Supporting an Information Systems Curriculum with a Management Science Course

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Abstract

The development of skills directly pertaining to information systems (IS) is often perceived as a task whose sole champions are the instructors in the discipline. However, there are reasons to believe that courses in other disciplines can be designed to further develop these skills, leading to improved student performance. In the case of a seemingly unrelated management science course, critical, problem-solving and development skills can be specifically developed to support a curriculum in IS. Many of the topics within management science – business process modeling, systems testing, coding techniques, etc. – have a direct linkage to topics in IS. Additionally, the application of management science techniques can be focused on uses that are typical needs of IS professionals. This paper explores the connection between the two disciplines and suggests ways in which a focused course in management science can be used to advance students' ability to process information and develop systems.

Introduction

Management science, or operations research as it has been promoted recently, is a discipline that has been usurped by many other areas of study. Courses in management science in a business school are frequently offered through a management or information systems (IS) department, with some courses falling under a standalone decision sciences department. These courses have been long considered a requirement for general business training, although recent trends in academia have pushed the management science curriculum to evolve into a more "relevant" topic or face elimination. Evolution required that the focus of the course transform from one that teaches students to be intelligent consumers of management science (i.e. respect the theory and be aware of when it might be useful) to one that trains students to identify and model practical business problems. In a management science course that is part of a general curriculum, the skill set must be focused on general business uses. However, on the occasion that a separate course is required for IS majors, or when sufficient IS majors can justify a more directed focus, a course in management science can be used to develop skills that are heavily utilized or valued by employers of those students.

Instructors of management science are generally tasked with instructing students in the area of linear, nonlinear, and goal programming and their applications, project management, decision analysis and game theory, queuing theory, simulation, forecasting, and inventory management, among others. There is significant overlap with other disciplines among these topics. For instance, the areas of project management, inventory

management and queuing theory are commonly covered in courses on operations management, and forecasting can be found in classes on economics and statistics. The common element among the topics covered in a course on management science is that they are based on a scientific (read "mathematical") approach to the solution of business problems.

The linkage to information systems becomes clear – scientific approaches require data; information systems manage data. Additionally, the software that has been adopted for use in many management science courses (outside of specialized software) is the spreadsheet. The use of spreadsheets is generally taught within the department of information systems. Finally, a scientific approach requires strong critical-thinking, problem-solving, and development skills. These are the same skills that are prized in the construction and development of information systems. Hence there is good reason to believe that training in a management science course could be beneficial and closely aligned with success in information systems. The internal development of these problem-solving skills within IS programming courses has been investigated without evidence supporting such a linkage.[1] It is possible that the development of this skill set in a related and focused management science course would produce students with improved IS skills.

An Abbreviated History of the Failures in Teaching Management Science

Management science has long been perceived as a mathematically challenging, yet relatively unusable discipline. This reputation was not so much the result of the topics themselves, but rather of the approach in teaching them. The focus was placed on the appreciation of scientific approaches to business problems, but the limited scope available without significant computational power rendered the problems of trivial size. Solutions found using techniques such as the simplex tableau or the stepping-stone method were tedious. Specialized software allowed for more significant problems, but the interface and the distribution of the software in the market convinced students that management science was practiced by specialists with little connection to regular corporate management – it was something that could be ignored at a very small cost to their education.

Many instructors in management science did not offer much to dissuade this opinion. Due to either general lack of computational resources or the pedagogical approach of instructors, management science courses often resorted to the explanation and utilization of mathematical algorithms and algebra. Explored techniques were isolated in their application, resulting in a sort of "technique of the week" feel. Additionally, most of the applications were focused towards manufacturing, leaving those disciplines oriented towards service relatively unserviced.

The Revival – A New Approach in the Instruction of Management Science

With the advent of the spreadsheet and its adoption in industry as the preferred tool for analysis, management science began to recraft itself utilizing the spreadsheet. Academia

[1] VanLengen, Craig A., and Maddux, Cleborne D. "'Does instruction in computer programming improve problem solving ability" *Journal IS Education*, Vol. 2, No. 2, 1990, pp. 47-49.

has been reticent in embracing the spreadsheet, preferring in many cases more specialized software with complex and unfriendly interfaces. With significant pressure from employers, many academic departments have now incorporated spreadsheet use in their courses, with the brunt of the training focused in the IS discipline. Management science has recast itself as the discipline that offers a scientific approach to business modeling via the spreadsheet. The Institute for Operations Research and the Management Sciences (INFORMS) Business School Education Task Force[2] stated that position clearly:

We recommend that individual faculty embed their analytical material strongly in a business context, use spreadsheets as a delivery vehicle for OR/MS algorithms, stress the development of general modeling skills, and work toward effective collaboration with colleagues in the functional areas of business.

In fact, research has been published in highly reputable journals concerning the ways in which the spreadsheet can be used in improve education in management science.[3]

The Connection – How this relates to Information Systems Skills

The crossover between the disciplines of management science and IS via spreadsheets is clear. The IS department is generally responsible for basic instruction in spreadsheets, typically accomplished through a low level course in microcomputing. The management science course is focused on the use of spreadsheets for modeling and decision support. However, this connection can be expanded to the benefit of the IS curriculum. A course in management science may be used to emphasize an IS approach to system development, train in the area of systems testing, and practice the art of coding and data manipulation, among others.

Systems design is a significant part of an IS curriculum. Substantial time is spent training students in the analyses of business problems and the feasibility of computerized solutions to those problems. That same emphasis can be made in the management science classroom. In their article on the role of management scientists in the development of spreadsheet models by users, Edwards, Finlay, and Wilson[4] identified eighteen guidelines to determine the value and acceptability of a spreadsheet approach to the solution of a business problem. The use of these or similar guidelines in a management science course as a first step in the evaluation of a business problem provides emphasis for IS students on the importance of problem definition and feasibility analyses. Once it is established that the approach is well-suited, the students may be allowed to experiment and develop their problem-solving skills in formulating a solution. As with IS courses, a significant amount of time should be spent in the management science classroom discussing how a problem can be solved, whether a spreadsheet is the best tool, and if the development of a spreadsheet model would provide a long term solution to the problem.

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[2] INFORMS, Business School Education Task Force, Operating Subcommittee "OR/MS and MBAs" *OR/MS Today*, Vol. 24, No. 1, 1997, pp. 36-41.

[3] Thiriez, Hervé "Improved OR education through the use of spreadsheet models" *European Journal of Operational Research*, Vol. 135, 2001, pp. 461-476.

[4] Edwards, John S., Finlay, Paul N., and Wilson, John M. "The role of OR specialists in 'do it yourself' spreadsheet development" *European Journal of Operational Research*, Vol. 127, 2000, pp. 14-27.

If the problem warrants a spreadsheet solution, a structured design approach can be utilized in the creation of the spreadsheet. Janvrin and Morrison[5] investigated the effect of this approach and found a significant reduction in "linkage" errors between spreadsheets but with no reported increase in time spent on the models. Too often, end users rush into spreadsheet development without prior consideration of the optimal design. In a management science classroom, prior to any development, students can be required to determine the objective of the model, the inputs and outputs of the model, and the calculations that will be necessary. In more complex models, data flow diagrams can be prepared to eliminate linkage problems between spreadsheets in a larger workbook. Additionally, students typically attempt to design a model as they develop it. When the instructor takes the time to discuss alternative options in structure and allows the student make the choice (sometimes the wrong one), the importance of design becomes clear. The incorporation of a structured design approach in a management science course on small spreadsheet models helps stress its relevance to students on larger IS projects.

Other formal aspects of IS systems design can be incorporated into spreadsheet modeling in a management science course. Documentation is often underappreciated by students as they study IS. The importance of documentation can be emphasized in a management science class by confronting the students with a previously created model with errors. If a student is given the choice to correct one of two alternatives, one of which is devoid of documentation, the student quickly identifies its importance. The extent of the documentation is also stressed as they read through the notes and try to fabricate a correct model. Lessons in correct and complete documentation appear more relevant after such an exercise.

This same exercise can be used to stress the auditing and testing of spreadsheet models. Up to 44% of end-user spreadsheet models contain at least one error according to research.[6] Formal systems development requires extensive effort in the area of systems testing. These are rarely acknowledged in the area of spreadsheet modeling. Additionally, most students are unrealistically confident of their ability to create a spreadsheet model without error. To emphasize these skills, the management science instructor must create opportunities for students to use the tools available for spreadsheet auditing (i.e. the "Formula Auditing" tool, the "Tools Options" to show formulas, and even the simple "edit" button in Microsoft Excel) and familiarize them with the concept of test data. In a spreadsheet, the utilization of test data is quite simple, particularly since the invention of the "undo" button. Formulas can be overtyped with values to determine if subsequent values are correctly calculated. The "undo" button can be used to restore the formula. With sufficient focus on model testing in a management science classroom, IS students will learn the importance of standard IS testing procedures and will better appreciate their role in larger and more overwhelming IS projects.

Programming skills can also be directly impacted by training in a management science course. One of the main focuses in the development of a spreadsheet solution to a business problem is the understanding of the relationships between variables. While this particular aspect of the management science class is not geared for IS training, the

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[5] Janvrin, Diane, and Morrison, Joline "Using a structured design approach to reduce risks in end user spreadsheet development" *Information & Management*, Vol. 37, 2000, pp. 1-12.

[6] Brown, Polly S., and Gould, John D. "An experimental study of people creating spreadsheets" *ACM Transactions on Office Information Systems*, Vol. 5, 1987, pp. 258-272.

understanding of business processes is beneficial as calculations and models are typically developed for the different functional areas of a typical business. This can provide additional mathematical understanding of these processes when IS systems are developed.

Other programming benefits include training in the use of variable naming and soft-coding. With the ability to name cell ranges in spreadsheets and use those references in formulas, students see the benefits of naming conventions in the self-documentation of calculations. More formalized naming requirements can be instituted by the instructor, but the benefits of a descriptive name versus the alphabetic placeholders become clear, particularly in exercises when the student is required to error-correct a model. The benefits of soft-coding can also be emphasized in such an exercise. If students are forced to evaluate models when these variables change, they quickly realize the disadvantage of coding values into formulas. These techniques become more relevant in a subsequent IS course when they are experienced and learned on a smaller scale in a management science classroom.

In summary, adaptations of a management science course to support IS learning can be accomplished via:

- The use of an initial problem definition and feasibility study to determine the value and appropriateness of a spreadsheet model;
- The incorporation of a systems analysis structured design approach to spreadsheet modeling;
- Stressing the importance and value of good spreadsheet documentation;
- The use of auditing tools and test data in spreadsheets to determine if calculations are made without error;
- The emphasis and utilization of IS techniques such as variable naming conventions and soft-coding of values.

Applications – Management Science Directly Applied to IS

Management science can also be used to train IS students using applications that may be utilized as IS professionals. For example, some computer hardware and software is available in either a lease or purchase option. While a management science class will include basic modeling, the use of this particular application may be more relevant to IS students. Additionally, if it is incumbent on the student to collect some of the information pertinent to the decision, students become more aware of the decisions that must be made concerning the costs of maintaining the software (i.e. updates), onsite or offsite support, training, and systems requirements, among others. In the case of hardware, decisions include the likely useful life of the system, technical support (including whether or not the necessary skills are in-house), updates to existing physical structures, etc. Using this knowledge, students can be stepped through the means by which a financial decision can be made on the lease or purchase of a system, or the comparison of multiple systems. Interestingly, this approach also provides students with an understanding of issues that are not considered in a financial analysis.

Other applications that have IS relevance include the use of a spreadsheet for project management. Most IS projects require significant time and personnel commitment. While specialized project management software is available, many managers will resort

to familiar software such a spreadsheet. Instruction in the correct use of a spreadsheet for project management – including optimization techniques for compressing the schedule and simulation for determination of critical activities in stochastic cases – can be oriented towards IS system development. The use of IS applications in a management science class can provide students with additional understanding of their use in industry and give them additional tools for making optimal IS management decisions

Conclusion – Is This Really Important?

There are distinct advantages to designing a management science class to accommodate IS students. Many of the tenets of IS systems design and development can be discussed and directly applied to spreadsheet model development. As the systems are small-scale, the time between incorporation and reward is minimized, providing a better opportunity for the benefits to be associated with the effort. A result is that more students are likely to internalize their use for future projects, regardless of the scale. In fact, there is little reason for a management science instructor to avoid many of the systems design and development approaches created by IS. To incorporate them into a management science course is a benefit to both and IS and non-IS students. Non-IS students learn to develop more sound systems and eliminate errors, and come to understand the IS process. IS students have principles taught in their IS classes reemphasized and made relevant in smaller systems.

The use of IS applications in a management science class also makes good pedagogical sense. As information flow and management has become such an important part of company management, all students should be aware of applications specific to the strategic IS area. Without sufficient exposure, students often do not make the application leap to this service-oriented function. For IS students, the application of management science techniques to decisions specific to the IS area allows them additional tools for effective and efficient management of their resources.

On a personal note, the effects of these changes have been rewarding. Students' perception of the course has been high, despite the seemingly unrelated topic. Many students have indicated that they have been able to put the techniques to use with their employer even during the semester of instruction. There has also been a high usability assessment for the course among former students that are in industry. Some have reported additional employment and advancement opportunities because of the knowledge they acquired in the course. With a sufficient IS student base, there is little reason for the management science course to not serve them properly.

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