logically, coherently, or palpably; to draw with suitable instruments so as to fulfill certain specified conditions; to assemble separate and often disparate elements.

Adapt: to make suitable (for a new or different use or situation) by means of changes or modifications.

Organize: to arrange or constitute into a coherent unity in which each part has a special function or relation; to arrange by systematic planning and coordination of individual effort; to arrange elements into a whole of interdependent parts.

Execute: to put into effect; to carry out fully and completely.

Other illustrative verbs at the *synthesis* level include: anticipate, collaborate, combine, compile, devise, facilitate, generate, incorporate, modify, reconstruct, reorganize, revise, and structure.

Level 6—Evaluation

Evaluation concerns the ability to judge the value of material for a given purpose. The judgments are to be based on definite criteria. These may be internal criteria (organization) external or criteria (relevance to the purpose) and the individual may determine the criteria or be given them. Learning outcomes in this area are highest in the cognitive hierarchy because they contain elements of all the other categories as well as conscious value iudgments based on clearly defined criteria.e

Evaluate: to examine and judge concerning the worth, quality, significance, amount, degree, or condition of.

Compare: to examine the character or qualities of, especially for the purpose

of discovering resemblances or differences. This definition is the same as for level 4; however, when used in context with the verb "evaluate" for outcome 8 (problem recognition and solving), the combined action requires evaluation and is a level 6 task.

Appraise: to judge and analyze the worth, significance or status of; especially to give a definitive expert judgment of the merit, rank, or importance of.

Justify: to prove or show to be just, desirable, warranted, or useful.

Assess: to analyze critically and judge definitively the nature, significance, status, or merit of; to determine the importance, size, or value of.

Self-assess: to personally or internally analyze critically and judge definitively the nature, significance, status, or merit of a personal trait. Outcome 23 (lifelong learning) uses the verb "selfassess" to convey the concept of introspective reflection.

Other illustrative verbs at the *evaluation* level include: compare and contrast, conclude, criticize, decide, defend, judge, and recommend.

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APPENDIX G

The Affective Domain of Bloom's Taxonomy

Overview

The civil engineering body of knowledge (BOK) is central to the profession. The BOK is the necessary depth and breadth of knowledge, skills, and attitudes required of an individual entering the practice of civil engineering at the professional level in the 21st century. The levels of achievement are described in terms of a standard educational taxonomy, initiated by Bloom et al.¹⁰

Blooms taxonomy consists of three domains: cognitive, affective, and psychomotor. The cognitive domain refers to educational objectives that deal with the recall or recognition of knowledge and the development of intellectual abilities and skills. It is used exclusively herein to describe desirable civil engineering outcomes and levels of achievement.

The affective domain includes objectives that describe changes in interest, attitudes, and values and is an inseparable complement. Progress in the affective domain is described in terms of internalization of values. The affective domain provides a distinct and valuable vocabulary and set of concepts that are relevant to professional education.

Several outcomes already identified as important to the profession would

be enhanced by descriptions in both the cognitive domain and the affective domain. Two examples are outcome 24 (professional and ethical responsibility) and outcome 16 (communication).

These examples illustrate the value added by including an affective domain description in cases in which cognitive development alone does not cover the full scope of the outcome. The BOK2 Committee recommends that further work be undertaken in this area.

Bloom's Taxonomy^{a,b}

There are many developmental taxonomies. Each describes the same thing—the human person—and the educational process of human development. The purpose of a taxonomy is to break down this overall development process into smaller discernable "chunks" within which:

- Goals can be articulated
- Metrics of achievement can be constructed
- Achievement can be assessed.

Because any taxonomy attempts to describe the whole, constructing a hybrid of different taxonomies is ill-advised

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unless one is prepared to engage in educational research per se.

According to Bloom,^a there are three domains:

- "...the cognitive domain ... includes those objectives [that] deal with the recall or recognition of knowledge and the development of intellectual abilities and skills."
- "...the affective domain ... includes objectives [that] describe changes in interest, attitudes, and values ..."
- the psychomotor domain, which includes "...the manipulative or motor-skill area."

The cognitive domain was found to be most amenable to easy study and formed the basis of the first Bloom-led study.^a The second effort—by Krathwohl^b—extended this into the affective domain without changing the cognitive domain. The third, or psychomotor domain, was in fact not recommended by Bloom^a for further study, although it remains a distinct domain.^c

In describing the affective domain, Krathwohl and others^b adopted internalization as the basis of classification in this domain. This domain is easily summarized with the hybrid phrase "internalization of values and attitudes." Clearly, this is very different from the cognitive domain. The affective domain consists of five levels of increasing achievement, as illustrated in Table G-1.

Appendices prepared by Krathwohl and others^b are very useful. Their appendices A and B summarize both the cognitive and affective domains. Descriptive phrases used in their Appendix A serve as examples to illustrate the affective domain and are quoted in Table G-2.

Perhaps the most compelling case for the relevance of the affective domain is the description of level 3, valuing: "This category will be found appropriate for many objectives that use the term 'attitude' (as well as, of course, 'value')."^b Several more current sources and activities^{d,e,f,g} provide additional discussion and example verbs for use in the affective domain originally developed by Krathwohl and others.^b

As mentioned above there are many taxonomies, all seeking to describe the same thing: human development. The cognitive/ affective divide is characteristic, but not universal. For example, the conceive-design-implement-operate (CDIO)^h taxonomy is a more contemporary (2001) creation. It mingles these domains in a different manner, combining "professional skills and attitudes" and also "personal skills and attitudes" quite deep in the taxonomy. Because of this, combining parts from disparate taxonomies is not advised lest the fullness and unity of the object be lost.

First Edition of the Body of Knowledgeⁱ

The first edition of the body of knowledge focuses on the knowledge, skills, and attitudes (KSA) required for the future civil engineer. There are 15 specific outcomes generally falling within the knowledge/skills arena. Beyond that, there is a significant discussion of attitudes. The following points are made:

- Attitudes are an essential component of the "what" dimension of the BOK.
- Attitudes are found to be integral parts of the BOK of other professions.

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Affective taxonomy						
1.0	Receiving	1.1	Awareness			
		1.2	Willingness to receive			
		1.3	Controlled or selected attention			
	Responding	2.1	Acquiescence in responding			
2.0		2.2	Willingness to respond			
		2.3	Satisfaction in response			
		3.1	Acceptance of a value			
3.0	Valuing	3.2	Preference for a value			
		3.3	Commitment			
1.0	Organization	4.1	Conceptualization of a value			
4.0		4.2	Organization of a value system			
5.0	Characterization by a value complex	5.1	Generalized set			
5.0		5.2	Characterization			

Table G-1. Levels and sublevels of achievement in the affective domain.^b

- Studies point to the essential role of attitudes in individual and group achievement.
- Knowledge and skills are necessary, but not sufficient, for the fully professional engineer.
- Absent a proactive effort at the university level, many civil engineering students and young engineers are not likely to acquire such attitudes—or worse, are likely to acquire negative attitudes.

There are three levels of achievement in the first BOK report:ⁱ recognition, understanding, and ability. These are suggested to be used in describing achievement of outcomes 1-15. The report also suggested that attitudes be connected to the achievement of outcomes 1-15; however the mechanism is not clear.

The Levels of Achievement Report^j

understanding, and ability-were deemed unworkable. The search for a replacement led this subcommittee to a survey of the assessment field and to the need for an established learning taxonomy. There are several. The subcommittee rejected the notion that ASCE could invent its own taxonomy. Following a review of extant taxonomies, Bloom's original taxonomy was found to be most useful. Specifically, the 15 outcomes were discussed in terms of Bloom's cognitive domain; and Bloom's six cognitive levels were recommended. The issue of attitudes and their connection to the 15 outcomes was not addressed, nor was the need for the affective domain, although the latter was noted.

By inference the LOA subcommittee found the cognitive domain of Bloom's Taxonomy sufficient for these original outcomes 1–15. The subcommittee's report was generally silent on addressing the need for or value of the affective domain.

In the levels of achievement (LOA) report, the three achievement levels—recognition,

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Table G-2. Illustrative affective domain objectives excerpted from Krathwohl et al.,^b Appendix A, "A Condensed Version of the Affective Domain."^a

2.0 Responding

- 2.2 Willingness to respond
 - Acquaints himself/herself with significant current issues in international, political, social, and economic affairs through voluntary reading and discussion.
 - Acceptance of responsibility for his/her own health and for the protection of the health of others

2.3 Satisfaction in response

- Enjoyment of self-expression in music and in arts and crafts as another means of personal enrichment.
- Finds pleasure in reading for recreation.
- Takes pleasure in conversing with many different kinds of people

3.0 Valuing

- 3.1 Acceptance of a value
 - Continuing desire to develop the ability to speak and write effectively.
 - Grows in his/her sense of kinship with human beings of all nations.

3.2 Preference for a value

- Assumes responsibility for drawing reticent members of a group into conversation.
- Deliberately examines a variety of viewpoints on controversial issues with a view to forming opinions about them.
- Actively participates in arranging for the showing of contemporary artistic efforts.

3.3 Commitment

- Devotion to those ideas and ideals that are the foundations of democracy.
- Faith in the power of reason and in methods of experiment and discussion.

4.0 Organization

- 4.1 Conceptualization of a value
 - Attempts to identify the characteristics of an art object that he/she admires.
 - Forms judgments as to the responsibility of society for conserving human and material resources.
- 4.2 Organization of a value system
 - Weighs alternative social policies and practices against the standards of the public welfare rather than the advantage of specialized and narrow interest groups.
 - Develops a plan for regulating his/her rest in accordance with the demands of his/her activities.
- 5.0 Characterization by a value or value complex

5.1 Generalized set

- Readiness to revise judgments and to change behavior in the light of evidence.
- Judges problems and issues in terms of situations, issues, purposes, and consequences involved rather than in terms of fixed, dogmatic precepts or emotionally wishful thinking.

5.2 Characterization

- Develops for regulation of his/her personal and civic life a code of behavior based on ethical principles consistent with democratic ideals.
- Develops a consistent philosophy of life.

^a This table excludes Section 1.0 and Section 2.1 as shown in Table G-1 because they are not appropriate for college education.

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The Curriculum Committee Report^k

In parallel, the ASCE Committee on Academic Prerequisites for Professional Practice (CAP³) created the Curricula Committee. This group's work is quite comprehensive, examining the original BOK and the recommendations of the LOA effort. Specifically, the committee endorsed the original 15 outcomes and the use of Bloom's cognitive taxonomy. Regarding attitudes, this committee echoed the description in the first BOK report and supplemented it. It endorsed the importance of attitudes within the profession and echoed the idea of linking attitudes to the 15 outcomes.

Predictably, there were difficulties—attitudes that were not measurable (cognitive) outcomes; some attitudes demonstrably both "good" and "bad," depending on the context; no definitive list; and no metrics of assessment.

Among the conclusions of the Curriculum Committee:^k

- Knowledge and skill are necessary, but not sufficient, for the practice of civil engineering.
- Professional attitudes can and should be learned.
- Attitudes cannot be taught, but can be "taught about."

The Curriculum Committee offered these recommendations:

- "Any use of this BOK to advance standardized measurements of attitude would be contrary to the committee's recommendations. When it comes to attitudes as part of the BOK, a flexible approach is in order.
- The committee believes that civil engineering departments and employers

should adopt the approach that understanding the value and meaning of certain attitudes is an educational and developmental opportunity.

■ The committee recommends that each employer and university civil and environmental engineering department select a set of constructive attitudes, possibly calling them professional attitudes. They may draw on the example list provided earlier or use other sources. They may choose to teach about the selected attitudes within the B+M/30&E process." (That is, during prelicensure formal education and experience.)

There is no recommendation here relative to what is clearly "affective" in Bloom's Taxonomy.

Second Edition of the BOK

In the second edition of the BOK (this report), the 15 outcomes have been refined and expanded to 24. In so doing the cognitive domain has been used as the basis of the rubric, generally following the LOA suggestions. Significant progress has been made.

Regarding the BOK1 attitudes issue, the BOK2 Committee considered interpreting the KSA categories (knowledge, skills, and as knowledge, skills, attitudes) and abilities-consistent with an overall focus on the cognitive domain only. This has the advantage of being more readily measurable. But despite the appeal of using a different "A" word, it is not a synonym. After consideration, the BOK2 Committee rejected this substitution for two reasons:

- Abilities do not seem different from skills.
- The sense of "attitude" is entirely lost.

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Interestingly, Bloom's cognitive domain denotes level 1 achievement as "knowledge;" while cognitive levels 2–6 are "intellectual abilities and skills."

Reflecting this, the BOK2 Committee has included an explicit, stand-alone attitude outcome: outcome 22 (attitudes). This outcome, like others, is described solely in terms of cognitive domain achievements. domain cognitive provides The а somewhat incomplete vocabulary for this outcome. There is overlap of the cognitive and affective domains, especially at the lower levels 1 and 2 of achievement. But at level 3, "valuing," the most obvious departure from the cognitive domain occurs. At level 3 and beyond, increasing affective achievement is uniquely described in terms of internalization of values and attitudes, a notion not relevant in the cognitive domain. Continued BOK2 Committee discussion indicates that there may be an affective dimension of achievement implicit in several identified outcomes

Conclusion: Two-Dimensional Outcomes

The BOK2 Committee concludes that there is value added in exploring an affective domain description of the present outcomes, to accompany the existing cognitive domain descriptions. There is nothing wrong with the cognitive domain; it is simply incomplete. The committee suggests a two-dimensional classification: cognitive and affective. This has the advantage of freeing some of the outcomes from a one-dimensional sense of achievement and allowing additional noncognitive verbs to enter the achievement descriptions as appropriate. A two-dimensional approach will add value to the description of the individual outcomes and add legitimacy in the sense of properly using the selected taxonomy.

The bottom line is this: the profession wants individuals who possess more than knowledge and skill.¹ The affective domain is one framework in which a more complete analysis and discussion can occur. Given the high and continuing interest in "affective" development, the BOK2 Committee recommends that this be explored, but not as part of the BOK2 Committee's efforts.

Example Affective Domain Rubrics

Consider the two example rubrics, using the Affective Domain, that appear in Tables G-3 and G-4. These supplement and enrich the existing cognitive rubrics; they do not replace them. For illustrative purposes the cognitive rubric is replicated here without change. Several possibilities occur in the professional outcome category, but not all. There may be something useful in the foundational category such as a scientific respect for theory and observation; humanist values directed at needs: an internalization of the value inherent in diversity in teamwork; and the foundational basis of ethics. The committee has not attempted these, but feel that the point is best made in the examples selected.

The example rubrics are followed by commentaries on the affective domain portions.

		Level of affective achievement									
Outcome title	1 Receiving		2 Responding		3 Valuing			4 Organizing conceptualizing		5 Characterizing	
To enter the practice of civil engineering at the professional level, an individual must be able to demonstrate this level of achievement										ent	
16 Communication	Develop an aware the factors involve effective verbal, w virtual, and graph communication. (B)	ness of Dis ed in inv ritten, ver ical and cor	Discuss the factors involved in effective verbal, written, virtual, and graphical communications. (B)		<i>Demonstrate</i> a commitment to effective verbal, written, virtual, and graphical communications. (B)		Integrate principles from effective communications into work products. (E)		<i>Discriminate</i> between effective and ineffective communications.		
					Level of cognitive	achievement"					
Outcome title	1 Knowledge	2 Comprehension		3 Application		4 Analysis		5 Synthesis		6 Evaluation	
To enter the practice of civil engineering at the professional level, an individual must be able to demonstrate this level of achievement											
16 Communication	List the characteristics of effective verbal, written, virtual, and graphical communications.Describ charact effective written, graphical communications.		the <i>Apply</i> the sand composite of and writte verbal, and writte communical cite source appropriat standards engineerin		rules of grammar osition in verbal n cations, properly es, and use te graphical in preparing g drawings.	Organize and deliver effective verbal, written, virtual, and graphical communications.		<i>Plan, compose,</i> and <i>integrate</i> the verbal, written, virtual, and graphical communication of a project to technical and nontechnical audiences.		<i>Evaluate</i> the effectiveness of the integrated verbal, written, virtual, and graphical communication of a project to technical and nontechnical audiences.	
	(B)	(.	(B)		(B) (B)			(E)			

Table G-3. Example rubric for a two-dimensional outcome—communication.

^a Taken from Appendix I

		Level of affective achievement										
Outcome title	1 Receiving	2 Respondi	2 Responding		3 Valuing		4 Organizing conceptualizing		5 Characterizing			
To enter the practice of civil engineering at the professional level, an individual must be able to demonstrate this level of achievement												
24 Professional and ethical responsibili	<i>Locate</i> and <i>ident</i> professional and ethical responsib of a civil enginee	<i>ify</i> the <i>Discuss</i> the profess ethical responsibilities civil engineer. r.	sional and ities of a	<i>Commit</i> to the standards of professional and ethical responsibility for engineering practice.		<i>Integrate</i> professional and ethical standards for the engineer's own practice.		<i>Display</i> professional and ethical conduct in engineering practice.				
	(B)	(B)	(B)		(B)		(B)		(E)			
	Level of cognitive achievement ^a											
Outcome title	1 Knowledge	2 Comprehension	3 Applic	ation	4 Analysis		5 Synthesis		6 Evaluation			
To enter the practice of civil engineering at the professional level, an individual must be able to demonstrate this level of achievement												
24 Professional and ethical responsibility	<i>List</i> the professional and ethical responsibilities of a civil engineer.	ne Explain the professional and sional and 1 and ethical nsibilities of a ngineer. engineer.		<i>Apply</i> standards of professional and ethical responsibility to determine an appropriate course of action.		tion iple fessional erests to ppropriate n.	<i>Synthesize</i> studies and experiences to foster professional and ethical conduct.		<i>Justify</i> a solution to an engineering problem based on professional and ethical standards and <i>assess</i> personal professional and ethical development.			
	(B)	(B)	(B) (B		(B)		(E)		(E)			

Table G-4. Example rubric for a two-dimensional outcome—professional and ethical responsibility.

^a Taken from Appendix I.