

TO : Professor Z.G. Gong. Head of DCIS - FST  
FROM : Kam H. Vat, Department of CIS – FST  
SUBJECT : Feedback after Meeting - GE-Driven Revised Program Proposal in DCIS  
DATE : January 20, 2010  
CC : Professor C.L. Philip Chen, Dean of FST; Professor E.H. Wu, Associate Dean of FST

Thanks for holding the 2010JAN19-departmental meeting, requesting for feedback and suggestions for the DCIS Revised Program Proposal in the occasion of our University's introduction of General Education (GE) program in the year 2011. On reflecting on the responses from our colleagues concerning the various changes rendered in the context of our Revised Program Proposal, I have organized my thinking and feedback for your reference as follows:

*Concerning the Change of Program Name:*

1. It is my observation that we are yet to establish justifiable rationales to switch our program name from the existing Software Engineering to the proposed Computer Science. It is understood that our original program in Software Engineering had been created in 1989 as if it looked very much like a Computer Science curriculum. Yet, it is our responsibility to continually adapt this program according to the needs of our society and those of our students, even though we have not done much in this important area in the past.
2. If, after some careful study, there is a justifiable need to set up another program in Computer Science, besides the existing Software Engineering program, we should do our best to make it a rigorous and competitive one, according to the guidelines of some world-famous bodies, such as IEEE/ACM's Computing Curricula 2001/2005/2009. It is a very healthy sign of growth and maturity in our department to resort to such international guidance.
3. It is not a legitimate reason to seemingly fix the deficiencies in our current program by simply changing its name to Computer Science, in an attempt to accommodate the explicit lack of thoughtfulness and lack of consistency in the current program. The expertise composition of our faculty is a concern; yet, it is not a sufficient reason to kill an existing program to solve this perceived problem by simply changing the program name. That is not the way it is supposed to be if we are committed to provide a quality college computing curriculum for student learning. I believe that it is too drastic to drop the original Software Engineering program name and to embrace the Computer Science program name; the revised program proposed is indeed not much different from the old one. Before we could proceed to propose any such important change, there ought to have some strategic planning, well collaborated among faculty, and specific action research performed indicating an explicit need from the society, and with some good enough revised scheme of student learning to support the proposal. The current proposal does not even have a section to explain the rationales of the changes made to support its claims (yet to be elaborated).
4. Moreover, there is no curriculum design philosophy of the revised program, elaborated for our University Authorities' understanding; no reasons explained for what changes have been made. Instead, it is found that the revised proposal has reversed the sequences of some core and supporting courses, making some of the compulsory pre-requisite courses electives, and other elective courses in the original plan compulsory, dismantling

the original pre-requisite structure, as exemplified by the courses in Compiler Construction, automata and programming languages. More undesirably, the extreme heavy study load of the original program has simply been transplanted into the revised program of study. Are we to coerce our students to continue their cramming study of 8-to-9 courses per semester again? What is the point of the curriculum design? What program educational objectives and course learning objectives are supposed to be? What are the principal methods of assessing student learning? Where have those important information items to support the program revision effort gone?

5. The GE-driven process of program revision in our Software Engineering undergraduate program has given us faculty the opportunity to reflect on what we have been doing to empower student learning in the field of Software Engineering. It is really important for us to examine how best we could tailor the most compatible “Computing Curricula” in undergraduate education nourished by the GE elements, and administered by the Department of Computer and Information Science.
6. If it is insisted, without much explicit collaborative efforts from the faculty in the making of the revised proposal, that our program name be changed to Computer Science, it is highly recommended that the original Software Engineering program should not be drastically eliminated. Instead, we could vision the development of our DCIS in such a way that our program is well designed to cater to the needs of prospective students, by offering a 4-year degree program in Computing, leading to a *Bachelor of Science in Computing* degree, with *specialization* in such options as a) Software Engineering, b) Computer Science, c) Information Science, and perhaps, a bit later, d) Information Technology, e) Information Systems, and even f) Computer Engineering. With the subsequent growth of our University in the new campus, it is not too much to dream this dream for the best possible higher education in computing for students in Macau. I sincerely hope that when my kids reach their age to attend college, our University, and our DCIS, in particular, is mature enough to entertain their needs. Currently, we could hardly convince our bright local students that we have the best possible programs for their computing study in DCIS, because we simply have not reached the required standards and their expectations. If we are not true to ourselves in terms of our strengths, weaknesses, opportunities, and possibilities (challenges), we could hardly have the continuous support of our local community, let alone the University Authorities.

*Concerning the accreditation of our Program:*

1. In order to accomplish the goal of accreditation, I believe a sincere and genuine ongoing attempt to review the curricular details of our CIS program is indispensable. This must also be done collaboratively among our faculty. We cannot afford to renovate only the façade of our program, naively believing that everything is good enough. Currently, our undergraduate program, leading to the degree of Bachelor of Science in Software Engineering, is not in par with the substances expected in a Software Engineering curriculum as recommended by the SE2004 guideline (<http://sites.computer.org/ccse/>). Instead, although it looks much like a Computer Science (CS) curriculum, it is largely short of a unifying philosophy hooking up modern CS elements as recommended by the CS2008 Curriculum Update (<http://www.acm.org/education/curricula-recommendations>). It is especially weak in the context of evidence-based assessment in student learning, a critical element in the accreditation requirement from such international body as ABET (Accreditation Board for Engineering and Technology).

2. I sincerely hope that accreditation of our program is not regarded as a make-believe trivial process which is important as far as the goal is yet to be reached. Surely, an engineering instructor's life was simpler in the old days, especially before 1990 in the US. All they have to do was lecture on the topics in the syllabus, give the assignments and tests, and assign grades. If the syllabus was covered, the course was considered successful, regardless of whether or not students learned anything. Conversations in the faculty lounge were about research budgets and words like "learning outcomes," and "Bloom's taxonomy" never entered the picture. And the term "assessment" was hardly heard, too. Skills such as critical thinking, creative problem solving, interpersonal skills and entrepreneurship, were hardly taught nor assessed nor valued in engineering curricula. Indeed, people in industry have been complaining about those deficiencies in engineering graduates for long, but it is only not long ago that growing numbers of engineering school administrators and faculty members around the world, especially, in the US and Europe, initiated curriculum reforms designed to equip students with a broad array of new skills. In the US, NSF's move to pour serious money into promoting those reforms in the 1990s, has been followed by ABET's dramatic switch (to the surprises of many) to an outcomes-based program evaluation and accreditation system, starting in 1996, and finalizing as a universal move in 2001. Namely, if we are to receive accreditation from ABET, we should better get started with outcomes-based learning, teaching, and assessment practices as soon as possible. It surely takes us from four to eight years time, as a conservative estimate, before any concrete evidences in student learning could be built up ready for external evaluation, given the current fuzzy state of our program.
3. Under the new ABET accreditation rules of game, a program was no longer evaluated based on what the faculty was teaching – how many credits of engineering XXX – but rather on what the students were learning. Engineering programs now had to define in concrete terms the knowledge, skills, and values they wanted their graduates to have and then prove that the graduates in fact were getting them. To get the proof, the program instructors had to come up with ways to measure those attributes – which is to say, they now had to get used to the business of assessing learning outcomes. Most of us on engineering faculties were uncomfortable with this situation. Some of the ILOs (intended learning outcomes) were familiar, such as mathematical problem solving ability, skills in computer applications, and they believed they knew how to teach and assess them. Other ILOs were problematic, since they included such attributes as awareness of professional and ethical responsibilities, communication skills, ability to work in multi-disciplinary teams, and understanding of global and societal impact of engineering decisions. Since the 1990s, many engineering professors have invented solutions in efforts to prepare for their next ABET visit, a sort of real-life scenarios to live with. If we are pursuing the path of ABET accreditation, we will definitely have to face similar situation. Fortunately, the GE program to be installed in 2011 at UM should put us in a head-start for such challenge, because the basic framework for our GE development is led by an outcomes-based LTA (learning, teaching, and assessment) process. It is time for us to re-structure each of our CIS courses following the outcomes-based LTA process; it is absolutely not too late, now, perceiving the immediate expansion of our university in three or four years.
4. To put things into perspective, I have listed below the ABET criteria during the 2006-2007 (just comes in handy) accreditation cycle, for institutions seeking accreditation for their engineering programs:

*These criteria are intended to assure quality and to foster the systematic pursuit of improvement in the quality of engineering education that satisfies the needs of*

*constituencies in a dynamic and competitive environment. It is the responsibility of the institution seeking accreditation of an engineering program to demonstrate clearly that the program meets the following criteria:*

#### Criterion 1 – Students

The quality and performance of the students and graduates are important considerations in the evaluation of an engineering program. The institution must evaluate student performance, advise students regarding curricular and career matters, and monitor student's progress to foster their success in achieving program outcomes, thereby enabling them as graduates to attain program objectives.

The institution must have and enforce policies for the acceptance of transfer students and for the validation of courses taken for credit elsewhere. The institution must also have and enforce procedures to assure that all students meet all program requirements.

#### Criterion 2 – Program Educational Objectives

Although institutions may use different terminology, for purposes of Criterion 2, program educational objectives are broad statements that describe the career and professional accomplishments that the program is preparing graduates to achieve. Each engineering program for which an institution seeks accreditation or re-accreditation must have in place:

1. detailed published educational objectives that are consistent with the mission of the institution and these criteria;
2. a process based on the needs of the program's various constituencies in which the objectives are determined and periodically evaluated;
3. an educational program, including a curriculum that prepares students to attain program outcomes and that fosters accomplishments of graduates that are consistent with these objectives;
4. a process of ongoing evaluation of the extent to which these objectives are attained, the result of which shall be used to develop and improve the program outcomes so that graduates are better prepared to attain the objectives.

#### Criterion 3 – Program Outcomes and Assessment

Although institutions may use different terminology, for purposes of Criterion 3, program outcomes are statements that describe what students are expected to know and be able to do by the time of graduation. These relate to the skills, knowledge, and behaviors that students acquire in their matriculation through the program.

Each program must formulate program outcomes that foster attainment of the program objectives articulated in satisfaction of Criterion 2 of these criteria. There must be processes to produce these outcomes and an assessment process, with documented results, that demonstrates that these program outcomes are being measured and indicates the degree to which the outcomes are achieved. There must be evidence that the results of this assessment process are applied to the further development of the program.

Engineering programs must demonstrate that their students attain:

- a) an ability to apply knowledge of mathematics, science, and engineering;
- b) an ability to design and conduct experiments, as well as to analyze and interpret data;
- c) an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability;
- d) an ability to function on multi-disciplinary teams;
- e) an ability to identify, formulate, and solve engineering problems;
- f) an understanding of professional and ethical responsibility;
- g) an ability to communicate effectively;

- h) the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context;
- i) a recognition of the need for, and an ability to engage in, life-long learning;
- j) a knowledge of contemporary issues;
- k) an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

In addition, an engineering program must demonstrate that its students attain any additional outcomes articulated by the program to foster achievement of its education objectives.

#### Criterion 4 – Professional Component

The professional component requirements specify subject areas appropriate to engineering but do not prescribe specific courses. The faculty must ensure that the program curriculum devotes adequate attention and time to each component, consistent with the outcomes and objectives of the program and institution. The professional component must include:

- a) one year of a combination of college level mathematics and basic sciences (some with experimental experience) appropriate to the discipline;
- b) one and one-half years of engineering topics, consisting of engineering sciences and engineering design appropriate to the student's field of study. The engineering sciences have their roots in mathematics and basic sciences but carry knowledge further toward creative application. These studies provide a bridge between mathematics and basic sciences on the one hand and engineering practice on the other. Engineering design is the process of devising a system, component, or process to meet desired needs. It is a decision-making process (often iterative), in which the basic sciences, mathematics, and the engineering sciences are applied to convert resources optimally to meet these stated needs;
- c) a general education component that complements the technical content of the curriculum and is consistent with the program and institution objectives.

Students must be prepared for engineering practice through the curriculum culminating in a major design experience based on the knowledge and skills acquired in earlier course work and incorporating appropriate engineering standards and multiple realistic constraints.

#### Criterion 5 – Faculty

The faculty is the heart of any educational program. The faculty must be of sufficient number; and must have the competencies to cover all of the curricular areas of the program. There must be sufficient faculty to accommodate adequate levels of student-faculty interaction, student advising and counseling, university service activities, professional development, and interactions with industrial and professional practitioners, as well as employers of students.

The program faculty must have appropriate qualifications and must have and demonstrate sufficient authority to ensure the proper guidance of the program and to develop and implement processes for the evaluation, assessment, and continuing improvement of the program, its educational objectives and outcomes. The overall competence of the faculty may be judged by such factors as education, diversity of backgrounds, engineering experience, teaching experience, ability to communicate, enthusiasm for developing more effective programs, level of scholarship, participation in professional societies, and licensure as Professional Engineers.

#### Criterion 6 – Facilities

Classrooms, laboratories, and associated equipment must be adequate to accomplish the program objectives and provide an atmosphere conducive to learning. Appropriate facilities must be available to foster faculty-student interaction and to create a climate that encourages professional development and professional activities. Programs must provide opportunities for students to learn the use of modern engineering tools. Computing and information infrastructures must be in place to support the scholarly activities of the students and faculty and the educational objectives of the program and institution.

### Criterion 7 – Institutional Support and Financial Resources

Institutional support, financial resources, and constructive leadership must be adequate to assure the quality and continuity of the engineering program. Resources must be sufficient to attract, retain, and provide for the continued professional development of a well-qualified faculty. Resources also must be sufficient to acquire, maintain, and operate facilities and equipment appropriate for the engineering program. In addition, support personnel and institutional services must be adequate to meet program needs.

### Criterion 8 – Program Criteria

Each program must satisfy applicable Program Criteria (if any). Program Criteria provide the specificity needed for interpretation of the basic level criteria as applicable to a given discipline. Requirements stipulated in the Program Criteria are limited to the areas of curricular topics and faculty qualifications. If a program, by virtue of its title, becomes subject to two or more sets of Program Criteria; however, overlapping requirements need to be satisfied only once. See the enclosed two pdf-documents downloaded from [www.abet.org](http://www.abet.org), referring to a) Software Engineering program criteria (p.19), and b) Computing program criteria.

### *Concerning the Curriculum Development of our Program:*

For almost two decades, the manner and methods of viewing education in terms of the outcomes of learning rather than the curriculum content or the actions of teachers have become increasingly the state-of-the-practice in higher learning, as exemplified by ABET's adoption of outcomes-based program evaluation and accreditation system. We have to accept that, after all, it is the learning done by learners that is the important result in educational activity. Yet, this outcomes-based work may not be smooth, as my personal experience over the past twelve years on course-based implementation (SFTW241 and SFTW300) has demonstrated, especially in an atmosphere where the concept of outcomes-based assessment has never landed officially (at UM) until recently. On a course delivery level, I have many students' hearts and minds to persuade. On a program implementation level, we have many faculty's hearts and minds to win over for a successful implementation. California State University – Monterey Bay (CSUMB), just slightly over 15 years old, is a good example showing the first fruit of outcomes-based LTA (learning-teaching-assessing) practice. CSUMB started out as an outcomes-based LTA university, but it still takes that long to enjoy its real fruit of student achievement. The key is that assessment matters in college education. Yet, what is assessment?

According to the Middle States Commission on Higher Education in the US (Suskie, 2009), the most straightforward way to understand assessment is to put it into the context of a dynamic learning-teaching-assessment cycle, composed of four steps as follows:

- 1) Develop clearly articulated written statements of intended learning outcomes;
- 2) Design learning experiences that provide intentional, purposeful opportunities for students to achieve those learning outcomes;
- 3) Implement appropriate measures of student achievement of key learning outcomes;
- 4) Use assessment results to improve teaching and learning.

The first step of the cycle is developing clearly articulated written statements of intended learning outcomes. Assessment here is a bit like planning a road trip; we cannot plot a route without knowing the eventual destination. Assessment requires clear statements of exactly what students should know and be able to do as a result of their learning experience. To be of maximum value in the assessment process, learning outcomes statements should fulfill the following:

- Focus on the most important things that students will learn. Often it is less important that students understand key concepts than that they can use their understanding to analyze and solve real-world problems;
- Use action words that describe not what students will know but what they will be able to do as a result of their learning. A statement that students will *explain* or *describe* key concepts is clearer, for example, than a statement that students will *understand* key concepts, and makes an appropriate assessment strategy easier to discern;
- Reflect the outcomes of a course or program – what students will be able to do after they have successfully completed the course or program – not the activities that happen during the course or program. A statement that students will write four lab reports is not a statement of learning outcomes; the learning outcome is what the lab reports are preparing the students to do, perhaps write clear, complete, and accurate summaries of lab research;
- Be developed for entire programs as well as individual courses. A good academic program is more than a collection of isolated courses; it is designed to focus on outcomes that are emphasized repeatedly, in multiple courses, throughout the students' studies.

The second step of the cycle is designing learning experiences that provide intentional, purposeful opportunities for students to achieve those learning outcomes. Students learn what we value when they have plentiful and well-designed opportunities to do so. Suppose, for example, that one of the goals of an academic program is for students to make effective oral presentations on their work. Students will be more likely to achieve this goal if the curriculum is designed to include oral presentation assignments at multiple points in the program. Students will also be more likely to achieve this goal if faculty designs their pedagogies or teaching methods to help students learn how to make effective oral presentations, with carefully designed opportunities for practice and feedback.

The third step of the cycle is implementing appropriate measures of student achievement of key learning outcomes. If the first two steps of the cycle are executed carefully and thoughtfully, namely, as long as the expected learning outcomes are clearly articulated and curricula and pedagogies are carefully designed to help students achieve the outcomes, appropriate assessments should become self-evident.

The final and also most important step of the teaching-learning-assessment cycle is using assessment results to improve teaching and learning. There is not much point in assessing student learning if the results are simply filed away. Assessment results can be used in two directions: If the evidence is that students are indeed learning what we want them to learn, results can be used to garner support and resources for the institution. If the results are disappointing, they can be used to promote the improvement of student learning by launching, as appropriate, modifications to intended learning outcomes, curricula, pedagogies, and/or assessment strategies and tools.

Indeed, the practice of outcomes-based assessment (OBA) is not a new movement, and it is related to an educational model in which curriculum and pedagogy and assessment are all focused on student learning outcomes. It is an educational process that fosters continuous attention to student learning and promotes institutional accountability based on student learning. Operationally, this approach emphasizes such important practices as: Faculty publicly articulating assessment information in advance of instruction; students being able to direct their learning efforts to clear expectations; and students' progress and acquisition of learning being determined by evidence demonstrated in achieving the learning outcomes. So, the key component in the OBA model is outcomes which inform curriculum, teaching and assessment. In this light, it is

convinced that if we are truly embracing a learner-centered model of undergraduate education, outcomes-based assessment is the necessary essence not to be ignored. One of the most important conclusions about the effect of outcomes on student learning comes from the studies of John Biggs (2007). Biggs found that students achieve deep learning when they have outcomes on which to focus. If students do not know what is important to focus on in their studies, they try to cover all the information, so they skim, they cram, and they stay on the surface. If they have a priority or focus, they are able to dig, to expand, and to achieve depth of understanding.

Biggs, J. & Tang, C. (2007). *Teaching for quality learning at university*, 3e. Buckingham, Great Britain: Open University Press.

Suskie, L. (2009). *Assessing student learning: A common sense guide*, 2e. San Francisco, CA: Jossey-Bass.

Finally, it is my conviction that the curriculum (intended learning outcomes) is the heart of a student's college experience. It is a university's primary means of helping students develop in directions valued by its faculty. In today's Macau, we are being urged to assess especially carefully the quality of our curricula. We as faculty are responding to this challenge as a practical means of both attracting and retaining more students and ensuring their success and producing high-quality outcomes for Macau. Thereby, a curriculum should be based on a carefully thought-out philosophy of education and should be clearly connected to our institution's stated mission. Any curricula mission statement and written curricula goals (students' intended learning outcomes or results) should articulate curricula purpose and aims – what graduates should know and be able to do and those attitudes and values our faculty believes are appropriate to well-educated men and women in the specific program of study. These goals and their more specific objectives must be described in considerable detail and in behavioral language that will permit designing the curriculum and assessing its degree of achievement (its actual outcomes).

With that note, please kindly accept, once again, my sincere thanks for the opportunities to share with you my comments and findings in this brief memo after our first meeting in 2010 for faculty feedback in the revised study plan for our DCIS undergraduate degree programs.

All the best!



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