COMMENTARY

For Construction and Similarly Named Engineering Programs
Draft of July 27, 2011

Purpose

This document has been prepared by the ASCE Committee on Curriculum and Accreditation (CC&A) with the assistance of the ASCE-CI Construction Engineering Education Committee. The purpose of this document is to provide guidance to construction engineering program evaluators by clarifying and amplifying the Construction Engineering Program Criteria to be utilized in association with the ABET/EAC Criteria for Accrediting Engineering Programs. Nothing in this Commentary is intended to add to, detract from, or modify the ABET/EAC Criteria. Although this document is written for program evaluators, others may find it useful in reviewing their own programs for consistency with the Construction Engineering Program Criteria contained in the ABET/EAC Criteria. References to the "current criteria" are those in effect for the 2011-2012 accreditation cycle and available on the ABET, Inc. web site (and as approved by the ABET Board of Directors as of October 30, 2010).

Programs accredited under the Program Criteria for Construction and Similarly Named Engineering Programs often have names such as "Construction Engineering" or "Construction Engineering and Management." The latter reflects that some exposure to management topics is required by the program criteria. ABET EAC has determined that programs named Construction Engineering and Management are not required to also meet the program criteria for Engineering Management because the word "management" does not modify the word "engineering" in the title of the degree.

Program evaluation is an inherently subjective process. This Commentary is intended to help evaluators make subjective judgments in a manner that is consistent with the ABET/EAC Criteria. Evaluators are encouraged to use this document as a resource for the decision-making process, not as a set of rigid rules to be followed without some flexibility. Ultimately, decisions about compliance with the criteria must be based principally on the evaluator's professional judgment—informed by the Team Chair's guidance and appropriate program documentation. The general criteria include the wording "*The program must demonstrate...*". The onus for this demonstration is on the program, not the program evaluator. There are innumerable methods available to demonstrate the various facets of the criteria. The role of the program evaluator is to make the judgment as to whether or not the submitted material adequately demonstrates what is claimed.

Throughout this commentary references are made to Bloom's Taxonomy. Bloom's Taxonomy is not a part of the Construction Engineering Program Criteria. However, the authors of the criteria consulted Bloom's Taxonomy in selecting the verbs used to describe intended *levels of achievement*. Consequently, references to the taxonomy are made to provide guidance in interpreting the language used. A brief discussion of the taxonomy is contained as an appendix to this document.

The information presented in this Commentary reflects the best collective judgment of its authors and reviewers. It is subject to continual review and revision, reflecting input from constituencies and lessons learned from accreditation practice.

Organization and Contents

This Commentary is organized in terms of the requirements prescribed in the **Construction and Similarly Named Engineering Program Curriculum Criteria**. Each section includes a discussion with suggestions for ways compliance might be demonstrated.

ABET/EAC GENERAL CRITERIA

The details of criterion 3 are provided immediately below for easy access and to provide some context for the rest of the discussion.

Criterion 3. Student Outcomes

"The program must have documented student outcomes that prepare graduates to attain the program educational objectives.

Student outcomes are outcomes (a) through (k) plus any additional outcomes that may be articulated by the program.

(a) an ability to apply knowledge of mathematics, science, and engineering

(b) an ability to design and conduct experiments, as well as to analyze and interpret data

(c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability

(d) an ability to function on multidisciplinary teams

(e) an ability to identify, formulate, and solve engineering problems

(f) an understanding of professional and ethical responsibility

(g) an ability to communicate effectively

(h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context

(i) a recognition of the need for, and an ability to engage in life-long learning

(j) a knowledge of contemporary issues

(k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice."

Discussion of Student Outcome 3(b)

This portion of the General Criterion is not further amplified in the Construction Engineering Program Criteria, but the following outcome as prescribed in the General Criteria merits some discussion:

> ...an ability to design and conduct experiments, as well as to analyze and interpret data.

Construction engineers generally do not develop experimental procedures; rather, they conduct laboratory experiments according to published standards, such as the American Society for Testing and Materials (ASTM) specifications and the American Association of State Highway and Transportation Officials (AASHTO). Nonetheless, it is important to recognize the responsibility for compliance with the experimental design provision of General Criterion 3(b).

Consistent with Bloom's Taxonomy (see appendix), the verb "design" in this criterion implies that the expected level of achievement is Level 5, Synthesis. Thus the experimental design must reflect the putting together of parts to form a new whole.

In a construction engineering context, this level of achievement can be demonstrated through laboratory experiences that are consistent with the standards-based testing used in the construction engineering profession. For example, a program might require students to design a quality control testing program for some aspect of a construction project, *through the selection and application of appropriate published standards.* Thus, for example, the experimental design might involve determining the type and frequency of ASTM tests to be performed on fresh and hardened concrete during the construction of a building or highway. The student-designed experiment does not necessarily have to be implemented, as long as students have opportunities to conduct experiments elsewhere in the curriculum. Experiments may also be defined in a broader context such as designing and implementing a study in the field for a senior-level design course. While such activities may not be in a laboratory per se, they are certainly consistent with the spirit of the criteria.

However, because the requirement for experimental design occurs only in the General Criteria, there is no requirement for students to design experiments in a construction engineering context. Thus the program would be in full compliance if students' ability to design experiments were acquired, for example, in a physics, chemistry, or engineering mechanics course.

Compliance with c*onducting* laboratory experiments or tests *in a construction engineering context* and then analyzing, interpreting, and applying the data should be demonstrated through graduates' successful completion of laboratory experiences that are characterized by many of the following elements and are documented in written laboratory reports:

- Understanding of the objectives and procedures associated with an experiment.
- The conduct of experimental setup, measurement, and data collection.
- Observation and documentation of error and uncertainties in data collection procedures.
- Critical analysis of data.
- Interpretation of the experimental results, with appropriate conclusions and recommendations.
- Application of the experimental results to a real-world construction engineering problem or situation.

Consistent with Bloom's Taxonomy (see appendix), the verb "conduct" in this provision of the Program Criteria implies that the level of achievement for such tasks as experimental setup, measurement, and data collection is Level 3, Application. The verbs “analyze” and “interpret” imply that the level of achievement for processing experimental data is Level 4, Analysis.

A growing trend in engineering curriculum development involves the use of “virtual laboratories”—computer simulations that attempt to replicate the hands-on experiences of conventional physical labs. In general, such curricular innovations are encouraged, and the program evaluator must keep an open mind when considering their effectiveness. An evaluation of a virtual laboratory experience should consider such factors as:

- The extent to which the subject matter lends itself to accurate simulation.
- The extent to which the simulation replicates the actual physical experiences of setup, measurement, and data collection.
- The nature of student interaction with the simulation.
- The students’ abilities acquired through the simulation.
- Students’ satisfaction with their abilities gained through the simulation.

ABET/EAC PROGRAM CRITERIA

Note that program criteria were previously found in “criterion 9” but are now in the third part of the overall criteria (there is no criterion 9). Also note that program criteria are “limited to the areas of curricular topics and faculty qualifications.” **This means that assessment and evaluation of the degree to which students have attained the skills described within the program criteria is not generally required.** However **if** the program has chosen to incorporate any of the elements of the program criteria into their student outcomes, then assessment and evaluation, as called for in Criterion 4, is required.

Program Criteria for Construction and Similarly Named Engineering Programs

1. Curriculum

The program must prepare graduates to apply knowledge of mathematics through differential and integral calculus, probability and statistics, general chemistry, and calculus-based physics; analyze and design construction processes and systems in a construction engineering specialty field applying knowledge of methods, materials, equipment, planning, scheduling, safety, and cost analysis; explain basic legal and ethical concepts and the importance of professional engineering licensure in the construction industry; and explain basic concepts of management topics such as economics, business, accounting, communications, leadership, decision and optimization methods, engineering economics, engineering management, and cost control.

2. Faculty

The program must demonstrate that the majority of faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The faculty must include at least one member who has had full-time experience and decision-making responsibilities in the construction industry.

Knowledge of Mathematics & Science

This section discusses the following portion of the Construction Engineering Program Criteria:

> The program must prepare graduates to apply knowledge of mathematics through differential and integral calculus, probability and statistics, general chemistry, and calculus-based physics; ….

Mathematics through differential and integral calculus, probability and statistics, calculus-based physics, and chemistry are considered to be part of the *technical core* of construction engineering and thus are explicitly required by the Construction Engineering Program Criteria. Knowledge of probability and statistics is explicitly required since many construction operations are probabilistic in nature and statistics concepts are integral to many engineering subjects. Moreover, graduates are required to be able to analyze and interpret data from tests and construction activities which implies some background in probability and statistics. Students should have an appropriate opportunity to acquire the mathematical prerequisites; however, it would be entirely feasible for such opportunities to occur in the associated engineering courses, rather than in a course in math or probability and statistics.

This criterion amplifies the requirements of Criterion 5, "Curriculum" of the general criteria. The general criteria require a minimum of one year of "college level mathematics and basic sciences". There are no specific requirements for a minimum number of credit hours or courses in the specific subject areas mentioned in the program criterion, therefore, the programs are free to be innovative as long as they can fulfill their mission and meet their objectives. Depending on the construction specialization, the program may provide for either added depth in physics and chemistry or breadth in biological sciences, earth sciences or other basic sciences. This list is by no means all-inclusive, and it is not necessary that all students within a program study the same areas of science. A course that is primarily engineering science in content would not fulfill this requirement. The Program Evaluator must be careful not to overtly or covertly require a prescriptive set of courses to meet the one year requirement of the general criteria. The evaluation should be based principally on graduates' demonstrated ability to solve problems, not on curricular content.

Consistent with Bloom's Taxonomy (see appendix), the verb "apply" in this provision of the Program Criteria implies that the expected level of achievement is Level 3, Application. To comply with this criterion, the program must demonstrate that its graduates can apply concepts and principles from math and science to solve relatively straightforward problems.

Design a System, Component, or Process

This section is a discussion the following portion of the Construction Engineering Program Criteria :

> The program must prepare graduates to … analyze and design construction processes and systems in a construction engineering specialty field applying knowledge of methods, materials, equipment, planning, scheduling, safety, and cost analysis; ….

Definition of Design

The ABET definition of engineering design is as follows:

> Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs.

This definition should form the basis for evaluation of Criterion 3(c), Criterion 4, and the design-related provisions of the Construction Engineering Program Criteria.

Consistent with Bloom's Taxonomy (see appendix), the verb "design" in this criterion implies that the expected level of achievement is Level 5, Synthesis. Evaluation of graduates' ability to design should take into account the following considerations:

- The engineering design process typically includes both analysis and synthesis. Analysis involves the application of engineering tools and principles to predict the performance of a system, component, or process; synthesis involves the creation of a new system, component or process to meet desired needs. Analysis without synthesis is *not* engineering design.

- Normally, analysis and synthesis are performed in an iterative cycle. Thus students should experience *some* iterative design in the curriculum. It is not necessary for *all* design experiences to be iterative, however. Such a requirement would place an unrealistically heavy burden on both faculty and students.

- Engineering design problems are generally ill-defined. As part of their design experience, students should have an opportunity to define a problem, to include determining the problem scope and design objectives.

- Engineering design problems are generally open-ended. They have no single correct answer, but rather a range of possible solutions. Nonetheless, the evaluator must recognize that, in an academic setting, there are significant practical constraints on a program's ability to implement truly open-ended design experiences across the curriculum. The program must strike an appropriate balance between the desirability of open-ended design problems, the limitations of students' knowledge and experience, and the need to provide students with high-quality feedback on their design computations. It is both typical and appropriate for a design problem to have a relatively narrow range of "correct" solutions. Similarly, the term optimal (or optimally) should be interpreted with caution. While some engineering design problems may have optimal solutions, others (such as ill-defined systems problems) may not have an optimal solution *per se*. Some engineers might even argue that no problems other than the most trivial have true optimal solutions. In this context, incorporation of a formal optimization process is not indicated.

- Engineering design does not necessarily involve the devising of a complete system. The design of a component (e.g., the bracing for a wall form) or subsystem (e.g., equipment mix needed for an earthmoving activity) constitutes an acceptable design experience. Students' design experience is enhanced, however, if they can also gain an appreciation for the design of large-scale systems.

- Engineering standards and realistic constraints are critical in construction engineering design. The program must clearly demonstrate where standards and constraints are taught and how they are integrated into the design component of the curriculum. In construction engineering, the most common types of standards are codes and regulations. Constraints explicitly cited in Criterion 3(c) are economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability considerations. In a construction engineering context, *manufacturability* is generally interpreted as *constructability*.

Design in Construction

In construction engineering, the focus is usually on the design of the construction process, the means of accomplishing the construction of a facility. The process may involve many construction systems and components. The designs of some systems and components have their foundations in other engineering specialties. Design of the construction process often involves consideration of costs, schedule, site layout, labor resources, safety systems, temporary structures and support facilities, and equipment operations as examples.

Construction covers many possible areas requiring many possible engineering specialties. The programs are frequently allied with one specialty, such as civil, electrical or mechanical engineering, but may have concentrations available in other engineering specialties, or in sub-specialties. To some extent, the design background is derived from design elements in those construction specialties with the remainder from the field of construction engineering itself. In any case, the curriculum should provide for adequate depth in design "... *in a construction specialty field*" rather than attempting to cover all specialties with little depth in any specialty. This statement is not, however, intended to limit exposure to other specialties.

One possible source of information that can be considered when evaluating compliance with this criterion is Table I-1 (Basic-Level Curriculum) of the program self-study. In this table, courses containing “significant design” are annotated with an “X”.

Consistent with Bloom’s Taxonomy, the verb “design” in this provision of the Construction Engineering Program Criteria implies that the expected level of achievement is Level 5, Synthesis.

Importance of Legal and Ethical Concepts and Professional Licensure

This section discusses the following portion of the Construction Engineering Program Criteria:

> The program must prepare graduates to ... explain basic legal and ethical concepts and the importance of professional engineering licensure in the construction industry.

The reference to “explain” in this criterion implies that the expected level of achievement is Level 2, Comprehension. Graduates should be able to explain engineers’ professional and ethical responsibilities, as described in the ASCE Fundamental Canons of Ethics and the associated Guidelines to Practice under the Fundamental Canons of Ethics. They should also be able to explain the legal contractual framework and relationships within which construction work is executed.

It is advisable (but not required) that programs involve practitioners in the development, teaching, and assessment of professional and ethical responsibilities.

Consistent with Bloom’s Taxonomy, the verb “explain” in this criterion implies that the expected level of achievement is Level 2, Comprehension. Graduates should be able to explain the nature of construction engineers’ responsibility to the project success and the general public and the consequent emphasis on professional licensure for construction engineers.

Concepts in Management

This section is a discussion of the following portion of the Construction Engineering Program Criteria:

> The program must prepare graduates to… explain basic concepts in management topics such as economics, business, accounting, communications, leadership, decision and optimization methods, engineering economics, engineering management, and cost control.

The forms of **management** most relevant to construction engineering are as follows:

- **Construction project management.** Basic concepts in construction project management include owner-designer-contractor relationships; project delivery systems (e.g., design-bid-build, design-build, construction management); estimating construction costs; bidding and negotiating; labor and labor management issues; and construction processes, methods, systems, equipment, planning, scheduling, safety, quality control, cost analysis, cost control, and dispute resolution.

- **Asset management.** Asset management seeks effective and efficient long-term ownership of capital facilities or construction equipment via systematic acquisition, operation, maintenance, preservation, replacement, and disposition. Basic concepts include optimizing life-cycle performance, minimizing life-cycle costs, achieving maximum benefit, and the use of appropriate equipment, tools and techniques.

Successful engineering efforts requiring a team always involve the need for management. Construction almost always involves a team and the construction engineer is frequently the lead professional for the construction process. Understanding in a selection of management topics is desirable because the construction engineers often accumulates management and coordination responsibility early in their careers as a result of their background in design of construction processes with an emphasis on resource, cost, safety, and contractual constraints. The topics listed are suggested to aid the Program Evaluator in identifying topics that contribute to this understanding. All are not required. Many of the topics overlap other required topics in mathematics and engineering and, where appropriate, may be integrated into courses that are simultaneously considered to be entirely mathematics, engineering science or engineering design. No specific amount of management is required. Rather, the program evaluator should consider the apparent emphasis in combination with the demonstration of understanding evidenced in the major design experience.

Basic business concepts that are typically applied in the private, government and non-profit sectors include legal forms of ownership, organizational structure and design, income statements, balance sheets, decision (engineering) economics, finance, marketing and sales, overhead, and profit.

Leadership, which differs from and complements management, requires broad motivation, direction, and communication skills. Desirable behaviors of leaders, which can be taught and learned, include earning trust, trusting others, formulating and articulating vision, communication, rational thinking, openness, consistency, commitment to organizational values, and discretion with sensitive information.

Consistent with Bloom's Taxonomy, the verb "explain" in this criterion implies that the expected level of achievement is Level 2 (Comprehension). Graduates must be able to explain *some* (but not all) of the key concepts in the management areas listed above. As an alternative, graduates' ability to explain generic, business-oriented management concepts (e.g., those acquired from a management course outside of the engineering program) also represents full compliance with this criterion.

It is not necessary for the program to offer one or more courses explicitly devoted to management, business, public policy, or leadership. Rather, management topics may be integrated into other courses or curricular experiences.

Faculty Requirements

This section discusses the following portion of the Construction Engineering Program Criteria:

> The program must demonstrate that the majority of faculty teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience. The faculty must include at least one member who has had full-time experience and decision-making responsibilities in the construction industry.

Common to both the general and program criteria is the wording "*The program must demonstrate...*". The onus for this demonstration is on the program, not the program evaluator. There are innumerable methods available to demonstrate the various facets of the general and program criteria. The role of the program evaluator is to make the judgment as to whether or not the submitted material adequately demonstrates what is claimed.

The phrase "... *courses that are primarily design in content..."* is intended to generally provide a differentiation between engineering science and engineering design courses. Courses in this category would be those in the major and specialty discipline, typically in the third or fourth years, where design is a majority percentage of the course.

The faculty teaching courses that contain a minority percentage of design in the overall course are not addressed in the program criteria.

As an aid to the Program Evaluator in differentiating which classes and faculty are covered by this criterion, the program may elect to include a tabulation which indicates the design component of each class, and the faculty who teach the respective courses.

The next phrase, "...*are qualified to teach the subject matter by virtue of professional licensure, or by education and design experience."* describes the minimal ABET/EAC qualifications necessary to teach the advanced design courses. The program must demonstrate to the program evaluator's reasonable satisfaction that the affected faculty meet one or the other of these qualifications.

Professional licensure, usually as a Professional Engineer (P.E.), is considered satisfactory evidence of necessary qualifications to teach engineering design. However, there are other factors which should also be considered, including, is the licensure current and granted by the jurisdiction where the faculty member is teaching? Is licensure outside of the United States, or in something other than engineering, adequate? Some jurisdictions explicitly consider the teaching of design courses, or engineering courses in general, as the practice of engineering. Therefore, engineering faculty in those jurisdictions may have a legal obligation for professional licensure, which is beyond the scope of the ABET/EAC accreditation evaluation.

In general, it is the opinion of CC&A that relevant professional licensure as an engineer, wherever granted, is satisfactory evidence of fulfillment of this requirement. As was stated, the legal ramifications of inappropriate or non-existent licensure (practicing engineering without a license) are beyond the scope of the program criteria and this commentary.

The demonstration by the program that the relevant faculty members are qualified by virtue of professional licensure can be as simple as a table with the appropriate information. Information to be included in the table could include state or jurisdiction of licensure, discipline of licensure (if appropriate), date of initial licensure, and the expiration date of the license.

Licensure in a discipline closely related to the field in which the faculty member is teaching design may constitute relevant licensure but may not be sufficient for satisfying this requirement. Certifications are available in many disciplines and specialties. Certifications are not licensure and can not be used to fully satisfy this requirement. However, certification may be an indication of proficiency or expertise in a particular field. Thus, certification may be helpful in demonstrating experience in a specific discipline or specialty.

The second half of the requirement "...*or by education and design experience."* is CC&A's means for providing an alternative route to the demonstration that a faculty member is qualified to teach design in a specific area. It is recognized by inclusion of this phrase that the appropriate qualifications to teach design in a construction engineering program can not be solely defined by professional licensure.

The education of a person claiming competency under this phrase probably will be in a field closely related to that in which they are teaching design. For construction engineering, a variety of engineering specialties may contribute to the program. Of equal or greater importance than the specifics of their education is what they have accomplished since obtaining the related education.

The specifics of claimed experience in design should be well documented by the claimant and the program. Design experience can come in many forms and from many types of employment. The most common may be industrial experience working for the private sector. Design experience may be gained by the co-teaching of design courses with a person having design experience and by conducting academic or industrial research. Design experience may come in a sustained period of employment, or it may come incrementally over a several year period. The specifics of how this claimed design experience is documented are left to the program. There is no one correct answer.

The second sentence, "*The faculty must include at least one member who has had full-time experience and decision-making responsibilities in the construction industry.*" has several facets. The requirement "... *full-time experience* ..." indicates the CC&A conclusion that full-time involvement is necessary, rather than part-time exposure, to accumulate understanding of the dynamics of the construction environment. The experience must be at a level involving "... *decision-making responsibilities*..." so that at least one faculty member understands by experience the professional, ethical, and business concerns of the construction engineer. The requirement "... *in the construction industry*" indicates that the experience should relate directly to the construction process, although it may be as a contractor, consultant, or owner's representative. The amount of experience is not specified since it is the quality, diversity and level of the experience that is most meaningful.

APPENDIX – Bloom's Taxonomy

Bloom, Benjamin S. ***Taxonomy of educational objectives: Cognitive domain****. New York: David McKay and Company. 1956*

Bloom's Taxonomy is a well-established framework for defining educational objectives in terms of the desired level of cognitive development. Bloom's six levels of cognitive development—*knowledge, comprehension, application, analysis, synthesis,* and *evaluation*—describe a hierarchy of increasing complexity and sophistication in thought. Definitions of the six levels are provided in the center column of Table 1.

The fundamental premise of Bloom's Taxonomy is that an educational objective can be referenced to a specific level of cognitive development through the *verb* used in the objective statement. Some illustrative examples of verbs associated with Bloom's six levels are provided in the right-hand column of Table 2.

Table 1. Bloom's Taxonomy – Levels of Cognitive Development and Illustrative Verbs

Level	Definition	Illustrative Verbs
1. Knowledge	the remembering of previously learned material; it may involve the recall of a wide range of material from specific facts to complete theories, but all that is required is the bringing to mind of the appropriate information.	define; describe; enumerate; identify; label; list; match; name; reproduce; select; state.
2. Comprehension	the ability to grasp the meaning of material; may be shown by translating material from one form to another (words to numbers), by interpreting material (explaining or summarizing), and by estimating future trends (predicting consequences or effects); this goes one step beyond the simple remembering of material, and represent the lowest level of understanding.	classify; cite; convert; describe; discuss; estimate; explain; generalize; give examples; paraphrase; restate (in own words); summarize.
3. Application	the ability to use learned material in new, concrete situations; may include the application of rules, methods, concepts, principles, laws, and theories; requires a higher level of understanding than those under comprehension.	administer; apply; calculate; chart; compute; determine; demonstrate; implement; prepare; provide; relate; report; solve; use.
4. Analysis	the ability to break down material into its component parts so that its organizational structure may be understood; may include the identification of parts, analysis of the relationship between parts, and recognition of the organizational principles involved; represents a higher level than comprehension and application because it requires an understanding of both the content and the structural form of the material.	analyze; break down; correlate; differentiate; discriminate; distinguish; formulate; illustrate; infer; organize, outline; prioritize; separate; subdivide.
5. Synthesis	the ability to put parts together to form a new whole; may involve the production of a unique communication, a plan of operations (research proposal), or a set of abstract relations (scheme for classifying information); stresses creative behaviors, with major emphasis on the formulation of new patterns or structure.	adapt; combine; compile; compose; create; design; develop; devise; facilitate; generate; integrate; modify; plan; reconstruct; revise; structure.
6. Evaluation	the ability to judge the value of material for a given purpose, based on definite criteria; contains elements of all the other categories, plus conscious value judgments based on clearly defined criteria.	appraise; compare & contrast; conclude; criticize; critique; decide; defend; evaluate; judge; justify.

Table 2. Examples of Instructional Objectives Referenced to Bloom's Six Levels of Cognitive Development

Level	Example Instructional Objectives
1. Knowledge	**List** the assumptions required for concrete formwork analysis and design.
2. Comprehension	**Explain** the procedure for calculating member forces in a braced form, using the *method of joints*.
3. Application	**Calculate** the member forces in a formwork system, using the *method of sections*.
4. Analysis	**Analyze** a formwork system, accounting for all relevant loading conditions.
5. Synthesis	**Design** a formwork system of specified dimensions, accounting for relevant loading conditions.
6. Evaluation	For a form of specified dimensions, **compare** the suitability of job built wood, rented steel/ aluminum, and purchased steel/aluminum configurations; and **decide** on an optimum selection.