

WANTED: NO BOUNDARIES IN SOFTWARE ENGINEERING EDUCATION

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1. INTRODUCTION

No boundaries should exist for software engineering education and practice. Is this just Pollyanna naïveté? Or is this a prediction, founded in isolated current practices? Since when do the problems of developing and helping people develop high-quality, useful and reliable software know boundaries of development, let alone usage? To be sure, at one time in the life of the author 40+ years ago, as a beginning professional, provincialism was practiced. However, this was probably because we simply did not know what, if anything, people next door, in the next city, state, country, or continent were doing in software development. My, my, how times have changed! And for the better! We have nearly 4,000,000 people world-wide developing software today. And how many of the 6,400,000 of the people across the globe are using that software? Estimates of Internet users alone go as high as 900,000. With dramatic increases in the pervasiveness of computing, and the consequent critical nature of the applications, software engineering educators have ample reason to be concerned about the practitioners (software development professionals – both current and prospective). The practitioners, as professionals, want to develop high-quality software. How do we “ensure” the best possible education and training opportunities are accessible to these 4M+ people?

For sure, we cannot continue to “do business as usual” – each university or school concentrating solely on those people within a 20 or 30-mile radius of our location. Nor can we reasonably request that those “in need” show up in our classes on Monday and Friday from 9:00 – 10:15 a.m. for 15 weeks in a row. Such time and location-constrained classes will not disappear, but we must offer alternative means of providing high-quality education and training opportunities to “those with the need to know” from “those in the know.” Aristotle may have been on to something with his “Golden Mean” – not focusing on one option to the exclusion of the other. We cannot provide any less, as practicing professional educators. Elizabeth Starrett, in the editorial column of an issue of Crosstalk, indicated an emphasis was on “distributed software development.” She wisely asked which distributed development concept the reader would prefer: distributed development of software, development of distributed software, or distributed development of distributed software (Starrett, 2001). It was easy for this author to make the leap to the following query – what about the “distributed development of software professionals?” This is exactly the focus of this paper – no boundaries to software engineering education. Develop a systemic solution for distributed development of software professionals around the

world with the assistance of international universities recognized for their software engineering expertise, combined with the use of hybrid learning technologies, for providing high-quality credit and non-credit courses at all levels.

As a possible solution, the author instigated the International Software Engineering University Consortium (ISEUC -- www.iseuc.org) in 2000-2001. Other “players” in a solution include individual universities, university consortia, ACM, IEEE, U.S. Department of Defense and book publishers. ISEUC is:

- formed of a worldwide consortium of universities designed to provide SE courses via distributed learning, primarily using the Internet
- composed of a group of 35 universities in Australia, Canada, the U.K., and the U.S.A., selected from the 100+ responders to a SE survey funded in 1999 by ACM and IEEE-CS
- based on international best SE education practices, accreditation standards, credit and non-credit programs
- designed to serve as a broker to provide additional students for existing and future Web-enabled courses, and is not meant to be a degree-granting organization
- intended to provide access for software-intensive organizations and their global sites, using renowned international universities (Modesitt, 2002a, b). Such organizations include business, industry, and government.

ISEUC (pronounced “I see, you see”) differs in several ways from the major example of a university consortium: degrees, members, and accreditation. The National Technological University (NTU, 2005) has a primary focus on M.S. degrees in 19 disciplines, one of which is software engineering. NTU currently has 18 universities participating in SE, all from the U.S.A. ISEUC extends its mission to international universities, and would also offer undergraduate courses via its members. NTU offers graduate courses to students abroad (employees of multinationals). NTU grants degrees under the auspices of the North Central Association. ISEUC is not designed to offer degrees. Both NTU and ISEUC include professional, non-credit, courses in their catalog offerings. The author was the first industry member (from Texas Instruments) on the board of NTU in 1980, and has a long-standing relationship with the founder, as well as former vice-president of NTU. So, it was natural that this was the very first place he visited in October, 2000, during his sabbatical to develop ISEUC.

Recently, other entities, including individual universities, ACM, IEEE, the Department of Defense, and even book publishers have developed a presence in this market. Some organizations can be distinguished by their targeting the market for training courses, as compared to credit-bearing courses.

2. INTERNATIONAL SOFTWARE ENGINEERING UNIVERSITY CONSORTIUM

2.1 Mission Statement

- *To provide academic software engineering expertise globally to those with the need to know now, from those in the know:* This is a one-liner to indicate the “just-in-time” approach vs. the “just-in-case” one.

- *Lifelong learning*: This is required on the part of people performing quality software development -- ISEUC provides easy access to them for such learning, via a combination of distributed and face-to-face learning.
- *Expand the scope of SE courses*: Software Engineering educators should expand the scope of their courses beyond their campuses to reach these developers -- ISEUC provides the infrastructure to do this.

2.2 Broad Objectives

The objectives include:

- Increase the number of software engineering professionals.
- Enhance the software skills of existing professionals from many disciplines.
- Facilitate cross-discipline software training and awareness for management.

Distributed Learning courses originating from “primary” universities will be coupled with traditional face-to-face aid from “associate” universities that are closer to the student. Thus, an effective hybrid program of web-based asynchronous and synchronous interactive learning modes can be fashioned to benefit the consortium participants, the students, and the industries that rely upon SE. ISEUC would have both faculty and professional advisory boards.

The plan for ISEUC called for a small number of courses, universities, and students from industry to be used in a pilot test the fall of 2003, with consequent ramp-ups occurring in later years. Granting agencies, such as the U.S. Foundation for the Improvement of Post Secondary Education (FIPSE) were particularly interested in the out-years to ensure that the seed funds provided would not be required then, and that ISEUC would be self-sufficient within 3-4 years (Modesitt, 2001). However, FIPSE had no mechanism for dealing with international universities. There is a dearth of such funding agencies for international efforts in this arena.

The curricular categories represent an adaptation of the ones used by SWEBOK, Carnegie Mellon University and the ACM/IEEE-CS Computing Curricula Software Engineering joint effort (ACM/IEEE, 2004): Modeling and Analysis, Design, Verification and Validation, Evolution, Process, Management, and Quality

2.3 Benefits for Software Engineering Education

There are several beneficiaries for this paradigm shift in software engineering education. These include companies who desire high-quality (useful, reliable, robust) software products to be developed efficiently, employees who do not have time to commute to a university, students who cannot find a SE course at a local university, and universities with SE/CS departments.

- *Benefits for Industry/Business/Government*: The primary benefit is to have a much larger supply of qualified SE professionals who can develop the desired products.
- *Benefits for Students*: Students would primarily be drawn from corporations and government. However, a vital secondary market is composed of those students who wish to enroll in SE courses that are not available through their local university.
- *Benefits for Consortium Participants*: If the organization were a “primary” university, additional students would enroll in existing SE DL courses. Also *new* SE DL courses may be

developed for additional university revenue from a worldwide population of students. Participation as an “associate” university would also increase revenues.

2.4 Current Status

“The best laid plans gang aft agley” Several factors have impacted ISEUC and why specific goals were not met. To date, there have been several prospective students around the world who have inquired about using ISEUC to take SE courses. They may have enrolled in such courses, but not via ISEUC. Until students actually use ISEUC to enroll in the course of a university member, ISEUC cannot “exist” in an operational sense. Here we look at some underlying reasons for this lack.

- *Author took another position:* A seemingly major one is that the author took a new position at another university. However, the structure of ISEUC was developed to account for such a contingency – there is no requirement for the developer to reside at a specific location. To be sure, the files had to be ported to a new server, but that was a minor issue. The learning curve required in the new position did take time away from developing ISEUC – this was a major “distracter” from the viewpoint of ISEUC development. Substantial time is required for any start-up effort, and time is also required to nurture the fledgling organization. This time was simply not available when starting a new position. Shortly after assuming his new position, he was also requested to serve as the Associate Dean for Research and External Partnerships for his School, at a 50% load level, and as Associate Chair at a 25% loading.
- *New entries:* More interesting from a prospective client basis is the rapidly expanding presence of other entities with a related mission. Such a presence could easily be viewed from a *competitive* viewpoint (zero-sum). The author prefers to view such new presence from a *collaborative* viewpoint (win-win). After all, a founding principle of ISEUC is that of collaboration, instead of competition. With few exceptions, however, the other entities do not share such a belief, or are unable to respond. The author has contacted ALL of them over the years, several of them multiple times. The most likely organization with which ISEUC would work is NTU. However, NTU has changed ownership, and the only other “nibbles” have occurred at trade shows with book publishers.

3. OTHER SOURCES OF SOFTWARE ENGINEERING EDUCATION/TRAINING

Since ISEUC was first conceived, the author has been pleased to see an increasing number of other organizations who have also recognized the need to provide “just-in-time” educational opportunities to working SE professionals via distributed learning venues. Clearly, there has long been a substantial presence of individual universities interested in providing distributed learning materials for professional engineering training and education courses. This was first articulated by the Association for Media Based Continuing Education for Engineers (AMCEE) that was the predecessor of the National Technological University. AMCEE used video-tapes as the primary mode of DL. The other current suppliers include university consortia, ACM, IEEE-CS, book publishers, and the Department of Defense. There are certainly other providers as well.

3.1 Individual Universities:

Carnegie-Mellon, Southern Methodist University, Stanford, MIT, Colorado State University and Purdue come to mind immediately. They have long been in the business of providing distributed learning to engineers (and others) in the U.S.A. and in some cases, across the world via video tape, microwave, TV, satellite, CD-ROM, DVD, and of course the Internet. The author helped initiate an on-line interdisciplinary M.S. SE program at his former institution in which 23 students are enrolled, as of January 2005. The Open University in the UK has been a paradigm, and there are undoubtedly additional ones throughout the world. As there are certainly many others, please contact the author if your favorite was left out.

3.2 University Consortia

National Technological University is the largest on-line school for engineering graduate studies in the nation. NTU has the longest history, to the author's knowledge, in providing DL courses to working engineers across the world – currently from over 500 major corporations and government entities. The author was the first industry board member for NTU in 1980, when he was the initial Corporate Education Director for Texas Instruments. NTU offers 19 M.S. degrees via distributed learning from top-flight U.S. engineering departments. They have already graduated over 1500 students who take about five years to complete the 33-hour program, as the students are all full-time employees. NTU has not offered any ABET-accredited B.S. programs in the past, but they are now actively considering just that, as well as doctoral programs. The author had coordinated an effort of five SE programs in the U.S. to develop an undergraduate SE degree in 2001. NTU does have any non-U.S. universities as members, although they have numerous students from around the world. In discussions with the founder and former vice-president for academic affairs of NTU, both were certainly willing to consider such an option. NTU also has a wide variety of professional development offerings from a large selection of sources, including universities. In February 2002, Sylvan Ventures, now Laureate Education, assumed control of NTU. On February 14th, 2005 NTU became the “NTU School of Engineering and Applied Science at Walden University.”

The Oregon Master of Software Engineering program is a “mini-version” of ISEUC involving four universities (all within Oregon) and was thought to be a very viable organization (OMSE, 2005). Three of the 12 core courses had been available online, until the Fall of 2003. OMSE is “still evaluating the on-line program.”

3.3 ACM

The Professional Development Centre (PD) advertises “over 450 valuable online IT training courses absolutely FREE” (ACM, 2005). The offerings include “Java, Web Development, Object-Oriented Programming, Project Management, Telecommunications, e-Business, Networking & Security.” These training courses are “all from leading providers of Professional Development, including Sun Educational Services, Digital Think, Telecommunications Research Associates.” None of the providers are university CS or SE departments.

3.4 IEEE-CS

The IEEE-Computer Society also provides a substantial number of training offerings in software (IEEE, 2005). Their literature indicates “350 interactive web-based courses at no additional charge to members...” Courses include “Java, project management, TCP/IP protocols, Cisco, UNIX, CompTIA, HTML, PowerPoint, Windows network security, Visual C++, and much more.” Again, none of these come from universities and are not part of any degree.

On October 14, 2003, Stevens Institute of Technology became the first university supplier for IEEE-CS. The WebCampus Stevens students can choose on-line graduate degrees in computer science/cybersecurity, networked information systems, and other areas of relevance to software engineering. They do not offer any degrees in SE, but do offer certificates in quantitative software engineering, project management, and other related areas. So, perhaps this section should go under the section on “individual universities,” but Stevens is unique in that it appears under the IEEE logo and students who enroll with IEEE or ACM membership receive discounts.

3.5 Book Publishers

An increasing number of textbook publishers have realized that coordinating text content with on-line delivery is a very profitable venture. McGraw-Hill content can be delivered through WebCT, the leading Internet-based learning tool for higher education. They just ask faculty to choose a McGraw-Hill textbook packaged with an Online Learning Center and they will pre-pay the WebCT site license for the students. Prentice-Hall also has a partnership with WebCT. Addison-Wesley, one of the leading publishers in computer science and software engineering, is quite aware of the importance of providing materials that be accessed by students via the WWW, having relationships with both WebCT and Blackboard. Course Technology specializes in the IT market, so it is no surprise that they have partnered with WebCT as well as BlackBoard. They claim to provide faculty with all the tools needed to teach an “interactive, informative class on information technology concepts, applications, and more.” Wiley, although a partner with both WebCT and BB, has no online offerings for either SE or Computer Science.. The closest is an “e-pak” for a text on systems analysis and design.

3.6 Department of Defense (DoD)

The Naval Postgraduate School (NPS) at Monterey, California is famous for offering the very first Ph.D in Software Engineering in the U.S., both on-site and via distributed learning (NPS, 2005). Initially targeted only for DoD personnel, the program expanded to include very highly qualified civilian personnel in the last few years. The author had the good fortune to know the first graduate from the program, and to have worked for him during an Intergovernmental Personnel Agency (IPA) assignment in SE during 2001. In May, 2002, Dr. Mike Saboe, Associate Director of the Next Generation Software Program of the U.S. Tank Automotive Command, died unexpectedly four months after earning his degree.

The Air Force Institute of Technology (AFIT) offers distance learning SE courses free to all DoD employees (Herman, 2002). During 2002, AFIT revamped its Software Professional Development Program, in its largest ever restructuring. The result is the ability of the DoD

employee to complete one or more certificates, such as SE Management or Advanced Software Development.

4. CONCLUSION

No boundaries should exist for software engineering education and practice. There is some disagreement about this proposition. Some are concerned if such an idea would work. These concerns revolve around the belief that some boundaries should exist, e.g., prerequisites, reimbursement for program costs, student progress monitoring to ensure educational goals have been achieved. The author would recommend that those with such concerns consider the demonstrated success of the National Technological University model for the last 20+ years. Prerequisites were agreed upon a long time ago, across dozens of engineering departments and schools at U.S. universities. They each did a cost/benefit analysis, invested in the course preparation, put the courses in the “pool” available, modified the content and delivery platforms over time, and have reaped the benefits of student enrolments they would never have seen otherwise. In conversations with the Provost of NTU, the author was shown longitudinal studies of NTU students who consistently performed better than students who took the same course in a traditional (on-campus) lecture-based mode. The author believes that ISEUC, in whatever incarnation it appears, will be very similar to NTU “writ large.” For those readers with a background in distance learning, this is analogous to the fact that the Internet is PLATO® “writ large” (Plato Learning, 2005), an international computer-based learning system dating back 45+ years to the University of Illinois.

A case for this proposition of “no boundaries” is given in this paper. The prediction is founded in current practice at increasing levels, as demonstrated. How times have changed! And for the better! We have offered a systemic solution for distributed development of software professionals around the world with the assistance of international universities recognized for their software engineering expertise, combined with the use of hybrid learning technologies, for providing high-quality credit and non-credit courses at all levels. ISEUC is an example, albeit an early one, of what such a solution may resemble in coming years. There are numerous other entries at various levels. One speculation is that ACM or IEEE-CS will adopt a model very similar to that of ISEUC. Another speculation is that NTU will expand to include non-U.S. universities as program/course providers via the WWW. A recent provocative article about forming a National Academy of Software Engineering (Wing, 2005) may well determine whether NTU, ACM or IEEE-CS will be the “early adopter.”

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