

Report of the UWB STEM Task Force

April 7, 2008

1. The Charge

The UW Bothell Science, Technology, Engineering, & Mathematics (STEM) Task Force was asked to provide the UW Bothell Vice Chancellor for Academic Affairs, Susan Jeffords, with:

- *A short list of initial majors that can be developed at UWB in a phased approach; this list should make the best use of available UWB faculty expertise while also considering student demand and faculty and staff recruiting;*
- *Suggestions for a realistic timeline for the development of new majors and a list of resources needed;*
- *Considerations of the best institutional structure for support of STEM growth at UWB; in particular, is a new program or unit needed to insure effective growth of STEM fields?*

The Task Force has held five 2-hour plenary meetings on the UW Bothell campus. In addition, members of the Task Force participated in a conference call with Dr. Judith Ramaley, President of Winona State University and they worked together in small groups to prepare a series of white papers describing proposed degree program offerings.

This report contains the Task Force's preliminary recommendations. The Task Force's final report will be presented after it has time to consider feedback from the faculty. The recommendations are presented in the main body of the report and more detailed descriptions of each of the new proposed degree program offerings are presented as a series of appendices.

2. A short list of initial majors

In choosing a short list of proposed new majors, priority was given to those that have the potential to significantly increase student enrollment and, at the same time, to build core competencies in STEM-related disciplines on the UW Bothell campus. In narrowing the list, the Task Force favored programs that build on or complement UW Bothell's existing programs and areas of faculty expertise.

The Task Force took it as its responsibility to consider specifically what core competencies (i.e., faculty disciplinary expertise) are needed at UWB, not only for developing these specific recommended majors, but also for creating opportunities for future growth. The proposed majors will require varying degrees of development of new core competencies over and above the existing ones. Each of the proposed majors also has different organizational/institutional implications.

The recommended programs, selected by means of a roundtable discussion interspersed with a series of straw votes, are

1. **Biology/Biological Science** with possible options in Health, Ecology and Conservation, Biology Education, Biotechnology or other high demand subfields. A Bachelor of Science degree in Biology could support students pursuing advanced study in health and medical fields, as well as those wishing to pursue careers in biotechnology, education, or environmental careers. By integrating a Biology program with the hallmark characteristics of a UWB education, we can offer a high quality degree experience, despite our small size.
2. **Mathematics Education and Science Education** Addresses the critical shortage of qualified teachers in the K-12 system. The program will provide students with an undergraduate mathematics degree and a Masters in Teaching, with a Washington State Teaching certification. Separate degree tracks are needed for Mathematics and Science.
3. **Mechanical Engineering (ME) and Electrical Engineering (EE)** Both are among the highest demand STEM degrees in the region, based both on student and employer demand. ME seems to be in higher demand at present than EE, and decisions to limit enrollment at UWS may represent an opening for UWB. On the other hand, presence of in-house expertise greatly reduces the difficulty of planning and implementing an EE degree. In either case, demand is likely large enough to more than fill any realistically sized program at UWB. Both degrees offer the opportunity for interdisciplinarity. Electrical and Mechanical Engineering are fairly diverse degrees, involving a number of subfields, and the exact mix of fields varies from school to school. During the Task Force discussions, Mechanical Engineering was mentioned in the context of sustainability and renewable energy while Electrical Engineering was discussed in the context of Systems Engineering.
4. **Environmental Science and Environmental Studies** Two related but distinct interdisciplinary degrees based in the natural sciences. The BS in Environmental Science is interdisciplinary primarily across the natural sciences, while the BA in Environmental Studies includes substantial elements of the social sciences and humanities as well as natural science. These degrees address identified demand, are consistent with campus mission and widely recognized UWB signature elements, capitalize on existing resources and produce new synergies, and can facilitate development in other STEM areas at UWB.
5. **Physics, Chemistry, Mathematics** Offering traditional math/science degrees would require few, if any additional faculty or laboratory facilities over and above those required to support the degree programs (1) through (4). Having degree programs in these subjects would be helpful in recruiting and retaining STEM faculty.
6. **Sustainable Business** A concentration or option that could be open to students from several majors. It addresses private sector opportunities for reducing environmental impacts (e.g., greenhouse gas emissions), either through eco-efficiency or radical redesign of products and processes. All students would gain common knowledge in environmental literacy, the basic principles of relevant STEM disciplines (e.g., biology, mechanical engineering), and the application of business functions (e.g., operations, marketing, strategy).

In addition, the Task Force learned that there may be opportunities to implement degree programs in Public Health and Sustainable Design, the former in cooperation with the School of Public Health and the latter with College of Architecture on the UW Seattle campus. The Task Force did not have time to evaluate these options.

In considering both new STEM degrees and a deepening of STEM education already in place, it is important to stress the most effective pedagogical practices. There is a large and growing body of evidence that interactive learning works well to retain students, especially when it begins early in their college careers and continues, through higher levels of complexity, into the upper division work. Peer learning, applied research beyond the campus walls, a problem- or inquiry-based focus, community engaged learning, internships, and guests from the professional fields also provide a pedagogical advantage for the students and a signature UWB experience. In addition, it is essential to support the active building of the K-12 pipeline and outreach to women and those underserved by traditional STEM education.

3. Timeline for implementation

It is envisioned that the degree options would be implemented as soon as practically feasible. Biology/Biological Science and the various proposed engineering programs could bring about a large increase in enrollment at UW Bothell, but to realize that potential will require a major investment in new teaching and research laboratory facilities. In combination, degree programs (1) through (4) would provide a broad based portfolio of STEM-related programs on the UW Bothell campus. Concern was expressed that an extended delay in the implementation of the Engineering degrees would leave an important area undeveloped, with CSS isolated from the mainstream of the STEM effort.

The Task Force recommends that core STEM disciplinary competencies such as mathematics, biology, chemistry, physics, engineering, and/or computing be clearly identified and embedded throughout the curriculum. This emphasis is consistent with the core values of the UWB campus and will help further guide strategic planning and development of new curricula. Further refinement of these competencies rests with the STEM faculty as they determine breadth requirements for UWB students. Over time these core competencies could evolve into new STEM majors. A competence-based approach provides a starting point for the creation of a variety of STEM-related pathways ranging from more traditional, discipline-specific specialization (i.e., Mathematics, Physics, and Chemistry) to options for innovative applied or issues-based degrees.

UW Bothell must be strategic about which degree options to develop, and in what order, in decisions on hiring faculty investing in laboratory facilities, etc. A strategy that will both allow the rapid development of high-enrollment majors and create opportunities over the longer term for a full range of STEM majors is to focus on developing core competencies in a relatively small number of fundamental disciplines. For example, further development of a core competence in biology seems obvious, as it would be the basis of offering the proposed major in Biology, which is expected to be a high-demand major, as well as the proposed majors in Environmental Science/Environmental Studies and for students pursuing Pre-Med/Pre-Health pathways. A contrasting example is Physics, in which a core competence may be desirable, but the Task Force is not recommending a Physics major in the short term because it would not be expected to generate high enrollment. Although it might be tempting to conclude that UWB does not need to strengthen its core competence in physics (and therefore could forego hiring faculty, developing labs, etc.), growth in this area is, in fact needed to support recommended majors in both engineering and science education. Over the longer term, the same core competence could provide the basis for a possible major in Physics.

Existing expertise can be the basis of some STEM discipline core competencies. For example, the ability of UWB to rapidly bring up a degree in Biology is supported by the existence of biological science faculty in a variety of current programs (e.g., IAS, Nursing, CSS). Future faculty hires can be thought of as leveraging existing core competencies and/or developing new ones.

E = current expertise that can be leveraged to create core competence

<i>Core Competence</i>	<i>Existing expertise, by program</i>				
	IAS	Nursing	Education	CSS	Business
Mathematics	E		E	E	E
Biology	E	E		E	
Chemistry	E			E	
Physics	E			E	
Electrical Engineering				E	
Mechanical Engineering					

Justification of the hiring of new faculty on the basis of expectations of increased enrollment in STEM-related areas should be based on realistic projections of faculty workloads, taking into account the time required for 1) curriculum development for the new degree programs; 2) coordination with UWS to creating new partnerships and/or complementary program offerings; 3) providing “service course” offerings to the entire campus; 4) adapting the curriculum to the level of preparation of 1st-year and transfer students. Other pedagogical design considerations such as course lab requirements, internships, service learning, seminars, small class size and collaborations with research and community partners will also impact traditional faculty FTE metrics/external expectations. In justifying its metrics, UWB’s distinctive approach to teaching STEM will need to be communicated to its stakeholders. Long-term metrics should also highlight UWB’s ability to increase student interest in STEM-related degrees, especially among underrepresented minorities, to improve science literacy across programs, to address regional/community needs, and to increase enrollment and graduation rates in STEM-related fields in the State of Washington.

Effective support of underrepresented populations will require the blend of academic support and service-faculty partnerships that has been a core feature of UWB throughout its history. UWB should also make particular efforts to recruit faculty from backgrounds that are underrepresented in STEM fields, because the existence of role models is also critical for attracting and supporting EOP students.

We believe that, in order for UWB's STEM initiative to be successful both in the short term and over the long run, the ongoing planning effort that builds on this report must be vigilant in assuring that two principles are always in sight: (a) developing UWB's core competencies in a

wide range of STEM disciplines by building and supporting a critical mass of UWB faculty in these disciplines, and (b) continuing and extending partnerships with community colleges and technical colleges, K-12 schools, and UW Seattle to rapidly build course offerings and to ensure a pipeline of well qualified students. We recognize that these two principles can be seen to be at odds, and we believe that it should be the responsibility of all the groups who work further on this initiative, and UWB leadership, to assure an appropriate balance. Just what this balance should be will need to be defined on a discipline-by-discipline basis by the UWB faculty associated with the curriculum and the responsible campus faculty. For example, UWB's collocation with Cascadia creates both particular legislated responsibilities and singular opportunities both for sharing laboratories and other teaching spaces and for other kinds of collaborations. In some disciplines that unique relationship between UWB and Cascadia might serve to enhance the creation of core competence at both institutions, while in others it might be preferable for UWB to preserve its self sufficiency by declining to "outsource" the creation of core competence.

Just how rapidly to proceed with the implementation of new degree programs will require careful planning on an ongoing basis. An accelerated implementation schedule is likely to have a more immediate effect on enrollment, which could serve to justify requests for additional resources. On the other hand, a more deliberate staging of the new programs would provide more time for building core competence in the STEM-related disciplines, recruiting and advising infrastructure, and facilities such as laboratories. Legislative mandates and opportunities for collaboration with the UW Seattle campus also need to be considered.

4. Institutional and Organizational Structure Considerations

To support growth of STEM-related degree programs and core competencies at UW Bothell requires an institutional and organizational setting that

- supports disciplinary depth: the academic values of the traditional STEM disciplines must be respected and genuinely supported, and faculty in STEM-related programs must have a degree of autonomy in matters relating to curricula, faculty recruitment, tenure and promotion comparable to that of faculty in departments housed in colleges.
- provides the STEM disciplines a "place at the table" in budget discussions with the UWB Chancellor and Vice Chancellor, so that the needs for growth of STEM disciplines are clear and unfiltered in the development of the campus' academic strategies and budgets for the campus.
- serves as an umbrella for multiple department-like entities.

With these criteria in mind, the Task Force recommends consideration of three possible structures for the STEM-related programs:

- **Option 1:** all STEM-related programs are housed, together with Computing and Software Systems (CSS) in a single unit .
- **Option 2:** Biology, Physics, Chemistry, Environmental Science and at least some of Mathematics are housed as units within Interdisciplinary Arts and Sciences (IAS) that have a degree of autonomy in matters relating to curricula, faculty recruitment, tenure and promotion

comparable to that of departments housed in colleges. Engineering and Technology are housed in a new unit that also includes CSS.

- **Option 3:** Two new STEM units are created: one housing Biology, Physics, Chemistry, Environmental Science and at least some of Mathematics and the other housing Engineering and Technology and also including CSS.

In all three options, the new STEM unit(s) would resemble the Schools on the UW-Seattle campus in the sense that it would serve as an umbrella for several department-like entities that would be responsible for curricula, faculty recruitment, tenure and promotion.

In the Task Force discussions of the strengths and weaknesses of these organizational models the following points were raised

Option 1: A single new STEM unit

The various STEM-related degree programs would be consolidated within a single unit but the individual department-like entities within that unit could still have a considerable amount of autonomy.

This option would maximize attention to UWB's STEM initiative, since all disciplines and majors would be in a single unit.

The creation of such a unit would not guarantee the development of a balanced STEM portfolio at UWB unless it is accompanied by a strong commitment for early implementation of degree programs in engineering as well as biology and education.

Option 2: Science and Math in IAS; new unit to include Engineering, Technology and CSS

The main concern is the degree of autonomy of the STEM-related programs that would be allowed in IAS.

One way to ensure autonomy would be for IAS to change from a highly cohesive, democratic unit, in which all faculty members participate in all curriculum, hiring, promotion, tenure and facilities decisions, into more of a School or College-like structure in which the Dean or Director bears the primary responsibility for decisions on behalf of the unit as a whole, and the purview of individual faculty members tends to be limited to matters affecting their respective divisions within the unit. The culture within IAS would need to change so as to place the primary focus on the specific degree tracks, rather than upon interdisciplinarity across the whole of IAS.

The peril of retaining a totally holistic IAS governance structure is that the viability of STEM-related units housed within it would depend on the voluntary support of the entire spectrum of IAS faculty. The Task Force was unable to reach a consensus as to whether STEM disciplines could grow in such an institutional setting.

A delay in the implementation of the Engineering degrees would leave CSS as an isolated department within a virtual to-be-developed-in-the-future school, analogous to the yet-to-be-implemented CSS Masters Program that was agreed upon six years ago.

Option 3: Two new STEM units, one for Science and Math, one for Engineering, Technology and CSS

Option 1 is predicated on the assumption that the STEM unit will function like a College or School. In the event that it proves impossible to establish a department-like structure within units on the UW Bothell campus analogous to schools and colleges on the Seattle campus, then it might be preferable to house STEM in two smaller units rather than a single large one.

Like Option 1, this option would bring attention to UWB's STEM initiative by creating units that are independent of existing programs. The rationale for proposing this alternative is that degree programs might enjoy a greater degree autonomy and higher visibility in budget negotiations if they were placed in separate Science/Math and Engineering/Technology units than if they were placed in a single STEM unit.

Because it involves the establishment of two new units, Option 3 would also have the highest administrative costs for startup. It would not be advisable to create such a unit without the implementation of an engineering program.

To leverage existing core competencies and develop new ones, coordination among disciplines is necessary, no matter which specific structure is chosen and implemented. The Task Force feels that despite the campus' stated mission and goals, UWB has not consistently done as well with cross-disciplinary efforts across programs, or even within programs, as will be needed to support and encourage development of the STEM initiative, particularly activities at the intersection of STEM fields or between STEM fields and non-STEM fields. The Task Force believes that the primary barriers to achieving the necessary coordination are [i] faculty have difficulty finding the time required to be involved in cross-disciplinary, cross-program, and/or cross-department efforts, [ii] individual programs feel that they are under pressure to protect enrollment, and that they therefore have to concentrate on program FTE rather than the campus FTE that could be generated by cross-program coordination, and [iii] the lack of entry points that would enable students from one program to take courses in another program.

Even with improved coordination, organization in fact does matter. Regardless of which option is chosen, coordination within a unit is likely to be easier than coordination between units, both among STEM disciplines and between STEM and non-STEM disciplines. If one or two new STEM units are created (i.e., Options 1 or 3) coordination between STEM and non-STEM fields will require committed attention. On the other hand, if some STEM disciplines are incorporated into IAS and others are placed in a new unit (i.e., Option 2), coordination between the STEM and non-STEM fields—within IAS— may be facilitated, but coordination between IAS and other units, both among STEM disciplines and between STEM and non-STEM disciplines, will require committed attention.

Regardless of which option is chosen, combining the curricular depth characteristic of high quality STEM-related degree programs with the interdisciplinary breadth characteristic of UW-Bothell programs will be an ongoing balancing act. For example, it will be an issue in considering the optimal placement of interdisciplinary STEM degrees, such as the existing BS in Environmental Science and proposed Environmental Studies BA degree. To optimize the curriculum with respect to these two competing goals will require teamwork between organizational units with specialist versus generalist orientations. Judicious use of joint and/or adjunct faculty appointments (for senior faculty) may be helpful in bridging the gaps between the contrasting cultures in these kinds of units.

The role of the Center for Undergraduate Studies and Programs (CUSP) in supporting the new STEM-related degree offerings will need to be defined. Currently, CUSP administers some of the core lower division mathematics and science curriculum, as well as serving as a cross-programmatic site for the development of new courses and faculty development. Next year's CUSP program review could provide a vehicle for the beginning of an ongoing discussion of how its role might change in response to the institutional changes at UW Bothell and the overall expansion of course offerings and course requirements in STEM areas