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Maximising the effectiveness of the thesis capstone project – the Master of Science in Industrial Management: a case study

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ABSTRACT: Many academic programmes are challenged to provide students with opportunities to engage in relevant and integrated thesis projects that call upon the breadth and depth of the content knowledge and skills that they have developed throughout the programme curriculum. In this article, the authors describe a method whereby curriculum and thesis projects were redesigned in order to accommodate the needs of a site-based programme delivery method for Master of Science in Industrial Management (MSIM) programmes.

GENERAL OVERVIEW OF MASTER OF SCIENCE IN INDUSTRIAL MANAGEMENT (MSIM) PROGRAMMES

A Master's of Science in Industrial Management (MSIM) degree programme is intended for engineers, technologists and scientists who are currently employed and who expect to be working in managerial positions that involve responsibility for manufacturing, design, production and material-handling functions in a variety of technical and industrial enterprises. These programmes are designed for those with undergraduate degrees in either engineering or engineering technology. Because the degree programme is intended primarily for individuals who are employed full-time, course offerings are typically available in the evenings.

Graduate degree programmes in industrial management are designed to accommodate either of the two following objectives:

- Increasing the breadth of an individual's education in various technical fields related to industrial management;
- Increasing the depth of education in a single technical specialty related to industrial management.

These programmes meet the needs of the employed individual who either seeks additional knowledge in subject areas that were not covered in his/her undergraduate degree programme or desires to extend the knowledge acquired as an undergraduate or through employment experience. The primary purpose of these programmes is to provide knowledge of management concepts and modern technical innovations as applied to technically based enterprises.

The degree requirements for the MSIM include 33 credit hours of coursework. A core of 15 credit hours comprising courses in industrial management, project management, operations systems analysis and modelling, analytical techniques for economic evaluation, and a capstone graduate project are required of all students. An additional 18 credit hours of approved supporting or elective courses complete the course requirements. Elective courses allow for specialisation in areas such as industrial safety, ergonomics, manufacturing systems analysis, decision sciences, marketing and finance. The elective course offerings and potential areas of specialisation permit students to tailor the programme to meet specific professional development objectives without compromising relevance to current and prospective occupational responsibilities.

UNIVERSITY-INDUSTRY PARTNERSHIP FOR SITE-BASED PROGRAMME DELIVERY

As a result of regional demand for existing workforce development, a mid-sized regional comprehensive University chose to modify a traditional on-campus Master of Science in Industrial Management degree programme to better fit community needs. Following consultation with business and industry, it was determined that a number of firms desired on-site instruction and had differing curricular content and skill development needs – focusing specifically on sector-specific managerial issues. As a result of careful engagement activities, in which the authors collected specific data and information on industry needs, deliberate modifications were made to the standard programme curricula. As a result of these changes, the University also modified the role, scope and focus of the thesis capstone project to provide students with the opportunity to undertake an applied research project with direct and tangible benefits for the sponsoring company.

The initial plan in this university-industry partnership was to attempt to explore ways that the University might be able to provide direct relevant assistance to this company in helping this firm accomplish its objectives and goals. The immediate area of interest was to find support for providing training and consulting in lean manufacturing and factory physics. Factory

physics is an analytical approach for enhancing knowledge, skills and expertise in the area of lean manufacturing. The firm had already decided to pursue this focus in their organisation and was looking for ways that would enable them to provide for continuous training of both their management and workforce on these topics and skill sets.

Initial discussion revealed that this training could be developed in a graduate course format and presented as a part of the University's industrial management programme. This idea was discussed and appeared to be of definite interest to this firm. Included in the discussion was the possibility that the university could deliver its Master of Science in Industrial Management (MSIM) programme on-site and on a schedule that could be tailored to the firm's needs.

As planning continued, the University also presented the idea that the firm could select a set of electives tailored to provide a common knowledge and skills base for all of the programme participants within the firm. This tailored programme could also provide a means for cross-training and trust and relationship building throughout the firm. Additionally, the elective courses selected by the firm also could be tailored to include firm-specific practices and information to support its further training and standards practices. The University would work with the firm in this effort on a course-by-course basis and would provide the control to maintain academic rigour and integrity of the programme as offered. The University's engineering department and office of university outreach developed a proposal to offer these services to the firm.

The industry partner also realised that this type of programme would likely be beneficial to its associate firm and discussed this arrangement with their associate firm's management. Both companies decided to conduct a survey and invited a number of their current employees who had graduated from accredited four-year degree institutions to determine the level of interest in such an idea. Over one hundred surveys were distributed. More than 70 surveys were returned expressing interest in the programme, especially if it was offered on-site. Twenty-four students were initially selected to participate.

In discussions with the company and those students selected to participate in the programme, several other concerns were discovered. Students were very interested and enthusiastic about the programme, but they wanted to condense the horizon for the full programme to be completed within a three-year period. The course term length was reduced from a University normal 16-week semester to a 12-week period. In order to deliver the equivalent contact time as experienced in a 16-week semester, the class would be required to meet four hours per week.

Through discussions with students, the firms involved, and University faculty, it was decided that meeting once per week on Monday evenings from 4:00 till 8:00 pm would be workable. This schedule was desirable because most students were expected to be home for weekends and at work on Monday, even though their respective jobs may require periodic travel out-of-town. Students also wanted the courses to be sequenced back-to-back without any break between courses so as to finish the programme as quickly as possible. Eventually, both firms met with the University and coordinated a compressed schedule to offer the programme on-site on a weekday evening. Due to company interest, the first course selected for the programme was the factory physics course.

MSIM ELECTIVE COURSE MODIFICATION

Preliminary discussions with the company revealed that they were interested in factory physics. The company had already decided to utilise the concept of factory physics in their organisation, and they were looking for local support to help them introduce and instil factory physics as a way of life in their organisation. Resources were available and the company was currently utilising other experts from around the country to help them. However, they were looking for someone in the local area to work with them on a more responsive and continuous basis to assist in this effort.

Factory physics is a systems approach to analysing a process or sequence of processes as a basis for continuous improvement. It is an analytical approach to developing information and using this information to improve manufacturing operations by reducing inventory, reducing cycle time and increasing throughput. In discussions with the company, it was decided that a local means of support could be formed to help them meet their needs. The support could be performed on a consulting basis or through formal arrangements with the University. Further, it was determined that this topic could possibly be developed into a graduate course for credit through the University if there was interest.

As discussions continued, it was further mentioned that the University had an MSIM programme that the company might find very useful and relevant to their needs. This course, assuming that it could be developed as a graduate course, could be an elective course in the MSIM programme and meet one of the 11 course requirements. The factory physics course was developed as an MSIM programme graduate elective course and given the title of Manufacturing Systems Analysis. In working with this company in this endeavour, management wanted to stress the analytical and technology focus, as well as management and teamwork, as the criteria to develop the six elective courses for their on-site experience. The following elective courses, in addition to Manufacturing Systems Analysis, were chosen:

- Manufacturing Systems Analysis;
- Survey of Statistics;
- International Business;
- Financial Management;
- Principles and Practices of Quality Management;
- Production and Operations Management.

PROGRAMME MODIFICATIONS FOR ON-SITE DELIVERY

Once the core and elective courses were selected, it was necessary to develop a schedule to sequence the courses in a logical order and to make arrangements for qualified faculty to be able to teach the courses in that particular order. This required close coordination and cooperation between the College of Science and Engineering, the College of Business, and the University Outreach or Extended Services area.

Each of the faculties involved in delivering this on-site MSIM programmes were already engaged in delivering full-time on campus undergraduate and graduate courses, as well as research in their respective fields. The schedule extending over two years required careful and attentive planning and cooperation by many different individuals, faculty, departments

and administrators within the University in order to make this programme effort possible and successful.

The company also made significant efforts through coordination and cooperation to develop the means to enable those participating in the on-site programme to attend and be successful. The firm was a manufacturing firm operating production on a three-shift basis five days per week and sometimes on weekends and through overtime for special production runs. Students needed some assistance in helping them to find time to attend class while also meeting their work responsibilities in supporting a three-shifts per day manufacturing operation, travel and commitments as a member of an international firm.

THE CAPSTONE EXPERIENCE

Typically, the capstone paper is the culminating written work for the Master's degree programme. The purpose of the thesis/capstone paper is to have the students demonstrate their ability to apply the knowledge acquired in the two years of study to an actual work setting, and to utilise skills of observation and analysis as demonstrated in a formal paper. It is written by the degree candidate when he/she is in the process of completing the core programme courses and is within one semester of graduation.

In order to make the capstone project relevant for the student cohort in this case study, it was quickly realised that some re-thinking needed to be undertaken of this course as it traditionally existed. The participants felt it was not reasonable for a company to be able to generate, support and commit resources for 25 individual graduate projects. After careful study and review, a separate synthesis course was developed for application whereby the MSIM programme was offered on-site to a company with many students participating in the programme.

A new course, Leadership Project, was developed. This course is a synthesis course that essentially mirrors the graduate project in its design, intent and outcomes. The primary difference in this new course from the traditional capstone course is that it was designed for students to work in teams.

This new approach for this synthesis course offered several advantages. From the firm perspective, the number of projects could now be reduced to a manageable number with the creation of teams with a maximum number of four students per team. This reduced the number of projects to be completed in a semester to six or seven, depending upon the team size selected.

The students would have the opportunity to work in a team environment similar to that in their normal work environment. They would also gain additional insights and skills in working collectively on major project experience that included the three deliverables of a successful project, namely:

- A written publishable thesis;
- A successful project;
- A presentation and defence of the thesis.

This course also presented a challenge to the faculty advisor for each team. In selecting projects for the course, both the company and faculty had to agree on the content, scope and efforts required for the capstone project.

In reviewing the project proposals, students were required to prepare a proposal outlining the project with a timeline. They also were required to:

- Justify the make-up of the team members in terms of number, skill sets needed and available;
- Assign individual responsibilities;
- Select a project manager as team manager.

The course, as delivered, was also team-taught, utilising three graduate faculty. One of the three graduate faculty served as the instructor of record and was responsible for the course delivery from the University perspective.

The MSIM programme thesis capstone was redesigned to accommodate the needs of the local and sponsoring organisations. The thesis redesign focused on five critical themes, namely:

- Communication skills;
- Statistical analysis;
- Project management;
- Project evaluation;
- Critical thinking.

The graduate project course is a capstone synthesis course and is usually the last course to be undertaken prior to completing degree requirements. This course requires the student to work with his/her employer to select a substantive project to complete during this course. The student enlists a mentor with his/her company who serves as a project advisor, as well as one who has the authority to both authorise the project and commit company resources to implement the project as developed.

There are three deliverables that are expected outcomes of the student for this course, as follows:

- Successfully meet his/her company project requirements with outstanding results;
- Develop a technical thesis report suitable for publishing;
- Present and defend the project effort and thesis before his/her committee.

The primary purpose is to afford the student an opportunity to utilise the knowledge and skills acquired in the MSIM coursework in an actual hands-on worthwhile project for his/her company. Usually, the company has afforded the student with the opportunity to pursue this degree effort through its continuing education employment benefits. This creates a real opportunity for a win-win-win situation. The student shows real worthwhile tangible benefits to the firm that the firm, in turn, realises through project economies, waste reduction, productivity enhancements and continuous improvement. The University also wins because it gains the recognition for enabling students and providing value-added services to its stakeholders and community.

The faculty also wins because they have an opportunity to work in the real world and become involved in the emerging issues that are relevant to its stakeholders. Faculty has an opportunity to enhance and utilise their knowledge, expertise, and skill sets. The knowledge, experience, and issues realised can be brought back into the classroom to inform and broaden the learning experience of others in the MSIM programme. Additionally, these insights also enable the programme director of the MSIM with an opportunity to modify its programme to

reflect subject matter and expertise relevant to its stakeholders, and keep the programme near state-of-the-art and on the cutting edge of emerging needs.

ADVANTAGES AND STRENGTHS OF THE PROGRAMME MODIFICATIONS

The principle benefit of the capstone thesis redesign is vocational focus and applicability of the project. The student, the sponsoring organisation and the University all benefit from the focused project. The applied scholarship of the revised project requirement is also considered to be more appealing and intrinsically rewarding for the programme participants.

The fact that the capstone thesis project captures each of the salient elements of the programme's curriculum, as well as the fact that it meets the workforce development needs of business and industry, are also direct benefits. Additional benefits include economic efficiencies and effectiveness for the sponsoring business, indirectly, economic development, curricular relevancy and reform through consistency and alignment with industry standards and expectations, timeliness of programme delivery, and direct company improvement.

Benefits to the sponsoring organisation are multifaceted. First, the organisation benefits by developing a key portion of its workforce in competitively important areas, such as advanced manufacturing tools and techniques, project management, statistics, human resource management and organisational behaviour. Secondly, the organisation benefits by creating a customised and flexible curriculum that is applied to real data and real examples within the organisation. This applied approach boosts the organisation's productivity and profitability and yields a tangible return on investment.

A third benefit falls into the human resources area in terms of employee retention and employee recruitment. Employees who complete the programme gain valuable skills, thus positioning themselves for greater responsibility and possible promotion within the organisation. These possibilities help build employee loyalty and reduce turnover. Also, providing company paid tuition and on-site delivery of credit courses attracts talent.

This arrangement benefits the participating educational institution by offering faculty avenues to enhance their real world knowledge, develop practical skill sets and surface areas for research. This rich experience allows faculty to bring real world problems, issues and concerns into the classroom to share with students in other programmes and to further enhance, sharpen and focus programme courses and topics to be on the cutting edge of industry.

The partnership between the University and business(s) required intense communication and collaboration between partners in order to shape the scope and content of programme curriculum, and curriculum result of engaged collaboration and based in part on industry standards. This is truly a six-way partnership in learning and discovery. The partners are the students, the organisation, the University, the faculty and, indirectly, the related industry and the community.

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