" The Oklahoma Act defined the practice of architecture in the recommended NCARB Model Law language. The Attorney General observed that both landscape architects and professional engineers are allowed to perform services if those services are "incidental to" the practice of architecture. The Attorney General concluded that incidental architecture are services which "are likely to ensure from and are minor consequence of the other services being performed." Incident to the Attorney General's opinion is a recognition that the practice of architecture is distinct from the practice of landscape architecture and the practice of professional engineering. Opinion of the Attorney General of Oklahoma, May 11, 2000

A recent anomalous decision from an intermediate court in Pennsylvania illustrates that, even where a statutory scheme appears to define a specialized sphere of professional practice exclusive to licensed architects, a broad statutory definition of the practice of engineering can lead a court to conclude that licensed engineers may perform tasks that constitute the practice of architecture. The Pennsylvania registration board disciplined a licensed engineer who had sealed design documents for the renovation of a private club into a law office with apartment, after the board found that the design work was 80 percent architectural in nature. The engineer contended that Pennsylvania law also licensed engineers to perform the same design work, since it defined the practice of engineering to include "the application of the mathematical and physical sciences for the design of public or private buildings [or] structures." An intermediate Pennsylvania court agreed and overturned the fine. The court concluded that state law "recognizes that there is indeed substantial overlapping of the professions," and that Pennsylvania law permits engineers to "design . . . public or private buildings [or] structures" without an architectural license. The court recognized that the Legislature had consciously defined the practice of architecture in terms different from that of engineering, but the court did not view this as manifesting a legislative intent to require separate licensing for the practice of architecture:

> "Our [Pennsylvania] General Assembly has inserted into the Architects' Law the words 'human habitation or use.' But the General Assembly has not seen fit, at the same time, to limit the type of buildings that engineers can design. The licensing statute applicable to engineers does not say "application of the mathematical and physical sciences for the design of public or private buildings [not for human habitation or use].' We believe, therefore, that the definition under the Engineers' Law is broader than that contained in the Architects' Law. Clearly, the phrase, 'human habitation or use' limits the range of projects that architects can undertake; but the language in the Engineers' Law does not likewise limit engineers in the same manner." *Rosen v. Bureau of Professional Affairs*, 763 A2d 962 (Pa. Cmmwlth, 2000)

Pennsylvania's highest court declined to exercise its discretion to review the *Rosen* decision.

Arguably, the reasoning and result of *Rosen* turn the statutory scheme on its head, and render meaningless the fact that the Legislature drew a distinction between the practice of engineering and architecture. The Pennsylvania court claimed that it was attempting to construe the statutory definitions of architecture and engineering practice so as to "harmonize" the definitions and give them "uniform effect," but it arguably would be a more harmonious and consistent construction to simply require those whose work qualifies for the definition of architectural practice to obtain an architectural license, notwithstanding whether or not they are licensed engineers.[3]

The Arkansas Supreme Court, by contrast, more recently upheld a $5,000 fine levied against an engineer who had designed a 13,000-square foot pre-engineered metal building consisting primarily of office space with a small amount of storage. The case was *Holloway v. Ark. State Board of Architecture*, 352 Ark. 427 101 S.W.3d 805, decided April 3, 2003. Like the NCARB Model Law, Arkansas' law described the practice of architecture in terms of buildings for "human occupancy or habitation." Arkansas' law provided that "an engineer may practice such architectural work as is incidental to the practice of architecture." The law also had the following additional provisions permitting engineers to design buildings with <u>some</u> human occupancy: "[An engineer may design] buildings intended for the accommodation of equipment, vehicles, goods, and/or processes or other utilitarian function, with

[3]It should be noted, as well, that *Rosen* fails to discuss a prior decision of the Pennsylvania Supreme Court that conflicts with the reasoning, if not the express holding, of *Rosen*. *Consulting Engineers Council of Pennsylvania v. Pennsylvania State Architects Licensure Board*, 560 A2d. 1375 (Pa. 1989) held that a state law which permitted the practice of architecture by a licensed architect "as an employee of a . . . partnership or corporation which is not an architectural firm" did not permit engineering firms to practice architecture by using employees licensed as architects, where the firms did not otherwise qualify as architectural forms. Rather, the court affirmed that the board's interpretation that the statue was intended merely to allow the practice of architecture for "non-business purposes," such as the design of a hospital wing by a staff architect hired by the hospital. In rejecting a trade association's argument that the law permitted engineering firms to hire architects who could then practice architecture in competition with architectural firms, the state Supreme Court expressly noted that the Legislature has chosen to "concentrate the performance of design functions in firms whose expertise is in the field of architecture." In other words, the Pennsylvania Supreme Court recognized that the Legislature had drawn a distinction between disciplines, a distinction that the lower court in *Rosen* ignored.

human occupancy including office space as required for the support of these functions . . .” Faced with the typical arguments that the Board of Architects overreached in interpreting its statute, and that the architects’ statute, read together with the engineers’ statute, was too vague to be understood, the Arkansas Supreme Court concluded as follows:

> “Reading these together, a person of ordinary intelligence can glean that architects plan and design buildings primarily intended for people to live and work in, and engineers plan and design buildings primarily intended for the accommodation of equipment, vehicles, goods and/or processes.”

APPENDIX B – OBSERVATIONS FROM PRACTICE

In order to assist NCARB Member Boards, which are often required to rule on whether a particular project requires the participation of a registered architect, NCARB's Procedures and Documents Committee interviewed six leading architects and engineers. The committee interviewed Harold L. Adams, Henry N. Cobb, Matthys Levy, Susan A. Maxman, William J. LeMessurier, and Leslie E. Robertson[4]. As leaders in their fields, they are all acute observers of the conditions under which buildings are designed in the United States. Their observations addressed issues concerning the cutting edge of practice, which encouraged the committee to face both existing sources of conflict between the two professions and those that will inevitably arise in the future. Their most important conclusions are shared below.

[4]Harold L. Adams, FAIA, RIBA, JIA, is chairman emeritus of RTKL Associates, Inc., one of the world's leading architecture and engineering firms. A practicing architect for more than 40 years, he has helped manage RTKL into an international, multi-disciplinary practice that specializes in the planning, design, and engineering of large-scale projects across the globe. Adams received the AIA's Kemper Award for Service in 1997, one of many honors he has earned throughout his exceptional career.

Harry N. Cobb, FAIA, is a founding principal of Pei Cobb Fried & Partners and is the former chairman of the Department of Architecture of the Harvard Design School (GSD). He has designed many iconic buildings, including the Hancock Tower in Boston, and has received a number of prizes, among them the Brunner Memorial Prize in Architecture from the American Academy of Arts and Letters and the Topaz Medallion for Excellence in Architectural Education.

William J. LeMessurier, PE, is the founder and chairman of the board of LeMessurier Consultants, one of the world's leading consulting engineering firms. He is an adjunct professor at the Harvard Design School (GSD) and has been principal in charge of a number of significant projects, including the National Air and Space Museum, Washington, D.C.; the Treasury Building, Singapore; Boston City Hall, Boston; and the King Khalid Military City, Saudi Arabia.

Matthys Levy, PE, a principal with Weidlinger Associates, a structural and civil engineering firm, has been designing domes, buildings, and bridges for nearly 50 years. The Georgia Dome Stadium in Atlanta and the La Plata Stadium in Argentina are among his most well-known projects. He has authored several books, including *Why Buildings Fall Down* (with Mario Salvadori) and *Engineering the City: The Story of Infrastructure* (with Richard Panchyk).

Susan A. Maxman, FAIA, is a nationally recognized expert and advocate of sustainable design practices. Her firm, Susan Maxman & Partners (SMP), has received more than 45 honors and awards for excellence in design. Most recently, SMP's Cusano Environmental Education Center has been recognized for its cutting-edge environmental sustainability. Maxman served as the first woman president of the American Institute of Architects (in 1993) and holds honorary doctoral degrees from Ball State University and the University of Detroit Mercy.

Leslie E. Robertson, PE, is the senior partner and director of design and construction of Leslie E. Robertson Associates, a prominent consulting engineering firm, which has been responsible for a number of major structural designs, including the Puerta de Europa in Madrid, Spain, the first leaning high-rise buildings. He has lectured at a number of universities and is the author of more than 50 papers on wind and structural engineering. Robertson also holds a patent on viscoelastic damping for buildings and other structures, and has received the Raymond C. Reese Research Prize of the American Society of Civil Engineers.

Buildings intended for human occupancy must be designed by an architect.

On this issue there was something approaching unanimity. Cobb, furnishing examples from his own practice, concluded that no building intended for human occupancy should be designed by an engineer without an architect's participation, and Robertson concurred. Cobb noted the importance of architects understanding how the imagination of people other than themselves can be effectively integrated into the making of a building, explaining, "Competence in relation to consultants is a key competence for an architect—more important than how much the architect may know about a special field."

The architect, as LeMessurier put it, has a mandate to "look after the overall public interest, the impact of that building on the character of the community."

In agreement, Maxman noted, "The architect has the overview required to put all the parts together. The human element is critical to the process. What is the vision for the structure? What is the spirit of it? These are the intangibles that architects so skillfully deal with. This is the gray matter that makes 'architecture' resonate." She added, "Architects are trained to think of their responsibility to society that goes beyond their responsibility to any client. How does a building impact its surroundings? . . . How does the building affect the ecology of the place and the overall environmental health? . . . It takes the architect to integrate the efforts of all consultants to achieve these buildings that 'tread lightly on the earth.'"

An architect should retain consulting engineers to assist in the design of any complex structure.

Here again, there was unanimity, along with a variety of opinions on what constituted a complex structure. Adams described the exponential growth in the complexity of buildings during the past 20 years. He noted, "Materials, systems, and technologies have become quite advanced, making it all but impossible for a single professional to manage the delivery of a large scale project."

Cobb, recognizing that a large number of architects may conventionally "do their own engineering," believed that architects should be obliged to retain engineers on all but the most simple projects.

LeMessurier elaborated on this point both as a practitioner and as a teacher of architects. He insisted that architects need consultants to design the mechanical and structural components of a building and that the law should require that engineers be responsible for such design. Even a small house, he observed, may pose complex structural issues.

Robertson agreed but was reluctant to have that obligation legislated.

Levy felt that architects tend to be generalists with an appreciation for a project's aesthetic aspects. Engineers, by contrast, tend to be more versed in a project's specific technical aspects.

Adams felt that, generally speaking, architects solve problems through applied art and engineers solve problems through applied science and mathematics. Architects create "spaces" and engineers create "systems." Neither can stand alone; the design of complex structures demands a symbiotic relationship.

Maxman explained that an architect's education stresses "integrative and imaginative problem-solving, not deductive reasoning as in the training of an engineer." She emphasized that "[a] building obviously needs both disciplines to be realized." Maxman added, "A good building is the creation of a design solution that incorporates the many elements that make the building into an integrated whole—where none of the parts scream out for attention. Rather, the structural and mechanical systems, though possibly noticeable, compliment the whole and become an integral part of it."

The architect's role as prime professional is acknowledged.
Each respondent acknowledged, with certain qualifications, the architect's traditional role as the coordinator of the design process—the one design professional qualified by education and training to understand and harmonize the various components that a building comprises. Those who addressed the issue recognized the importance of public accountability. That is, having as prime professional an individual who has been trained to focus on how people respond to the built environment and how the built environment affects the people who use it.

The pressures of development on large-scale projects, however, have affected the traditional organization of the design process. Several respondents noted the trend by large developers to "unbundle" the design process. LeMessurier laid out reasons why large-scale developers are unbundling the traditional process by entering into direct contracts with structural engineers, among other tactics. Developers who understand the technical advice and counsel of their engineers want to hear such advice "unfiltered" by the architect. LeMessurier illustrated his point by describing a project in which he recommended tuned mass dampers as a way of saving on structural steel while maintaining user comfort, but the architect insisted on a more conventional and expensive design, ultimately rejecting LeMessurier's innovative suggestion.

Toward the end of his interview, LeMessurier was asked, "Would you say that sophisticated developers are actually taking over the role traditionally played by architects?"

"Absolutely, no question about it," he replied.

"And is it working?"

"Yes."

LeMessurier explained that large, complex projects demand concentrated decision-making authority and sophisticated management and coordination skills. Nationally prominent developers have a full complement of design professionals on staff who clearly understand their employer's objectives. Such developers have often absorbed the architect and his/her skills; as a result, they are well able to coordinate the design and construction process.

Adams stated the case for the traditional process with the architect as coordinator: “I do believe that architects are more adept at serving as ‘orchestra’ leaders because their education and professional practice foster a broader understanding of the building process. Engineers, on the other hand, are trained and examined for their understanding of components of the building—its systems and technologies. One is taught to use a telescope; the other a microscope.”

Robertson noted that even when the developer unbundles the process, the architect invariably ends up as the coordinator. That the architect and engineers are separately engaged is, in his experience, of little practical consequence. In fact, Robertson said, on a project in which the owner appropriated the coordinator’s role from the architect, the resulting confusion would likely require an engineer, like Robertson, to withdraw from the project.

Levy added, “Generally, for major building projects, the architect is the natural team leader since such projects deal with planning space for human occupancy and the aesthetic treatment of these spaces.” Still, he noted, “There are some projects—such as transportation or infrastructure complexes where functional, technical aspects take precedence over form—for which engineers are more suited to be the team leader.”

Cobb distinguished between “management of complex processes,” for which he believed engineers were best qualified, and “management of complex outcomes or products,” for which he believed architects were best qualified. Architects, he said, balance the interaction of systems to achieve their vision of a product such as an office building that, in terms of its effect on human beings, involves complex values. In contrast, he cited the design of a missile: extremely complex to design but very simple and single-minded in its purpose.

With respect to the unbundling of professional services, Cobb expressed views close to those of LeMessurier. When the developer is sophisticated, he observed, unbundling poses little risk to the public health, safety, and welfare. He warned, however, that such sophisticated developers are rare. When public clients such as school boards “unbundle,” the design and construction processes often becomes a nightmare. Nevertheless, Cobb concluded, the concept of registration is strong enough to accommodate some experimentation in the design process, and innovative relationships among those involved in the building process should be explored further.

APPENDIX C – COMPARISON OF CURRICULA IN SIX ACCREDITED ARCHITECTURE AND CIVIL ENGINEERING PROGRAMS*

Subject Area	B. Architecture	B.S. Civil Eng.	
General Education			
English (oral and written)	7.7**	7.8	
Mathematics	5.2	17.3	
Physical Sciences	6.8	22.8	
Social Sciences and Humanities	14.0	13.0	
Applied Art, Fine Art, Arch. History	*14.0*	*3.2*	
Technical Systems			
Structural Systems	8.5	20.6	(specified among three subject areas)
Environmental Systems	7.6	15.2	
Construction Materials and Systems	6.7		
Applied Sciences	1.0		
Design			
Basic Design, Fundamentals of A/E	*8.4* *3.8*	*3.8*	
Comprehensive Design	*39.3*	*5.8*	
Graphics, Computer Applications	*5.8*	*3.0*	
Professional Practice	*9.0*	*3.2*	
Professional Electives	20.3	23.5	
Total Semester Hours	*157.3*	*122.3*	

*Based on curricula at California Polytechnic State University at San Luis Obispo, Carnegie-Mellon University, Kansas State University, Mississippi State University, Norwich University, and Washington State University. Sample reflects diversity in geographic location, university size, academic reputation, and public/private status. Catalogue course descriptions were used to categorize courses.

**All academic course units were converted to semester hours.

APPENDIX D – OUTLINE OF EXAMINATIONS

The registration of architects is one of the means by which United States registration boards and Canadian provincial associations fulfill their mission to safeguard public health, safety, and welfare. Any individual may apply to one of the U.S. state or territorial boards or one of the Canadian provincial associations (together referred to as Boards of Architecture, or Boards, in this publication) for registration as an architect. However, to become registered, a person must demonstrate that he or she is qualified to render architectural services by meeting education, training, and examination standards established by each Board.

The Architect Registration Examination (ARE) is developed by the National Council of Architectural Registration Boards (NCARB). The ARE has been adopted for use by all U.S. state and territorial registration boards and by the Canadian provincial architectural associations as the registration examination for all candidates for architectural registration.

The ARE assesses a candidate's knowledge, skills, and abilities to provide the various services required in the practice of architecture. No single examination can test for competency in all aspects of architectural practice; the ARE is not intended for that purpose. The ARE concentrates on the professional services that affect the public health, safety, and welfare. The intent of the examination is to evaluate a candidate's competence to protect the public by providing the architectural services of pre-design, site design, building design, building systems, and construction documents and services as they relate to social, cultural, natural and physical forces, and to other related external constraints.

In addition to testing for competence in specific subject areas, NCARB is aware of the responsibilities an architect may have for coordinating the activities of others involved in the design/construction process. The ARE attempts to determine a candidate's qualifications not only in performing measurable tasks, but also in exercising the skills and judgment of a generalist working with numerous specialists. In short, the objective is to reflect the practice of architecture as an integrated whole.

The ARE is administered exclusively on computers at a network of test centers across the U.S., its territories, and Canada. If a candidate does not successfully complete a division of the ARE, he or she will have the opportunity to repeat that division once every six months. Scores for each division will be sent to the Board of Architecture that qualified the candidate for the examination. That Board of Architecture has the ultimate authority to determine a candidate's qualifications to practice architecture within its jurisdiction.

ARE Multiple-Choice Divisions

Multiple-Choice questions are administered for the following six divisions of the ARE:

- Pre-Design
- General Structures
- Lateral Forces
- Mechanical & Electrical Systems
- Building Design / Materials & Methods
- Construction Documents & Services

Each multiple-choice division consists of a fixed number of questions delivered within a maximum time limit.

MULTIPLE-CHOICE DIVISIONS

		NUMBER OF QUESTIONS		TESTING TIME		SCHEDULED APPOINTMENT TIME
PRE-DESIGN	→	105	→	2.5 HOURS	→	3 HOURS
GENERAL STRUCTURES	→	85	→	2.5 HOURS	→	3 HOURS
LATERAL FORCES	→	75	→	2 HOURS	→	2.5 HOURS
MECHANICAL & ELECTRICAL SYSTEMS	→	105	→	2 HOURS	→	2.5 HOURS
BUILDING DESIGN / MATERIALS & METHODS	→	105	→	2 HOURS	→	2.5 HOURS
CONSTRUCTION DOCUMENTS & SERVICES	→	115	→	3 HOURS	→	3.5 HOURS

ARE Graphic Divisions

The three graphic divisions of the ARE consist of a set of problems called vignettes used to assess candidates' knowledge, skills, and abilities in the different facets of architectural practice. Candidates are required to create a solution for each of the 13 vignettes listed below based on the program and code requirements presented with each vignette.

- Site Planning Division
  Site Design, Site Parking, Site Grading, Site Zoning, Site Analysis

- Building Planning Division
  Interior Layout, Schematic Design

- Building Technology Division
  Building Section, Accessibility/Ramp, Stair Design, Structural Layout, Mech & Electrical Plan, Roof Plan

GRAPHIC DIVISIONS

DIVISION	MAXIMUM SECTION TIME	VIGNETTE	RECOMMENDED TIME	SCHEDULED APPT. TIME
SITE PLANNING				**3.75 HOURS**
	1.5 HOURS	SITE DESIGN	1 HOUR	
		SITE ZONING	30 MINUTES	
		15 MINUTE BREAK		
	1.5 HOURS	SITE PARKING	30 MINUTES	
		SITE ANALYSIS	30 MINUTES	
		SITE GRADING	30 MINUTES	
BUILDING PLANNING				**5.75 HOURS**
	1 HOUR	INTERIOR LAYOUT	1 HOUR	
		15 MINUTE BREAK		
	4 HOURS	SCHEMATIC DESIGN	4 HOURS	
BUILDING TECHNOLOGY				**6 HOURS**
	2.5 HOURS	BUILDING SECTION	1 HOUR	
		STRUCTURAL LAYOUT	45 MINUTES	
		ACCESSIBILITY/RAMP	45 MINUTES	
		15 MINUTE BREAK		
	2.75 HOURS	MECH & ELEC PLAN	1 HOUR	
		STAIR DESIGN	1 HOUR	
		ROOF PLAN	45 MINUTES	

Fundamentals of Engineering Examination
Morning Session Specifications
(Effective October 1996)

SUBJECT	% of Questions
Chemistry	9
Computer	6
Dynamics	7
Electric Circuits	10
Engineering Economics	4
Ethics	4
Fluid Mechanics	7
Material Science/Structure of Matter	7
Mathematics	20
Mechanics of Materials	7
Statics	10
Thermodynamics	9
TOTAL	**100**

CHEMISTRY
Acids and Bases
Equilibrium
Equations
Electrochemistry
Inorganic Chemistry
Kinetics
Metals and Nonmetals
Nomenclature
Organic Chemistry
Oxidations and Reduction
Periodicity
States of Matter
Solutions
Stoichiometry

COMPUTERS
Algorithm Flowchart
Spreadsheet
Psuedocode
Data Transmission and Storage

DYNAMICS
Forces, Mass, and Acceleration
Friction
Impulse and Momentum
Kinematics
Vibrations
Work and Energy

ELECTRIC CIRCUITS
AC Circuits
Diode Applications
DC Circuits
Electric and Magnetic Fields
Capacitance and Inductance
Ideal Transformers
Fourier and Laplace Transforms
Operational Amplifiers (Ideal)

ENGINEERING ECONOMICS
Annual Cost
Breakeven Analysis
Benefit-Cost Analysis
Future Worth of Value
Present Worth
Valuation and Depreciation

FLUID MECHANICS
Flow Measurement
Fluid Properties
Fluid Statics
Impulse and Momentum
Pipe and Other Internal Flow
Similitude and Dimensional Analysis

MATERIAL SCIENCE/ STRUCTURE OF MATTER
Atomic Structure
Crystallography
Corrosion
Diffusion
Materials
Binary Phase Diagrams
Properties
Processing and Testing

MATHEMATICS
Analytic Geometry
Differential Equations
Differential Calculus
Difference Equations
Integral Calculus
Linear Algebra
Laplace Transforms
Probability and Statistics
Roots of Equations
Vector Analysis

MECHANICS OF MATERIALS
Beams
Bending
Columns
Combined Stresses
Shear
Stress and Strain
Tension and Compression
Torsion

STATICS
2-Dimensional Equilibrium
3-Dimensional Equilibrium
Centroid of Area
Concurrent Force Systems
Friction
Moment of Inertia
Vector Forces

THERMODYNAMICS
1st Law
2nd Law
Availability-Reversibility
Cycles
Energy, Heat, and Work
Ideal Gases
Mixture of Gases
Phase Changes
Properties: Enthalpy, Entropy, Free Energy
Thermodynamic Processes

ETHICS
Relations with Clients
Relations with Peers
Relations with Public

- The FE Examination is an eight-hour supplied-reference examination: 120 one-point questions in the four-hour morning session and 60 two-point questions in the four-hour afternoon session
- The morning session is common to all disciplines.
- The afternoon session is administered in six disciplines—Chemical, Civil, Electrical, Environmental, Industrial, and Mechanical—with a general engineering section for all remaining disciplines.
- Examinees will work all questions in the morning session and all questions in the afternoon section they have chosen.

Architecture as It Differs From Engineering

Fundamentals of Engineering Examination

Afternoon Session Specifications
(Effective April 2002)

SUBJECT	% of Questions
Chemical	
Chemical Reaction Engineering	10
Chemical Thermodynamics	10
Computer & Numerical Methods	5
Heat Transfer	10
Mass Transfer	10
Material/Energy Balances	15
Pollution Prevention	5
Process Control	5
Process Design & Economics Evaluation	10
Process Equipment Design	5
Process Safety	5
Transport Phenomena	10
Civil	
Computers & Numerical Methods	10
Construction Management	5
Environmental Engineering	10
Hydraulics & Hydrologic Systems	10
Legal & Professional Aspects	5
Soil Mechanics & Foundations	10
Structural Analysis	10
Structural Design	10
Surveying	10
Transportation Facilities	10
Water Purification & Treatment	10
Electrical	
Analog Electronic Circuits	10
Communications Theory	10
Computer & Numerical Methods	5
Computer Hardware Engineering	5
Computer Software Engineering	5
Control Systems Theory & Applications	10
Digital Systems	10
Electromagnetic Theory & Applications	10
Instrumentation	5
Network Analysis	10
Power Systems	5
Signal Processing	5
Solid State Electronics & Devices	10
Environmental	
Water Resources	25
Water & Wastewater Engineering	30
Air-Quality Engineering	5
Solid- & Hazardous-Waste Engineering	15
Environmental Science & Management	15

SUBJECT	% of Questions
General	
Chemistry	7.5
Computers	5
Dynamics	7.5
Electrical Circuits	10
Engineering Economics	5
Ethics	5
Fluid Mechanics	7.5
Material Science/ Structure of Matter	5
Mathematics	20
Mechanics of Materials	7.5
Statics	10
Thermodynamics	10
Industrial	
Computer Computations & Modeling	5
Design of Industrial Experiments	5
Engineering Economics	5
Engineering Statistics	5
Facility Design & Location	5
Industrial Cost Analysis	5
Industrial Ergonomics	5
Industrial Management	5
Information System Design	5
Manufacturing Processes	5
Manufacturing Systems Design	5
Material Handling System Design	5
Mathematical Optimization & Modeling	5
Production Planning & Scheduling	5
Productivity Measurement & Management	5
Queuing Theory & Modeling	5
Simulation	5
Statistical Quality Control	5
Total Quality Management	5
Work Performance & Methods	5
Mechanical	
Automatic Controls	5
Computer	5
Dynamic Systems	10
Energy Conversion & Power Plants	10
Fans, Pumps, & Compressors	5
Fluid Mechanics	10
Heat Transfer	10
Material Behavior/Processing	5
Measurement & Instrumentation	10
Mechanical Design	10
Refrigeration & HVAC	5
Stress Analysis	10
Thermodynamics	10

Engineering
Principles and Practices of Engineering Examinations

(Only the examinations in the Civil, Electrical, Mechanical, and Structural disciplines are presented for comparison with the ARE.)

EXAM	LENGTH	QUESTIONS
PE CIVIL	8 HOURS (two 4-hour sessions)	80 MULTIPLE-CHOICE QUESTIONS (40 per session) Examinee takes a common breadth exam and chooses one depth exam (of five offered).
PE ELECTRICAL	8 HOURS (two 4-hour sessions)	80 MULTIPLE-CHOICE QUESTIONS (40 per session) Examinee takes a common breadth exam and chooses one depth exam (of three offered).
PE MECHANICAL	8 HOURS (two 4-hour sessions)	80 MULTIPLE-CHOICE QUESTIONS (40 per session) Examinee takes a common breadth exam and chooses one depth exam (of three offered).
PE STRUCTURAL	8 HOURS (two 4-hour sessions)	80 MULTIPLE-CHOICE QUESTIONS (40 per session)
PE STRUCTURAL II	8 HOURS (two 4-hour sessions)	FOUR ESSAY QUESTIONS (two per session) Examinee chooses one question per session.