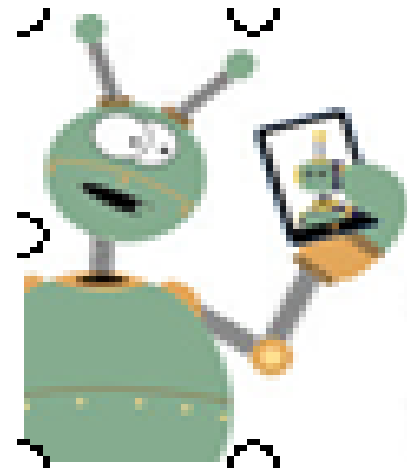# *Software Engineering Curriculum in Turkey with respect to IEEE/ACM Guidelines*

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Agenda

- *Introduction*
- *SE Curriculum and Software Industry*
- *Development of SE Curriculum*
  - *SWEBOK (IEEE/ACM Guidelines)*
- *SE Undergraduate Education in Turkey*
- *Curriculum Implementation*
- *Discussion*

Introduction

- SE deals with the creation and application of engineering fundamentals for
  - the systematic and team-based analysis and development

  use and evaluation of large, software-intensive systems as technical products.

- There is a need for highly qualified specialists capable of mastering complex, software-intensive systems. (Horn and Kupries, 2003)

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- SE is a multidimensional field that involves activities in various areas and disciplines such as
    - Computer science
    - Project management
    - System architecture
    - Human factors
    - and Technological evolution (Brazilay et al.,
    - 2009).

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- Software engineering rests on the following three principal intellectual foundations (Shaw, 2005):
  1. Technical Foundation
  2. Engineering Knowledge
  3. Social and Economic Context

- Complaints of software developing companies
  – Lack of practice in solving real-life problems
  – Low quality of teaching

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- SE education has become widespread and is still growing

- SE is the fastest-evolving engineering discipline

- It is the responsibility of SE education to prepare SE professionals for the industry by providing them with skills to meet the expectations of the software industry.

- The objective of this paper is to provide an assessment of SE curriculum in Turkish Universities with respect to IEEE/ACM guidelines mentioned in SEEK (2004).

SE Curriculum & Software Industry

- Problems with the quality & the cost of producing software (Ford and Gibbs, 1996): Software industry complain about the knowledge and skills of graduates in some of key areas of SE such as:

  1. Software development models

  2. Requirements engineering

  3. Software architecture and high-level design

  4. Software processes

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5. Software quality assurance and management

6. Software project management

7. Managing people organizations and working in teams

8. Software testing

- These areas are directly in compliance with the phases of the software development life-cycle.

- Topics important for the software industry and students (Lethbridge, 2000a):
  - Object-oriented concepts and technologies
  - Requirements gathering and analysis
  - Analysis and design methods
  - Testing, verification and quality assurance
  - Project management
  - Human–Computer Interaction (HCI)/user interfaces
  - Databases
  - Configuration and release management
  - Ethics and professionalism
  - Technical writing
  - Delivering presentations/seminars to an audience
  - Leadership skills.

- According to Lethbridge (2000b), there is a need to include these subjects in a curriculum along with real industrial practice.

- An additional critical element in the success of SE programmes is the involvement and active participation of industry (SEEK, 2004).

- The selection of a suitable industry partner to provide a challenging and motivating project is critical to the success of industry-related projects.

Development of SE Curriculum

- According to Pinto (2010), the design of a curriculum should take the following into consideration:

    1. Identify job opportunities and duties involved
    2. Identify personality traits (soft-skills) required for the job
    3. Identify the competencies required to perform the job
    4. Identify the knowledge, know-how and current skills required to achieve these competencies

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5. Identify corresponding subject concepts (theory) to acquire the knowledge base required

6. Identify assignments (practice) that enhance the "know-how" of the subject

7. Identify the skill set (the means) required to perform the assignments

8. Identify the reference materials whose subject objectives match the knowledge required in items 5, 6 and 7 above

9. Design assessments that can check a candidate's knowledge at various levels for a given competency.

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- Modern SE education is driven by an expectation that industry best practice and state of the art software technologies should be an integral part of the curriculum (Hogan et al., 2005).

- Within the Software Engineering Body of Knowledge report (SWEBOK, 2008) designed by joint IEEE-CS/ACM task force, the software engineering core curriculum comprises of ten knowledge areas, each of which has several knowledge units.

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- Knowledge Areas (Total 499 class hours)
  - CMP = Computing Essentials (172)
  - FND = Mathematical and Engineering Fundamentals (89)
  - PRF = Professional Practice (35)
  - MAA = Software Modelling and Analysis (53)
  - DES = Software Design (45)
  - VAV = Software Verification and Validation (42)
  - EVL = Software Evolution (10)
  - PRO = Software Process (13)
  - QUA = Software Quality (16)
  - MGT = Software Management (19)

SE UG Education in Turkey

- A comparative study is made to measure the level of conformity of the SE UG ptograms to SWEBOK.

- Universities in Turkey have initiated SE undergraduate programmes only in the last decade.

- Before this the software industry relied heavily on the graduates of the Computer Engineering and other related programmes.

- So far,in Turkey 11 universities out of 162 (10 foundation/private and 1 government) offer SE undergraduate programmes with a total number of 921 intakes in the 2010-11 Academic Year where the acceptance (by exam) rate was only about 50%.

- Here, the coverage of knowledge areas by the eleven SE undergraduate programmes in Turkey will be investigated. The following observations are made about the programmes:
  - The duration of a course is 14 weeks, and therefore, 42 hours in the SWEBOK corresponds to one three-hour credit course.
  - Majority of the courses are taught as three hour lectures (three credit units) per week.
  - All programmes have a Senior Design Project (two semesters long) in the last year.
  - First two years of the programmes are similar to the classical engineering programmes.
  - Some of the SWEBOK units are taught as technical elective courses.

Table 1. SE Curriculum Compliance

#	University	CMP	FND	PRF	MAA	DES	VAV	EVL	PRO	QUA	MGT	Total
	Equivalent Units (hrs/42)	**4.09**	**2.12**	**0.83**	**1.26**	**1.07**	**1.00**	**0.24**	**0.31**	**0.38**	**0.45**	**11.76**
1	Atılım	3.83 *pe*	1.76 *pe*	0.71 *c*	1.00 *c*	1.07 *c*	1.00 *c*	0.08 *m*	0.15 *m*	>0.38 *c*	>0.45 *c*	10.43
2	Bahçeşehir	3.62 *c*	1.67 *c*	0.63 *m*	0.00	1.07 *c*	1.00 *c*	0.00	0.08 *m*	0.00	>0.45 *c*	8.52
3	Beykent	3.52 *c*	1.90 *c*	0.71 *c*	1.00 *c*	1.07 *c*	0.00	0.08 *m*	0.15 *m*	>0.38 *c*	>0.45 *c*	9.26
4	Işık	3.62 *c*	1.43	0.00	0.25 *m*	0.26 *m*	0.00	0.00	0.05 *m*	0.00	0.11	5.72
5	İstanbul Aydın	3.50 *c*	0.48	0.75 *c*	1.00 *c*	0.54 *m*	0.00	0.00	0.08 *m*	>0.38	>0.45	7.18

#	University	CMP	FND	PRF	MAA	DES	VAV	EVL	PRO	QUA	MGT	Total
	Equivalent Units (hrs/42)	**4.09**	**2.12**	**0.83**	**1.26**	**1.07**	**1.00**	**0.24**	**0.31**	**0.38**	**0.45**	**11.76**
6	İzmir Ekonomi	3.10 *ce*	1.83 *pe*	0.75 *c*	0.00	0.54 *m*	1.00 *c*	0.16 *e*	0.15 *m*	0.00	>0.45	7.98
7	İzmir	3.81 *c*	1.81 *pe*	0.30 *c*	1.00 *c*	1.07 *c*	0.50	0.00	0.00	0.19	>0.45	9.13
8	Maltepe	3.81 *pe*	1.64	>0.83	1.00 *e*	1.07 *c*	1.00 *c*	>0.24 *c*	0.05 *m*	>0.38 *e*	>0.45 *c*	10.47
9	Toros	3.33 *c*	1.33	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	4.66
10	Yaşar	3.33 *c*	1.52 *c*	>0.83 *c*	1.00 *e*	1.07 *c*	1.00 *c*	>0.24 *e*	0.05 *m*	>0.38 *c*	>0.45 *c*	9.87
11	Fıratt	*Programme became inactive as of 2011-12 Academic Year*											

e ≡ *Offered as an elective course unit*   pe ≡ *Offered partly as an elective course unit*

c ≡ *Compulsory course unit*   m ≡ *Module in a course unit*

> ≡ *Over emphasized unit*

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- Using the table, one can conceivably make the following remarks and suggestions on the SE curriculum of the ten universities in question:
- All programmes seem to cover the majority of the topics in the "Computing Essentials" (CMP) and "Mathematical and Engineering Fundamentals" (FND) knowledge areas.
- In CMP the coverage of the following topics within the "construction technologies" are at an unacceptable level:
  - Middleware
  - Construction methods for distributed software
  - Constructing heterogeneous systems
  - Performance analysis and tuning.
- In addition, "formal construction methods" of CMP are not covered by any of the programmes.

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- In FND, a majority of the programmes offer a compulsory course in "Engineering Economics" to all engineering students. However, such a course should include topics which take into account some economic value considerations over the software life cycle.

- Again, for the FND, some of the "engineering foundations of software" units such as measurement theory, empirical methods and experimental techniques, and systems development issues need to be incorporated.

- In all but two programmes, "Software Evolution" (EVO) is either missing or covered partially. Similarly, "Software Process" (PRO) coverage is at an unacceptable level.

- "Software Management" (MGT) and "Software Quality" (QUA) units are over emphasized since these units are taught as one-semester courses instead of course modules.

Curriculum Implementation

- An undergraduate SE curriculum usually requires a total of 125-145 credit hours.

- In addition to the fundamental course units in science and engineering, the curriculum is supported by a set of technical and non-technical electives.

- In order to fulfill the ABET or similar engineering accreditation criteria, the universities need to consider a balance of credit units in science, mathematics, social science and software engineering.
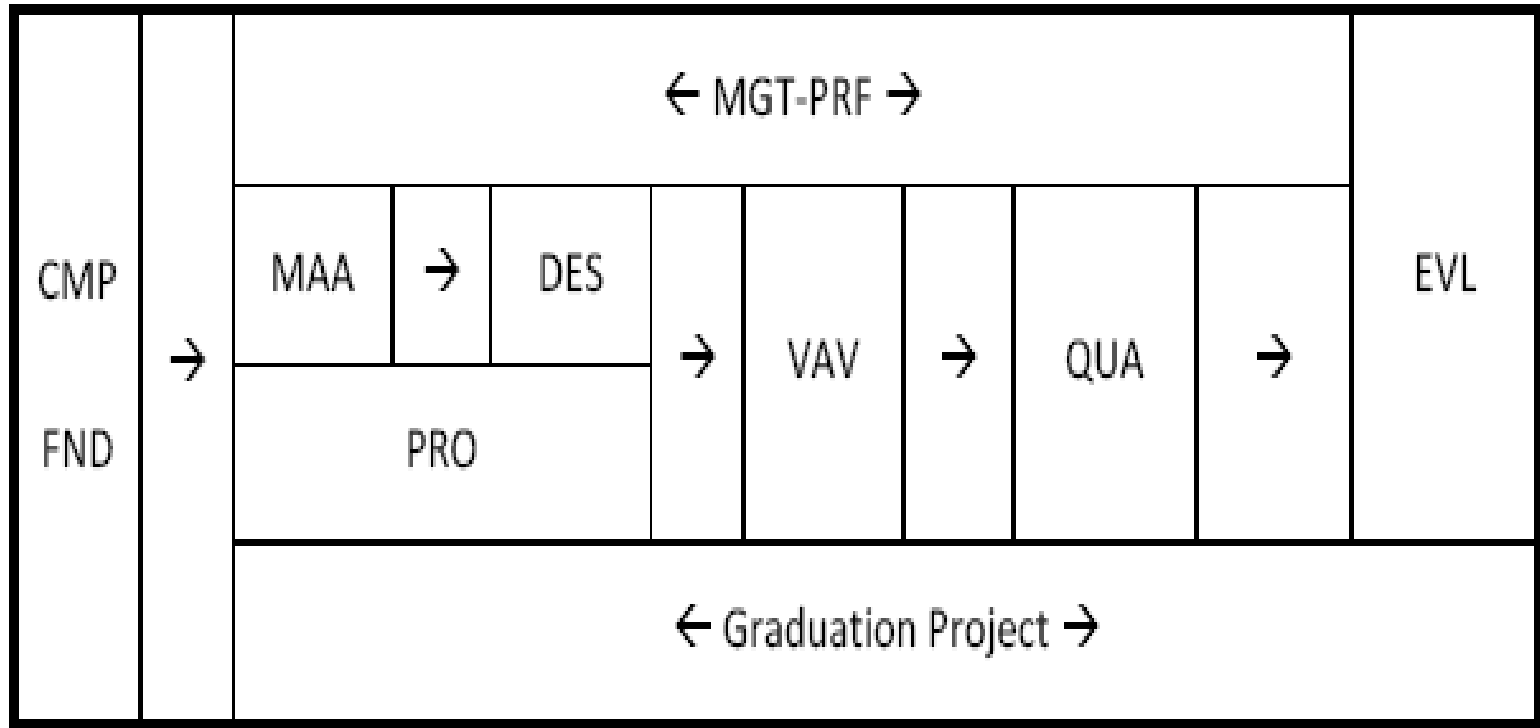
Order of SWEBOK Units

Figure 1. SWEBOK prerequisite chart

Discussion

- For a more attractive and effective SE curriculum, the following points need to be considered:
  - A close collaboration with the technology parks in terms of curriculum development, internship and summer practices
  - Inclusion of software developers and CEOs as well as alumni in the curriculum development process
  - Partnerships with the leading software companies by incorporating software development and testing tools, and frameworks into the curriculum

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- Provision of student involvement in all stages of the software development life cycle by introducing term projects in parallel with the software development phases

- Introduction and close cooperation with the professional NGOs in software engineering such as IEEE, ACM, Software Engineering Institute

- and at the national level, YASAD (Software Industrialists Association), TBD (Turkish Informatics Society), TBV (Turkish Informatics Foundation), and so on.

Thanks for listening...

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Vision
The vision of our department is to educate our students to become competent software engineers, and open up new horizons to software engineering by academic research.

International
Software Engineering department started to exchange students and teaching staff with its 12 partners in European countries.