Computing Accreditation Commission

PROPOSED CAC CRITERIA CHANGES OVERVIEW

The Computing Accreditation Commission (CAC) and CSAB, Inc., the lead ABET member society for accreditation of degree programs in computer science, information systems, information technology, and software engineering have jointly proposed revisions to the *Criteria for Accrediting Computing Programs*. This proposal is the result of a three-year effort by the Joint CAC-CSAB Criteria Committee, and the proposed changes described here have been approved for public review and comment by both the ABET Computing Accreditation Commission in July 2016 and the ABET Computing Area Delegation in October 2016.

The layout of this document is:

- The overview of the proposed changes, including motivation, is shown on pages 2 and 3.
- The proposed CAC criteria, marked up as changes from the current CAC criteria, are shown on pages 4 to 10.
- The proposed CAC criteria, without any markup, are shown on pages 12 to 16.

Public review and comment plays a critical role in further refining these accreditation criteria. CAC and CSAB request that you review the proposed changes and provide us your feedback at the ABET website, http://www.abet.org.

Note. The proposed criteria, revised after public review and comment, will be presented for approval to the ABET Computing Accreditation Commission in July 2017 and the ABET Computing Area Delegation in October 2017. If the proposed criteria are approved, CAC will then announce a schedule for rolling out the proposed criteria. Until then, institutions should only refer to the current CAC *Criteria* for making decisions about their current computing programs.

PROPOSED CAC CRITERIA CHANGES: OVERVIEW

MOTIVATION

These proposed changes have been motivated by three independent considerations:

1. The publication of the ACM/IEEE Computer Society's *Computer Science Curricula 2013*.

2. Structural issues with CAC Criteria 3 and 5, along with a general desire to reduce the assessment burden and focus the assessment process towards more meaningful continuous improvement. Some of this effort was motivated by a desire to ensure a consistent accreditation methodology to institutions with ABET-accredited programs. This includes the motivation to strive for consistency with similar criteria revisions that are concurrently being undertaken by the Engineering Accreditation Commission (EAC).

3. Requests from constituents that ABET place greater emphasis on fostering innovation and ensuring cost-benefit is considered in the program's efforts required to meet accreditation Criteria.

STRUCTURAL ISSUES WITH CAC CRITERIA 3 AND 5

CAC Criteria 3 is entitled "Student Outcomes" (SOs), yet only the first paragraph of the current criterion refers to SOs. That first paragraph requires that programs have SOs, and that there be a process for reviewing and revising the outcomes. Although the second paragraph of CAC Criterion 3 enumerates several items that look like outcomes, these are actually interpreted by CAC simply as program "characteristics" which (unlike SOs) only have to be enabled but do not have to be assessed unless the program chooses to adopt them as outcomes (which many programs do). Thus, Criterion 3 is at best confusing, as it looks like Criterion 3 from the other commissions – but unlike the other commissions (as well as its title), CAC Criterion 3 does not introduce any required SOs that have to be assessed.

The proposed changes attempt to clear up this issue and have Criterion 3 strictly address outcomes, while Criterion 5 states requirements for curriculum content without requiring assessment of the delivery of that content. These changes will put the CAC Criteria 3/5 in a similar format to the other commissions and consistent with the changes currently underway with the EAC criteria. Additionally, this work will look at general content revisions to the criteria (in part considering new recommendations in CS2013) within this revised organizational framework.

PROPOSED GENERAL CRITERIA 3/5 CHANGES

The following are the substantive changes to General Criteria 3 and 5 and the rationale for each change:

1. *Addition of 5 required Student Outcomes* – As discussed above, the resolution of the structural Criteria 3/5 issues required that the (a) – (i) elements, which were not treated as outcomes, either be treated as outcomes or modified and treated as outcomes. The proposal here involves reducing (a) – (i) to (1) – (5), and requiring (1) – (5) as outcomes for every accredited program. (1) – (5) are basically a subset of the previous (a) – (i) elements in Criterion 3. The new (1) – (5) are structured as reasonable expectations for students graduating from any accredited *computing* program.

2. *Addition of a technical cybersecurity requirement for computing majors* – The revision of Criterion 5 includes a substantially increased cybersecurity curriculum requirement. The previous criteria had a "soft skill" requirement of an understanding of security issues (along with the legal and ethical implications of computing). But the revision requires that "information assurance and security principles and practices" be included in the curriculum, which introduces a stronger technical requirement in the

general criteria than before. In the current edition of the Criteria, the IS and IT Program Criteria already possess a substantial cybersecurity requirement, and the CS 2013 guidelines indicate that a substantial cybersecurity requirement is also needed for CS. To address this, we could have simply added a cybersecurity requirement to the CS program criteria, but because we saw no reason that other nascent computing disciplines should be exempt from such a requirement, we moved the requirement to the general criteria. As such, it is applicable to CS, IS and IT without repeating it in all three program criteria.

SUMMARY OF PROGRAM CRITERIA CHANGES

The Program Criteria were changed as follows:

1. *Required Student Outcomes were added for CS, IS and IT, supplementing the list in Criterion 3 that now consists of outcomes rather than curriculum characteristics.*
2. *Stylistic changes were made for consistency across the various criteria*.
3. *The requirement for faculty with a terminal degree was changed from "some" to "at least one" in both the CS and IS criteria*. The previous version of the criteria required that "some" faculty must have a Ph.D. (or terminal degree) in the discipline. There was considerable ambiguity over what "some" meant – and whether it allowed for just one. So it is proposed that this be stated in a less ambiguous fashion.
4. *Several changes were made to the CS program criteria to strengthen the relationship with new computer science curricular guidelines (CS 2013)* – These changes include:
    a. Addition of curriculum topic areas that are part of CS 2013. Since there are a large number of topics in CS 2013, an attempt was made to select the topics that appear to be the most agreed upon fundamental Computer Science curriculum concepts.
    b. Addition of a project requiring integration of skills and knowledge acquired from previous courses – such as a capstone project, research project or other course project that integrates knowledge and skills acquired from previous courses.
    c. Some clarification of the previous requirements regarding "programming languages and systems."

The criteria for accreditation are in two sections.

General Criteria – General Criteria apply to all programs accredited by an ABET commission. Each program accredited by an ABET commission must satisfy every criterion that is in the General Criteria for that commission.

Program Criteria – The Program Criteria provide discipline-specific accreditation criteria. Programs must show that they satisfy all of the specific Program Criteria implied by the program title. Any overlapping requirements need be satisfied only once.

DEFINITIONS

While ABET recognizes and supports the prerogative of institutions to adopt and use the terminology of their choice, it is necessary for ABET volunteers and staff to have a consistent understanding of terminology. With that purpose in mind, the Commissions will use the following basic definitions:

Program Educational Objectives – Program educational objectives are broad statements that describe what graduates are expected to attain within a few years of graduation. Program educational objectives are based on the needs of the program's constituencies.

Student Outcomes – Student outcomes describe what students are expected to know and be able to do by the time of graduation. These relate to the knowledge, skills, and behaviors that students acquire as they progress through the program.

Assessment – Assessment is one or more processes that identify, collect, and prepare data to evaluate the attainment of student outcomes. Effective assessment uses relevant direct, indirect, quantitative and qualitative measures as appropriate to the outcome being measured. Appropriate sampling methods may be used as part of an assessment process.

Evaluation – Evaluation is one or more processes for interpreting the data and evidence accumulated through assessment processes. Evaluation determines the extent to which student outcomes are being attained. Evaluation results in decisions and actions regarding program improvement.

The Computing Accreditation Commission also uses the following definitions:

One Academic Year - For programs using standard semester units, one academic year is defined as 30 semester units. For programs using standard quarter units, one academic year is defined as 45 quarter units. For other programs, one academic year requires an equivalent amount of coursework.

College-Level Mathematics – College-level mathematics consists of mathematics above the pre-calculus level.

General Criteria 3 and 5

Criterion 3 Student Outcomes

~~The program must have documented student outcomes that prepare graduates to attain the program educational objectives.~~ ~~There must be a documented and effective process for the review and revision of these student outcomes.~~ The program must have documented and publicly stated student outcomes that include (1) through (5) below and any additional outcomes required by applicable Program Criteria. The program may define additional student outcomes at its discretion.

1. An ability to analyze a problem, and to identify and define the computing requirements appropriate to its solution.
2. An ability to design, implement, and evaluate a computer-based solution to meet a given set of computing requirements in the context of the discipline.
3. An ability to communicate effectively with a range of audiences about technical information.
4. An ability to make informed judgments in computing practice based on legal and ethical principles.
5. An ability to function effectively on teams to establish goals, plan tasks, meet deadlines, manage risk, and produce deliverables.

~~The program must enable students to attain, by the time of graduation:~~

~~a) An ability to apply knowledge of computing and mathematics appropriate to the program's student outcomes and to the discipline~~

~~b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution~~

~~c) An ability to design, implement, and evaluate a computer based system, process, component, or program to meet desired needs~~

~~d) An ability to function effectively on teams to accomplish a common goal~~

~~e) An understanding of professional, ethical, legal, security and social issues and responsibilities~~

~~f) An ability to communicate effectively with a range of audiences~~

~~g) An ability to analyze the local and global impact of computing on individuals, organizations, and society~~

~~h) Recognition of the need for and an ability to engage in continuing professional development~~

~~i) An ability to use current techniques, skills, and tools necessary for computing practice.~~

Criterion 5 Curriculum

The program's requirements must be consistent with its program educational objectives and designed in such a way that each of the student outcomes can be attained. ~~The curriculum must combine technical and professional requirements with general education requirements and electives to prepare students for a professional career and further study in the computing discipline associated with the program, and for functioning in modern society.~~ The curriculum must combine technical, professional, and general education components to prepare students for a career, further study, and lifelong professional development in the computing discipline associated with the program.

~~The technical and professional requirements must include at least one year of up-to-date coverage of fundamental and advanced topics in the computing discipline associated with the program. In addition, the program must include mathematics appropriate to the discipline beyond the pre-calculus level. For each course in the major required of all students, its content, expected performance criteria, and place in the overall program of~~

~~study must be published.~~

The curriculum requirements specify subject areas, but do not prescribe specific courses. The program must include each of the following in a manner appropriate to its discipline:

1. At least one academic year of up-to-date coverage of fundamental and advanced computing topics that provides both breadth and depth.
2. College-level mathematics.
3. Current techniques, skills, and tools necessary for computing practice.
4. Information assurance and security principles and practices.
5. Concepts involving the local and global impact of computing solutions on individuals, organizations, and society.

Program Criteria
Computer Science and
Similarly Named Computing Programs

Lead Society: CSAB

These program criteria apply to computing programs using computer science or similar terms in their titles.

3. Student Outcomes

~~The program must enable students to attain, by the time of graduation:~~

~~(j) An ability to apply mathematical foundations, algorithmic principles and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices. [CS]~~
~~(k) An ability to apply design and development principles in the construction of software systems of varying complexity. [CS]~~

In addition to outcomes 1 through 5, the following outcomes are required:

6. An ability to apply theory in the design and implementation of computer-based solutions. [CS]
7. An ability to reason about and explain computer-based solutions at multiple levels of abstraction. [CS]

5. Curriculum

~~Students must have course work or an equivalent educational experience that includes:~~

~~a. Computer science: One and one-third years that must include:~~
~~1. Coverage of the fundamentals of algorithms, data structures, software design, concepts of programming languages and computer organization and architecture. [CS]~~
~~2. An exposure to a variety of programming languages and systems. [CS]~~
~~3. Proficiency in at least one higher level language. [CS]~~
~~4. Advanced course work that builds on the fundamental course work to provide depth. [CS]~~

~~b. One year of science and mathematics~~
~~1. At least one half year that must include discrete mathematics. The additional mathematics might consist of course work in areas such as calculus, linear algebra, numerical methods, probability, statistics, number theory, geometry or symbolic logic. [CS]~~
~~2. Science: A science component that develops an understanding of the scientific method, and provides students with an opportunity to experience this mode of inquiry in courses for science and engineering majors that provide some exposure to laboratory work. [CS]~~

The curriculum requirements specify subject areas, but do not prescribe specific courses. These requirements are:

a. Computer science: At least one and one-third academic years that must include:
    1. Computer science fundamentals including:
        a. Algorithms and complexity, computer science theory, concepts of programming languages, and software development.
        b. At least three of the following: computer architecture and organization, information management, networking and communication, operating systems, and parallel and distributed computing.
    2. Advanced course work that builds on fundamental topics to provide both breadth and depth.
    3. Design, implementation, and evaluation of computer-based solutions of varying complexity.
    4. In-depth coverage of at least one high-level language.
    5. A project requiring integration of knowledge and skills acquired in earlier course work.

b. Mathematics: At least one-half academic year of college-level mathematics that must include discrete mathematics. The additional mathematics might consist of course work in areas such as calculus, linear algebra, numerical methods, probability, statistics, number theory, or geometry.

c. Science: Natural science course work that develops an understanding of the scientific method, provides exposure to laboratory work, and provides students with an opportunity to experience this mode of inquiry in courses appropriate for science or engineering majors.

6. Faculty

~~Some~~ At least one full time faculty member~~s~~ must have a Ph.D. in computer science.

Program Criteria
Information Systems and
Similarly Named Computing Programs

Lead Society: CSAB

These program criteria apply to computing programs using information systems or similar terms in their titles.

Definition

Information Systems Environment - An information systems environment is an organized domain of activity within which information systems are used to support and enable the goals of the activity. Examples of information systems environments include (but are not limited to) business, health care, government, not-for-profit organizations, and scientific disciplines.

3. Student Outcomes

~~The program must enable students to attain, by the time of graduation:~~

In addition to outcomes 1 through 5, the following outcome is required:

6. ~~(j) An understanding of and an~~ An ability to support the delivery, use, ~~delivery,~~ and management of information systems within an information systems environment. [IS]

5. Curriculum

~~Students must have course work or an equivalent educational experience that includes:~~

~~a. Information Systems: One year that must include:~~

~~1. Coverage of the fundamentals of application development, data management, networking and data communications, security of information systems, systems analysis and design and the role of Information Systems in organizations. [IS]~~

~~2. Advanced course work that builds on the fundamental core to provide depth. [IS]~~

~~b. Information systems environment: One-half year of course work that must include a cohesive set of topics that provide an understanding of an environment in which the information systems will be applied professionally [IS]~~

~~c. Quantitative analysis or methods, including statistics [IS]~~

The curriculum requirements specify subject areas, but do not prescribe specific courses. These requirements are:

a. Information systems: At least one academic year that includes coverage of fundamentals and applied practice in application development; data and information management; IT infrastructure; systems analysis, design and acquisition; project management; and the role of information systems in organizations.

b. Information systems environment: At least one-half additional academic year of course work that includes a cohesive set of topics that provide an understanding of an environment in which information systems are applied professionally.

c. Quantitative analysis or methods that must include statistics.

6. Faculty

~~Some~~ At least one full-time faculty member~~s, including those responsible for the IS curriculum development,~~ must hold a terminal degree with a program of study in

information systems.

Program Criteria
Information Technology and
Similarly Named Computing Programs

Lead Society: CSAB

These program criteria apply to computing programs using information technology or similar terms in their titles.

3. Student Outcomes

~~The program must enable students to attain, by the time of graduation:~~

~~j) An ability to use and apply current technical concepts and practices in the core information technologies of human computer interaction, information management, programming, networking, and web systems and technologies. [IT]~~
~~k) An ability to identify and analyze user needs and take them into account in the selection, creation, evaluation, and administration of computer-based systems. [IT]~~
~~l) An ability to effectively integrate IT-based solutions into the user environment. [IT]~~
~~m) An understanding of best practices and standards and their application. [IT]~~
~~n) An ability to assist in the creation of an effective project plan. [IT]~~

In addition to outcomes 1 through 5, the following outcome is required:

6. An ability to identify and analyze user needs and to take them into account in the selection, integration, evaluation, and administration of computer-based systems. [IT]

5. Curriculum

~~Students must have course work or an equivalent educational experience that includes:~~

~~a. Coverage of the fundamentals of~~
~~1. The core information technologies of human computer interaction, information management, programming, networking, web systems and technologies; [IT]~~
~~2. Information assurance and security; [IT]~~
~~3. System administration and maintenance; [IT]~~
~~4. System integration and system architecture; [IT]~~
~~b. Advance course work that builds on the fundamental course work to provide depth. [IT]~~

The curriculum must include coverage of fundamentals and applied practice in the following areas:

a. The core information technologies of human-computer interaction, information management, programming, web systems and technologies, and networking.
b. System administration and system maintenance.
c. System integration and system architecture.

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Criterion 3 Student Outcomes

The program must have documented and publicly stated student outcomes that include (1) through (5) below and any additional outcomes required by applicable Program Criteria.

The program may define additional student outcomes at its discretion.

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5. An ability to function effectively on teams to establish goals, plan tasks, meet deadlines, manage risk, and produce deliverables.

Criterion 5 Curriculum

The program's requirements must be consistent with its program educational objectives and designed in such a way that each of the student outcomes can be attained. The curriculum must combine technical, professional, and general education components to prepare students for a career, further study, and lifelong professional development in the computing discipline associated with the program.

The curriculum requirements specify subject areas, but do not prescribe specific courses. The program must include each of the following in a manner appropriate to its discipline:

1. At least one academic year of up-to-date coverage of fundamental and advanced computing topics that provides both breadth and depth.
2. College-level mathematics.
3. Current techniques, skills, and tools necessary for computing practice.
4. Information assurance and security principles and practices.
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In addition to outcomes 1 through 5, the following outcomes are required:

6. An ability to apply theory in the design and implementation of computer-based solutions. [CS]
7. An ability to reason about and explain computer-based solutions at multiple levels of abstraction. [CS]

5. Curriculum

The curriculum requirements specify subject areas, but do not prescribe specific courses. These requirements are:

a. Computer science: At least one and one-third academic years that must include:
    1. Computer science fundamentals including:
        a. Algorithms and complexity, computer science theory, concepts of programming languages, and software development.
        b. At least three of the following: computer architecture and organization, information management, networking and communication, operating systems, and parallel and distributed computing.
    2. Advanced course work that builds on fundamental topics to provide both breadth and depth.
    3. Design, implementation, and evaluation of computer-based solutions of varying complexity.
    4. In-depth coverage of at least one high-level language.
    5. A project requiring integration of knowledge and skills acquired in earlier course work.

b. Mathematics: At least one-half academic year of college-level mathematics that must include discrete mathematics. The additional mathematics might consist of course work in areas such as calculus, linear algebra, numerical methods, probability, statistics, number theory, or geometry.

c. Science: Natural science course work that develops an understanding of the scientific method, provides exposure to laboratory work, and provides students with an opportunity to experience this mode of inquiry in courses appropriate for science or engineering majors.

6. Faculty

At least one full time faculty member must have a Ph.D. in computer science.

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Lead Society: CSAB

These program criteria apply to computing programs using information systems or similar terms in their titles.

Definition

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3. Student Outcomes

In addition to outcomes 1 through 5, the following outcome is required:

6. An ability to support the delivery, use, and management of information systems within an information systems environment. [IS]

5. Curriculum

The curriculum requirements specify subject areas, but do not prescribe specific courses. These requirements are:

a. Information systems: At least one academic year that includes coverage of fundamentals and applied practice in application development; data and information management; IT infrastructure; systems analysis, design and acquisition; project management; and the role of information systems in organizations.

b. Information systems environment: At least one-half additional academic year of course work that includes a cohesive set of topics that provide an understanding of an environment in which information systems are applied professionally.

c. Quantitative analysis or methods that must include statistics.

6. Faculty

At least one full-time faculty member must hold a terminal degree with a program of study in information systems.

Program Criteria
Information Technology and
Similarly Named Computing Programs

Lead Society: CSAB

These program criteria apply to computing programs using information technology or similar terms in their titles.

3. Student Outcomes

In addition to outcomes 1 through 5, the following outcome is required:

6. An ability to identify and analyze user needs and to take them into account in the selection, integration, evaluation, and administration of computer-based systems. [IT]

5. Curriculum

The curriculum must include coverage of fundamentals and applied practice in the following areas:

a. The core information technologies of human-computer interaction, information management, programming, web systems and technologies, and networking.
b. System administration and system maintenance.
c. System integration and system architecture.