A Business School Offering in CIM

F. C. 'Ted' Weston, Jr.
CIS Department, Colorado State University

Abstract

The literature on *computer integrated manufacturing* or CIM largely follows the disciplines of engineering, information systems, and/or operations management. Coursework at various universities and in various disciplines is presumed to follow the literature. This paper will describe a graduate course in CIM within a business school. This course is designed to attract students from any discipline who have an interest in major issues related to manufacturing, including change management and global considerations. The structure of the course is primarily three-fold: 1) lecture and discussion on various topics within the domain of CIM, 2) field trips to eleven sites locally to view manufacturing and related operations, and 3) projects of the students choosing related to CIM, often with one of the firms visited. Exams and an extensive reading list are also included in the course. An underlying theme of the course is integration of CIM-type functions within a manufacturing organization, including the most important element of business communications within and between functional areas. The course is housed and taught in a department of computer information systems (college of business) and cross-listed with the production/operations management department, also college of business.

Introduction

Approximately in 1986, a graduate course focusing on MRP II was restructured to focus on the more functional aspects of computer integrated manufacturing or CIM. The course was intended to be of interest to students from business, engineering, and industrial sciences. Within business, interest was strongest with students from computer information systems (CIS), and MBAs with an interest in manufacturing, quality, and/or technology management. Mechanical engineering and industrial technology were the two areas outside business most frequently represented after CIS and MBAs. The course was offered at the '500' level meaning both undergraduate and graduate students may take the course but the course could not be required of undergraduate students. Undergraduate students are rare but most likely come from either CIS or production/operations management. The course is currently not required of any major in any discipline. Registration is restricted to approximately twenty students per semester with one offering per academic year. Possibly exhibiting a content bias, students are informed that the instructor does not necessarily like the term 'CIM' but in fact prefers the term 'cIMS' representing computer integrated manufacturing *systems* with an emphasis on both integration and systems, and a lesser emphasis on the 'computer.' The MES (manufacturing execution systems) acronym is also employed. No text is used in the course. Instead, readings are provided each student. The course is a regular three credit class meeting twice per week, with the second

meeting day during most weeks reserved for field visitations. The focus of the class is developing CIM as a concept or framework for understanding the entire manufacturing function. For students with little real-world business experience, the course also serves to better understand the general workings of a manufacturing organization.

I. Course Structure

The CIM course is divided up into seven components - two exams, two projects, field visits, readings, and class participation. Each exam is worth 15% of the total grade, a signal to the student that traditional exams are *not* the most important element of the course. The focus of the exams is largely conceptual with exams being mostly essay questions where the student is asked to prepare a memo to a VP of Manufacturing, CIO, or other senior executive. The purpose of the essay exams is two-fold: 1) to ascertain the student's general knowledge of the subject area of the question asked, and 2) to determine whether the student can express in writing, views, thoughts, and ideas that are organized and presented in a logical and coherent fashion. Technical exam questions may relate to concurrent engineering, benchmarking, CAD/CAM integration, MRP II, master scheduling, shop floor control, IS integration, and theory of constraints. Example topical areas from the essay exams in fall, 1996 included:

- why is the concept of CIM important to a modern manufacturing organization;
- why is 'speed to market' an important issue and what should be included or considered;
- discuss the role of competitive benchmarking including what areas should be benchmarked, metrics to be employed, and steps that could/should be included;
- what are the non-technical, business issues surrounding CAD/CAM including information systems integration;
- what are the major issues surrounding the IS organization including understanding of reasons for both outsourcing and downsizing, plus appropriate use of metrics or critical success factors;
- what is meant by reengineering including why is this term of importance/relevance to the manufacturing firm facing global markets, downsizing, restructuring, as well as refocused strategies that are collectively performance, cost, customer satisfaction, and quality driven.

In the first of two course projects (15% of total course grade) the student is expected to prepare a brief report developing a philosophy and framework for including, expanding and/or modifying the IS/IT organization into the strategic fabric of a manufacturing firm. The student may choose to focus on one particular functional area, such as mechanical engineering, where they may be expected to be employed in the future. The report is to be directed to a functional area VP or the CIO. The student is cautioned that, in developing their philosophy and framework, they may be called upon to implement any ideas proposed, such as was personally experienced by the author/instructor. This cautionary note was also intended to warn the student against proposing unrealistic recommendations. To provide background for this project report, a scenario was provided where the IS department in a manufacturing organization has a history of not getting reports out on time, reports that are inaccurate, past implementation projects that have been less than successful, and an IS environment that is generally under considerable pressure from top management to both improve performance and provide metrics proving the contribution of IS to the total organization. A related perspective is to suggest that the engineering organization and

IS organization are at odds over ownership of the CAD/CAM database, or that problems exist within engineering related to processes that need documentation for ISO 9000 purposes, and/or systems problems related to the handoff of new designs from design engineering to manufacturing engineering.

In the second course project (35% of total course grade) each student is expected to engage in a personal project or work in a small group (restricted to three or less students) with a local manufacturing firm. These projects involve real problems and may be arranged for by the instructor or sought out by the students. The purpose of the project is for the students to investigate/research in-depth and report on a topic area of the firm's choosing and of interest to the student team. The project must be within the domain of CIM and is subject to instructor approval. 'Value-added' to the firm is expected. A hidden agenda of this project is development of teamwork skills. The project should contain a perspective that includes some consideration of the information systems function as well as metrics that define (if possible) project success. Also, the project should include elements that describe how successful conclusion of the project fits into an overall plan or framework for continuous improvement. The project 'deliverable' is to be determined by the student and project sponsor with a cautionary note to the student to scope the project within reason, allowing for the amount of time that the student can reasonably spend on this one project.

The second project includes a stand-up, professionally prepared, oral presentation to the entire class. This is in lieu of a final exam. The project may also be presented at the company site wherein the research or project activity was undertaken. As instructor, all external presentations are scheduled to include the instructor's presence. Several of these projects have resulted in additional work by the student(s) after the course has concluded, an internship, and even full-time employment following graduation.

The final elements of the grading structure include assigned readings (10%) and class participation (10%). Points toward a course grade for assigned readings are generally a 'given' unless it is discovered that the student is not cognizant of the main points from these readings. Articles are distributed to each student versus putting them on file in the library. The latter strategy has not worked historically. Other means of student's acquiring readings, such as purchasing copies of the articles through the bookstore or Kinkos has not been done because of copyright concerns and the fact that articles turnover about 50% from year to year. Class participation points are assigned based on the quality, versus quantity, of student's comments both during class and at the various company visitations. Foreign students often end up with fewer points in this area as the culture from which these students emanate may not be conducive to the student speaking up in class, e.g., female students from the far east, or students who are hesitant to speak up for fear of making language mistakes.

II. Field Visitations

A major component of this course is field visitations to firms, mostly in the manufacturing community and in the physical proximity of the university. However, two visitations are included to non-manufacturing firms. One non-manufacturing visit is to a major retail distributor

whose distribution center territory covers several states. Another visitation is to the local hospital to understand the role of information systems related to the operations function in a service environment. Trips to local firms are organized in the following manner:

- firm 1 -- small, family owned business producing commercial lawn care products with a growing international sales base and virtually no history of CIM usage;
- firm 2 -- global Fortune 500 firm with heavy usage of CIM including flexible manufacturing systems, operations in one area paralleling a 'lights-out' facility, high usage of manufacturing cells, plus issues related to integrating CAD/CAM into the remainder of the business, IS in particular;
- firm 3 -- a consumer products firm within a large conglomerate who is experiencing organizational and integration issues due to corporate restructuring, including infusion of products and product lines quite dissimilar from historical core competencies;
- firm 4 -- a national brewery who is simultaneously experiencing internal pressure to change and corporate resistance to locally promoted changes;
- firm 5 -- a multi-state distributor for a national chain of retail stores with a mix of automation and productivity issues;
- firm 6 -- a plastics parts manufacturer that is a separate division of one of the firms previously visited;
- firm 7 -- a small electronics manufacturer who has recently been acquired by a large national firm and who also has seen a dramatic change in their product lines, marketplace, and channels of distribution;
- firm 8 -- a Fortune 500 firm of consumer and medical-related products who has been following a CIM strategy related to manufacturing processes for several years, and who is currently addressing core competency and IS restructuring issues;
- firm 9 -- a Fortune 500 firm in the electronics arena whose primary focus is making printed circuit boards for other divisions within the same company, and who is simultaneously experiencing outsourcing pressures and quick delivery issues;
- firm 10 -- another division within the Fortune 500 company represented by firm 9 and whose focus is high-mix, low volume production of printed circuit boards, and also experiencing similar business pressures as firm 9;
- firm 11 -- the local hospital who is constantly under pressure to modernize their information systems while facing conflicting change management pressures from the medical establishment, plus efficiency pressures from HMOs, insurance companies, and regulatory authorities.

These company visitations are the part of the course that are perceived as most valuable (and enjoyable) for all students, regardless of discipline, if for no other reason than to see what real companies are doing and real problems being experienced. It is highly likely that some graduate students without relevant work experience have never visited a manufacturing facility prior to taking this class. These visitations generally follow a format of a quick introduction to the company followed by a walking tour of key areas where specific operations and/or functions can be viewed. The last part of each tour is a 'Q & A' where students are encouraged to pose questions to managers, engineers, and/or technical specialists. In addition to the plant visits, one or two guest speakers are scheduled for in-class presentations on topics related to CIM.

III. Lecture Topics

Lecture topics in the CIM course are structured along functional area views of CIM. After a 'big picture' overview of a manufacturing environment is presented, including global considerations, lectures begin with an engineering perspective of CIM, followed by an IS perspective, and concludes with a multitude of issues in the operations area. For example, the class discussion on CAD/CAM focuses on CAD/CAM databases, 'islands of information,' and ownership of these databases. Also, CAD/CAM is discussed as part of a concurrent engineering strategy. Applications of CAD/CAM are viewed in several field trips. Readings are provided to address various organizational and strategic/policy issues. Economic issues, including metrics, related to using robotics, bar code systems, AGVs, flexible manufacturing systems, group technology, are discussed in general. Other lecture/discussion topics related to engineering include concurrent engineering and 'speed to market.' The purpose of these class discussions is for the business student to understand engineering views and perspectives, and the engineering student to understand these same issues from a larger business perspective.

Other lecture topics include changes in the IS/IT domain including client-server versus 'legacy' mainframe systems, relational versus object-oriented database management systems, internet and intranets, plus organizational, performance, and political issues facing the IS community. IS metrics receive a considerable amount of attention since this is a common theme in both firms visited plus readings pertaining to other national and international firms. Subjects of downsizing and outsourcing are woven into these discussions as well as change management and reengineering. Elements of project management are also discussed in the context of managing both small and large IS projects and dealing with scope, schedule and resource issues across the entire organization. An attempt is made for students to understand how pressure on the IS organization is increasing as global and domestic competitive pressures are constantly increasing.

Lectures related to the operations area include MRP II, master production scheduling, and theory of constraints. By the time these lectures are given, students have heard several references to a company's MRP system and are sufficiently curious to request class time on these subjects. Similarly, class time may include a guest lecture on a current 'hot' topic such as SAP or changes occurring related to the quality movement. As instructor, it is important to lay the foundation for these discussions and then step out of the way and let the discussion develop in a directed fashion. Given the amount of course time spent in the field, there is no way that all material that should be lectured on and discussed, may adequately be covered.

Finally, the last lecture/discussion topic area relates to outside consulting activities of the instructor. These discussions generally focus on problems related to change management, reengineering of business processes, or a systems conversion project that the author has been involved with recently. All of these discussions are meant to focus on CIM as an integrative concept versus details of hardware, connectivity and/or software. Students quickly learn that the *real* issues related to CIM are not technical and most often relate to people, strategy, organizational pressure to produce specific performance results, and politics.

IV. Conclusion

If the CIM course described above is at all successful it is because of the applied focus given to the major components of lecture, field visits, projects, and assigned readings. Students may complain about the number of readings, the time it takes to make field visits that is over and above 'normal' class time, and the time to engage in a worthwhile class project. However, these complaints are minimal. The course is intended to provide both perspective and focus into real issues facing a modern manufacturing environment. This includes small as well as large firms. CIM is a philosophy that takes on different meanings depending on whether the functional view is engineering, information systems, or operations management. It is deemed important to develop in the mind of the student a 'big picture' framework of a modern manufacturing environment. This framework, independent of a student's academic orientation, must include the realization of the difficulties of managing all functional areas in a constantly changing, rapid-paced, competitive environment. This changing competitive environment includes a growing global perspective plus increased pressure for customer satisfaction, quality, cost control, and profits. Both engineering and business students are viewed as benefiting from a philosophy of CIM that includes multi-functional perspectives accompanied by a communications focus. An understanding of the importance of hands-on projects where the student must learn first-hand about communication skills, organizational politics, plus the difficulties in working in a team environment, may not be truly appreciated until the student leaves the university and is off on his or her own. Practitioner guest speakers speaking on the same subjects that are being read about and discussed in class also provides credibility to the importance of these same subjects. Students learn that the real CIM issues are rarely technical, but most often people, communications, teamwork, and organizational related.

Bibliographic Information

F.C. 'Ted' Weston, Jr. is Professor of Computer Information Systems in the College of Business at Colorado State University. He is an active consultant in the manufacturing community specializing in information systems implementation, change management, quality, applied statistics, and management science.