Developing a Body of Knowledge for Civil Engineering
Specialization: Geotechnical Engineering

Abstract

The body of knowledge (BOK) for civil engineers recommended by the American Society of Civil Engineers (ASCE) continues to evolve through the efforts of ASCE’s Technical Council on Academic Prerequisites for Professional Practice (TCAP). The ASCE BOK includes a Technical Specialization outcome, designated to be primarily met through master’s level graduate study or equivalent continuing education. ASCE has not defined bodies of knowledge for post-baccalaureate formal learning within the Technical Specialization outcome. However, it could be helpful to individuals and department programs to have insights or a systematic process for developing a suitable institute-specific plan of study for Technical Specialization. The findings of such a study would also be useful to graduate students making decisions about graduate courses.

The paper presents a systematic process that could be used to assess the appropriate body of knowledge for students seeking technical specialization in geotechnical engineering, but this process could apply to any engineering field. It involves development of a list of topics to be considered for a body of knowledge through a focus group comprised of practicing engineers and engineering faculty; creation, use, and interpretation of an assessment tool distributed to both practicing engineers and engineering faculty to acquire insights for setting priorities for learning; and development of a body of knowledge that accounts for the insights of practicing engineers, needs of graduate programs, and pedagogical and personnel limitations of a specific program.

This process is illustrated in the paper for a technical specialization in geotechnical engineering. The paper supports permitting individual departments to define the appropriate body of knowledge for Technical Specialization, but encourages programs to engage in a systematic process to develop appropriate bodies of knowledge for their civil engineering subdisciplines as a service to their students.

Introduction

Much has been written lately about the future of engineering and engineering education. The National Academy of Engineering (NAE) has a project under way to redefine engineering and engineering education, with several publications from that effort already in print. The University of Michigan’s Millennium Project is studying new paradigms for learning institutions, and has issued an insightful report on engineering education. The American Society of Civil Engineers (ASCE) has been especially proactive about the future of civil engineering education. It has now been ten years since ASCE adopted Policy Statement 465 (PS 465), recommending the Master’s or equivalent as the first professional degree for civil engineers. ASCE is making progress towards implementing that vision of PS 465. Recent publications include their reports on development of civil engineering curricula and the second edition of the proposed civil engineering body of knowledge. ASCE’s efforts will likely impact all of engineering education. For
example, ASCE led the effort that resulted in approval of a new Model Law for licensure by the National Council of Examiners for Engineering and Surveying (NCEES) that increases the mandatory engineering education for licensure by 30 semester credit hours.

A recurring theme in the ongoing dialogue is the merit of having the Master’s degree or equivalent required for the design engineer and thus necessary for an engineer to become licensed. Substantial ongoing effort by ASCE has helped to clarify the learning appropriate to the body of knowledge (BOK) for civil engineering and much dialogue continues on the baccalaureate curriculum for civil engineering. Meanwhile, the Master’s level learning defined in the ASCE BOK is only recently being examined in detail. The 24 learning outcomes in the ASCE BOK are separated into three categories: foundational, technical and professional learning. Master’s level learning is not identified as a part of the foundational and professional learning categories, while three of the outcomes in the technical category include learning at the Master’s level. Those learning outcomes are (7) Experiments, (8) Problem Recognition and Solving, and (15) Technical Specialization. The three outcomes and the rubrics for assessing learning in those outcomes are in Table 1 from ASCE’s second edition BOK report.

While the civil engineering community continues to discuss and evolve the BOK for civil engineers, departments of civil engineering would do well to examine carefully the content and intent of the BOK as a road map for the preparation of their students for the

<table>
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<tr>
<th>Outcome rule</th>
<th>1 Knowledge</th>
<th>2 Comprehension</th>
<th>3 Application</th>
<th>4 Analysis</th>
<th>5 Synthesis</th>
<th>6 Evaluation</th>
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<tr>
<td>Experiments</td>
<td>Identify the procedures and equipment necessary to conduct civil engineering experiments in more than one of the technical areas of civil engineering.</td>
<td>Explanatory concepts related to problem recognition, problem articulation, and problem-solving processes, and how engineering techniques and tools are applied to solve problems.</td>
<td>Develop problem statements and solve well-defined fundamental civil engineering problems by applying appropriate techniques and tools.</td>
<td>Analyze the results of experiments and evaluate the accuracy of the results within the known boundaries of the tests and materials in or across more than one of the technical areas of civil engineering.</td>
<td>Synthesize the solution to an ill-defined engineering problem appropriate to civil engineering by selecting and applying appropriate techniques and tools.</td>
<td>Evaluate the effectiveness of a designed experiment in meeting an ill-defined real-world need.</td>
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<tr>
<td>Problem recognition and solving</td>
<td>Identify key factual information related to engineering problem recognition, problem solving, and applicable engineering techniques and tools.</td>
<td>Explain key concepts and problem-solving processes in a traditional or emerging specialized technical area appropriate to civil engineering.</td>
<td>Apply specialized tools, technology, or technologies to solve simple problems in a traditional or emerging specialized technical area of civil engineering.</td>
<td>Analyze a complex system or process in a traditional or emerging specialized technical area appropriate to civil engineering.</td>
<td>Design a complex system or process or create new knowledge or technologies in a traditional or emerging advanced specialized technical area appropriate to civil engineering.</td>
<td>Evaluate the design of a complex system or process, or evaluate the validity of newly created knowledge or technologies in a traditional or emerging advanced specialized technical area appropriate to civil engineering.</td>
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<tr>
<td>Technical specialization</td>
<td>Define key aspects of advanced technical specialization appropriate to civil engineering.</td>
<td>Explain key concepts and problem-solving processes in a traditional or emerging specialized technical area appropriate to civil engineering.</td>
<td>Apply specialized tools, technology, or technologies to solve simple problems in a traditional or emerging specialized technical area of civil engineering.</td>
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civil engineering profession. The learning defined in the BOK is appropriate and should be considered for immediate adoption for departments regardless of how accreditation or licensure may guide a civil engineer’s learning. Some areas of specialization already expect a civil engineer to earn a Master’s degree regardless of whether their baccalaureate is sufficient for licensure. All areas of civil engineering design are sufficiently specialized to require Master’s to produce the best quality designs. Townsend even suggests that the geotechnical profession should consider a Doctor of Engineering for geotechnical engineering practitioners. However, among the professional community, some civil engineering graduate programs have come under scrutiny in the past decade. As cited later, there have been concerns expressed that graduate programs have become less focused on preparing civil engineers for the professional practice of civil engineering and more focused on engineering research. An added concern in this perceived trend has been that the future educators of civil engineers who graduate with Ph.D.’s may be less prepared to foster the best possible learning in practical civil engineering design. These concerns may or may not be justified, but the current dialogue certainly provides an opportunity for civil engineering departments to reexamine their graduate programs to identify whether they are doing to their best to prepare their graduates. Implied in the M/30 learning is the knowledge, skills and attitudes necessary to do engineering work in the defined area of specialization.

Curriculum development and assessment is inevitably driven by accreditation to some extent. The intent of this current work is to maintain focus on the needs of the profession and graduates on their way to becoming professionals. However, the accreditation of graduate degrees is facilitated in part by the types of processes expressed in this paper. Departments of civil engineering who adopt this or similar processes should include consideration of the role of accreditation in their mission and effort.

This paper proposes a process civil engineering programs may consider following to identify whether their graduate programs have chosen an appropriate BOK for each specialization in their graduate program. Not only could this facilitate some curriculum redesign, but it could also lead to development of guidelines helpful to graduate students in planning their course work. The process herein is illustrated through application on a trial basis to the geotechnical specialization. The paper does not propose creation of a specific BOK for geotechnical specialization. It is believed that from region to region, the appropriate body of knowledge will vary. In fact, some programs may choose to develop different BOK specifically for practitioners, researchers, or educators in the engineering profession. In all cases, it is recommended that the BOK developed by departments should be recommended, not mandated, so that engineering students can gain from the best judgment of their departments while retaining flexibility in developing their own programs of study with the assistance of their mentors within the profession.

Process

The recommended process is five steps: (1) define mission, (2) literature review, (3) consult trusted experts, (4) practitioners’ survey, and (5) interpretation of findings. Each of the steps is summarized below, and was conducted for this study for the geotechnical
specialization. The results of the study for the geotechnical specialization are provided later in the Findings, and a reflection on the process and how it may be improved is provided in the Conclusions and Recommendations for Further Study.

**Define Mission**

Within the BOK framework, the final formal education of professional engineers takes place during their graduate study. The baccalaureate provides a broad base of learning that prepares the civil engineering student to move into specialization, but the BOK intends the majority of specialization to occur in graduate study. Each civil engineering specialization within a department should define their mission in filling this need. They may choose to emphasize preparation of the best possible engineering designer, manager, researcher, or educator. They may make it their mission to provide several tracks students could follow to one of those goals. However, it is important the mission of the suggested BOK in each specialization is clearly understood by the department, the faculty members and the students. This defining statement should guide the remainder of this process. For the demonstration study herein, the mission is to prepare the best possible civil engineer for entry into private practice in the geotechnical specialization.

**Literature Review**

Engineering curricula for both undergraduate and graduate study have not evolved without thoughtful dialogue on the subject in the engineering community. A review of the literature on the subject of appropriate learning within a civil engineering specialization may not uncover many works, but thoughtful discussions can be found. Departments should conduct a literature review on the subject so they can gain from past work on the subject. Most specialization areas in a department will be represented by at least several faculty members, so the writing of a summary of findings by colleagues will likely enrich the learning of all involved and, if published in an appropriate venue, add to the knowledge of the civil engineering community.

Within the geotechnical area specialization, there has been some recent dialogue in the literature about the education of geotechnical engineers. Townsend (2005) considered the challenges to geotechnical graduate education in light of the ASCE BOK and future needs, issuing a call to give increased attention to teaching the practical aspects of geotechnical education, to the possible merit of a Doctor of Engineering degree in geotechnical engineering, and to change curriculum and course content in response to the ASCE BOK. Geotechnical engineering education was debated in a series of papers in the periodical *Geotechnical News*. The details of those and other discussions will not be summarized herein, but the concerns expressed were sufficient to justify initiation of the study reported herein.

**Consult Trusted Experts**

Input from the professional community that will employ the graduates of a specialty program is essential to this process. Input should comprise a minimum of two steps. The
first step is to interview trusted experts consistent with the mission, and the second step is
to survey practitioners or researchers in the specialty area. This step would appropriately
focus on either researchers or practitioners, or an appropriate combination, depending on
the weight the program wishes to place on preparation for private practice versus
research, as identified in the mission statement.

Interviews with trusted experts should be conducted to identify (1) consistencies in
essential core knowledge agreed upon by most of the experts, (2) differences of opinion
between experts and (3) difference between what experts believe should be learned and
what they believe is being learned in existing programs. The experts should be selected,
trusted practitioners if the emphasis is on preparation for private practice, and researchers
if the emphasis is on research. Once consistencies and differences have been identified,
the specialty program can then develop a survey for distribution among appropriate
practitioners or researchers to obtain input for a recommended BOK. This survey
development should not exclude insights from the faculty members in the specialty area
themselves.

For this demonstration, four experts were selected. The experts were comprised of two
consultants of high integrity holding Ph.D. degrees in geotechnical engineering, and two
respected faculty members with a reputation for emphasis on preparation of students for
successful private practice. The experts’ observations from one-on-one interviews were
compiled and evaluated. Based on the interviews, a core of five geotechnical courses for
inclusion in a geotechnical Master’s BOK was identified. These led to the consistencies
identified as the first category at the beginning of the prior paragraph. Course titles were
used at this stage although it was acknowledged that course content is not necessarily
identified by course title. This was necessary to facilitate a starting point for the
discussion and was specifically discussed with each of the experts to provide a consistent
understanding of what course content would be associated with those courses. Within
those and ensuing discussions, the experts naturally identified other knowledge that they
believed may be omitted or undervalued, what knowledge has traditionally been excluded
altogether from programs, and what knowledge may be overemphasized in some
programs. This information was compiled as the second and third categories from the
beginning of the previous paragraph.

Information from the expert interviews were used for the next step. The interviews also
provided insights crucial to a geotechnical BOK that demand further study beyond the
scope of this paper and will not be addressed herein. These are discussed in the
Conclusions and Recommendation for Further Study later in this paper.

Practitioners’ Survey

Based on the expert interviews and study reflection, a survey for practitioners should be
prepared for distribution to the specialist community. The survey should profile
respondents to the survey, perhaps identifying the practitioners’ region of primary
practice and their opinion about their own level of expertise. It could be useful for civil
engineers outside the specialty area to provide input to the survey, so it should be possible for respondents to identify their specialty area if different from the survey focus.

This activity was completed for this demonstration. The experts generally agreed upon a core of five geotechnical courses for the specialty BOK. These were the “consistencies” identified earlier. The course titles were somewhat different from one expert to another, so the following titles are a synthesis of their suggestions:

- Advanced soil mechanics (with interpretation of field and lab data)
- Advanced foundations (with planning and implementation of investigations)
- Earth retaining structures, embankments and slope stability
- Flow through porous media
- Numerical geotechnical modeling

Important features of the first two courses are included in parentheses for consistency with the experts’ insights. These identified core courses were provided on the survey and respondents were asked to identify to what extent they agreed with the list of core courses. The scale used for the respondents’ level of agreement with the core courses was (0) Not at all, (1) Somewhat, (2) Mostly, and (3) Agree completely. Respondents were invited to elaborate on their response in a comment box provided on the survey.

The experts also identified topics that may or may not be appropriate for core knowledge in a geotechnical BOK, or that may be suitable for recommended study even if they may be excluded from the core courses. These were the “differences” topics identified earlier. The following identifies these topics in no particular order, based on the interviews:

- LRFD of geotechnical systems
- Machine foundations
- Engineering economics for geotechnical investigation, design and construction
- Advanced testing (triaxial, controlled strain consol., flex. wall perm., etc.)
- Advanced field testing (geophysical, dilatometer, pressuremeter)
- Engineering management
- Liability and loss prevention
- Ethics
- Geomorphology related to engineering behavior
- Unsaturated soil mechanics
- Soil-structure interaction
- Advanced structural analysis
- Finite element analysis
- Advanced mechanics of materials for geotechnical engineers (braced excavations, connections, deflections under distributed loads)
- Wave mechanics (in ground and in piles, for example)
- Instruments (knowledge/skills to direct lab and field testing, field load tests)
Each of these topics may be included under Outcome 15 – Technical Specialization for the BOK. Thus, practitioners were asked in the survey to identify the level of knowledge appropriate to the topics using the rubrics suggested for Outcome 15 in the BOK, with the following numeric ratings:

(0) This topic need not be included in the body of knowledge for a geotechnical Master’s (M)
(1) M graduates should be able to Define key aspects of this topic area
(2) M graduates should be able to Explain key concepts and problem solving processes in this topic area
(3) M graduates should be able to Apply knowledge and Solve simple problems in this topic area
(4) M graduates should be able to Analyze complex systems or processes in this topic area
(5) M graduates should be able to Design a complex system or process or Create new knowledge in this topic area

The two page survey that was provided is included at the end of this paper.

Interpretation of Findings

Interpretation of findings will be subject to the needs and resources of each department’s specialty area. The study team may decide to place more weight on the recommendations provided by seasoned experts as opposed to novice engineers. Insights may come from the survey that would cause the study to team to reconsider the findings of the selected expert interviews. Certainly, the survey and expert insights may not be able to consider the limitations and needs of the department, and factors having to do with student workload, available credit hours. The study team should weigh the value of content that can only be effectively learned in a controlled formal setting as compared to content that can be effectively learned after graduation. Two or three years of mentoring before licensure under a qualified engineer is essential training, and departments would be remiss not to acknowledge that some learning will occur much more effectively after graduation and before licensure in a work setting.

Conversely, even some employers admit they hire new graduates with the expectation that the graduate will bring skills to their company that will raise the bar of private practice. Similarly, the hiring of a research engineer often carries with it a hope for raising the bar or bringing a new skill to a research team. Responsibility for raising the bar in such a way falls on the departments where the engineers are educated.

Ultimately, the prior steps should provide more information than is typically acquired as specialty areas consider their BOK. It is appropriate to obtain such input from both trusted sources and from the community at large, and preparation of an instrument to assist with that data collection requires literature review and dialogue with experts. Finally, specialty areas should not be assessing their BOK in any department without first agreeing upon a unified vision or Mission for their specialty area.
Findings of Demonstration Study

Conclusions about the effectiveness of the described process are deferred to the following section of the paper. However, a summary of the findings of this study is appropriate, but the study sample was not sufficient to draw conclusions that could guide geotechnical programs in the development of a graduate BOK. Even so, enough data was collected to observe some trends, to stimulate dialogue, and to facilitate improvement to the process. The author anticipates this to be the first stage in an ongoing effort to help departments focus their graduate programs to better advise students with respect to the ASCE BOK. The survey was conducted over a 1 week period. Approximately 70 copies of the survey were distributed in hard copy to a joint lunch meeting of geotechnical and structural groups in a moderate-sized city. Twelve geotechnical and twelve structural engineers completed the survey at that meeting and provided their input in hard copy to the author. The survey was also distributed by email to 27 geotechnical group contacts across the U.S. along with the invitation to distribute the survey to the members of their own geotechnical group. Each email included a copy of the abstract for this paper, a spreadsheet version of the survey that would simplify both survey completion and data compilation, and a printable copy for engineers who may be reluctant to open a spreadsheet file provided by a relative stranger. As expected for the short time frame, many of those contacted by email did not respond or had not responded by the time of writing of this paper. However, some of the geotechnical group contact members completed the survey, though there was no evidence whether most had passed it on to their local geotechnical group. It was apparent at least one contact member did pass the survey on to their geotechnical group members because numerous responses were received from a specific region.

A total of 37 surveys were compiled, 21 of which identified themselves as geotechnical engineers. Thirteen respondents reported they were structural engineers, one was a construction engineer, one a transportation engineer, and one reported their specialty area to be landfill engineer. In the interest of brevity for this paper, only the results from the 21 geotechnical engineers will be reviewed. Of those 21 engineers, 12 reported themselves to be seasoned experts. The remaining were three novices and six recent experts. A summary of the overall responses and the responses for the two subgroups (seasoned experts and novices or recent experts) is shown in Table 2.

All respondents generally agreed an average level of learning in the topics surveyed should be on the order of Level 3: Apply Knowledge and Solve Simple Problems. Note that the seasoned expert respondents provided an average learning level for all topic areas

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<th>Table 2. Summary of Geotechnical Survey Responses</th>
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<tr>
<td>All respondents</td>
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<tr>
<td>Number of Responses</td>
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<tr>
<td>Extent of Agreement with proposed Core Courses</td>
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<td>Average Learning Level for all topic areas</td>
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noticeably lower than the response for the novices and recent experts. For this reason, the reported average level of learning for the two sub groups of respondents was normalized to allow review of how each group comparatively rated the level of learning in each topic area. To do this, the “As Reported” score for each “Topic Area” in Table 3 was divided by the “Average Learning Level for all topic areas” in Table 2. In each case, this was computation was completed to the specific group to which it applied. The topic-specific results are provided in Table 3.

The topic areas are ranked from highest average learning level to lowest. Note that this ranking and these average values do not indicate the relative importance of each topic, but rather the respondents’ opinion of the necessary level of learning. Only one topic area, soil-structure interaction, is rated by all respondents to be appropriate at or near the Analyze Complex Systems or Processes level, level 4.

In addition to the numeric data, respondents were invited to comment on the proposed core classes, and some did so. The details of those comments are still being reviewed and will provide some guidance for the next steps in this study. It was clear from some of the suggestions that the list of topics was not comprehensive enough for the survey and should be expanded to include other important topics, such as rock mechanics, earthquake engineering, and others.

<table>
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<th>Table 3. Average Learning Level for Specific Topic Areas</th>
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<tr>
<td>Topic Area</td>
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<tr>
<td>Soil-structure interaction</td>
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<tr>
<td>Advanced testing (triaxial, controlled strain consult., flex. wall perm., etc.)</td>
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<td>Advanced mechanics of materials for geotechnical engineers (braced excavations, connections, deflections under distributed loads)</td>
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<td>Engineering management</td>
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<tr>
<td>Liability and loss prevention</td>
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<tr>
<td>Advanced structural analysis</td>
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Conclusions and Recommendations for Further Study

In addition to the development of a process, it was the intent of this paper to identify preliminary suggestions about several possible bodies of knowledge for graduate geotechnical specialization. The study may have posed more questions than it answered in this first stage, however. For example:

- There could be logical reasons why the results differed for seasoned experts versus novices or recent experts. For example, seasoned experts identified LRFD (load and resistance factor design) as requiring a lower level of knowledge. The reason for this difference was not discerned by the study, but it is possible the novices and recent experts are more qualified to assess the learning level required for this topic area because of their current duties and responsibilities. Thus, those assessing the survey may choose to discount the recommendations of the experts if further exploration of that topic area supports this decision.
- The 1-5 rating of specific topics was for appropriate level of learning, not importance for inclusion in the graduate curriculum. The “zero” rating was for exclusion from the BOK. This suggests another rating dimension may be needed for each topic area to allow respondents to rate the knowledge as either in the category (0) need not be included, (1) worth being familiar with, (2) important to know and do, or (3) of enduring understanding, as recommended by Wiggins and McTighe\textsuperscript{12}.
- None of the topic areas were considered by the respondents to merit learning at level 5 – Design a Complex System or Process. This is the desired learning level for the ASCE BOK in Outcome 15 – Technical Specialization. This rating may be appropriate since level 5 of Outcome 15 may only be achieved by means of a significant project activity beyond a specific topic area.
- The study did not address the other two graduate level outcomes, Outcome 7 – Experiments, and Outcome 8 – Problem Recognition and Solving. However, the learning level rating in the survey for the Advanced Testing topic area was high, suggesting there may be some agreement between the survey respondents and ASCE BOK. Outcome 8 captures the essence of some of the concerns about current Master’s level education expressed by the experts in the interview stage of this study. This is discussed further below. Both Outcomes 7 and 8 require further study and possible inclusion in the next generation assessment for this study.
- The experts who were interviewed supported a higher level of knowledge in ethics, management, economics, and legal issues, but the self-identified “seasoned experts” who responded to the survey generally rated the knowledge level for these categories low. This was unexpected. It is possible the format of the survey and interview process produced this discrepancy between two different groups of seasoned experts.

As noted previously, the interviews with experts also provided unanticipated insights that demand further study and cannot be managed within the scope of this paper. These included:

- \textit{Basic Concepts.} Graduates may be well prepared to manage some advanced theoretical or modeling solutions to bounded problems, but do not seem to be well versed in basic concepts. This lack of understanding of the basics was also identified by some of the references noted previously in the literature review. The expert who
identified this area of concern speculated that students in the geotechnical specialty need repetitive exposure to basic concepts in much the same way that undergraduate students use basic statics over and over in their undergraduate courses. The lack of command of basic concepts could prevent designers from being able to judge the reasonableness of their solutions using simple mental or analytical models that approximate a complex problem.

- **Advanced Mechanics of Materials for Geotechnical Engineers.** An expert noted command of soil-structure interaction is essential for geotechnical engineers providing guidance for structures’ ground contact, but that knowledge should not be from a structural engineer’s perspective. The expert noted that structural engineers are not generally prepared to make judgments about the effect of the ground on structures in contact with the ground. It was suggested that geotechnical engineers should have much more command of structural design principles, but from a different perspective. The design and comprehension of the soil-structure interaction should be less oriented towards codes and more towards basic engineering mechanics. The interview concluded there was need for a new course, perhaps titled Advanced Mechanics of Materials for Geotechnical Engineers.

- **Geology and Geomorphology.** All of the experts agreed that geotechnical engineers must have exceptional command of the fundamentals of geomorphology and geologic factors significant to their engineering projects, but did not suggest a course of this title as a part of the core curriculum because the department may not have control over course work in this area. The experts agreed there are excellent courses offered by some programs in this area, but not all programs. In some cases, these courses were undergraduate courses. Further study is appropriate to identify how the geotechnical community may recommend an appropriate course as a science elective in the undergraduate BOK that could be a prerequisite for graduate study in geotechnical engineering.

- **Ethics, Risk Management, and Business Management.** Several experts noted that new graduates are often not prepared to make ethical choices. While that knowledge is acquired over time, they noted that early in their careers, some geotechnical engineers can be faced with significant ethical decisions because of the uncertainty in geotechnical engineering. The experts also noted that new graduates are not often prepared to make choices appropriate to an employer’s risk management program. Similarly, some basic business management skills were identified as helpful for new graduates. This study notes these topics are all within the scope of the baccalaureate BOK, but believes some examination whether the learning level identified for the BOK is sufficient for geotechnical professionals. These topics were left in the practitioners’ survey to collect insights from a larger community.

This preliminary study significantly increased the author’s understanding of some new and old issues in the development of a graduate BOK for geotechnical engineering. This seemed to be similarly true for the experts who were interviewed. The effort thus enhanced the potential for development of appropriate recommendations that students could use to guide decisions about graduate courses. It is suspected the specialization areas within departments would have the same experiences if they followed a similar process. However, it is apparent that more questions need to be answered before a
definitive process for devising a specialty graduate BOK can be recommended. Similarly, more study is needed before a geotechnical specialization BOK can recommended for any specific program.

Bibliography

Appendix: Distributed Geotechnical Master’s Survey (two pages)

Thanks in advance to those engineers who choose to complete this survey. In this PDF form, the survey should be completed by hand and then either faxed or scanned and emailed to [email address] and the fax number is [number]. Although intended primarily for the geotechnical community, other engineers or professionals with knowledge of geotechnical practice are welcome to share their own insights. Please respond no later than February 4, 2009.

This survey is being conducted to demonstrate a process graduate programs may use to identify an appropriate body of knowledge for a geotechnical M.S. or M.E. suitable for practitioners, not researchers. The results of this study, including the survey results, will be published and presented at the American Society for Engineering Education Annual Meeting in June of this year. Your assistance is greatly appreciated.

Q: If you do not consider your primary expertise to be geotechnical, indicate at least the civil engineering subdiscipline that best characterizes your expertise.

(1) structural  (2) water resources  (3) environmental  (4) construction
(5) land/urban planner  (6) transportation  (7) other

If you chose "other" above, please clarify:

Q: In what region of the U.S. is most of your work conducted?

(1) east  (2) central  (3) south  (4) west  (5) other

If you chose "other" above, please clarify:

Q: What category would you say best describes your expertise in your area of engineering design?

(1) seasoned expert  (2) recent expert  (3) mid-level  (4) novice

Prior to the survey, geotechnical experts in private practice and academia were questioned about an appropriate body of knowledge (BOK) for a geotechnical M.S. or M.E., designated by the letter “M” herein. Most agreed that a core of courses typical of the following is appropriate for a geotechnical M.S. BOK, assuming undergraduate coursework in Soil Mechanics and Foundation Engineering has already been completed:

- Advanced soil mechanics with interpretation of field and lab data
- Advanced foundations with planning and implementation of investigations
- Earth retaining structures, embankments and slope stability
- Flow through porous media
- Numerical geotechnical modeling

Q: To what extent do you agree with the above list?

(1) Not at all  (2) Somewhat  (3) Mostly  (4) Agree completely

Feel free to elaborate on the above response below, if you wish.

In a typical “M” program, there is room for three to five additional courses beyond those identified previously. Listed below are topics or modules that could be considered for inclusion in those additional courses. It is understood that each survey respondent may have a different perspective on which materials are most important to their own current practice. However, rank the following based on what you believe is most appropriate for geotechnical engineering graduates in the region in which most of your work is conducted. Use the scale below:
(0) This topic **need not be included** in the body of knowledge for a geotechnical Masters.

(1) M graduates should be able to **Define** key aspects of this topic area.

(2) M graduates should be able to **Explain** key concepts and problem solving processes in this topic area.

(3) M graduates should be able to **Apply** knowledge and **Solve simple problems** in this topic area.

(4) M graduates should be able to **Analyze complex systems** or processes in this topic area.

(5) M graduates should be able to **Design** a complex system or process or **Create** new knowledge in this topic area.

- LRFD of geotechnical systems
- Machine foundations
- Engineering economics for geotechnical investigation, design and construction
- Advanced testing (triaxial, controlled strain consol., flex. wall perm., etc.)
- Advanced field testing (geophysical, dilatometer, pressuremeter)
- Engineering management
- Liability and loss prevention
- Ethics
- Geomorphology related to engineering behavior
- Unsaturated soil mechanics
- Soil-structure interaction
- Advanced structural analysis
- Finite element analysis
- Advanced mechanics of materials for geotechnical engineers (braced excavations, connections, deflections under distributed loads)
- Wave mechanics (in ground and in piles, for example)
- Instruments (knowledge/skills to direct lab and field testing, field load tests)