Accreditation of Undergraduate Programs in Computing, Software Engineering, and Systems Engineering – Ties to CMMI-based Improvement

Seventh CMMI Technology Conference and User Group
Denver, Colorado
November 14, 2007

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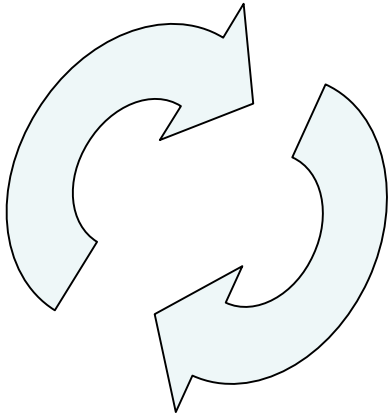
Does This Look Familiar?

- Set goals.
- Determine where you are.
- Determine where you want to be.
- Analyze the gap.
- Make a plan to overcome the gap.
- Execute the plan.
- Learn lessons and do it again.



Quality Improvement Cycle

This is being done today in universities.

Your CMMI and improvement expertise is very relevant!

You can help!

Agenda

- Background
  - Changes in higher education
  - ABET (nee the Accreditation Board for Engineering and Technology)
  - CSAB (nee the Computing Sciences Accreditation Board)
- The ABET accreditation process
- Accreditation criteria
- Status of accreditation of disciplines of interest
- Government and industry practitioners
  - ABET and CSAB want you!

Forces on Higher Education in Science and Engineering

- Greater demands for
  - relevance
  - accountability
- Answers to important questions
  - How can employers judge preparation of graduates?
  - How can students choose appropriate programs and institutions?
  - How can professions guide the establishment of new programs and improve current programs?

Changes in Educational Approach

- Traditional approach to science and engineering education
  - Emphasis on curricula
    - ***how*** students are educated
  - Culture of independence among faculty

- Target approach for science and engineering education
  - Emphasis on outcomes
    - ***what*** knowledge, skills, abilities graduates possess
  - Emphasis on continuous improvement based on measurement and assessment
  - All this requires greater coordination among faculty

- ABET is a key actor in furthering this approach

- established in 1932
  - incorporated computing accreditation responsibility beginning in 2001 (from CSAB, formed in 1982)
- provides a mechanism for professional societies to examine and affect academic quality
- a federation of 31 technical and professional societies representing over 1.8 million technical professionals
- accredits applied science, computing, engineering, and technology programs

Why is ABET Accreditation Important?

Parents and Students . . .

- **Look to accreditation to choose the right study programs.**

Employers . . .

- **Rely on accreditation to ensure that employees are qualified to practice.**

Licensing and Certification Boards . . .

- **Count on accreditation to screen applicants.**

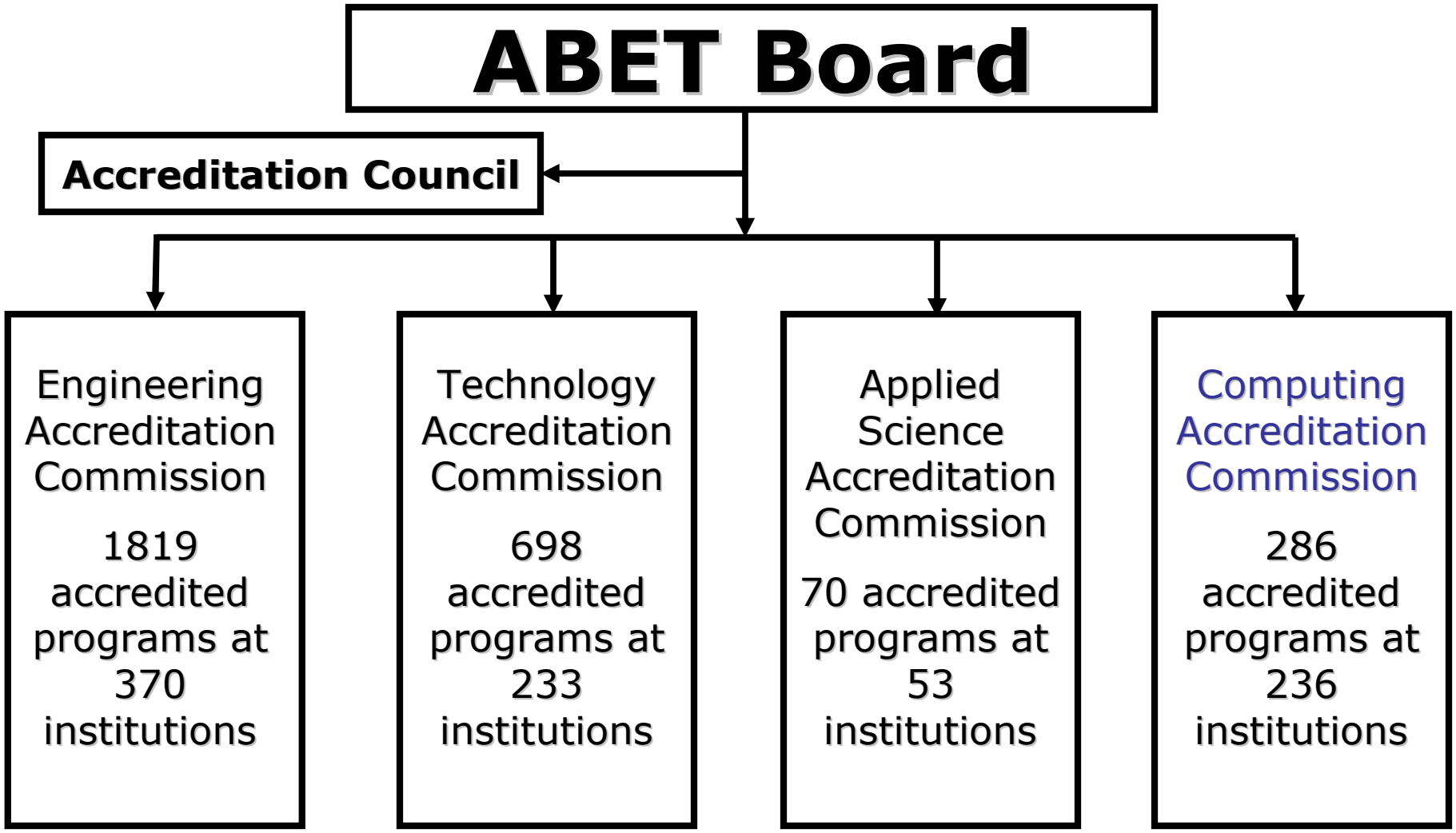
Colleges and Universities . . .

- **Use accreditation as a structured mechanism to assess, evaluate, and improve the quality of their programs.**

Graduate Schools . . .

- **Check accreditation to determine the eligibility of applicants.**

ABET Governance



- CSAB is a federation of the ACM, IEEE-Computer Society and Association for Information Systems for accreditation issues.
- Formed in 1982 for accrediting computing programs
- Transferred accreditation mechanics responsibilities to ABET beginning in 2001
- Continues on as the “society” representing the member societies on matters of accreditation.
  - computer science
  - information systems
  - information technology
  - software engineering

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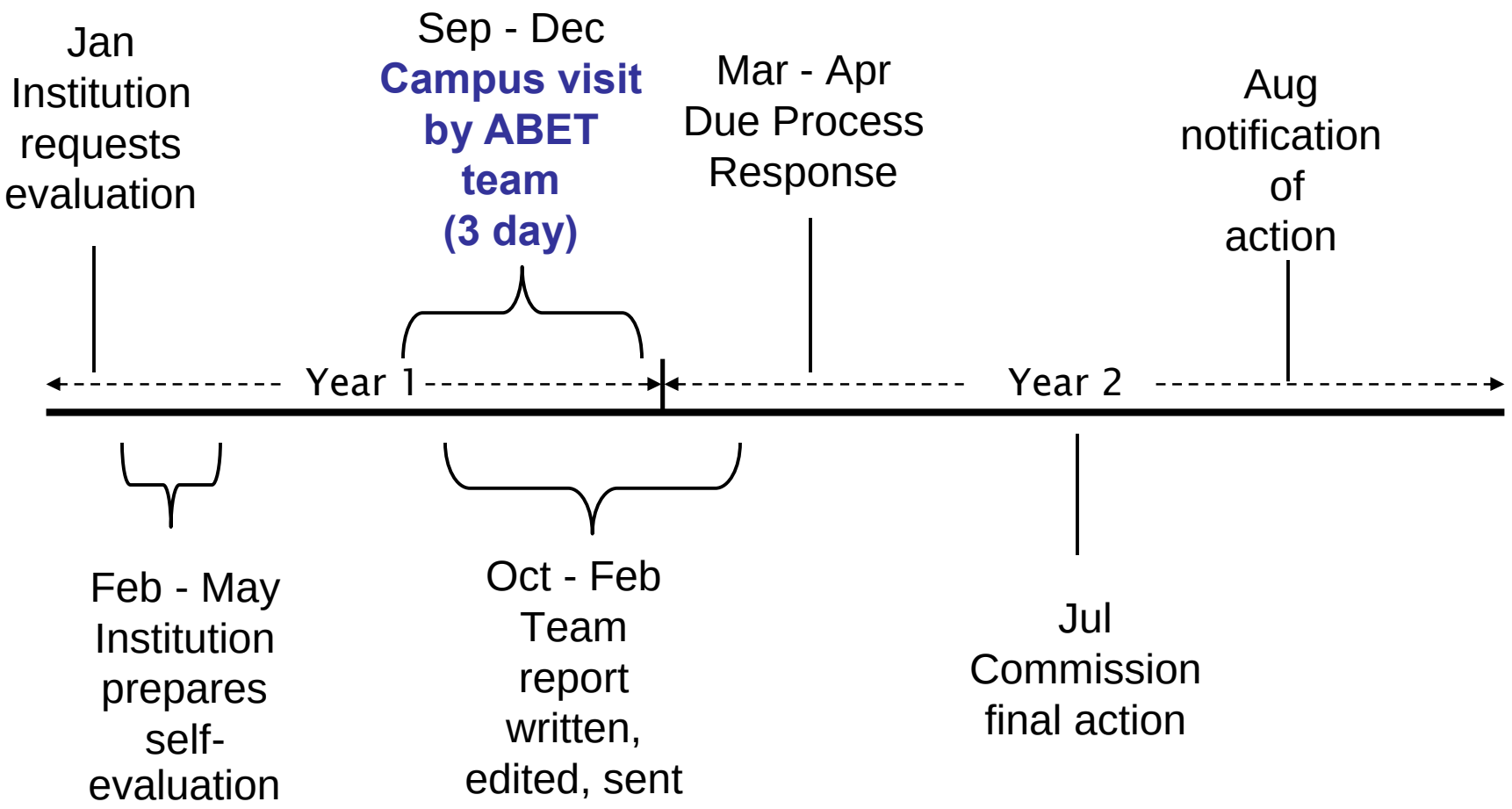
Accreditation Timeline



Visit teams

Composition

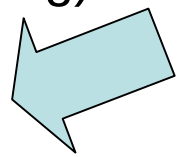
- Team Chair
- Program Evaluators (PEVs) (2 or more)

Team Chair

- a member of the Commission
- appointed by the Commission Executive Committee
- leads the Visit Team
- interfaces with the institution
- presents the findings at the July commission meeting

Program Evaluators

- selected by their member societies (CSAB for computing)
- provide expert knowledge
- evaluate programs according to **evaluative criteria**



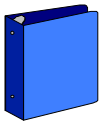
Program Evaluation

Evaluate program against CAC General and Program criteria and ABET Policies and Procedures.

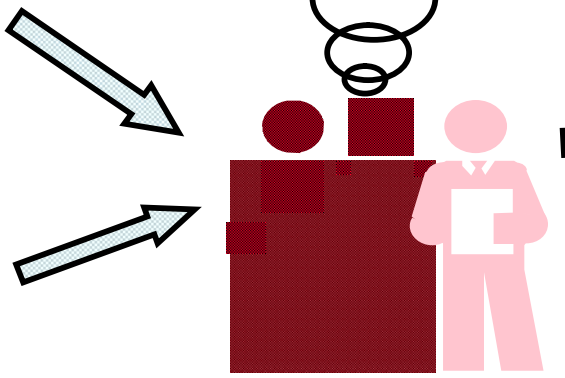
Pre-visit inputs

- Self Study
- Transcripts
- Catalogs
- Web materials

Visit inputs

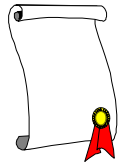


- Course displays
- Supplements to Self Study
- Interviews
- Observations

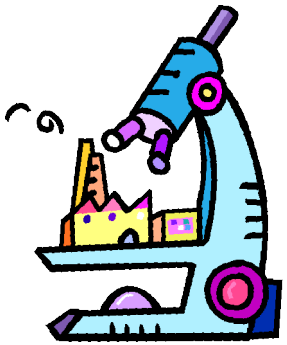


Outputs

- Report to institution and ABET (strengths, shortcomings)
- Recommended accreditation action to CAC



Are the Ties to Continuous Improvement and CMMI Appraisals Obvious?



Making observations

Comparing observed practices against standards

Applying professional judgment

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Criteria Categories

1. Students
2. Program Educational Objectives
3. Program Outcomes
4. Continuous Improvement
5. Curriculum
6. Faculty
7. Facilities
8. Support
9. Program Criteria

Criterion 3: Program Outcomes[1]

- The program has documented, measurable outcomes that are based on the needs of the programôs constituencies.
- The program enables students to achieve, by the time of graduation:
  - (a) An ability to apply knowledge of computing and mathematics appropriate 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

Criterion 3: Program Outcomes[2]

(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.

4: Continuous Improvement

- The program uses a documented process incorporating relevant data to regularly assess its program educational objectives and program outcomes, and to evaluate the extent to which they are being met.

- The results of the evaluations are documented and used to effect continuous improvement of the program through a documented plan.

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Programs of Specific Interest for This Conference

Computing Accreditation Commission (currently three program-specific criteria)

- computer science (250 programs)
- information systems (30 programs)
- information technology (7 programs)

Engineering Accreditation Commission (currently nineteen program-specific criteria)

- software engineering (15 programs)
- system engineering currently under consideration

Systems Engineering Accreditation[1]

- INCOSE is pursuing admission as a member of ABET with the intent to be the lead society for *systems engineering*.
- The ABET Board of Directors considered starting the ratification process during its November 3, 2007 meeting.
- Accreditation would fall under the Engineering Accreditation Commission.

Systems Engineering Accreditation[2]

If INCOSE is admitted, it will need to address Program Evaluator responsibilities.

Through the PAVE (Partnership to Advance Volunteer Excellence) Project common support mechanisms for program evaluators exist for

- a program evaluator competency model
- recruitment and selection
- training and evaluation
- reference: http://www.abet.org/pave.shtml

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Who Are ABET Program Evaluators?

- **Deans**
- **Department heads**
- **Faculty**
- **Industry leaders**
- **Government representatives**
- **Private practitioners**

ABET PROGRAM EVALUATORS: THE FACE OF QUALITY IN TECHNICAL EDUCATION

Additional Industry Program Evaluators Needed

- Practitioner participation is critical
  - Where did the emphasis on continuous improvement and outcomes-orientation come from? ï industry inputs!
- The Computing Accreditation Commission is under-represented in industrial participants
  - 10 industry/government reps out of 47

What Do Program Evaluators Do?

- Step 1: **Review the self-study report**
- Step 2: **Visit the campus**
- Step 3: **Decide whether the program meets the criteria**
- Step 4: **Travel home and tie up loose ends**

ABET pays travel expenses

Relevant Minimum Qualifications for Program Evaluators

1. **Demonstrated interest in improving education**

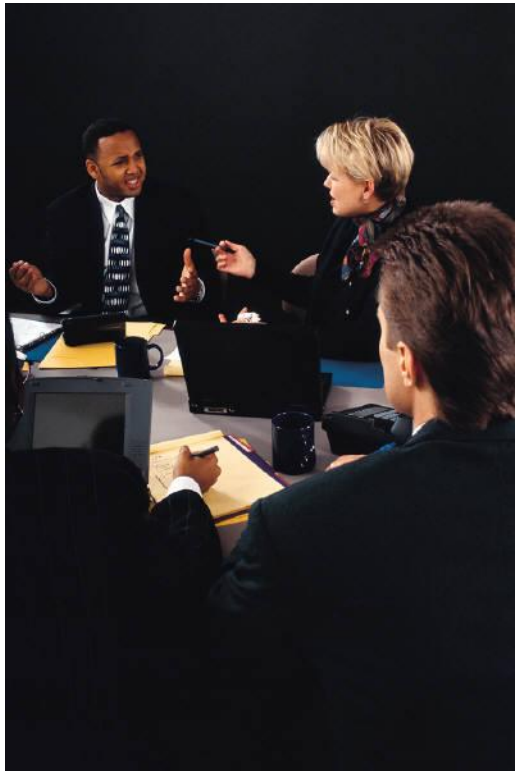
2. **Membership in one or more ABET member societies or willingness to become a member prior to applying to serve as an evaluator**

3. **Formal education and recognized distinction in their field**
   a. **Program evaluators with an industry background must possess the following:**
      i. **Degree appropriate to the field**
      ii. **Experience in employment of graduates from accredited programs**

ABET PROGRAM EVALUATORS: THE FACE OF QUALITY IN TECHNICAL EDUCATION

Characteristics of Successful Program Evaluators

- **Technically current**
- **Effective at communicating**
- **Interpersonally skilled**
- **Team-oriented**
- **Professional**
- **Organized**



Are You Qualified?

- Is there any doubt that CMMI and improvement experience is an excellent background?

How to Apply

1. **Begin the application process to be a CS, IS, IT or SW Engr PEV at http://www.csab.org/pev.htm***

2. **If accepted, you will be asked to complete some online work to prepare for formal program evaluator training.**

3. **If the online work is completed satisfactorily, you will attend formal program evaluator training.**

4. **If the training is completed satisfactorily, you will be approved as a program evaluator. In some cases, you will be asked to observe a campus visit prior to approval as an evaluator.**

5. **Based on your availability and the demand for program evaluators in your field, you will be assigned to evaluate a program.**

*** other disciplines should go to: www.abet.org/volunteer.shtml**

Conclusion

- Additional details are in handouts
- Contact information
  - Larry Jones: lgj@sei.cmu.edu
  - Dan Nash: j_Dan_Nash@raytheon.com
  - Pat LaMalva: lamalva@csab.org
- Apply at
  - **http://www.csab.org/pev.htm**

Backup Slides

Terminology

ABET Term	Definition
Program Educational Objectives	Broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. (*What can graduates do in about 5 years and continue to do as they grow professionally?)*
Program Outcomes	Narrower statements that describe what students are expected to know and be able to do *by the time of graduation*. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program

Criteria Organization

- Students
- Program Educational Objectives
- Program Outcomes
- Continuous Improvement
- Curriculum
- Faculty
- Facilities
- Support
- Program Criteria

Criterion 1: Students

Students can complete the program in a reasonable amount of time. They have ample opportunity to interact with their instructors. Students are offered timely advising, by qualified individuals, about the program's requirements and their career alternatives. Students who graduate from the program meet all program requirements.

Criterion 2: Program Educational Objectives

*The program has **documented**, **measurable** educational objectives that are based on the needs of the program's **constituencies**.*

Criterion 3: Program Outcomes

The program has documented, measurable outcomes that are based on the needs of the program's constituencies.

The program enables students to achieve, by the time of graduation:

Criterion 3: Program Outcomes

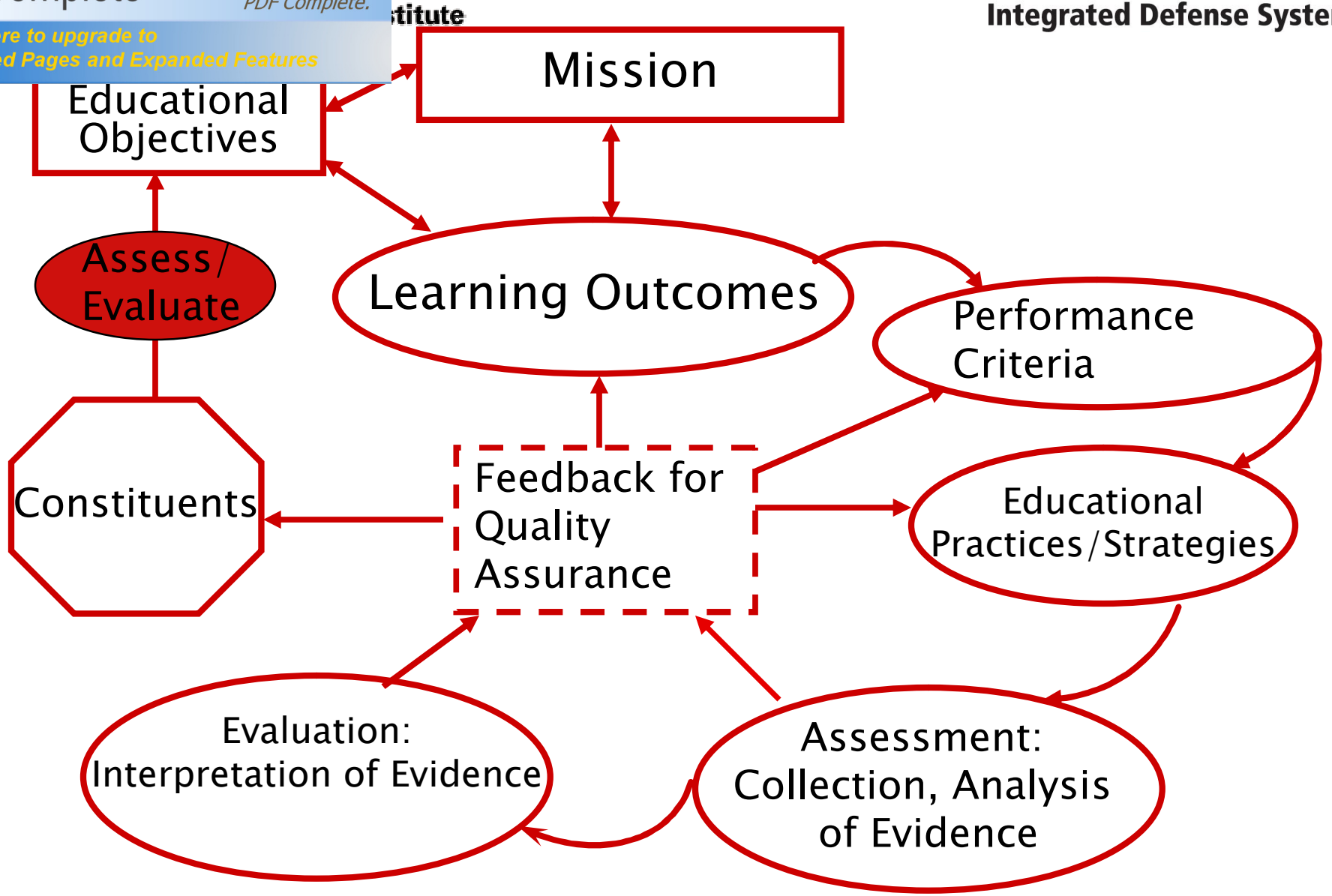
- *(a) An ability to apply knowledge of computing and mathematics appropriate to the discipline*
- *(b) An ability to analyze a problem, and identify and define the computing requirements appropriate to its solution*
- *(c) An ability to design, implement, and evaluate a computer-based system, process, 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*

Criterion 3: Program Outcomes

- *(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 4: Continuous Improvement

The program uses a documented process incorporating relevant data to regularly assess its program educational objectives and program outcomes, and to evaluate the extent to which they are being met. The results of the evaluations are documented and used to effect continuous improvement of the program through a documented plan.



Assessment for Quality Assurance

Criterion 5: Curriculum

The program's requirements are consistent with its educational objectives and are designed in such a way that each of the program outcomes can be achieved. The curriculum combines 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 technical and professional requirements 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 includes mathematics appropriate to the discipline beyond the precalculus level. For each course in the major required of all students, its content, expected performance criteria, and place in the overall program of study are published.

Criterion 6: Faculty

- *A. Faculty Qualifications*

  Faculty members teaching in the program are current and active in the associated computing discipline. They each have the educational backgrounds or expertise consistent with their expected contributions to the program. Each has a level of competence that normally would be obtained through graduate work in the discipline, relevant experience, or relevant scholarship. Collectively, they have the technical breadth and depth necessary to support the program.

Criterion 6: Faculty

- *B. Faculty Size and Workload*

  There are enough full-time faculty members to provide continuity, oversight, and stability, to cover the curriculum reasonably, and to allow an appropriate mix of teaching, professional development, scholarly activities, and service for each faculty member. The faculty assigned to the program has appropriate authority for the creation, delivery, evaluation, and modification of the program, and the responsibility for the consistency and quality of its courses.

Criterion 7: Facilities

Institutional facilities including the library, other electronic information retrieval systems, computer networks, classrooms, and offices are adequate to support the educational objectives and outcomes of the program. Computing resources are available, accessible, systematically maintained and upgraded, and otherwise adequately supported to enable students to achieve the program's outcomes and to support faculty teaching needs and scholarly activities. Students and faculty members receive appropriate guidance regarding the computing resources and laboratories available to the program.

Criterion 8: Support

The institution's support for the program and the financial resources available to the program are sufficient to attract and retain qualified faculty members, administer the program effectively, acquire and maintain computing resources and laboratories, and otherwise provide an environment in which the program can achieve its educational objectives and outcomes. Support and resources are sufficient to provide assurance that the program will retain its strength throughout the period of accreditation.

Criterion 9: Program Criteria

Each program must satisfy applicable Program Criteria (if any). Program Criteria provide the specificity needed for interpretation of the General Criteria as applicable to a given discipline. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria, then that program must satisfy each set of Program Criteria; however, overlapping requirements need to be satisfied only once.

Computer Science

- *3. Program Outcomes*

  The program enables students to achieve, 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]

Computer Science

- *5. Curriculum*

Students have the following amounts of course work or equivalent educational experience:

a. Computer science: One and one-third years that includes:

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]

Computer Science

- *b. One year of science and mathematics:*

  1) Mathematics: At least one half year that must include discrete mathematics. The additional mathematics might consist of courses 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 or engineering majors that provide some exposure to laboratory work. [CS]

Computer Science

- *6. Faculty*

  A. Qualifications

  Some full time faculty members have a Ph.D. in computer science.

Information Systems

- *3. Program Outcomes*

  The program enables students to achieve, by the time of graduation:

  (j) An understanding of processes that support the delivery and management of information systems within a specific application environment. [IS]

Information Systems

- *5. Curriculum*

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

a. Information Systems: One year that includes:

1) coverage of the fundamentals of a modern programming language, data management, networking and data communications, systems analysis and design and the role of Information Systems in organizations. [IS]

2) advanced coursework that builds on the fundamental coursework to provide depth. [IS]

b. Information Systems Environment: One-half year of coursework that includes varied topics that provide background in an environment in which the information systems will be applied professionally. [IS]

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

Information Systems

- *6. Faculty*

  Some full-time faculty, including those responsible for the IS curriculum development, hold a terminal degree in information systems.

Information Technology

- *3. Program Outcomes*

  The program enables students to achieve, by the time of graduation:

  (j) An ability to use and apply current technical concepts and practices in the core information 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]

Information Technology

- *5. Curriculum*

  Students 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]

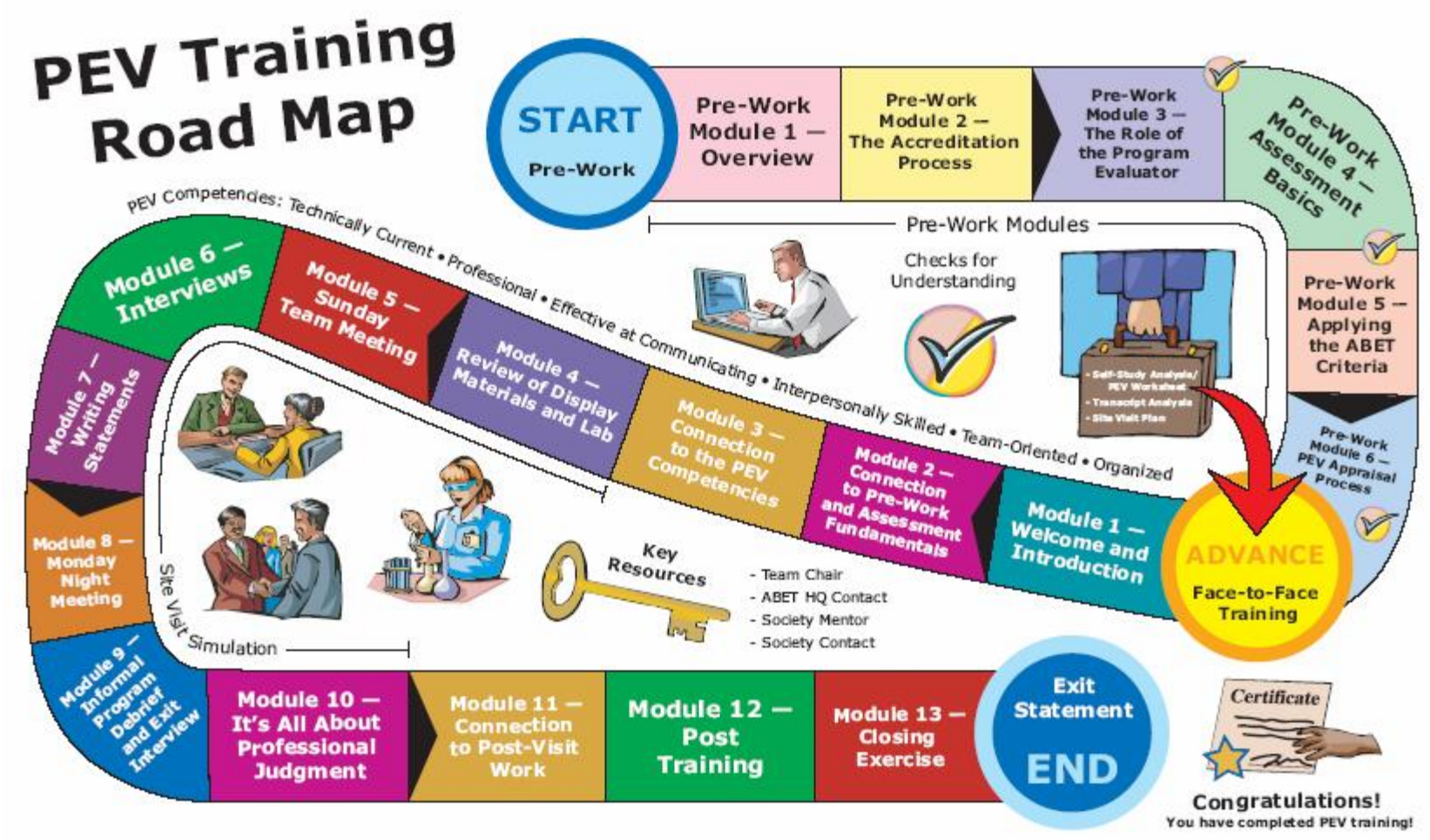
  2) information assurance and security. [IT]

  3) system administration and maintenance. [IT]

  4) system integration and architecture. [IT]

  b. Advanced course work that builds on the fundamental course work to provide depth. [IT]

Program Evaluator Training



Note: Travel expenses for training paid by ABET