Engineering and Science Institute: An Innovative Partnership to Provide Seamless Undergraduate Education

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Abstract: WSU Vancouver was established in 1989 and was mandated by the Legislature to provide upper division and graduate education. Undergraduate students transfer to WSU Vancouver following a 2+2 model where the lower division coursework is often completed at a local community college. An extensive survey of high school students in the service region of the university indicated that the engineering and science students are least likely to utilize the 2+2 transfer option. In response to these findings, the WSU Vancouver Engineering and Science Institute was conceived as a way to provide a seamless four-year experience. In this unique model, faculty from two partnering community colleges moved to the WSU Vancouver campus to provide the lower division curricula in Mechanical Engineering, Computer Science and Biology. The lower division courses were re-designed to create seamless four-year programs offered by the three institutions on the university campus. This paper describes the Institute and highlights its unique aspects as a model that can be adapted in other states. The detailed development of the ME curriculum is used as the example of how the partnership process worked over the past two years to create a unique program.

I. Introduction

Technology industries have been driving Washington's economy, providing forty percent of the wage growth in the past five years and creating thousands of jobs with a median wage of over \$100,000 per year, according to the Governor's "Closing the Technology Gap" report from September, 2000. The expansion of the economy in southwest Washington has been driven by a cluster of semiconductor manufacturing and related efforts.

These industries rely heavily on higher education. In addition to a workforce of employees with a wide range of skill sets and job functions, these industries require employees with advanced education in areas that are based upon higher-level mathematics and science; specifically engineers, computer scientists, and scientists. While Washington colleges and universities have made great progress, studies indicate that there is a shortage of workers with advanced professional education in these areas. Currently, the industry imports much of its highly educated workforce from outside the state of Washington. In addition, the expansion of these industries relies heavily on the research and development efforts of research universities for innovation and discovery.

WSU Vancouver was established as a branch campus of Washington State University in 1989. It is the state's only available option for southwest Washington companies to partner within this effort to improve the economic vitality of the region and provide numerous opportunities for expanded public and private partnerships. By Legislative mandate WSU Vancouver can only offer upper division and graduate education. Undergraduate students transfer to WSU Vancouver following a 2+2 model where the lower division coursework is often completed at a local community college.

II. Need

In March 2002 WSU Vancouver administered a survey to 1,338 high school students. Survey results indicated that only 36% of all college bound students were considering the 2+2 option for obtaining a bachelor's degree. This is a significant issue since the 2+2 is currently the only available option in southwest Washington. The survey also indicated that the engineering and science students are least likely to utilize the 2+2 transfer option and that 43% of students pursuing engineering and 57% of those targeting computer science would consider attending WSU Vancouver over other institutions if four-year programs were available.

As clearly indicated by the results of the 2002 survey and by the regional industry, there is a need for four-year engineering and science programs in southwest Washington. However, currently the Legislative mandate prevents WSU Vancouver from offering four year undergraduate programs. Hence, the WSU Vancouver Engineering and Science Institute was conceived as a way to provide a seamless four-year experience. In this unique model, faculty from two partnering community colleges moved to the WSU Vancouver campus to provide the lower division curricula in Mechanical Engineering, Computer Science and Biology. The lower division courses were re-designed to create seamless four-year programs offered by the three institutions on the university campus.

In this paper we describe the Institute and highlight its unique aspects as a model that can be adapted in other states. The detailed development of the ME curriculum is used as the example of how the partnership process worked over the past two years to create a unique program. Included in the discussion are streamlining of course content and credits between the three institutions, mechanics of course transfer, admissions, enrollment, joint recruitment and marketing efforts. The Institute opened its doors for the first time in Fall 2004. The current enrollment in mechanical engineering, and in the Institute, projections, success stories, lessons learned and the feedback from the community are reported.

III. The Institute

The Institute is a public/private partnership and an inter-institutional partnership. Its goals are to provide: (1) Undergraduate programs giving access to high demand fields for the citizens of southwest Washington; (2) Graduate programs linked to the regional industry needs; and (3) Outreach to attract youth to the science and engineering fields. Graduate degree programs are offered by the university faculty in the respective departments.

Undergraduate Programs: In this unique model, faculty from two partnering community colleges moved to the WSU Vancouver campus to provide the lower division curricula. Students take all four years of classes on the WSU Vancouver campus but pay community college tuition for freshman and sophomore level classes. At the junior level, students move smoothly into the WSU Vancouver degree programs. Students are admitted simultaneously to WSU Vancouver and to either Clark or Lower Columbia college through a *co-admission* process. Co-admitted students have the opportunity to move immediately into the upper division major without going through the 2+2 “transfer” process. They are assured that all necessary courses and prerequisites will be offered within a four year time frame, thus reducing the time to degree.

Currently, the Institute offers B.S. in Mechanical Engineering, Computer Science and Biology and B.A. in Computer Science. In addition, Master of Science graduate programs are offered by the university in Mechanical Engineering, Computer Science and Environmental Science.

Outreach Programs: For the outreach effort, the Institute has recently formed a partnership with the Girl Scouts to develop and offer LEGO Robotics and Design and Discovery summer camps. During this academic year, we are offering workshops on nanotechnology, material science, CAD, rapid prototyping, manufacturing and artificial intelligence. The outreach program has been so successful that there are waiting lists to get into the workshops.

More information about the Institute can be found at:

<http://www.vancouver.wsu.edu/institute/>

IV. Institute Development Process

In Fall 2003 two directors, one for the community colleges and one for WSU Vancouver, were appointed for the Engineering and Science Institute. Four committees were established with one representative from each institution: (1) *Curriculum*, charged with aligning lower- and upper-division curricula; (2) *Student services*, to focus on career and academic support; (3) *Enrollment services*, to develop admissions criteria, registration processes, financial aid support, and recruitment strategies; and (4) *Marketing*, to develop and recommend content and strategies for promoting the Institute. The two directors, who were charged with monitoring, reporting outcomes and problem solving, provided oversight for all of the committees.

The committees mostly carried out tasks with their core members. This provided efficiency and led to faster development. From time to time committees were expanded by bringing in additional members based on the task in hand.

IV.1. Curriculum

Development work began in the summer of 2003. Our goal was to open the doors in Fall 2004, bringing in students at the freshman, sophomore and junior levels. The first challenge the committee faced was that the community colleges were on the quarter system and WSU Vancouver was on the semester system. The committee spent significant amount of time exploring registration systems, financial aid, transcript issues, IT details of record keeping, credit transfer and equivalencies. After a considerable amount of background work, it was concluded that changing the systems in the partnering institutions was too big an undertaking in the given time period before the doors were opened in Fall 2004. Hence, it was decided to have the students transition into the semester system as they begin their junior year. This presents a great need for communication and coordination in working with students, since both systems now co-exist on the same campus.

When mechanical engineering students complete their lower division requirements at the community college (2+2 system), they end up accumulating extra credits. For example, the year-long physics sequence is 15 quarter (10 semester) credits. The university requirement is 8 semester credits. The credits are not transferred to the university but the courses are to fulfill the degree requirement. However, students are paying for and sitting in classes for these extra credits. In mechanical engineering lower division the 2+2 program had about 21 quarter (14 semester) extra credits. This is significant because the typical semester load at the university is 15 semester credits. In other words, the students are overloaded by an extra semester worth of credits during their lower division coursework. The committee worked with faculty from various departments in partnering institutions to streamline the credits in the lower division curriculum. This led to development of a new set of courses to be offered only to the Institute students on the university campus by the community college faculty. For example, the Institute physics sequence is now 12 quarter (8 semester) credits. As the credits were adjusted for the Institute in Vancouver, the content of all lower division courses were also streamlined to match their equivalents at the main WSU campus in Pullman, WA. The new Institute lower division courses automatically transfer to the university when students get to the junior level.

Getting faculty involved early in the development process was the key factor in our success. Community Colleges provided stipends or release time for their faculty who faced significant course or laboratory development.

IV.1.a. Lower division ME curriculum

The lower division of the mechanical engineering curriculum is a standard one that is found at many universities. However, as mentioned earlier, the course credits and content were redesigned to better align the lower division with the upper division. The Table below shows the lower division in the quarter system. The credits are quarter credits.

Freshman Year (Fall quarter)	
Courses	Cr
MATH 171 Calc I	4
CHEM 171 Gen. Chem. I	4
ENGR 130 Intro. to Eng.	3
GER Tier II	5
	16

Freshman Year (Winter quarter)	
Courses	Cr
MATH 172 Calc II	4
CHEM 172 Gen Chem. II	4
ENGR 131 Eng. Graphics	5
GER Tier I	5
	18

Freshman Year (Spring quarter)	
Courses	Cr
MATH 173 Calc III	4
CHEM 173 Gen. Chem. III	4
BIOL 105 Gen. Bio.	5
GER Tier I	5
	18

Sophomore Year (Fall quarter)	
Courses	Cr
MATH 274 Calc IV	3
PHYS 231 Eng. Phys. I	4
ENGR 231 Statics	4
GER Tier I	5
	16

Sophomore Year (Winter quarter)	
Courses	Cr
MATH 216 Lin. Alg	3
PHYS 232 Eng. Phys. II	4
ENGR 232 Dynamics	4
GER Tier II	5
	16

Sophomore Year (Spring quarter)	
Courses	Cr
MATH 241 Diff. Eq.	5
PHYS 233 Eng. Phys. III	4
ENGR 233 Stren. Of Mat.	4
ENGR 235 Cpt. For Eng.	3
	16

IV.1.b. Upper division ME curriculum

The upper division faculty completed extensive literature search to complete a benchmarking study to revise the curriculum. In light of this study, the rapidly emerging new technologies, national [1 - 4] and global trends, input from regional industry and desire to educate future engineers who are ready for the 21st century technologies, the faculty recently finalized significant revisions to the mechanical engineering upper division curriculum. The program emphasizes fundamentals and provides flexibility in selecting a course of study through four technical electives. Students can either take any four elective courses, provided they meet the prerequisites, or they can choose to take a set of three related electives comprising an option area and a fourth elective of their choice. If they choose to complete an option area, then they will receive a certificate along with their diploma. The options are: (1) Micro/nanotechnology; (2) Design and manufacturing; and (3) Mechatronics.

Junior Year (Fall semester)	
Courses	Cr.
MECH 313 Num. Analysis	3
MECH 309 Intro. to Eng. Materials	3
MECH 303 Fluid Dynamics	3
MECH 304 Instr. and Meas.	3
STAT 360 Statistics	3
Total Credit	15

Junior Year (Spring semester)	
Courses	Cr.
MECH 310 Intro. to Design & Mfg	4
MECH 314 [M] Design Process	3
MECH 348 Dyn Systems	3
MECH 301 Thermodynamics	3
MECH 4xx Option X.1	3
Total Credit	16

Senior Year (Fall semester)	
Courses	Cr.
MECH 404 Heat	3
MECH 414 Machine Design	3
MECH 4xx Tech. Elective	3
MECH 416 [M] Mech. Sys. Des. I	2
Tier II GER [I, G, K]	3
MECH 4xx Option X.2	3
Total Credit	17

Senior Year (Spring semester)	
Courses	Cr.
MECH 402 Therm. Sys. Design	3
MECH 417 Mech. Sys. Design II	3
ENGL 402 Technical Writing	3
Tier III GER [T]	3
MECH 4xx Option X.3	3
Total Credit	15

Technical elective and option areas

	Micro and Nanotechnology	Design and Manufacturing	Mechatronics
MECH 4xx Option X.1	MECH 431 Semiconductor Devices	MECH 425 Intro to Manuf. Systems	MECH 405 Intro to Microcontrollers
MECH 4xx Option X.2	MECH 432 Microfabrication Technology	MECH 476 Adv. Manuf. Eng.	MECH 467 Automation
MECH 4xx Option X.3	MECH 450 Adv. Nanoscience and Technology	MECH 485 Computer Aided Design and Eng. Systems	MECH 468 Robotics

IV. 2. Student and Enrollment Services

Although they started out as separate committees, over time the student services and enrollment services groups actually began meeting as a single group. This provided better coordination and planning for student issues. Prior to the Institute, WSU Vancouver had developed a co-admission agreement with Clark and Lower Columbia Colleges. The group revised the agreement and the form that was subsequently used by the Institute applicants.

Institute students must meet university admission requirements to be admitted to WSU Vancouver as freshman or transfer. At the same time, they are admitted to one of the two community colleges since students register at and belong to the community college during the lower division. In addition, the Institute students must be ready for calculus and college level English to be admitted. If they are entering as sophomores, the student must have completed the specific prerequisite courses in order to be enrolled. These requirements were developed by the curriculum committee and were implemented by the Student and Enrollment Services committee. The committee also screening of the first pool of applicants to the Institute. If an applicant's case was complex, a faculty committee from Clark and Lower Columbia Colleges made decisions regarding acceptance to the Institute.

Faculty advisors for each program were available to students. Enrollment in Institute classes was by permission only so students were required to make that contact. Students enrolled for the first year of the Institute are mixed in levels of preparation. Some are taking mostly sophomore level classes with one or two freshman courses, others are going part-time. Collaboration and communication between all Institute partners were essential for cohesive advising.

IV.3. Marketing

The marketing group developed many radio, television and other Ads, fliers, graphic designs and admissions fact sheets. In addition, an Institute Website and an award winning Institute DVD were produced. The marketing group also worked closely with the enrollment services group to organize Institute open house events. Finally, the group organized the event where Governor Locke dedicated the Institute on March 22, 2004.

IV. 4. Space and Auxiliary Services

A unique aspect of this program is that the community college faculty moved to the university campus. In the summer 2004, an auxiliary services group began meeting to formalize agreements about services for faculty, staff and students in the lower division who are now housed at the WSU Vancouver campus. Auxiliary services include mail, information technology, custodial, media, bookstore, library, and parking. Some informal and formal processes were already in place, and the leaders from all three institutions with their colleagues, built upon prior work to establish formal, signed agreements between the community colleges and WSU Vancouver.

As is the case at any university campus, space is at a premium at WSU Vancouver. Office space for six lower division faculty and one staff was created by remodeling a laboratory. Part of a computer lab in the same building was also remodeled to provide adjunct faculty office space. A laboratory technician is housed next to a science laboratory. A student services staff was given an office in the classroom building.

Being in borrowed space is somewhat awkward and some services are not available except from the faculty's home campus. It is not ideal, but the partner institutions are willing to do everything they can to make life easier for faculty and as seamless as possible for the students.

V. Lessons Learned

The committee structure worked well during the development phase. The most important point was to keep these committees to a minimum size for efficiency and fast development. The combination of Student and Enrollment Services allowed for extensive discussion on topics that impacted all of student services. It was important that the groups divided responsibilities but still had one or two members that met with all groups, and minutes and results were widely distributed.

The curriculum development was done under a lot of time pressure. The formal committee structure was not in place until October, 2003. Because courses were to begin in Fall of 2004, and all lower division courses had to be revised and sent to curriculum committees at both community colleges for approval, there was not a lot of time for faculty to discuss and develop more unique approaches to the programs. One idea would have been to give the lower division programs another year to get materials organized. A second idea would have been to offer only freshman courses in Fall 2004 and begin sophomore courses in 2005. Part of the time pressure came from having to deliver FTE results to the state by the end of the budget biennium in 2004 in exchange of the funding received for the Institute.

Because the late start for developing curriculum, many student services and marketing efforts had to wait on a finalized version of the program curricula. The first cycle of the admissions process was difficult and confusing for students, advisors and staff involved

in the process from all three institutions. This year we are getting ready for the second cycle of admissions. The process and all forms have been revised to provide a smoother admission and registration process for students. Since more faculty and staff are now familiar with the programs, advising will improve.

Recruitment and marketing for the first cycle started primarily in February 2004. This was too late for those students making decision about major universities. Activities should occur in November through January to capture the most motivated and qualified students in high schools, as well as good transfer students.

VI. Opening the doors

Institute classes began in Fall 2004. There are a total of 85 lower division students in the three programs, with the freshman class the larger of the two. First year biology and mechanical engineering has about 20 students each. Computer science has nine. The intent is to increase to 40 students in the first and second year for biology and mechanical engineering, and to 30 and 24 students, respectively, in each year of the computer science programs by Fall of 2006. The numbers are driven by the capacity and funding for the junior level courses in each program. The intent is also to leave some room in the junior level courses so that other transfer students can be admitted to the upper division from outside the Institute. In the junior level, upper division programs, there are 38 mechanical engineering, 15 computer science and 32 biology majors, with the capacity at 40, 30 and 48 students, respectively.

Orientation sessions for new students and lower division faculty were organized in September 2004. Classes are running smoothly. The first year mechanical engineering students have already “bonded” as a cohort. They study together, and one student put everyone’s picture and contact information on a web site so they could ask each other questions from home. Upper division mechanical engineering students are tutoring lower division students for math, physics and chemistry.

VII. Conclusions

The Institute is an unique inter-institutional model for providing a streamlined undergraduate education with automatic course transfers between institutions. It brings the partnering institutions together in many ways than simply in course equivalency agreements that are typical at other places. The community enthusiastically embraced the new “four-year” option in southwest Washington. Since the very beginning, we have seen a significant and growing interest from the parents and the prospective students. The Institute is a viable alternative since it provides a local four-year option and a university diploma at the end with a significantly reduced total tuition cost due to the lower tuition rates of the community colleges in the first two years.

Clark College has a 60,000 square-foot building currently under construction on the WSU Vancouver campus. The intent is for the lower division courses and faculty to move into the new facility when it is completed in January 2006.

References

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