

The Information Technology Legacy and Future Directions at MIT

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Abstract

The Information Technology group at the MIT Sloan School of Management has two principles that underlie its research, teaching, and professional activities. The first is a balance and depth on both the organizational and technical aspects of information technology. The second is the striving for innovation, leadership, and excellence.

Current IT Academic Staff:

Eric Brynjolfsson, Geoffrey Brooke, Randall Davis, Amar Gupta, Chris Kemerer, Dick MacKinnon, Stuart Madnick, Tom Malone, Jeff Meldman, Wanda Orlikowski, Jack Rockart, Michael Scott Morton, Richard Wang

Former members of IT Academic Staff (partial list):

Tom Gerrity, Jawaid Ghani, Anthony Gorry, John Henderson, Peter Keen, Lyn Markus, David Ness, Michael Zisman

1. Introduction

The identity and goal of the Information Technology (IT) Group at the MIT Sloan School of Management can best be understood by considering it in three levels:

- The Critical Perspective: Who and what we are
- Our Strategic Vision: What we want to do
- Enabling Methodologies: How we will get there

1.1 The Critical Perspective

We believe that information technology is the essential technology underlying management. From spreadsheets used in decision support of an individual, to knowledge-based expert systems employed to capture expertise and maintain a corporate memory, to a distributed network of machines and people spread across a continent, information technologies play a crucial enabling role in management. Information technology is the technology of management.

This view is particularly appropriate both for our group and for the MIT Sloan School of Management. The strengths of our group make it possible - the IT Group is unique among business schools in having the depth and breadth of faculty capabilities to exploit and pursue this view. The strengths of MIT make it particularly effective - the Institute's historical strengths in technology offers a unique leverage and a natural connection to the rest of the institution.

1.2 Strategic Vision

We see two foci as central to our strategic vision: the study of cooperative work and management of information technology.

The increasingly widespread use of IT has made it evident that a crucial challenge looming in IT and in organizations is the problem of cooperative work. The problem exists at all levels, from multiple different word processors with incompatible file formats, to multiple spreadsheet users with slightly different, incompatible models, to multiple distributed databases with incompatible structures, to multiple distributed branches of an firm with incompatible structures and models, we are faced with the difficulties of getting information processors (both machines and people) to work together cooperatively. We focus on this problem in many forms, including:

- IT to support group problem solving and design
- IT to enable cooperation between disparate organizations
- IT to facilitate computer-supported cooperative work, from intelligently routed electronic mail to new ways to design organizations.

A second crucial challenge in information technology lies in its management. The importance of IT, its rapid evolution, and relative unfamiliarity in many organizations all combine to produce management problems of considerable size and difficulty. Managers must be concerned with both the introduction of new technologies and management of new kinds of resources (e.g., corporate databases).

1.3 Enabling Methodologies

The research interests and accomplishments of the IT Group faculty provide the tools and methodologies we use in attacking these problems. For our focus on cooperative work we have experience and strength in information system connectivity (encompassing the range from physical connectivity to organizational and strategic connectivity) [Madnick, MacKinnon], knowledge-based expert systems [Davis], coordination theory [Malone], management of interdependence [Rockart], and the organizational cooperation [Orlikowski].

For our focus on management of IT we have strength in prioritizing the introduction of technology [Rockart], performance measurement [Kemerer], economic measurement [Brooke, Brynjolfsson], and the legal and ethical issues surrounding IT [Meldman].

The members of the Information Technology pursue these goals both through their individual efforts and through the various affiliated research centers, including: the Center for Information Systems Research (Jack Rockart, director), the Center for Coordination Science (Tom Malone, director), the International Financial Services Research Center (Stuart Madnick, Research Advisory board), the Artificial Intelligence Laboratory (Randall Davis, co-director), the Laboratory for Computer Science, and the Center for Transportation Studies.

Our enthusiasm for this perspective and vision is supported by our belief in three key hypotheses:

- Our strategic view of IT provides an important and differential vision for Sloan and MIT,
- The technologies and methodologies listed are critical and necessary to effectively attain that vision, and
- Sloan's IT Group is uniquely positioned, both in terms of past accomplishments and current capabilities, to pursue these goals and make the vision a success.

2. Background

2.1 Research Contributions

Early recognition came to the IT group for its work in Support Systems. The field was pioneered by Michael Scott Morton, the creator of the Decision Support Systems concept. Scott Morton authored the first papers and the first book defining the concept and creating a new and important field of computer usage. Peter Keen followed closely on his heels, defining the new processes of implementation for these systems, best expressed with a book co-authored by Scott Morton.

Rockart did significant work in another area of support systems, the field of Executive Support Systems. His Harvard Business Review article was the first in the field and the Rockart-Delong book on ESS has been the seminal book length treatment of senior executive use of workstations in the management of an organization.

Also, in the tradition of supporting managers with information, Rockart developed the concept and method of Critical Success Factors (CSFs), now used by a wide variety of consulting firms worldwide to assist managers in determining their information needs. Like "DSS," the letters "CSFs" have become a common expression and commonly used concept by practitioners of information technology management.

The group's contributions to the development of technology concepts have been similarly pathbreaking. Malone's work on the psychology of computer games is widely known and cited and has influenced development of educational software at many sites. His work on the Information Lens and Object Lens systems that use artificial intelligence techniques to help people share information in organizations, is widely viewed as prototypes of the new field of computer-supported cooperative work. Several major computer vendors are currently developing products that incorporate ideas from his research.

Davis has been providing fundamental contributions to the field of artificial intelligence and knowledge-based expert systems for the past ten years. In the early 1970s his early work at Stanford helped to define the field, assisting in the design and creation of the Mycin system, going on to create the first system for automating knowledge acquisition, and developing a number of subsequent major systems. His work on distributed problem solving provided concepts later employed by Malone in his work on electronic markets. More recently his work on model-based reasoning systems has set in a place a "next generation" of AI technology for the creation of expert systems.

Madnick is widely known for developing important concepts in database systems, file systems, and operating systems that have had a significant impact in both research and practice. He was co-author of one of the first and most widely used textbooks on operating systems, which has been used by more than 100 Universities and translated into 5 languages. He was a principal designer of IBM's VM/370 operating system and Lockheed's DIALOG information retrieval system and later designer of one of the first on-line fourth-generation languages for database processing. More recently, he has served as the principal investigator of the INFOPLEX Database Computer project and the Composite Information Systems Laboratory project.

2.2 Professional Contributions

The group has been instrumental in the development of the International Conference on Information Systems (ICIS), the major broad-focus MIS/IT academic conference. Three past or present Sloan faculty, (Henderson, Keen and Rockart) were among the group of founders of the conference. Rockart has twice served as Conference Chairman. Henderson has twice served as Program Chairman. Both have served on the executive committee of the conference.

Madnick has been instrumental in the establishment of the International Conference on Very Large Databases (VLDB), the premier conference on databases; he was also a founding member of and former chairman of the IEEE Technical Committee on Database Engineering. Kemerer was one of three founders of and co-chair of the first Workshop on Information Systems and Economics (WISE) and Wang was the organizer of and co-chair of the first Workshop on Information Technology and Systems (WITS). Davis has been program committee member for the two pre-eminent AI conferences (the American Association for AI, and the International Joint Conference on AI). Malone has organized workshops on cooperative work; Davis organized a series of conferences on distributed problem solving.

Members of the group serve on a wide variety of editorial boards, including: *IEEE Transactions on Industrial Electronics*; *Human-Computer Interaction*; *MIS Quarterly*; *Artificial Intelligence*; *AI in Engineering*; *New Generation Computing* (journal of the Japanese 5th Generation project); *Knowledge Engineering Review*; *Accounting, Management, and Information Technologies*; *Organizational Computing*, and others.

The IT group at Sloan is also known for its Center for Information System Research (CISR). Founded more than fifteen years ago, the Center has been supported by 25 companies for most of the past decade, providing research funding for faculty and doctoral students as well as research support for the faculty. The Center has a reputation as the leading national information technology research center in a school of management. As one measure of its success, its sponsorship fees are approximately five times those of the dozen other, more locally oriented, "clones" that now exist.

3. Current Environment

The IT group enjoys a preeminent position among MIS faculties in Schools of Management. In a recent evaluation of Business Schools, for example, the Sloan School was ranked first with respect to its contributions in the Information Systems area. The PhD program reflects this as well: it receives more

than fifty high quality applications for the program each year. In the last five years, there have been only two students admitted into the program who have chosen to go to a competitive program. The PhD graduates are sought after and placed in the best universities. The high level of demand and perceived quality is also demonstrated in the M.B.A. and undergraduate programs.

Our faculty have historically had a high level of research support from external sources, including both government (e.g., DARPA, NSF) and industrial sponsors (e.g., DEC, Wang, the 25 CISR sponsors), with grants ranging in size from single-person research efforts to multi-million dollar research programs.

3.1 Recent Research Activities

The increasingly widespread availability of information from numerous sources both within and external to organizations and the rapid changes in information technology pose significant opportunities and challenges to management. The Information Technologies group is addressing these issues by experimenting with new technologies such as expert systems and heterogeneous databases, by examining a variety of strategic information applications, and by studying underlying organizational issues.

Professor **Randall Davis** continues his artificial intelligence studies of model-based reasoning of "how things work" and of the attributes of good representations of knowledge. He has also initiated new research on developing methods for cooperative multi-expert knowledge acquisition and the policy implications of knowledge transfer in global markets. Professor **Thomas Malone** established the Center for Coordination Sciences which focuses on developing a body of principles about how separate actors (whether people, computers, or mixed) can coordinate their activities. Specific activities include the development of computer systems that help people work together in groups and organizations, predicting and suggesting changes in human organizational structures that accompany the use of information technology (e.g., will information technology increase the desirability of market coordination over hierarchical coordination), and developing computer systems whose internal structure is based on insights gained from analyzing human organizations. In related research, Professor **Stuart Madnick**, in cooperation with the International Financial Services Research Center, has been analyzing Composite Information Systems (CIS) that facilitate applications requiring inter-organizational coordination (e.g., between supplier and buyer) and intra-organization coordination (e.g., between branches in New York and London). A prototype system, called CIS/TK, which currently

integrates five disparate information systems has been developed by this group. Professor **Richard Wang** is working on the issue of "where is the data from?" in Composite Information Systems by means of a Polygen Model he has developed for tagging data sources in heterogeneous database systems. In addition, he has worked with Professor Madnick and Dr. Yang Lee on modeling the cooperating and competing forces in organizations through the concept of territorial entity.

Professor **Chris Kemerer** has developed models to aid the management of software development and maintenance, and is developing and testing measures of software productivity and quality. An important focal point of his research is the study of and evaluation of the efficacy of new Computer-Aided Software Engineering (CASE) tools. Dr. **Jeffrey Meldman** continues to track developments in the legal protection of information, particularly proprietary rights in software and personal rights of privacy. Professor **Wanda Orlikowski's** research concerns the relationship between information technology and applied organizations. She has continued her research into the automation of systems development work, and begun two studies: one examining the role of electronic communication media in coordinating work, the other into the restructuring of organizations through information technology. Dr. **John Rockart** continues his work on critical success factors and management of data resources. He is expanding his work on Executive Support Systems downward into the organization as Management Support Systems and is exploring the use of information technology to manage interdependent organizations of a firm. Professors **Eric Brynjolfsson** and **Geoffrey Brooke** are evaluating previous attempts to evaluate the impacts of information technology on the firm and developing new and more reliable economic measures.

Acknowledgement

Although the author takes sole responsibility for this article, he has attempted to draw together ideas and viewpoints from all members of the Sloan School IT group, both past and present. Parts have been taken from an earlier report largely authored by Randall Davis.

Appendix

The article that follows is reproduced from the Fall 1990 issue of *MIT Management* magazine

Sloan's triple crown

It's hard to be all things to all people. But that's exactly the feat that has been accomplished by the

Information Systems group headed by Stuart Madnick, John Norris Maguire Professor of Information Technology. In a recent sweep of honors, the group headed three independent lists grading U.S. business schools' graduate IS programs.

Coming out on top of the surveys--each of which used different methodologies and criteria--suggests that Madnick's group has achieved a breadth of expertise and notoriety that puts it in a class by itself. Only one other school--the University of Minnesota--even appears in the top five slots of all three surveys.

In an exclusive report on IS graduate programs published last October by *Computerworld*, Sloan came out number one in a survey of 250 corporate recruiters, academics, and IS executives. The School won highest marks for placing graduates in high-level positions and for the quality of its research programs.

A University of Maryland study, also published last October, assessed faculty scholarship at thirty-two leading business schools. MIT's management school came out first overall, as well as in IS. The study made relative evaluations of scholarly achievement by measuring the number of publications in leading academic journals, citations by other authors, and peer ratings of scholarship. Data was collected concerning 2,410 faculty members at the thirty-two schools.

U.S. News & World Report, in its March 19 edition, placed MIT's IS department in the lead in terms of reputation among deans and heads of MBA programs across the country. (Sloan rated fifth in the overall business school rankings, while achieving the somewhat dubious distinction of commanding the highest tuition of the top twenty-five schools).

The objectives and methodologies of the three surveys varied widely. *Computerworld's* study gives the strongest indication of schools' reputations among recruiters and executives in the field. *U.S. News*, on the other hand, looks at schools' reputations from the vantage of their peer institutions. The University of Maryland assessment stuck to a purely research perspective, focusing on scholarly achievements.

Madnick, whose tenure at Sloan stretches back eighteen years, employs a researcher's healthy skepticism in evaluating the import of the findings. "You have to look at all these studies with a lot of grains of salt," he says. Pointing out that ranking surveys often contain methodological weaknesses in the way they choose, measure, and evaluate criteria, Madnick nonetheless adds, "That doesn't mean there's nothing to be gleaned from them."

He says that, taken together, the surveys paint a three-dimensional image of Sloan's department as having the highest standards in teaching, research, and career placement in the country. Few IS graduate programs can claim such a broad scope of excellence, he notes.

He says that the IS departments' across-the-board strength lies in its readiness to accommodate faculty with disparate ideas and backgrounds. Whereas some schools emphasize either strategic applications of technology or analysis of technology's fundamental underpinnings, Sloan seeks to do both. "To have both those strengths in one schools is very unusual," he says. "In other schools, they are seen as antitheses."

At Sloan, Madnick adds, these contrary approaches can cohabit peacefully because in a small academic community "people have to get along" and because the School's strong research emphasis breeds tolerance of other people's ideas.

He also attributes the School's success to its approach in recruiting new faculty. "We're willing to take people who don't necessarily fit the standard mold," he says. Sloan's IS faculty, he adds, are "shakers and movers," people who have "fresh and very powerful viewpoints" to share. And he points to faculty members such as Senior Lecturer Jack Rockart, Associate Professor John Henderson (Management Science), Professor Randall Davis (Management Science and Computer Science and Engineering), and Thomas Malone, Patrick J. McGovern Professor of Information Systems, as role models who inspire other members of the group, as well as students -- A.K.