AC 2009-1468: MANAGING COURSE OFFERING RESOURCE CONSTRAINTS IN NEWER GRADUATE PROGRAMS THROUGH SPECIAL TOPICS COURSES

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Managing course offering resource constraints in newer graduate programs through special topics courses

Introduction

Most new graduate programs face many challenges including lower initial enrollments, limited educational resources such as laboratory equipment, faculty lines, and under developed or "work-in-process" curriculum. While the institution has its resource constraints, the students may have totally different perspectives of the expectation. Since they have to compete with all the other graduates from the established programs, they seek more unique and competitive varieties in the curriculum. Furthermore, when the institution has diverse student population such as international and full time students, they desire to have frequently offered courses to be able to graduate on time because of their financial circumstances. This causes a tremendous pressure on the academic program to manage the course offering cycle with limited faculty lines. This paper presents a case study of special topics courses developed for its "newly born" M.S. in Technology Program at Indiana University-Purdue University Fort Wayne (IPFW). In the MS Tech. program at IPFW, the students are from diverse educational and professional backgrounds with wide research interests. They are interested in courses that are related to their background that could help them towards the Directed Project research. While on one hand, due to resources constraint, it is not practical to offer several courses that cover all of student interest areas. On the other hand, because of the newly launched programs, often times the enrollment number is not enough to run a full course. The proposed special topic courses aim to narrow this gap by allowing students to work on a semester long course which will help them to understand the state-of the-art in their fields of technology. These courses are designed to prepare students for their Master's Project. In other words, they will provide them with the opportunity to explore their potential research areas for their MS Project. Furthermore, having an additional course in the same area as their field of interest will provide them with sufficient time to accomplish a scholarly work. Consequently, such courses will better equip them for post graduation career in the today's competitive world.

MS Tech Program at IPFW

The Master of Science in Technology at the Indiana University Purdue University Fort Wayne (IPFW) was formally launched in the Spring Semester of 2007 with an enrollment of six full times students. The enrollment since then has increased almost four fold but the actual active student number is slightly less because of transfers (of current) and deferral of admission by some international students. The program has two tracks- information technology/advanced computer applications (ITAC) and industrial/ manufacturing technology (ITM) each with roughly 10 active students. Of these students, their background is very diverse such as government services, military, manufacturing, engineering design, supplier, software, machine tool, electrical, economics, and computer engineering. Furthermore, the very wide levels of work experience among students have created even greater heterogeneity in terms of their research interest.

MS Tech Program Objective

The program objectives are to provide the knowledge and skills to students with both technical

and non-technical backgrounds to be able to function effectively in a technical environment and accept increasing responsibility in technical leadership positions. The curriculum requires a total of 33 semester credit hours distributed as follows:

- Technical Core (9 credit hours)
- Principal Technology Area (12 credit hours) – students will select a principal technology area and choose four graduate courses in that area with the approval of their graduate advisor and committee.
- Technical Electives (9 credit hours) – students will choose three technical electives from a list of approved graduate level courses: Applied Computer Science, Business, Communication, English, Mathematics, Organizational Leadership and Supervision, Statistics, and/or Technology
- Directed Project (3 credit hours) - This requirement consists of one-credit hour project proposal followed by a two-credit hours course during which the project is completed and the results defended.

Program Strategy and Resource Commitment
New program development involves many concurrent activities such as curriculum design, course design and development, market development (student), faculty development and recruitment, as well as the development of administrative capabilities. With the resource restriction imposed by the University, the College decided to implement the new born M.S. in Technology program without additional faculty resources but with goals to develop faculty and grow the program so new faculty lines can be justified to sustain the success of the program. These key goals should be seen as the guiding principles for the short-term work in developing our new graduate program. A fundamental question was raised: What strategies, policies, practices, and decisions result in a sustainable M.S. in Technology program? After an internal program-level SWOT (strengths, weaknesses, opportunities, and threats) analysis, it became apparent that we need to accept the given contradictory limited resources and constraints, seek to understand what recruitment and retention strategies and management practices, and work to maximize its human (faculty and supporting staff), financial and physical resources to ensuring the initial program success. With this resource constraint, the implementation of this new program should consider the following important categories of variables:

- Structural and cultural context of the new program supporting department, and potential barriers/threats
- Partner opportunities with other graduate programs within the College (M.S. in Organizational Leadership & Supervision, M.S. in Applied Computer Science, M.S. in Engineering - System Engineering track) and IPFW (M.S. in Applied Mathematics, M.S. in Professional Communication, IU-MBA and Business program) would provide needed resources to cover 9 credit hours of approved technical electives.
- Administrative capability and faculty advisor development
- Program marketing and promotion
- Faculty capabilities audit and resource reallocation such as shifting a portion of undergraduate teaching responsibilities to graduate teaching to meet the immediate needs.
- Curriculum design: the needs, competitors, program goals and quality position, facilities and equipment (computers, programs, research labs, etc), graduate committee, faculty specialties and competitive advantages, plan of study, etc.

- Student recruitment and admission: minimum enrollment and long-term goals, admission requirements, prerequisite courses and/or experience
- Funding and requirements for teaching assistant positions and mentoring
- Course offerings and delivering strategy: The strategy of offering courses for the new program so that students can meet the program requirements and are able to graduate in two years. Course offering time, frequency, online/live lecture, etc
- Faculty and administrative capabilities development
- Aligned research and teaching strategies

Further, centralized attention on additional faculty resources, computing and other academic support systems (e.g., the library and office space) will be needed from the college. Program assessment and lessons learned will provide feedback for continuous improvement of program implementation.

Program Implementation History/Plan
Prior to fall 2006, all faculty members expected to teach graduate-level courses had submitted their graduate faculty applications and all were approved by Purdue Graduate School. With no formal advertising or promotion, the first graduate level course in Technology (*ECET 581 Workshop in Electrical Engineering Technology*) was offered in August 2006. It was offered as a dual-level special topic course entitled ECET 581/CPET 499 Wireless Sensor Network Systems and Applications which enrolled 2 graduate and 4 undergraduate students. The course sponsoring department anticipated the initial low-enrollment and decided to offer the course for the purpose of developing graduate teaching capability.

The M.S. Graduate Committee was formed in fall 2006 and held its regular meetings to develop Graduate Handbook and curriculum. After the faculty capabilities auditing, it was decided to offer the degree with only two viable principal technology areas: Information Technology/Advanced Computer Applications and Industrial Technology/Manufacturing with the following plan-of-studies:
- Technical core (9 credit hours)
  - IT 507 Measurement and Evaluation in Industry and Technology (3) OR
  - Statistical Methods (3)
  - IT 508 Quality and Productivity in Industry and Technology (3)
  - TECH 646 Analysis of Research in Industry and Technology (3)
- Principal Technology Area (12 credit hours)
  - Information Technology and Advanced Computer Applications Track
    - CPET 545 Service-Oriented Architecture and Enterprise Applications
    - CPET 555 Advanced Network Security
    - CPET 565 Mobile Computing Systems
    - CPET 575 Management of Technology
    - CPET 581 Workshop in Computer Engineering Technology
  - Industrial Technology and Manufacturing Track
    - TECH 540 Reliability & Maintenance
    - TECH 557 Tolerance Techniques
    - TECH 569 Simulation Modeling
    - TECH 561 Industrial Project Management and Control

- ▪ TECH 574 Advanced Quality Engineering Methods
  - Technical Electives (9 credit hours)
  - Directed Project (3 credit hours)

Faculty Lines and Their Undergraduate Course Load
Since the MS Tech program at the IPFW is still at in infancy level, adding new faculty lines does not seem to be a very plausible option in such a situation. The MS program[1] covers two departments- manufacturing & construction engineering technology and interior design (MCET), and computer & electrical engineering technology and information systems & technology (CEIT). The faculty members in both departments have heavy undergraduate teaching loads. Often times, the faculty members are with overload assignment, of course with additional salary compensation. Currently, in MCET Department there are six full time tenured/tenure track faculty of which two of them are under half time and one-eighth retirement[2]. The regular full time teaching load is 4 courses[3] per semester and there are no teaching assistants to support the faculty. Many courses are assigned to part time lecturers. However, it is sometimes hard to find a qualified limited term lecturer who can teach a bachelor's level course in engineering technology. Such situation leaves very limited room to develop and teach new graduate level courses for the current faculty members who are already overloaded with their undergraduate teaching assignments.

The situation in the CEIT department is very similar to that of MCET.

Enrollment and Course Offering
In any given semester, there are roughly about seven to ten courses offered per program in mechanical and industrial engineering technology in the MCET department. There are only two full time and one one-eighth retired faculty teaching these courses in the industrial engineering technology (IET) program. However, one of the two full time faculty members in the IET is almost entirely dedicated to MS Tech program. As a matter of fact, he is the only faculty teaching all the MS Tech core courses and most of the ITM track courses so far. This has severely limited the course offering cycles for the graduate program. As of Fall 08 semester, there are five approved courses for each track. While in ITAC, currently three faculty members are teaching the graduate courses in rotation, in the ITM track there is only one full time faculty who is teaching three core courses and two ITM track courses. On one hand, there are not sufficient instructors to offer new courses in the graduate program; on the other hand, given the new program the enrollment number is typically very low for the track courses. For example, the average class size for any of the track courses (ITM or ITAC) is about five to six. As a result, the MS Tech program has devised a policy to offer courses every other year. However, the downside of this scheme is it may delay student's graduation if the student begins the program at different times such as during spring semester. In order to avoid this problem, the course offering cycles are prepared in such a way that a student will have opportunity to take each of the core courses and few major track courses during a two year cycle (*See next section for course enrollment history of MS Tech program at IPFW*).

Cross listing of graduate and undergraduate courses to makeup the enrollment number has a long

tradition in the universities including IPFW. For example, some of our IET courses do not get sufficient number of students enrolled yet those courses need to be offered in order to graduate the students. To that end, one option may be to cross list some of the junior/senior level IET courses with their graduate version and make necessary adjustment during teaching. While this has been an option, past experience has shown that it might discourage students to get into graduate program upon completion of their undergraduate degree from the same department. Because they feel that there are very few new courses on the table for them to get motivated into the graduate program. Although, at the moment, this has been implemented in one or two courses, this is only a temporary measure.

Course Enrollment History in MS Tech Program

In spring 2007, the program began to offer a core course entitled IT 507 Measurement and Evaluation in Industry and Technology which enrolled 6 graduate students. The second course offered in the same semester was ECET 581 Workshop in Electrical Engineering Technology. However, due to low-enrollment concern, the ECET 581 was offered as a dual-level special topic course entitled ECET 581/CPET 499 Mobile Computing Technology & Applications which enrolled 2 graduate and 5 undergraduate students. An additional ten students were admitted during spring 2007 and the number of course offered in fall 2007 was expanded to three courses: one core course and two ECET 581 courses as dual-level special topic courses entitled ECET 581/CPET 499 Advanced Network Security but the latter course was offered as an independent study course due to low-enrollment. All courses offered from fall 2006 to fall 2008 are listed in Table 1.

Table 1: M.S. in Technology Courses Offering Fall 2006 to Fall 2008

Semester	Course	Title	Graduate Enrollment	Undergrad Enrollment
2006-F	ECET 581	Wireless Sensor Network Sys & Apps (CPET 499)	2	4
2007-S	CPET 581	Mobile Computing Tech & Apps (CPET 499)	2	5
2007-S	IT 507	Measurement and Eval in Indus & Tech	6	N/A
2007-F	ECET 581	Wireless Sensor Network Sys & Apps (CPET 499)	2	1
2007-F	ECET 581	Advanced Network Security (CPET 499)	5	5
2007-F	IT 508	Quality and Productivity in Indus & Tech	11	N/A
2007-F	TECH 646	Analysis Research in Industry & Tech	6	N/A
2008-S	CPET 575	Management of Technology	13	N/A
2008-S	IT 507	Measurement and Eval in Indus & Tech	10	N/A
2008-F	CPET 545	Service-Oriented Arch & Enterp Apps (CPET 499)	6	0
2008-F	CPET 581	Sel Topics in Adv Networks (CPET 499)	4	6
2008-F	CPET 598	M.S. Directed Project (1 cr)	3	N/A
2008-F	TECH 574	Adv. Quality Engr Methods	5	0
2008-F	TECH 569	Simulation Modeling (IET 369)	5	4
2008-F	TECH 646	Analysis Research in Industry & Tech	7	0

Course Offering Strategy for M.S. in Technology

Any new academic program adoption process within an ever-changing society and an age of choice is similar to the well-known technology adoption life cycle, a model for understanding the acceptance of new products[5] as shown in the Figure 1. It is very important for us to be able to apply a course offering strategy that enables us to successfully deliver sufficient new graduate

courses during the program start-up phase so the new program will not fail in the chasm, which is a big gap between the few early enrolled students and a potentially large block of future students. While the following paragraph explains details of course offering strategy of ITAC track, this strategy is also applicable, to a large extent, for the manufacturing track as well.
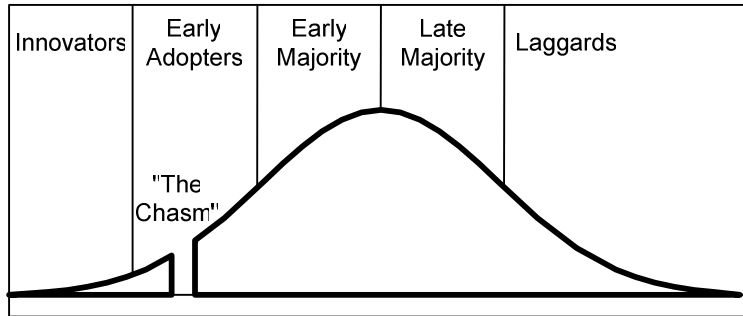

Figure 1: Technology Adoption Process

When we began to offer our first course in fall 2006 even before fully launching the program, we had only ECET 581 Workshop in Electrical and Computer Engineering Technology course approved by the College of Technology at Purdue main campus. Later in spring 2007, the CPET 581 Workshop in Computer Engineering Technology (max 8 cr. hr, variable title) was approved. The course description of the workshop course is "Advanced study of technical and professional topics. Emphasis is on new developments relating to technical, operational, and training aspects of industry and technology education." CPET 581 is parent course designation of a variable title course that is needed to be able to offer new M.S. technology graduate courses in the area of computer engineering technology prior to requesting a fixed title. In the first instance, it was offered in fall 2006 as "ECET 581 Wireless Sensor Network Systems and Applications" by the department of Electrical and Computer Engineering Technology (ECET). Then it was offered in spring 2007 as CPET 581 Mobile Computing Technology and Applications, before we created a similar course with a fixed course number CPET 565 Mobile Computing Systems. These variable courses are also considered as special topic courses which can be used to fulfill the requirements of both primary technology area and technical elective portions of the coursework. Students may take special topics courses with permission from their advisor and the course instructor.

Adopting the special topics course approach for a new program would provide the following advantages:
- Provides with the faculty the opportunity and flexibility to develop new graduate-level courses based on current interests and trends in the field. After a course has been offered several times, the faculty vote on whether it will be entered into the regular curriculum or cease to be offered.
- Some of these courses may be offered only occasionally rather than on an annual basis. It is very important to have this flexibility for an agile program.
- This is a student-centered strategy that fosters student initiatives and focuses the student on real-world, state-of-arts topics.

- These special topics courses for IT/Advanced Computer Applications fostered a wide range of abilities, not only those related to content knowledge or technical issues, but also other practical skills.

One of the most important lessons learned from course offerings strategy for students enrolled in the IT/Advanced Computer Applications track is that without offering sufficient courses as special topics, dual-level courses to serve both undergraduate and graduate students we would not be able to justify the course offering, may lose the opportunity to establish a strongholds in early majority segment (our current enrolled student level - 20), and may be unable to develop graduate teaching capabilities and look forward for continued growth.

It is worth mentioning that there are four students who completed first part (1 cr-hr) of their M.S. Directed Project course as of fall 2008, and enrolled in the remaining second part (2 cr-hr) for the spring 2009. It is expected the M.S. Technology program will graduate three to four students (including both tracks) at the end of spring 2009.

Summary of Current Situation and Justification for the Special Topic Course
In the MS Tech. program, the students are typically with diverse background and research interest. Due to resources constraint, it is not practical to offer several courses that cover all of student interest areas. The proposed special topic course aims to fill in this gap by allowing students to work on a semester long course which will help them to understand the state-of the-art in their fields of technology. In other words, it will provide them with the opportunity to explore their potential research areas for their MS Project. Furthermore, having an additional course in the same area as their field of interest will provide them with sufficient time to accomplish a scholarly work. Consequently, it will better equip them for post graduation career search in the today's competitive world. Following sections describe the two examples of special topic courses one each for ITM and ITAC track.

Special Topic Course Structure
The course will be entitled as *"Special Topics in XXXX"* and designed as a research oriented variable credit independent study for M.S. Tech students. The manufacturing track students will register in *IT590 Special Topics in Industrial Technology* whereas the computer applications track students will enroll in *CPET 590 Special Topics in Computer Engineering Technology*. In order to qualify for this course, a student must have completed at least 9 credits hours of Graduate level courses. It will be under the guidance of a graduate faculty member from the relevant academic unit who will serve as the student's academic advisor. A typical study starts with several weeks of intensive investigation and analysis of related literature. The initial exploratory study will be followed by a formulation of research problem based on the findings. Even though the course is independent study, student will be expected to document the time invested in the study. A student will be expected to spend a minimum of 3 to 9 hours per week (depending upon the registered credits hours) to successfully complete the study.

Course Outline
The list of topics covered in the course can vary depending upon the areas of interest. The

typical independent study topics in ITM (but are not limited to) include the best practices and gaps in

- Quality and performance improvements of Industrial and Manufacturing Systems
- Techniques in project management and control
- Design and reliability studies of technological systems
- Facility management and green construction
- Operations management of industrial and manufacturing systems
- Performance improvements in service industry and government enterprises
- Review of the best and state-of-the-art practices in the industry and technology

Similarly, the topics in the ITAC track can be, but are not limited to, the following:

- Quality and performance improvements of IT/Advanced Computer Applications and Systems
- Techniques in IT/Advanced Computer Application project management and control
- Design and reliability studies of IT/Advanced Computer Technological Systems
- Operations and security management of IT/advanced computer applications and systems
- Integrating of technology (IT/advanced computer applications and systems) and competitive strategies in business, manufacturing, service industry and government enterprises
- Review of the best and state-of-the-art practices in the IT/advanced computer applications and technology

Class Activities and Method of Assessment
Class Activities
The student will meet at least once a week for two to three hours depending upon the credit registered. There will be series of homework in the form of literature review and reading assignments. A student needs to prepare the analytical summary and his or her thoughts on the topic under discussion. The final product of the course would be a presentation and professionally written research report.
Grading policy:
Homework: 25%
Research Presentation: 25%
Written Research Report: 50%
Grading scale may vary depending upon the instructor's grading policy.

Reading List
Reading will be required from scholarly journals and periodicals. Course instructor will suggest the reading list after discussing the research interest of the student.

Potential Benefits and Challenges
Based on our experience, we argue that offering special topics courses reduces the immediate burden on the academic department in terms of course offering. The biggest advantage is it provides students with a unique opportunity to enhance their learning in the area of their research interest hence also the post graduation career. Since the newer graduate programs do not have

enough faculty lines to develop and offer newer courses, it will provide a short term solution. However, the success of such policy and practice depends upon the interest and availability of the faculty. At IPFW, this has been implemented successfully in the graduate and undergraduate programs alike. In addition to administrative benefits with respect to course offering, this will also bring about the avenues for scholarship and creative endeavors. For example, a special study focuses on few specific topics and issues in the chosen field. Therefore, a good project work on the course can have a good prospect for publication in conference proceedings and research journals, not to mention the training it provides to students in terms of conducting research and preparing technical reports.

Conclusions

New program development involves many concurrent activities such as curriculum design, course design and development, market development (student), faculty development and recruitment, as well as the development of administrative capabilities. Resource restriction as well as low student population makes the course offering a very difficult task to manage for any young graduate program. At IPFW, various strategies were tried and adopted to deal with this problem such as cross listing of the courses and offering course every other year. However, these efforts have not been regarded positively by the students because it makes students to wait for as long as 18 months to be able to take a required course which is not desired for an MS curriculum. Further, IPFW experience has shown that cross listing of graduate and undergraduate courses has not been very successful because students falsely assume that there are not many choices in the graduate program. The situation can easily go out of hand in terms of course offering especially when we have the diverse student background with wide areas of interest. This paper has presented special topics courses strategy to fulfill the demand for the short run. It has presented a case study from a new MS in Technology program at IPFW. The paper has described the program objective, course offering strategy and how to structure the special topic courses.

While it is a strategy that is working in the short term for us at IPFW, we would like to caution the readers that the success may depend upon many factors such as the faculty interests and availability. It also very much depends upon the student population. In our case, we have had relatively mature and working student population who would like to work on independent study in the field of their interest. Such model may not be applicable in a setting where student population mostly consists of *full time students*. Lastly, of course, the best approach without any doubt is to offer regular courses with dedicated full time faculty if the economic situation is plausible.

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