

## ENHANCING THE SCOPE OF SEE BY INCORPORATING ENTREPRENEURIAL SOFTWARE ENGINEERING INTO SE CURRICULUM

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The SE2004 guideline by ACM and IEE-CS on software engineering body of knowledge is the baseline document on which the current curriculum for software engineering education is drafted worldwide. However, this guideline has the demerit that its objective is limited to equipping the next generation software engineers to meet the future demands of the software industry. It does not promote or provide the incentive for necessary skills to develop entrepreneurs. Realizing the need to develop entrepreneurial orientation among the young generation, there is a general consensus now to include entrepreneurship education in the curriculum. Though IT is one of the fastest growing industries of today, the software engineering academia have largely ignored the need for incorporating entrepreneurship education in the software engineering curriculum. This paper proposes that in order to exploit the full potential of the growing IT industry, the basic entrepreneurial knowledge and skills must be included in the software engineering curriculum as one of the specialized knowledge areas.

Keywords: Software Engineering, Software Engineering Education Knowledge, Entrepreneurial Software Engineering, Entrepreneurship Education, Software Engineering Education.

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### 1. INTRODUCTION

Since its inception in 1968 at the NATO conference, Software Engineering (SE) has made substantial progress. However, despite many developments in the field, SE has not yet turned into a matured engineering discipline. It has achieved the stature of a matured engineering discipline only in isolated cases. Because of this immaturity in its infrastructure elements (Ford & Gibbs, 1996) like initial professional education, accreditation, skill development, certification, licensing, professional development, code of ethics and professional society, SE still has considerable room to develop.

Considering the evolving and dynamic nature of the SE discipline, many efforts and research in SE and SE education are directed to understanding what the SE curriculum provides, what the practitioners and industry demand, what new technology emerges, what the gaps between supply and demand are, and how to reorient the courses to the emerging scenario to improve education and skills (Kumar, 2006). Since its beginning, there have been constant efforts to redefine and update the SE curriculum. The SE2004 guideline (Rich et al., 2004), a combined effort by IEEE-CS and ACM, is a culmination of several such software engineering education and computing curriculum efforts by SE organizations, workgroups, professionals, researchers and other SE communities. The SE2004 defines the knowledge that an undergraduate SE student should

possess upon graduation, including knowledge of mathematics, general engineering principles and other related areas (David et. al, 2000). Although there are critics of the guideline, the industry and the academia in general, treat this guideline as the baseline document of Software Engineering Education Knowledge (SEEK) and use it widely to design the curriculum of Software Engineering Education (SEE) worldwide.

Considering the ever-evolving nature of the SE, the designers of SE2004 guideline have given considerable space and flexibility for inclusion of new Knowledge Areas (KAs), Knowledge Units (KUs) and Topics into the design of the guideline. In order to ensure universal adaptability, as the designers state, the SE2004 is not a complete undergraduate curriculum and it provides scope for adaptability to the localized needs of the implementing country, region, institution, industry and the students. Besides the ten core KAs that are necessary for anyone to obtain an undergraduate degree in the field, the SE2004 guideline comprises a section Systems and Application Specialties that includes specialized topics like network-centric systems, information systems and data processing, financial and e-commerce systems and many more. As part of an undergraduate software engineering education, students should also specialize in one or more of these special areas.

The objective of this paper is to make use of the adaptability freedom offered by the SE2004 guideline and to enhance the scope of the SEE by incorporating the necessary knowledge and skill set required for new generation entrepreneurs in the IT industry. I refer to this addition to the SE2004 guidelines as Entrepreneurial

Software Engineering (ESE). This suggestion is derived from the observation that the SEEK formulated by the SE2004 baseline document is guided by the belief that the prime objective of the SEE is to create SE professionals having strong technical and management skills to equip them to take up their more professionally demanding roles. This view of the SEE has the demerit that students of the SE discipline will strive only for equipping themselves as quality SE professionals to be hired by potential employers and it may kill their abilities to become potential entrepreneurs. This paper recommends that necessary entrepreneurial knowledge and skills be included in the SEE curriculum in order to tap the global growth potential of the IT industry.

## 2. NEED FOR ENTREPRENEURSHIP EDUCATION

Entrepreneurs play an important role in developing and contributing to the economy of a nation as they are the propellers of social and economic changes. The search is on in many countries for more and better ways of creating enterprising people and specially for developing entrepreneurs. Entrepreneurship education and training plays an important role in this. Entrepreneurship education seeks to prepare people, especially youth, to be responsible, enterprising individuals who become entrepreneurs or entrepreneurial thinkers and who contribute to economic development and sustainable communities. It is not based on a textbook course. Instead, students are immersed in real life learning experiences where they have an opportunity to take risks, manage the results, and learn from the outcomes. Entrepreneurship education is not just about teaching someone to run a business. It is also about encouraging creative thinking and promoting a strong sense of self-worth and accountability. Through entrepreneurship education, students learn a. to legitimize entrepreneurship and develop an entrepreneurial culture with the purpose of fostering economic growth; b. to change attitudes towards the entrepreneurship function, the entrepreneur, and the entrepreneur's image among students; c. access to the "make a job" option; d. to develop and stimulate the entrepreneurial skills, producing in the mid and long term, a generation of new and better trained entrepreneurs, well informed about when, where, with whom, and how to start a new business; e. to prepare students for a dynamic labour market; f. to contribute to the development of entrepreneurs and; g. to produce knowledge by research in this field of study.

Traditionally, the Indian educational system was not equipped to promote or provide the incentive for necessary skills to develop entrepreneurs. Educated youth lack entrepreneurial mentality, given that the education they receive as well as social expectations is oriented towards employment and promotion. Realizing the need to develop entrepreneurial orientation among the young generation, there is a general consensus now that formal

entrepreneurship education is one of the many ways by which the entrepreneurial spirit can be fostered and that it is important to incorporate entrepreneurship into the curriculum. Unfortunately, the entrepreneurship education in the country is still largely limited to B-schools only. To take advantage of the diverse nature and business opportunities available in the industrial sector it is high time our education system was reoriented towards entrepreneurship that would set in an encouraging trend with youngsters displaying a natural bent towards entrepreneurship as a career option.

## 3. ENTREPRENEURIAL SOFTWARE ENGINEERING IN SEE

Though SE is a relatively young discipline, the term is now widely used in industry, government, and academia: hundreds of thousands of computing professionals go by the title Software Engineer; numerous publications, groups and organizations, and professional conferences use the term software engineering in their names; and there are many educational courses and programmes on SE. The SE discipline is more relevant today because software is the new infrastructure of the 21<sup>st</sup> century. It pervades our society, is becoming increasingly critical for business as well as for leisure time entertainment and will continue to play an increasingly important and central role in all aspects of daily life. However, viewing SE simply as an engineering discipline, especially in the current knowledge-based economy, will underestimate its potential. In the current knowledge-based economy, SE has the status of an industry, and, in fact, it is one among the fastest growing industries of today. With its immense potential for growth, there are two great challenges before the IT industry - the dearth of skilled workforce and the inability to exploit the new business avenues in the IT industry. The effort made by the SE2004 guideline addresses only the first of these challenges. In order to exploit the full potential of IT industry, the new generation software engineers must be trained in entrepreneurial skills.

ESE is a new concept in SEE designed to instill entrepreneurial skills in the new generation software engineers. The method employed to achieve this objective is to incorporate entrepreneurship education into the existing SE curriculum to identify and build the next generation entrepreneurs of the IT industry. The ESE has the following objectives: learning the SE through real world experiences, not just reading a textbook, infusing entrepreneurial concepts into the SE curriculum to develop an entrepreneurial mindset, discovering opportunities everywhere, practising creative thinking, encouraging students to ask questions and solve problems on their own, involving entrepreneurs and business people as consultants for students, spreading the understanding of how entrepreneurship creates wealth and builds the economy of the country.

4. IMPLEMENTATION OF THE ESE

The ESE can be implemented in two stages. First, the existing curriculum, which is designed with an objective of imparting the software engineering body of knowledge, is to be reoriented towards imparting the necessary industry exposure. For this, wherever possible, include in each KAs and KUs of SE2004 guideline the topics that impart real-time industrial experiences and business opportunities. For example, the KA, Computing Essentials, must provide the students with an exposure to a. the languages that are currently popular in the IT industry, the related program development, GUI and testing tools and their importance and the current and future trends in application development and deployment; b. popular databases of today, their design principles, success stories, business opportunities in the database domain, future trends; c. popular operating systems of the time, design principles, success stories of the various modern operating systems, future trends, entrepreneurial opportunities in the field of operating systems, concepts and the current status of the distributed software, business opportunities in the field of distributed systems; d. popular system development platforms, their design principles, success stories, and e. web-based application, types, architecture, success stories and entrepreneurial possibilities. Similarly, the KA, Mathematical and Engineering Foundation, must provide the students with an exposure to the scientific, engineering, and industrial applications such as industrial controls, embedded systems, microcontroller applications and the like. In short, each KA in the SE2004 guideline must include KUs and topics that provide maximum possible industrial exposure to the students.

The second stage of ESE has the objective of imparting the students with a more formal training in entrepreneurship reorientation. The KAs currently included in SE2004 do not address this issue. For this, I propose that a specialized KA area Entre-pre-neurship in SE is to be added into the Systems and Application Specialties section of the SE2004 guideline.

5. THE PROPOSED SPECIALIZATION

The proposed specialization of the SE2004 is titled Entre-pre-neurship in SE. The objective of this specialized KA is to impart a potential entrepreneur with fundamental knowledge of entrepreneurship and enterprise during launching and management. This specialized KA consists of the following KUs.

Fundamentals of Entrepreneurship: The objective of this module is to acquaint an entrepreneur with basic concepts such as qualities, role and functions of an entrepreneur, fundamental theories of entrepreneurship, characteristics of economy and the fundamental concepts of knowledge entrepreneurship and knowledge-based economy.

Motivational Inputs: The competence of an entrepreneur is indispensable for the success of any enterprise. Entrepreneurial traits and motivational inputs are to be included in the curriculum to strengthen self-awareness, confidence, creativity and other entrepreneurial qualities.

Management Inputs: To equip the potential entrepreneurs with sound management techniques, they must be introduced to the basics of functional areas of management.

Support System Services: The potential entrepreneurs must be exposed to the role and functions of promotional agencies which support the entrepreneur for setting and running the enterprise. They should be aware of the policies and procedures laid down by the government, industrial services agencies and financial support system institutions for the promotion of an enterprise.

Project feasibility study: The potential entrepreneurs must be given information and counselling about the various business opportunities in the IT sector. They are also trained in preparing the feasibility report of a proposed business enterprise for which they need to be trained in conducting market surveys, technical and commercial viability analysis, and project appraisal.

Industrial exposure: The potential entrepreneurs must be introduced to the current status and trends of the IT industry.

Table 1 lists the proposed specialized KA and its subtopics along with its relevance to core KAs and the teaching hours needed for each subtopic.

6. CONCLUSION

China’s success story of effectively utilizing both the domestic and export-oriented IT industry should be emulated for harnessing the huge growth potential of the Indian domestic IT industry along with the current export orientation. For this new generation software engineers must be trained to become potential workforce who can meet the future challenges of the IT industry. At the same time, they must be given enough exposure to become potential employers. This is more relevant in the current knowledge-based economy where IT industry has a crucial role to play.

Table 1  
The Proposed Specialized KA and its Sub Areas

Topics	*k,c,a	*E,D,O	Hrs
Entrepre-neurship in SE			50
Fundamentals of Entrepreneurship	c		5
Characteristics, qualities, role and functions of the entrepreneur	c	E	
Theories of entrepreneurship	c	D	Contd...

Contd...		
Knowledge entrepreneurship	c	D
Knowledge-based economy	c	D
Motivational inputs		
Motivational inputs to strengthen entrepreneurial traits	a	E
Management inputs		
Basic managerial skills	a	E
Business communication skill	a	E
Personnel management	a	E
Labour laws	a	E
Working capital management	a	E
Decision making and problem solving	a	E
Purchase management	a	E
Sales management	a	E
Quality control	a	E
Marketing management	a	E
Support system services		
Supporting systems and their roles	c	E
Role of commercial banks	c	E
Policies and procedures for setting up enterprises	c	E
Entrepreneurial laws of the land	c	E
Procedures for procuring fixed assets	c	E
Project feasibility study		
Preparation of project reports	a	E
Feasibility study	a	E

Contd...

Market surveys	a	E
Technical and commercial viability analyses	a	E
Industrial exposure		
Field visits	a	E
Field analyses	a	E
Case study	a	E

\*k,c,a: knowledge, comprehension, application, \*E,D,O: Essential, Desirable, Optional

7. ACKNOWLEDGEMENT

The author thankfully acknowledges receiving part of the financial support from a project grant funded by the University Grants Commission of India.

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