AC 2008-1232: DEVELOPING TOMORROW'S TECHNOLOGY LEADERS: ISSUES RELATED TO MASTER'S LEVEL TECHNOLOGY CURRICULUM

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Developing Tomorrow's Technology Leaders:

Issues Related to Master's Level Technology Curriculum

Abstract

Students at the Master of Science degree level in technology are preparing themselves for leadership or supervisory roles in the field. Students who will be assuming leadership roles in their professions need not only the technical and applied skills their jobs demand, but also knowledge of the business environment, leadership, ethics and laws, strategic planning, project management, quality, and supervisory skills. The School of Technology at this institution encompasses seven diverse programs, including organizational leadership and supervision. The Master of Science in technology is, by design and necessity, cross disciplinary, to serve the diverse needs of the students in the school and in the field.

This paper will review important issues in developing a master's level degree in technology, and will discuss the importance of considering the leadership and soft or conceptual skills areas for curriculum. Furthermore, review of the federal statistics on job outlook for some higher level positions in engineering technology fields will be presented in support of the curriculum which includes these types of courses to equip tomorrow's leaders with an education appropriate for higher level positions. Institutions can also serve tomorrow's technology leaders by considering graduate or post-baccalaureate certificates including these types of courses to aid in professional development of those currently in the field in these leadership positions.

Background

Purdue University Calumet (PUC) is a regional campus serving about 9,300 students, located in a highly urban environment in a large metropolitan area. The campus serves a diverse population of about half traditional students and half non-traditional students. Sixty percent of the student population is full-time. Seventy-four percent of its students are first generation college students (neither parent attended college). Minority students comprise about 30% of the total body and female students comprise 57% of the student body. Most of the students are commuters, with a small but increasing percentage of residential students. [1]

In Lake County, where the campus is located, only about 16% of the population over age 25 has a four-year degree or higher, compared to a rate of 19.4% for the state overall, based on 2000 census data. The county ranks twenty-first in the state in post-secondary education, even though it is the second most populous county in Indiana. While the total enrollment is 9,300, graduate enrollment for the campus for 2007-08 is 1021, with 835 part time graduate students, and 186 full time students. This is reflective of the campus student population overall, where many of the students work near full-time or full-time. According to the 2000 census data, only 5.5% of adults 25 or older in the county have attained a graduate or professional degree.[2] Compared with a

7.2% rate for graduate and professional degrees in the state, and 8.9% for the nation, the region is well below both state and national averages.[3]

Within the campus, the School of Technology (SOT) is comprised of seven very diverse Bachelor of Science degree programs, including Computer Graphics Technology, Computer Information Technology, Construction Management Engineering Technology, Electrical and Computer Engineering Technology, Industrial Engineering Technology, Manufacturing Engineering Technology, and Organizational Leadership and Supervision.

The Master of Science (MS) in Technology degree is in its initial phase. A degree modeled after a MS degree from the main campus (Purdue University West Lafayette), the regional campus authority to offer this degree is pending final approval from the state. To build the graduate degree program while awaiting final degree approval, SOT is offering some courses under main campus authority to build a student base. The overall program structure is a directed project-based degree and consists of 33 hours: three core courses (9 credit hours), Measurement and Evaluation in Industry & Technology, Quality and Productivity in Industry & Technology, and Analysis and Research in Industry and Technology; four primary area courses (12 credit hours) in the area of concentration, three courses in technical electives (9 credit hours), and a directed project course (3 credit hours).

Issues

While the overall degree pattern discussed above is structured based on the main campus model, the curriculum within this structure is not set beyond the core courses and the directed project. This has led to a number of discussions and issues about structuring the curriculum within this broad, cross-disciplinary framework. The flexible and interdisciplinary nature of the degree leaves faculty and administration with no clear and unambiguous direction for a planned development of curriculum. To address this overall concern, there are three areas where the faculty and administration have looked for guidance in curriculum development: the degree proposal, the employment market for candidates, and similar degrees offered elsewhere. To a lesser degree, informal surveys of existing master's level students have also played a role. These students are, as a rule, already in the workforce and have an idea of what they want the degree to enable them to do. Essentially, this is the first phase of a needs analysis or needs assessment for curriculum development, based on determining the desired outcomes which will meet the needs of the students in the program and the employers who will be hiring our students.

In this case there is a clear gap: the region served by the campus is lagging in the area of educational attainment for graduate and professional degrees, compared to both the state and national statistics. This leads us to focus on the need for advanced technology graduates, which is discussed in the employment data below.

Objectives in Degree Proposal

The springboard for these curriculum discussions is, of course, the objectives of the degree. The degree objectives discussed below are from the proposal pending for state approval.

> This program is designed for students with both technical and non-technical backgrounds and will provide the knowledge and skills required for its graduates to function effectively in a technical environment and *to accept increasing responsibility in technical leadership positions*. (Emphasis added.) The program permits specialization in an area of modern technology applicable to each student's working environment or area of interest. Emphasis is placed on preparing students for technical leadership positions in business and industry, faculty positions in technology and engineering technology at community college and university levels, or to continue for a PhD in technology or a closely related field at Purdue or another university.
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> The program outcomes for the graduates, consistent with the existing Purdue Calumet engineering technology programs, are:

- Ability to develop research concepts and practical applications of research methodologies in technical environments and analyze, evaluate and synthesize research
- Ability to communicate effectively and employ constructive professional and interpersonal skills
- Ability to function effectively in one or more of the technology disciplines
- An ability to function on multidisciplinary teams
- Ability to continue for a PhD program in technology or a related field

For those acquainted with the TAC of ABET a-k criteria, these will look very familiar. The a-k criteria are a blend of leadership skills such as communication and teamwork, and technical expertise. The need to develop these skills can be met through courses in those areas, or through including learning activities designed to develop these skills within other courses.

From a review of these objectives, the soft or conceptual skills will play a vital role, since the degree is intended to prepare the graduates for leadership and/or academic roles in the field. Out of the five program outcomes, there are several undisputed soft skill outcomes (communication, teamwork, and constructive professional and interpersonal skills).

Statistics for outlook and need for degree

As mentioned above, another source of information about curriculum needs (gap analysis) is the employment outlook for the degree graduates. The Bureau of Labor Statistics maintains the Occupational Outlook Handbook (OOH).[4] Though some judgment must be exercised, it is possible to look at upper (manager) level positions where our master's level graduates will be employed. In the case of this degree, the data examined were for Engineering Technicians,

Human Resources, Training, and Labor Relations Managers and Specialists, Construction Managers, Computer Information Systems Managers, Industrial Production Managers, and Artists and Related Workers (for Computer Graphics, and Multimedia and Animation). These categories encompass most of the diverse programs in the school, although these broad categories do not necessarily address the cross-disciplinary positions that our graduates might occupy.

What follows is a summary of the information available in the 2006- 2007 Occupational Outlook Handbook and which will be considered in the curriculum development process.

Occupational Outlook Handbook (BLS) statistics through 2014 for degree areas:

Changing employment between 2004 and 2014	
If the statement reads:	**Employment is projected to:**
Grow much faster than average	Increase 27 percent or more
Grow faster than average	Increase 18 to 26 percent
Grow about as fast as average	Increase 9 to 17 percent
Grow more slowly than average	Increase 0 to 8 percent
Decline	Decrease any amount

Summary of Category Data

Human Resources, Training and Labor Relations Managers and Specialists (OLS)	grow faster than average (+ 18%-26%)
Construction Managers (Construction Sciences)	increase as fast as average (+9%-17%)
Computer and Information Systems Managers (Computer Information Technology)	grow faster than average (+ 18%-26%)
Engineering Technicians	as fast as average (+9%-17%)
Industrial Production Managers	grow more slowly than average (+0%-8%)

Artists and Related Workers (CGT)	grow as fast as average (+9%-17%)

Based on this information, there is a need for graduates in most areas, which are growing at least as fast as or faster than average.

Based on this data, one can research other sources of information on occupational information which enhances and refines this broad overview. One example of an additional source type is the O*Net OnLine link for the Occupational Information Network.[5] This information can be searched by STEM discipline, high growth industry (such as advanced manufacturing), and job family.

For example, a search of Industrial Engineering Technician leads to a source of information on the following job description and titles: *Apply engineering theory and principles to problems of industrial layout or manufacturing production, usually under the direction of engineering staff. May study and record time, motion, method, and speed involved in performance of production, maintenance, clerical, and other worker operations for such purposes as establishing standard production rates or improving efficiency.*

Sample of reported job titles: Manufacturing Engineer, Engineering Technician, Industrial Engineering Technician, Production Staff Worker, Project Engineer, Industrial Engineering Analyst, Process Documentation and Methods Analyst, Manufacturing Technician, Quality Control Engineering Technician (QC Engineering Technician), Quality Process Engineer[6]

In this resource, each summary report lists tasks, tools and technology, knowledge, skills, abilities and work activities and context for these related jobs. For example, for network and computer systems administrators, some skills, abilities and work activities are: principles of training design, leadership techniques, critical thinking, creative thinking, and meeting quality standards for services.[7] Investigation may be done into all the related job titles to assess a common matrix of skills for employment positions at the manager or leader level to arrive at some guidelines for curriculum development to meet industry needs.

Another source of information about the needs of employers is the major employer information for the region which the campus serves. It is possible to locate information on Major Employers by county and state for the areas where the campus is located, or where the majority of its graduates are likely to end up.[8] This serves two purposes: it provides ideas for a graduate level industrial advisory committee, and it also gives a direction for employment needs in the area.

Comparable Programs

Another source of information can be comparable programs. There are not many degrees in technology which are not focused on a specific area within the technologies, and several schools have combined schools of technology and business, which can affect the degree offerings. However, one program which might provide guidance is at University of Pennsylvania, which offers an Executive Master's in Technology Management.[9] The program does combine technology and business, but seems to include the kind of cross-disciplinary approach which our MS in Technology uses. In that degree, students take course in both technology areas and business. Some example classes which focus on leadership skills are Legal Aspects of Entrepreneurship, Management of Technology, Managerial Economics, Marketing, Organizational Behavior & Design, Negotiations, and Total Leadership.

The campus is also considering the courses offered at another campus in the system (located in a non-competing area) which offers this degree. Courses offered there include: four Computer graphics courses (Development of Graphics in Technology; Human Factors of Computer Interface Design; Interactive Multimedia Development and Research and Projects in Graphics); five courses in computer information technology (Technology from a Global Perspective, Organizational Impact of Information Technology, Information Technology Economics, Management of Information Technology, and Advanced Network Security); two course in Electrical and Computer Engineering Technology (Applications in Forensic Engineering Technology and Facilities Engineering Technology); and eight organizational leadership and supervision courses (Managerial Training & Development, Advanced Topics in Human Resources Management, Organization and Administration of Training and Development, Leadership in International Human Resources, Emerging World-class Leadership Strategies, Interpersonal Skills for Leaders, Leadership and Organizational Change, and Individual Research Problems in Supervision and Personnel). Note the predominance of OLS courses, which can be used to enhance the leadership capabilities of students in any area. (That campus also offers a master's degree in OLS, which also accounts for the number and variety of OLS courses offered at there.)[10]

At Northern Kentucky University (NKU), the Master of Science in Technology is offered in four tracks: Technological Innovation, Technology Management, Quality Assurance, and Construction Management.[11] Looking to the technology management track as analogous to the program outcomes of preparing leaders in technology, NKU's core classes in that program include courses in Project Management in Technology and Technical Management in a Global Economy.

At Eastern Illinois, courses such as Science and Technology of Leadership, Total Quality Systems, and Global Technology are included. [12]

Northern Illinois University offers a Master of Science in Industrial Management, which is also

analogous to what this campus' master's degree encompasses. The Strategic Management track offers classes in Leadership Theories and Techniques, Teaming, and Industrial Project Management.[13]

The unifying theme of the proposal and program objectives, the occupational data, and some comparable programs is the inclusion of soft skills with the technical core. The soft skills of leadership and its components, communication, teamwork, interpersonal skills, etc., should all be a focus of the degree's supporting curriculum to produce well rounded technology leaders.

Conclusion

Based on the above research, the faculty will be discussing development of courses which can foster development of soft skills and business skills for technology leaders. Part of the discussion will also focus on course delivery methods, such as hybrid and online options, which is part of the next phase of development. Courses being contemplated by faculty to complement the technical core courses include: Interpersonal & Group Skills for Leaders, Leadership & Ethics, Strategic Planning, Project Management in Industry & Technology, Building Partnerships with Customers and Employees, Coaching and Mentoring in Organizations, Technology from a Global Perspective, Leading Organizational Change, and Advanced Quality Applications.

The University has been given an opportunity to construct a "green field" degree, building from scratch with no preconceived ideas. Using the principles of needs assessment, and given the proposal and program objectives, the employment information, and other programs, faculty have been given an exciting chance to offer course which prepare graduates for the current and future job market and advance in their careers.

References

[1] http://www.calumet.purdue.edu Purdue University Calumet home page for link to student body data

[2] http://www.stats.indiana.edu/profiles/pr18089.html (Lake County Information)

[3] http://www.stats.indiana.edu/sip/

[4] http://www.bls.gov/ The percentages of growth have changed slightly for the 2006-2016 projections.

[5] http://online.onetcenter.org/

[6] http://online.onetcenter.org/link/summary/17-3026.00

[7] http://online.onetcenter.org/link/summary/15-1071.00

[8] See for example www.hoosierdata.in.gov/major_employers.asp

[9] http://www.seas.upenn.edu/profprog/emtm/

[10] http://bulletin.ipfw.edu/preview_program.php?catoid=2&poid=58&bc=1 and http://bulletin.ipfw.edu/preview_program.php?catoid=2&poid=64&bc=1

[11] http://www.nku.edu/~mst/mstover.htm

[12] http://catalog.eiu.edu/preview_program.php?catoid=15&poid=1859&bc=1

[13] http://www.ceet.niu.edu/tech/academic/programs/msiminfo/msim0203.html