PROFESSIONAL SOFTWARE ENGINEERING EDUCATION

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This paper is a speculation about how universities might organize new lines of business in software engineering professional education. Professional education enables practicing professionals to achieve defined levels of competence and to be certified according to standards in their professions. This kind of education is offered at very few universities. This paper proposes a conceptual framework for designing professional education programs; software engineering is the central example. It suggests a strategy for combining traditional degree programs and professional certificate programs, in any mix suitable for a department and its clientele.

Professional education is related to, but is not the same as, distance education and continuing education. Distance education refers to new educational practices enabled by Internet technology, practices that allow students to participate actively in courses whose meetings, presentations, exercises, projects, homework, and examinations are conducted mostly by electronic means with few in-person workshops. Continuing education encompasses educational services for adults from age 25 through retirement. Professional education as envisioned here will be a heavy user of distance education and it will be a form of continuing education. Experience with professional education programs will contribute to distance education and continuing education, and is likely to provide useful alternatives to traditional classroom education.

Because they want to stress the active role students must play, some of my critics would have me use the term (professional) *learning* instead of (professional) education. They mean to shift the role of teacher from controller to guide and from authority to facilitator. I understand the point, but I think it downplays the role of the teacher. Strong career and market forces animate students. They *want* authoritative representatives of the profession to be their teachers: for

without positive assessments from such teachers, students cannot gain entry to the profession. I will first discuss the nature of the forces animating students and of the knowledge they seek --- for only then can I discuss strategies for professional education.

From Threats to Possibilities

The debates about software engineering professional education occur in the context of a much larger discussion about the nature of higher education in the decades ahead. Recent shortages of trained workers in information technology have exacerbated the pressures on universities. Professional education is a part of the response.

The New Realities

Because they can be volatile and temporary, workforce shortages are not a sufficient motivation for starting new lines of business.[1] The workforce issue is a manifestation of the rapid growth of the information technology sector. The rapid growth, however, is linked to several deeper realities that affect education.

(1) The wildfire spread of the Internet is making powerful computing and high bandwidth data communications available to the multitudes. Individuals will soon be able to participate in sophisticated, on-line educational services, when and as needed, progressing at their own speeds without constraint of campus schedules and logistics.

(2) People are generally dissatisfied with public education and its costs relative to perceived value. They expect universities to improve services and offerings continually, just as any other businesses. They expect digital delivery to make education cheaper, more accessible, and more focused on useful knowledge.

(3) For-profit education companies are entering the adult-education market and are competing effectively for students.

(4) Most people can expect to go through two or three career transitions during their professional lives. To stave off obsolescence, more of them seek professional education while remaining fully employed

(5) As corporations downsize or outsource, they shift responsibility for continuing education and training from the firm to the individual; because they feel that universities are not responsive to these new needs, many are inviting outside contractors to operate internal company "universities" for their employees[2]. The number of corporate universities grew from 400 in 1990 to over 1,000 in 1998.

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[1] Peter Denning, "Business Designs for the New University," *Educom Review*, November 1996.
[2] Jeanne C. Meister, Corporate Universities: Lessons in Building a World-Class Work Force, McGraw-Hill, 1998 (2nd edition).

Thus, both companies and individuals are looking to universities and other educational organizations to assist them. Professional education is going to be a *very* big business.

Pervasive information technology has been a strong catalyst behind these realities. Software engineering, computer engineering, and telecommunications engineering have always been professions critical to information technology. Modern concerns about our increasing dependence on trustworthy, safe, and dependable software systems have brought to the fore the question of what it means to be a competent software engineer. Debates about software engineer certification have intensified; they now feature political and legal disputes over the use of the word "engineer" in Canada and in some states of the USA. The two leading societies in computing, ACM and IEEE/CS, have joined forces to define the body of knowledge and practice constituting software engineering; their final report will doubtless influence licensing and certification. The Center for National Software Studies (formerly the National Software Council) was formed in 1996 to promote a healthy software industry populated by ethical practitioners capable of producing trustworthy software systems.

MARK – COMBINE FOLLOWING TWO PARAGRAPHS SOMEHOW?

Despite thirty years of experience with software engineering, many companies are openly dissatisfied with software engineering education in universities. They demand competent software engineers and say that universities are not producing them. The sharper critics among them believe that computer science departments are constitutionally incapable of embracing curricula for professional software engineers because of a false dichotomy between "education" and "training"; these critics have called for the formation of separate software engineering departments.

Responses

Public concern about trustworthy and safe software systems is at an all-time high and shows no signs of diminishing. This has created political forces favoring licensing and certification, some forms of which appear inevitable. Most industry people I have discussed this with agree with the basic premise that the university should provide a broad education, but they also believe that the balance has gone too far over of the side of theory and models, leaving graduates of software engineering programs with insufficient practical experience or appreciation of customer concerns to be effective in the workplace.

I think it is our duty and self-interest to respond constructively to these pressures. We need to take a serious look at certification and its place in our curricula. We need to rethink our reaction to "training". I will speculate about how we might go about this, and I will offer some working models.

Northern Virginia illustrates the problems being faced in many regions. In the past five years, George Mason University has received a growing barrage of requests from organizations who want certificate programs, delivered on-site, in engineering, management, and to a lesser extent in the sciences. Many

companies tell us that several tens to several hundreds of their employees would enroll as students. At least four area business groups seek strong participation from George Mason University in support regional economic development and workforce preparation. Yet, we have been unable to respond effectively to these requests. Why? Our faculty are fully booked and class sections are nearly full, especially in the areas of high demand; we could accommodate only a fraction of the new students in our existing programs. We cannot expand our programs because the State has frozen our budgets and has limited tuition increases. Our ability to offer new programs through contracts is limited because contract courses do not qualify for State matching funds and the operating cost of most graduate courses is higher than the tuition.

The marketplace is not sitting idle while universities figure out what to do. Novell and Microsoft license well-regarded programs in network engineering and systems administration. Private training companies offer extensive sets of hands-on technology courses. The major telecommunications and entertainment companies are positioning themselves to be conveyors (and even purveyors) of educational programs. Professional societies such as ACM and IEEE are offering eclectic reading programs leading to certificates of knowledgeability in current hot topics. Several organizations such as the Open University, National Technical University, University of Phoenix, University On Line, and NYU are offering full degree programs via Internet. Fifteen western states have formed the virtual Western Governors University, an alliance to offer proficiency-based degree programs. ARPA sponsored the Computer Aided Education and Training Initiative (CAETI), a major, sprawling project that produced new public-domain tools for an educational Internet.

For a period of time, few of these external activities will threaten main-line universities because they are small or are not accredited. But this situation will change within five to ten years. Some non-university programs will establish a strong market reputation, others will have partnerships with accredited universities, and others will be accredited by new, industry-sponsored accrediting bodies. Universities can ignore this situation only at their peril.

Design of Professional Education Programs

Business leaders believe that we live in an Age of Convenience and are moving into an Age of Identities.[3] Since professional education is rooted in the business workplace, it will offer its greatest value to its clients when it is designed for their convenience and enhances their professional identities. People want education to come to them; they don't want to have to go to it. They want it to be relevant to their concerns now, not at some undetermined future time. They want to be part of a learning community that does not have to meet face-to-face frequently to sustain itself. They want meaningful certifications they can display in their professional records. Many educators in both academe and industry are addressing these issues now, under the buzz words of distance learning and

[3] "The Leaders of the Future", by Fernando Flores, in *Beyond Calculation*, Copernicus Books, 1997.

asynchronous learning. Such interests have built into strong market forces with which professional education must be aligned.

Before we can discuss the structure of professional programs, we need to examine the kind of learning such programs should accomplish. I call this learning embodied knowledge, and in any domain it can appear in at least six different levels of competence. Perhaps the most important point is that it takes time and considerable practice to achieve high levels of competence.

Embodied Knowledge

The buzz words distance education and its cognates call attention to the technology but not to the deeper issue that the technology is forcing us to rethink what we mean by knowledge.[4] What is competence? How does education confer competence? Is education for competence really "training"? What does this mean for teaching and learning practice in the Internet?

The Internet has been likened to a huge space of billboards offering information transfers. Knowledge is much more than information, it is the capacity for effective action. People do not consider that you know something unless you demonstrate it by doing it. You need more than the facts, you need the capability to act, and act effectively. As long as the Internet is seen as an information transfer medium, it will be incapable of helping to confer knowledge. As if to confirm this, David Rothenberg recently gave direct evidence that the information available in the Internet, along with the search practices supported by the Internet, is insufficient for good quality research papers from students.[5]

Lewis Perelman has discussed the problem of knowledge at length.[6] He offers an analogy: the difference between the menu and the dinner. People go to a restaurant for dinner, not to read the menu. Web pages are nothing more than menus. I am going further than this. I say that the kind of knowledge that people are seeking is *embodied knowledge*, knowledge that has become part of their biological structure and is ready for action. It's knowledge that shows up when you need it, even though you are not consciously aware you have it. It's not "critical thinking" or "reflection" because you act without thought. Extending Perelman's analogy, it's the incorporation of the nutrients from dinner into your body through digestion.

Examples of this are everywhere. They can be found in our everyday routines --- without which we would accomplish very little. A good example is typing, essential today for skillful use of computers. A lot of people know how to type. But they have long since forgotten how they learned it. They have no awareness of what makes their hands move when they type. They just think the words and their hands type.

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[4] Peter Denning, "A glimpse of the future," *Educom Review*, July 1997.
[5] David Rothenberg, "How the Web destroys the quality of student research papers,"*The Chronicle of Higher Education*, August 15, 1997, page A44.
[6] Lewis Perelman,*School's Out*, Avon Books, 1992.

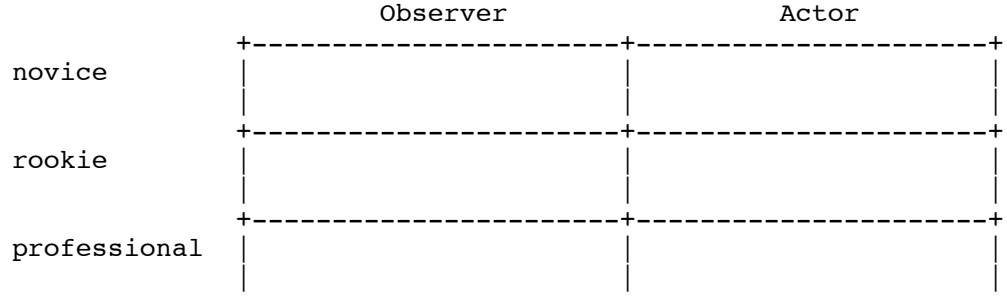
One hallmark of embodied knowledge is that we learn it during involvement with other people -- in their practices, stories, and narratives. We also learn many intangible but important things from our groups and communities, including virtuous behavior, oratory skills, leadership, management, and more. We learned typing in a group guided by a typing teacher who told stories about typists, and we were tested in job interviews by real people counting words per minute and errors per page.

Embodied knowledge is not limited to individuals. Groups and organizations have it. It is observable in their cultures, narratives, practices, routines, traditions, and conventional wisdom. It sometimes is called "organizational core competence". Some organizations get very good at certain things that others cannot seem to master at all. A looming challenge for education is to help organizations embody the core knowledge they need to carry out their business effectively.

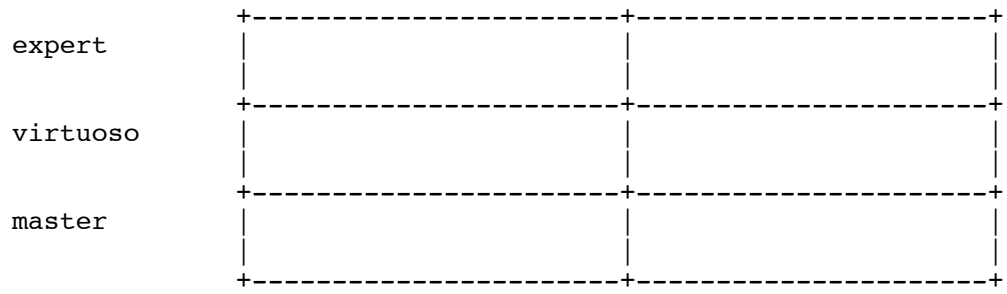
Education, then, is about the embodiment of knowledge. Preserving this principle with education delivered via Internet is a real challenge. As a start, we are going to have to stop thinking of the Internet as an information transfer medium and start thinking of it as a way to sustain learning communities. If I want to be a member of a community of physicians, say, I have to be accepted by them -- how will I do that? In a world of virtual campuses, how will I develop my skills and a professional identity as a competent physician? In other words, how do I appropriate some of the community's embodied knowledge? I don't know the answer to this yet, but I am certain the current set of information technologies is not up to the task. Distance asynchronous learning technologies are no more than baby steps along the path.

Levels of Competence

The 6x2 matrix shown below, inspired by works by Dreyfus[7] and Flores[8], is a useful guide to embodied knowledge. The rows correspond to six levels at which one is capable of acting in a domain; the columns correspond to two kinds of knowledge. It is important to note these twelve categories of action and knowledge are domain dependent.



[7] Hubert Dreyfus,*What Machines Still Can't Do*, MIT Press, 1992.
[8] Charles Spinoza, Fernando Flores, and Hubert Dreyfus, *Disclosing New Worlds*, MIT Press, 1997.



The two kinds of knowledge designated by the columns are:

- An **observer** has informational knowledge --- the person has read certain works in the domain, has watched activities, can carry on an intelligent conversation, and can make appropriate distinctions, assessments, and criticisms about that domain. (The "menu" in Perelman's analogy.)

- An **actor** has practical, actionable knowledge --- the person embodies skills and practices enabling effective action. (The "digested dinner" in Perelman's analogy.)

In reality, these distinctions can be blurred because the same person can be both an actor and observer; and because some acts occur in speech, using the same language as for description.

A person need not be simultaneously a good observer and actor. Some people are competent actors but not good observers, and some are competent observers but not good actors. The distinction is roughly between "knowing about" and "knowing how", between a sports journalist and a ball player. At the higher competence levels, the distinctions between observers and actors blur: it is very hard to imagine a master who is not both a skilled observer and a skilled actor. (One can further refine the number of categories of knowledge, e.g., with the Bloom levels, but that is not useful in this discussion.) The six levels of competence are:

- The **novice** knows that there is a domain with basic rules of action and strategy. All action appears to be governed by rules. Even common situations are unfamiliar.

- The **rookie** (advanced beginner) recognizes common situations. Most action is deliberate application of rules or conscious recall of prior actions in the familiar situations. Without help from a supervisor in new situations, this person is likely to produce breakdowns.

- The **professional** is able to carry out standard actions without causing breakdowns. This person can make standard promises to a client and fulfill them to the client's satisfaction. This person

performs most standard actions without conscious application of rules. When faced with a new situation, this person is able to work out appropriate actions by application of rules.

- The **expert** can deal with complex situations effortlessly. This person seldom thinks in terms of rules and may have some difficulty telling others what rules he works with. This person's performance is admired by others and sets new standards of performance for others.

- The **virtuoso** gives consistently inspiring and excellent performances. All those with whom the virtuoso works and collaborates perform at higher levels of excellence than they would otherwise.

- The **master** has developed the capacity for long range strategic thinking and action. The master sees historical drifts and shifting clearings. The master has produced innovations in the standard practices of others, has altered the course of history, and knows how to do this again.

Each level represents a community standard. The competent person is not competent because he says so, but because others who are already competent members of the community judge him to be so. Community standards shift and evolve. This is why it is vitally important for us as educators to stay in touch with the communities of people who practice what we teach.

The six levels can represent an individual's career path. Having attained a given level, a person can move to the next higher level by getting guidance from teachers and mentors at that level or higher.

An exciting challenge is to create a map of the learning levels of organizations, and to plan programs that would help organizations move among those levels. This question is very much on the mind of people in management schools.

Planning Professional Education

The learning-levels map can be a powerful tool for planning and designing professional education programs in selected domains. It can be used as a framework for market surveys and other input. A three-step process would be involved.

The first step would be to specialize the map into a domain. Working with potential customers, decide which domains are in greatest demand among professionals. Working with experts from the domain, characterize each level of competence with criteria by which people in the domain decide that a person is performing at that level.

The second step would be to select entries in the matrix in which programs will be created. Teams of faculty and industry experts design the programs. The

designers would (1) specify the entry requirements into the program and how to test whether prospective registrants meet those requirements; (2) specify the curriculum of the program; and (3) specify the manner in which the student would be certified as having attained the level of skill promised by the program. All programs would be marketed with specific promises about actions the certified graduates will be capable of. Sequences of programs leading toward higher levels of competence can be designed.

The third step would be to design series of programs that would lead a person to higher levels of competence over time --- e.g., programs to turn a professional software engineer into an expert software engineer, or an expert into a virtuoso. This would take us into virgin territory educationally. For example, by the standards of the engineering field, our baccaleaurates are rookies and our masters graduates are entry-level professionals. No accredited university offers programs designed to produce experts, virtuosos, or masters in engineering. With help from professional people of such accomplishment, we could design and offer such programs.

Design of Professional Programs

The standard classroom campus is not the best venue for professional programs. The classroom structure, in which everyone follows a fixed path over a fixed time, produces a variable outcome according to how much one achieved --- not a sure path to community-standard competence. The learning environment must instead allow variable paths and variable times while it leads students to the fixed outcome of certified competence. This is the environment Perelman calls hyperlearning. Hyperlearning is what happens on the job in an intellectually stimulating environment. The processes constituting it can be described precisely and supported or simulated with technology.

Hyperlearning is a generalization of linear classroom learning. In the classroom, the syllabus is partitioned neatly into units corresponding to the weekly lecture periods. Students progress in lockstep through the units, one per week. Midterm and final exams measure how much the student learned, signified by grades A, B, C, D, or F. The hyperlearning environment removes most of the constraints: the units become modules, modules can be any digital objects, the connections can be arbitrary links, lectures can be replaced by recordings, and the outcome is assessed as a "yes-no" answer to whether the student demonstrates competence that meets the community standard. Each student may follow a different path in this space, with different amounts of time, different modules visited, and different orders. The case of maximum deviation from the linear classroom, one not all that unlikely, works *backwards* from the outcome: the student immediately tries the final certification, backtracks to modules identified as weak points, and retries the certification, repeating until complete. Such a structure is difficult to implement with classrooms but easy in the Web.

Hyperlearning is more than a Web structure: it is a business model. It responds to people who want to learn what they need as and when they need it --- they want a particular dinner brought to them when they are hungry and do not wish

to bother with a restaurant. Domino's Pizza is like this. Even as Domino's took business away from traditional pizza restaurants, hyperlearning will take business away from traditional schools. Since hyperlearning can accommodate both on-demand learning and organized cohort learning, it will operate more like a restaurant with a pizza delivery service.

What does this say about the planning and execution of professional education programs? (1) Providers must begin with market assessments to determine what kinds and subjects of learning are in demand. (2) Programs in demand must be developed and deployed rapidly. (3) Programs must be organized with a modular structure that allows students to trace their own, individual paths through the learning space. (4) Self-assessment must be ubiquitous so that students can find out how they are doing, and as important, what they can and cannot skip over. (5) Coaching must be available on demand (perhaps at extra cost). (6) An authoritative certificate must be issued to those who demonstrate community standards of action.

An Approach to Professional Software Engineering Education

Let us now translate these principles into the design of a software engineering professional certificate program. Software engineers are the people who help design reliable, dependable, cost-effective software systems to support their customers' application domains. A certificate is a declaration that a person is competent as an actor at a given level in the domain. The process leading to a certificate requires that we:

(1) Carefully and explicitly define the community standards and criteria for judging whether a person meets them (this can be done only by working closely with members of that community to develop the criteria);

(2) Organize a curriculum that brings students to the point where they can meet the standards;

(3) Require each student to demonstrate with appropriate actions that they meet the standards; and

(4) Design administrative and business structures that enable these programs to flourish and stand on their own financially.

Certificates are an essential element of professional education programs. They are the focal points signifying the value generated by the programs. These programs must make concrete, valuable promises; they must contain certification methods that guarantee that certificate holders can actually do the actions promised. They must evolve with changing community standards.

The Role of Credit

A course is listed as "for-credit" if it counts toward a formal degree. Credit is usually counted in credit-hours, which is the number of classroom hours per

week. Accreditation criteria are often formulated in terms of the number of credit hours in various subjects that students must accumulate. Concerned about the relationship of certificate programs to for-credit programs, faculty are inclined either to build certificate programs as packages of for-credit courses, or to declare transfer equivalences should a student wish to apply a certificate toward a formal degree.

It may not be worth a lot of trouble to define how certificate programs receive degree credit. Industry people tell us repeatedly that "credit" will become less important than meaningful university certification of competence. In their view, packages of for-credit courses will not deliver competence, and a diminishing number of students will want to apply their certificates toward advanced degrees. Although most professional education programs will be aimed at people holding bachelors degrees, similar programs may eventually be offered at the undergraduate level as the dividing line between undergraduate and graduate fades to a continuum. (It will fade because more adults are seeking undergraduate degrees, either as completion of prior college work or as transition into a new field.)

Standards for Certification

The first step in the design of a certificate program in software engineering is to decide on the standards for certification. This should be done in cooperation with industry groups and professional societies, who are already busy studying standards for software engineering competence. Until these groups promulgate standards, the best I can do here is give examples. Listed below are examples of entry and exit standards for a software engineering program promising professional competence. The objective of the program is to transform software engineering rookies into professional-level software engineers. The software engineering rookie must already have demonstrated the following:

- Write programs consisting of up to 100 modules and objects and demonstrate to others that they meet their specifications.
- Use common packages for word processing, database, windows, networking, spreadsheet, and graphics.
- Use a procedural language, an object-oriented language, and a data-base query language effectively.
- Is familiar with structured design methods and CASE tools for constructing software systems.
- Select and use the most efficient data structures for the application at hand.
- Speak knowledgeably and critically about the literature, history, methods, and practices of software engineering.
- Served on at least one software development team that delivered a system to a customer; the system should have consisted of components some of which were off-the-shelf and others were designed by the team.

And here are examples of the standards to be met by certificate holders:

- They will expand the set of languages with which they are facile to include logic languages, rule-based systems, and functional languages.
- They will integrate off-the-shelf components and configure distributed systems.
- They will do software testing.
- They will produce clear documentation and understandable specifications of their systems.
- They will use revision control systems to manage the development of large software systems involving thousands of modules and objects and several programmers.
- They will know how to locate code segments in large software systems that need to be modified to produce a desired change of system behavior.
- This will have performed safety, security, and risk analyses of large software systems.
- They will be able to translate client requirements into precise system specifications and interact with clients with prototypes to help determine if the requirements were complete.
- They will complete a major project in which they design, build, and test a large software system to the satisfaction of an outside customer. The system will be of sufficient scope to demand the use of the above tools and methods and to require the demonstration of resourceful integration of basic system components.

Curriculum

The second step in the process is to organize a curriculm that will deliver the promises. The curriculum will consist of modules, each corresponding to about four days' work, culminating in a practicum module that would span about three months of one day's work a week. The modules would be designed to work well within the Internet and Web, although this does not mean the elimination of in-person sessions.

Here is a model that builds a synergistic combination of academic and commercial education. The overall certificate program consists of three parts:

(1) **Science of Software Systems.** A set of 6 modules covering the academic side of software engineering: the big picture of the field, its history and development, principles, processes, methods, theories, models, and abstractions. Those who complete these modules receive a software science certificate. (Note to be confused with M. Halstead's "software science" of the 1970s.)

(2) **Software Technology.** A set of 4-6 modules covering the hands-on technology side of software engineering: detailed hands-on training in specific systems and CASE tools commonly used by professional software engineers. Those who complete all these modules receive a technician certificate.

(3) **Software Engineering Practicum.** A three-month period in which a team of students constructs a large, sophisticated software system that meets the requirements set by an industry customer. To qualify for this module, students must hold both the software science and software technology certificates. The module culminates in the demonstration and public exhibition of the project and the individual skills of the participants. Those who pass the demonstration receive the professional software engineer certificate.

The software technology part can be out-sourced to a commercial training company. (They are already legion and their numbers are growing.) The practicum can be designed jointly with industry partners and representatives of the companies who supply the hands-on training. The module schedules can be coordinated so that homeworks in the academic modules can employ tools students have already learned in the technology modules.

Demonstration

The third step is to provide a method for students to demonstrate their capacity to act competently. The method is embodied in the practicum module. The module is organized around a carefully monitored project in which students are thrown into action and the expert judges can watch to see how much knowledge they have embodied. This is one of the reasons that a team project with industry customer is so valuable. The customer and team members will provoke many breakdowns (e.g., constraints, deadlines, deliverables) to which the immediate response is going to be the student's embodied knowledge. Whatever method is chosen for the demonstration will have to be validated: do the community experts agree that a person who passes the demonstration really does have the promised competences?

Support Structures

The fourth step is to establish university structures that will support the curriculum The model established at GMU is outlined in the Appendix. The essence of the model is that it recognizes that: (1) There won't be enough regular faculty to meet the demand; the university must support teams of module maintainers, presenters, and coaches, led by a faculty course director. (2) These programs must be financially self-supporting and include financial incentives for the various players. (3) Most of the revenue surplus should be plowed back into support of ongoing program development and maintenance, including beta-testing of proposed curricula. (4) It must be possible to field a new program within six months, rather than the usual two-year academic cycle for new degree programs.

The structures operate at four levels. From lowest to highest they are:

(1) **The infrastructure level:** the technologies of desktop delivery including video service, hypertext services, collaboration support, administrative support, self-assessment, and testing. These technologies are components of a so-called distance education delivery system. The term "distance education" is often despised because the central distinctions of education have little to do with distance and much to do with learning, communication, and coordination practices. These technologies are components of a hyperlearning environment and will be used long after the term "distance" loses its meaning in this context.

(2) **The modules level:** modules on particular topics, that can stand alone educationally or be building blocks of programs.

(3) **The program level:** certificate programs such as professional software engineer, together with internal administrative processes for operating and maintaining them.

(4) **The Virtual Community level:** offers rich communication services for members to share information about professional education opportunities and select the best courses for them; it is complemented by internal administrative, management, and technology infrastructures that operate programs, keep them up to date, and deploy new ones rapidly. This level will arise from the need to stay in constant communication with our clientele. The virtual community business model[9] illustrates a way this can be done. The university establishes a "virtual college" of professional education and registers persons interested either in enrolling, or in monitoring developments in their fields. Members will form into interest groups and share information about courses and programs available to them. Job brokers will help members find paths facilitated by educational programs to jobs available in companies. Course brokers will help members find the best offerings from public and private providers, according to their individual needs and to "consumer information" they have learned from other members of the community. Educational service providers, both public and private, will be able to set up shop. Individual members will be notified of interesting upcoming educational events and opportunities.

Open Questions

A number of questions remain open:

- How to recognize the work faculty in professional education, so it could count toward promotion, tenure, and raises in the same way that other forms of faculty work now do.
- How to integrate professional education programs into the work of every academic unit.

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[9] John Hagel and Arthur Armstrong. *Net Gain: Expanding Markets Through Virtual Communities.* Harvard Business School Press. 1997.

- How to accommodate a potentially large number of part-time faculty who will teach modules of professional education programs.
- Details of the administrative support required in schools, departments, and the university. These include marketing, course management, types of personnel needed to staff courses, laboratories, teaching assistants, and system administrators. They also include faculty development (teaching the faculty how to do professional education programs) and preparation time for new programs.
- How to establish means of listening to the markets and answering the question, "What can the university do to help you accomplish your professional and business goals?"

When Degrees Become Obsolete

Because ongoing education is a lifelong concern of most professional people, high-quality certificate programs will always be in demand. Professional people will portray their professional identities with a portfolio of accomplishments that goes well beyond a traditional resume. They will have authoritative certificates testifying to their skills and knowledge in all areas of importance to them. Their certificates will collectively demonstrate what they know and can do. Over time, the Bachelors and Masters degrees will just be two of many certificates. So powerful is the notion of an evolving, lifelong portfolio of certificates that the Bachelors and Masters degrees may well become obsolete within another generation.

In the short term, professional certificates will be for those already holding bachelor's degrees. As a university builds its professional education programs, it will begin to offer certificates at the undergraduate level, partly because these certificates will be useful to establish the competence levels of undergraduates and partly because they will be professionally valuable to students seeking part-time employment. Eventually, Masters degrees (and perhaps some Bachelors degrees) may be defined as a set of certificates. Once that happens, those degrees may become obsolete, being replaced by the more flexible format of certificate portfolios. Certificates will become the "coin of the realm".

The university will not be the only purveyor of certificates. Prospective students are likely to find a bewildering array of certificate offers and will seek help in maintaining a sense of the "big picture" in a landscape littered with intense specializations. The university can provide such a larger perspective. It should emphasize that it does so in its advertising.

Undergraduate certificates might correspond to pieces of our current Bachelors curricula. Most would require a year or less work to achieve. There is value in eventually extending certificates to the undergraduate level. Students would start to build their portfolios of certificates early, positioning themselves for certain kinds of jobs and careers. This would encourage undergraduate students

to acquire the habit of continuing learning. These people would be constant customers of our ongoing programs for years after formal graduation.

Conclusions

We have emphasized professional certificates, which are not offered on most campuses and would be valued highly by business, government, and individuals. A full range of professional education services would include:

- Certificates in various critical fields, appealing mainly to working professional employees. Certificate programs can be designed for credit toward formal degrees or for non-credit.
- Certificates attesting to high levels of professional expertise for IT managers, senior engineers, senior designers, and executives.
- Modules that can be stand-alone short courses or components of certificate programs.
- Professional seminars, possibly incorporated as elements of certificate programs; may partner with regional short-course firms.
- Virtual community support services.

A rich set of delivery strategies is needed. Employees will not have to come to class in the traditional way as often as before, they will be able to get all materials on line, they will be able to traverse course modules via non-linear and hyperlinked paths, they will be able to skip material they already know, they will be able to participate in instructional sessions on-line or play back the recordings of missed sections, they will be able to collaborate with group members on-line, they will be able to adjust their participation schedules around work constraints, and they will be able to get a certificate of competence at the end. These strategies will exploit the synchronous and asynchronous capabilities of Internet technology. Major redesigns of teaching and learning practice will be needed to accomplish this. The professor will not disappear, but will become more visible and more accessible especially to those most in need of help.

Professional education programs would break new ground by offering certificates declaring that their holders have certain well defined competences, and by allowing new kinds of programs aimed at cultivating experts, virtuosi, and masters. Because certificate portfolios may well become the standard way professionals market themselves, the university should begin now, to break the new ground and to learn how to do these programs well and at reasonable cost.

Professional education programs would define a new mission for the university. The university's mission would no longer end with the graduation of BA, BS, MA, or MS holders within at the rookie and professional levels; instead it would support education throughout a person's career all the way to genuine mastery.

The software engineering example is meant only to suggest how a professional education program might be specified and advertised. It is not meant to suggest

that the professional education programs will all be in software engineering. It is easy to envisage programs in many other disciplines, including humanities. Yes, that's right, humanities. Why might a person want such certificates? Because a person applying for a job in a multinational company that does business in South America will want to demonstrate working knowledge of Latin languages, culture, history, and business practices. A person applying for a job in an engineering firm will to demonstrate knowledge and skills in communications, writing, and speaking.

This document has speculated about a conceptual framework for professional educational programs that certify competence at various defined levels in participating disciplines. The program would be attuned to community needs and would be able to adjust to constantly rising standards of performance. It would adapt to the schedules of people who work part time and want to continue developing new skills and new knowledge indefinitely. The new program offers the opportunity to create novel faculty compensation packages and to guarantee that a portion of the revenue can be channeled to faculty, departments, and schools.

APPENDIX: Example at George Mason University

The university evaluated four basic strategies for organizing itself to realize its objectives with professional, continuing, and distance education:

(1) Take no special action, doing the best we can within current structures and budget restrictions.

(2) Spin off a separate corporation in which we hold a majority interest.

(3) Establish a separate internal school for continuing professional education.

(4) Distribute the management responsibility for professional education throughout the schools by designating a faculty member as course director for each program.

The first three options would be attractive if GMU had low interest in professional education and the university's executives needed a way to get started. But there is considerable interest in professional education throughout GMU, making the fourth option our choice. To support this model, we made these organizational changes:

(1) **Provost.** The provost's office of continuing professional education coordinates the efforts at establishing professional education offerings throughout the university. It creates standard policies, it promotes interaction with industry in the design of courses and setting of priorities for development, and it seeds the development of new programs through a system of loans.

(2) **Consortium.** The Mason Professional Education Consortium (MPEC) serves as GMU's partner in bringing professional education and training to

company sites. MPEC supports the university in setting priorities, giving advice and direction, helping to develop, establishing industry-approved standards for certification, and sponsoring a virtual community for professional education.

(3) **Internal Accounting.** We modified internal accounting systems to accommodate the flows of money involved with PE programs. Fees collected for credit courses flow into accounts associated with student enrollments. Fees collected for non-credit courses flow into other accounts. Surplus funds remain available as carryover from one fiscal year into the next.

(4) **Marketing.** GMU is establishing a new approach to marketing that emphasizes the on-going relationship between GMU and its customers.

(5) **Faculty Acceptance.** The Provost and other officers are working closely with deans and program directors to win acceptance by the faculty for professional education as a recognized part of academic mission and workload.

Progam Requirements

The general principles above translate into these implementation guidelines:

(1) Professional education programs offer on-line pre-testing, self-assessment testing, and post-testing so that students can select only the programs they genuinely need, can determine if they are qualified for a program, can assess their progress within a program, and can demonstrate that they meet the certification standards at the end. Entry requirements for a program must be carefully defined in terms of one of more of
   -- prior professional practice
   -- experience
   -- other demonstrations of competence (e.g., certificates)
   -- conventional academic testing

(2) Professional education programs are largely self-contained, with few prerequisites.

(3) Professional education programs promise competences according to industry-approved standards. They award certificates only to students who successfully complete a thorough evaluation and demonstration of their skills.

(4) Professional education certificates have formal standing. Where appropriate, they will count as credit toward degrees.

(5) Professional education programs offer a guarantee that GMU will work with the student for as long as it takes for the student to achieve the competence and earn the certificate; and that any student can get personal help when and as needed.

(6) Professional education programs are designed so that the home or the workplace, not the campus, is the primary medium of delivery; digital technology, the Web, the Internet, and virtual communities will be the principal media. In-person group meetings will be limited and will address topics, exercises, and practices that can only be done in groups or that require hands-on training.

(7) Professional education programs are designed by "working backwards" from workplace and employer needs; students will have the latitude to adjust program pace to their work schedules. The programs have significant portions that can be adapted by individual students to meet their personal and company needs.

(8) Professional education programs may eventually offer certificates at competence levels such as expert, virtuoso, and master associated with high levels of professional skill and achievement. At the lowest level, most of the learning can be accomplished by the individual student using Internet access. At the higher levels, much of the learning will be accomplished in group and collaborative settings.

(9) A certificate program is offered as a set of modules, each the equivalent of a day's work, culminating in a practicum, equivalent to a day's work a week for three months.

(10) Three levels of access can be associated with a program:
-- browsing (no fee; can see some of the content and the self-assessment tests)
-- enrolled (there is a fee; students get coaching and mentoring; "we stick with you until done" guarantee applies)
-- certification (an additional fee; for access to the certification modules only)

(11) Modules should be "delivered" by a combination of
-- real-time "chats" with the instructor over the Internet; aiming at "desktop" delivery rather than TV studio or classroom
-- homeworks sent and returned electronically
-- students accessing on-line media and services
-- students cooperating in working groups
-- workshops as appropriate

Pricing will be a big issue. Industry people are reluctant to pay more than the regular tuition for programs that look like credit-hour granting academic courses. People generally have an expectation that Internet-based courses should be cheaper. Program designers will have to chose their niches carefully. Does a program provide a lot of service and aim for a higher priced market? Or very little, bare-bones service, cheap? Most graduate level courses cost more to produce than the tuition takes in. GMU is exploring ways to have most of the labor done by part-time people at lower wages and reserve the most experienced faculty for overall design and management responsibility.

Financial Structures

Financial models tell us how to generate revenue, what expenses we have, how to compensate people involved, and how to distribute excess revenues among the participants.

We found that most faculty tend tend to think of compensation in terms of a "build down" model --- a professor's time is assumed to begin with a four-course teaching load and is then "bought out" for various activities such as research and service. This model may be appropriate when passing state laws but it is not useful for running a business. We find it much easier to think in terms of a "build-up" model displaying all assignments of a faculty member are listed and accounting for 100% of the professor's time. Here is an example of a build-up matrix of a professor's contract.

Activity	Fall Semester	Spring Semester
Teaching	25% Course A (State funds)	25% Course C (State funds) 8.3% Module E (State funds) 8.3% Module F (sponsored) 8.3% Module G (sponsored)
Research	50% (sponsored)	25% (sponsored)
Service	20% internal (State funds) 5% external (sponsored)	15% internal (State funds) 10% journal editor (sponsored)
Consulting and Extra Tasks	+3.8% Module H (sponsored)	

This example illustrates how a professor's time might be allocated among various tasks and how it is paid for. In the fall, this person teaches 1 three-credit course, works half-time for a research grant, works quarter time on department-approved service, and as an extra task teaches a one-credit-hour equivalent professional education module (for which an external contract pays up to 3.8% extra compensation, replacing external consulting).

In the spring, this professor teaches 1 three-credit course and 3 modules; one of the modules is for-credit and sponsored through Ledger 1, while the other two are non-credit and sponsored by an external contract. This person works quarter time on research, has an outside grant to support editorial service, works 15% time on other service, and receives no extra compensation through the university.

This chart shows that professional education courses can be part of a faculty member's regular teaching load or an extra task (or both). When a professional education module is an externally-sponsored extra task done in lieu of consulting, the faculty member can receive extra compensation for the task.

How does an individual department or school integrate professional education programs into its portfolio of offerings? The essence of the model is that each professional education offering is managed by a faculty member designated as

course director. The course director has full responsibility and accountability for the quality, content, operation, and staffing of the program. This model pushes management responsibility down to the lowest possible level.

(1) Each time a professional education module is offered, it has a budget showing its revenues, expenses, and payments to each party involved. To minimize the risk of loss, the budget sets a minimum enrollment and structures compensation to be a base plus an increment for each student enrolled above the minimum.

(2) A university overhead is charged on all expenses.

(3) Schools and departments are likely to hire additional people to staff PE courses, some full-time. Deans and Directors will have to enter into clear understandings with these people about the terms and durations of their appointments, which will be subject to availability of funds.

(4) Course directors will generally use administrative services for marketing, enrollment, registration, course technical support, and other support services. Some may be internal to GMU, others external. These services will be shown as line items in the module's expense budget.

(5) One faculty member can assume more than one of the roles. For example, the Course Director can also maintain and present some of the modules.

(6) Maintainers should present at least once a year to ensure they are in close contact with students and that the materials are current.

(7) As a quality incentive, a presenter's compensation can be structured into a guaranteed part and a bonus part. The bonus part would be paid only if the student ratings of the course were sufficiently high.

(8) Course Directors will generally need support for their work to develop modules and supporting technologies. Support can come in several forms, such as a designed course development task or a technical assist. Schools and LAUs should be the primary sources of such support. The Provost's OCPE can help with seed money in the form of loans that should be repaid from course revenues.

(9) Excess revenue is defined as the difference between actual revenue and actual expenses. Excess revenue will be apportioned equally between provost and dean until any seed loans are repaid, and thereafter 75% will go to the dean. Deans are strongly encouraged to distribute portions of their shares back to the participating departments.

Role	Responsibilities	Compensation
Office of Provost (Continuing Professional Education)	Infrastructure development, marketing, market assessments of proposals, enrollment, tracking, contract administration, seed funding, and university policy.	Receives 50% of excess revenue until loans repaid, then 25%
Dean's or Director's Office	School seed funding, school infrastructure, coordination among departments and programs, school policy.	Receives 50% of excess revenue until loans repaid, then 75%; allocate at least half to department
Department or LAU	Main sponsor of a program, often in cooperation with other departments.	Receive half of Dean's share of excess revenues
Course Director	Faculty member bearing final responsibility for the content, conduct, and delivery of professional course, which may consist of one or more modules. Selects and manages maintainers and presenters.	Receives 1/12 AY salary from course budget for each one-year certificate program directed
Module Maintainer	A full or adjunct faculty member who, in cooperation with the course director, designs a module's content and processes, and keeps them up to date.	Receives royalty payment according to number of students enrolled
Presenter	A qualified instructor who teaches a module and manages its group of enrolled students.	Receives consulting fees