Critical Skills and Knowledge Requirements of IS Professionals: A Joint Academic/ Industry Investigation[1]

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Abstract

This study was initiated in response to concerns expressed by the membership of the Boston Chapter of the Society for Information Management (Boston SIM) to investigate anticipated changes in the information systems (IS) profession, to study the impact of these changes on the skills and knowledge requirements, and to relate these requirements to the academic preparation of future IS professionals. To provide as broad a perspective as possible, the study was conducted by a joint industry/academic group of investigators. A series of focus group meetings was conducted first with representatives of the profession's different stakeholder groups (i.e., IS managers, user managers, and IS consultants) for issue generation. A survey instrument was then designed for data collection on computing trends and changing knowledge and skills requirements.

Overall, our study suggests that industry will demand a cadre of IS professionals with knowledge and skills in technology, business operations, management, and interpersonal skills to effectively lead organizational integration and process reengineering activities. The lower-level IS jobs are rapidly disappearing, and the requirements for IS professionals are becoming more demanding in multiple dimensions, particularly in the areas of business functional knowledge and interpersonal/management skills. Our results also found some clear patterns in IS staffing and activity trends that point to the shift in emphasis from a traditional, central IS organization toward a more decentralized, end-user-focused business orientation. Aligning IS solutions with business goals and needs as well as building the infrastructure for technological integration are becoming the top priorities for IS activities. Our results indicate these changes will likely lead to different career tracks with differing emphasis on the multi-dimensional knowledge/skills for IS professionals.

The realignment of IS activities in organizations will require corresponding re-structuring of IS curricula at universities. Our findings suggest that current IS curricula are often ill-matched with business needs. Many subjects emphasized in the typical IS curricula are assigned low priorities by practitioners, while there is pressing need to add both breadth and depth to the education of IS pro-

fessionals. We argue further that the concept of a generic curriculum to meet the educational needs of all future IS professionals is obsolete, and different IS curricula must be tailored to meet the needs of different IS careers. These career-driven IS programs will require the adoption of multi-disciplinary approaches and educational innovations for adding breadth, depth, and relevance to the curriculum in accordance with the focused mission of each specific program.

Keywords: Human resource management, IS career path, IS curriculum, IS education and research, IS skill requirements, IS training and development, IS staffing issues, SIM

ISRL Categories: EBUF, EH02, EH0201, EH0206, EH0208, I, IA01, IC01

Introduction

Few professions have seen as rapid a change over the past several decades as the field of information systems/services (IS). Today, computers not only provide the backbone of information processing for organizations, they are also changing in fundamental ways how organizations operate (Child, 1987; Davenport and Short, 1990; Hammer, 1990; Verity, 1990; Zuboff, 1982).

These changes in information technologies and their use create different demands on the jobs of IS professionals and new expectations about the roles of IS professionals within organizations (e.g., Keen, 1988b). Concerns have been raised by business executives and educators regarding the knowledge and skills that are required for IS professionals to function effectively in the changing technological and business environments, as well as how university curriculum must be revised to meet the changing needs of the profession (e.g., Nelson, 1991; Niederman, et al., 1991; Weiss, 1987; Yaffee, 1989).

Recognizing these growing concerns among the various constituents of its membership, the executive board of the Boston Chapter of the Society for Information Management (Boston SIM Chapter) initiated a series of open forums to address the changing human resource needs of the IS profession. These forums, which began in 1987, started a continuing dialogue among IS practitioners and academicians in the New England area and led to a formal joint research project supported by the Boston SIM Chapter.

The objectives of the research project were to investigate the changing skills and knowledge requirements of the IS profession and to relate these requirements to the academic preparation for future IS professionals. The key research questions posed by the constituents of the Boston SIM Chapter were:

1. What are the expected future changes in various types of IS jobs?
2. What are the expected changes in the portfolio of critical activities performed by IS professionals?
3. What are the expected changes in the critical skills and knowledge required by IS professionals?
4. Do perspectives on the human resource needs of the IS profession differ among the various constituents (stakeholders)?
5. What are the implications of these expected changes on IS curriculum design?

This paper, based on data collected from various industrial participants during the research project, reports the changing IS human resource needs as they relate to the re-alignment of IS activities at the work place. It also discusses the implications for redesign of the IS curriculum.[2]

Pressures for Change

There is considerable agreement among practitioners and academic researchers that the job requirements and the associated knowledge/skills needs of the IS professionals are changing rapidly (e.g., Forcht, et al., 1987; Hartog and Rouse, 1987; Kirkley, 1988; McCann, 1992). As part of a series of research studies that examine critical IS issues, Niederman, et al. (1991) found that the need to improve IS human resources is quickly emerging as a high priority in the 1990s among IS executives.

[2] An earlier paper contrasted the skills/knowledge requirements of IS professionals as perceived by industrial participants and university educators (Trauth, et al., 1993).

To understand how the profession might need to change, it is useful to analyze the following forces that have been driving the changes: (1) the changing technologies; (2) the changing business environment; and (3) the changing role of IS in organizations.

Changing technologies

IS professionals face a basic challenge in assimilating the ever increasing amount of new knowledge in the field. Few technologies in human history have advanced as rapidly as computing technology has in the last several decades. Cost/performance ratios of microprocessors have improved at exponential rates (Benjamin, 1982; Friedrichs and Schaff, 1982; Port, et al., 1994). Similarly, impressive gains have occurred for storage technologies, input/output devices, and communications. These rapid changes also apply to computer science and software development methodologies. Not only have programming languages evolved from one generation to the next, but new development methodologies and tools such as CASE have changed the way we manage the software development process. Advances in the areas of artificial intelligence, expert systems, group decision support systems, neural network computing, massive parallel processors, and networking and telecommunication technologies have provided drastic new capabilities for computer systems. As technology experts within their organizations, IS professionals are expected to stay abreast of these developments and to provide assessment and advice to users. The burden of effectively dealing with the complexities and uncertainties associated with new technologies and ensuring the smooth adoption and operation of these technologies invariably rests on the shoulders of the IS professionals.

Changing business environment

The challenges of information technology implementation faced by IS professionals go beyond solving technical problems. As business environments become increasingly competitive, IS professionals, faced with more stringent pressure for resource allocation, must search for more cost-effective ways to apply computer technologies to solve business problems, and they must demonstrate to upper management that information technology investments will provide commensurate returns (Kay, 1989). Many business executives recognize that information technologies can provide businesses with powerful strategic weapons (Cash and Konsynski, 1985; McFarlan, 1984; Parsons, 1983). Classic case studies such as American Hospital Supplies, American Airlines, and Otis Elevator have demonstrated how information systems can provide strategic, competitive advantages to companies and how they alter the infrastructure of industries (Cash, et al., 1983; Davenport, 1993; Keen, 1988a). However, recent research studies have found mixed relations between investments in computer-based technologies and productivity improvements for businesses (e.g., Brynjolfsson, 1993; 1994; Kelley, 1994; Lee and Heiko, 1994; Loveman, 1988; Roach, 1989).

In most cases, achieving the effective application of information technologies for competitive operational advantage requires that the business processes be reengineered (Davenport and Short, 1990; Hammer, 1990). The assessment of new information systems thus includes the consideration of radical change to business processes as well as to technologies. This implies that it is no longer adequate for the IS professionals who are responsible for design and implementation to be competent only in technology; they must also have an in-depth understanding of business functions and needs (Couger, 1988). In addition, this focus on process reengineering requires that IS professionals develop interpersonal and management skills to work with their functional peers in defining new ways to conduct business.

Changing role of IS

The rapid growth and diffusion of micro-computers and packaged software, the ease of technology acquisition by end users, and the downsizing of computing from mainframe-oriented processing to network-based, client-server computing have led to fundamental changes in the role of the IS function in organizations (Bulkeley, 1990; Goldberg, 1986; Guimaraes, 1986; Maglitta, 1993; Rockart and Flannery, 1983). The traditional role of the central IS organization as the sole proprietor of information technologies has been challenged (Farwell, et al., 1992). Dearden (1987) argues that the changing economics of information technologies, increasing user sophistication, and increased outsourcing of information systems will cause the central IS department to become obsolete and to "wither away." Others, however, believe that in spite of the undisputed trend toward distributed computing, certain vital IS functions such as data administration, telecommunication, networks, and systems integration must remain centralized to some degree (La Belle and Nyce, 1987).

Keen (1988b) proposes that IS departments must change from a "task orientation" to a "role orientation" in order to function effectively in the new business environment. With a traditional "task orientation," the task often becomes the end in itself, and the IS professional can lose sight of the larger goal that the system is trying to accomplish. This "task approach" reinforces an IS culture of narrow technical orientation and stubbornness, leading to the perception by the user community that IS is "unresponsive." Keen argues that future IS activities should be examined from a "role" perspective, which emphasizes the relationship between IS and users.

Keen is not alone in advocating a new role for IS. Sullivan-Trainor (1988a) suggests that many IS managers can work more effectively with users by assuming the role of internal consultants. Livingston (1989) points out that with the trend toward computer-integrated operations and the burden of IS to link and integrate the many disparate systems, the IS organization must play a cross-functional, liaison role within the organization. The proposition that future IS professionals will have to function more like change agents has been echoed by a number of other writers as well (e.g., Forcht, et al., 1987; Kopcych, 1986). Farwell, et al. (1992) proposes that the IS function must make a radical shift from being the proprietor of information systems and products to being a service provider to end users.

Pressure for curriculum change

These pressures to restructure IS activities and the resulting demands on the knowledge/skills of IS professionals have raised major questions among IS managers and educators regarding the effective education of IS graduates (Ball, 1988; Carlson and Wetherbe, 1989; Licker and Miller, 1989). In commenting on the failure to meet the challenges of the evolving IS profession, at least one vocal critic has condemned IS education as "a Twentieth Century disaster!" (Yaffe, 1989).

The potential gap between what industry will require and what IS education can provide has been further accentuated by demographic trends that project an acute shortage of qualified entry-level IS professionals by the year 2000 (Couger, 1988; U.S. Department of Labor, 1989). Universities have also become concerned about recent declines in IS enrollment and the need to understand more about industry's requirements for IS graduates (e.g., Schiffman, 1989).

Early dialogues among IS managers and educators during a series of open forums sponsored by the Boston SIM Chapter indicate that both sides must work together more closely to ensure that universities will provide appropriate education to meet the changing needs of industry. Our research represents the cooperative effort of a group of regional IS managers and educators working as equal partners to investigate the changing skills/knowledge requirements of the profession and to relate these changing needs to curriculum design.

Methodology

Due to the emerging nature of the human resource issues and the difficulty in applying established measures, the research team adopted a multi-step field research approach to guide the research data collection. The first phase of the research project involved a series of open forums and focus group discussions for issue generation. An open forum on IS curricula and careers was organized to identify and discuss the key issues facing the IS profession. As a result of these discussions, involving about 50 people from various industries and universities, an initial set of issues regarding IS human resource needs in industry and education was recommended for consideration.

A key observation that emerged during these initial discussions was that the perception of IS human resource issues and the critical skills/knowledge requirements might vary among the different professional stakeholder groups (e.g., IS managers, business/user managers, or consultants).[3] To explore the issues in greater depth and to compare the possible biases among stakeholder groups, a series of focus group meetings was held. These focus group discussions were designed to generate more specific questions for subsequent data collection and to insure consideration of the viewpoints of the different constituents of the profession. Each focus group, facilitated by a member of the research team, was attended by a specific stakeholder group. Each focus group discussion was guided by a set of questions concerning IS staff hiring requirements, competencies required for success, and future trends for the IS profession. The comments made by the participants during each session were transcribed and then content-analyzed for issue generation (Farwell, et al., 1991).

Based on these issues generated by the focus groups, the research team developed a survey instrument for more systematic data collection. Slightly different versions of the survey instrument were used to collect data from different respondent groups, reflecting differences in the respondents' general background and in the type of information they would be most qualified to provide (see Appendix 1). The three stakeholder groups targeted for the analysis in this paper included: (1) IS managers; (2) business/user managers; and (3) IS consultants.[4]

Several considerations guided the choice of these groups for our survey. First, the rapid growth of distributed computing and the trend toward downsizing of computing platforms could create different priorities for IS activities between the central IS function and the business user areas (e.g., Couger, 1988; Kerr, 1989). Second, to reduce costs or improve performance, companies have been increasingly outsourcing certain types of IS development and support services to outside consulting firms (e.g., McFarlan and Nolan, 1995). Since organizations tend to hire outside consultants for those activities they can perform at a comparative advantage, the portfolio of the outsourced IS activities could differ significantly from the IS activities kept in-house. Third, because of their work relationships with multiple clients, consultants could provide a broader perspective of industrial trends.

The Boston SIM Chapter membership list was used for the survey of IS managers and consultants because the SIM chapter is the largest professional organization of IS executives and managers in New England and because the membership database separates IS managers and consultants. In order to obtain more meaningful comparisons, it was decided that the surveys for the business/user managers should come from the same organizations as the IS managers. Hence, each IS manager in our survey was asked to pass along a second questionnaire to a user (non-IS) manager in a business area (e.g., the manufacturing, product, or service division) within his or her own company. This method of data collection to obtain corresponding views from IS and business managers is similar to the one used in an earlier study by Brancheau and Wetherbe (1987).

The IS and user managers were asked to respond to the survey with respect to IS human resources and activities under their direct control. IS managers provided information about the people and tasks within the central IS function, and business/user managers provided information about the IS staff and tasks within their own divisions. For example, a staff member assigned by the central IS organization to implement a system in a user area is considered to be under the jurisdiction of the central IS, while an IS staff member who reports directly to a business manager is considered to be within the jurisdiction of the user manager. Finally, IS consultants provided information based on the work they perform for their clients in different organizations.

The questionnaires were pilot-tested using a group of 20 IS managers and consultants. Final

[3] In this study, IS managers work for the central IS function; business/user managers work in non-IS divisions but manage IS resources as part of their overall job function; IS consultants work as independent contractors for client firms.

[4] The survey also included two other stakeholder groups, i.e., university professors and recent graduates. The results for the university participants are discussed in a separate paper (Trauth, et al., 1993).

questionnaires were mailed to 123 matched pairs of IS managers and user managers, as well as 150 IS consultants, based on the Boston SIM Chapter membership list. Because the Boston SIM Chapter membership database was used to identify survey recipients, the survey population was limited to the New England states in the northeastern United States.

Table 1 shows a profile of the survey respondents from the three groups of practitioner stakeholders. A total of 98 usable survey responses were received. The highest response rate (42.3 percent) was from the IS managers, while the response rate for IS consultants was 20.7 percent and the response rate for user managers was 13.0 percent. The low response rate among the user managers was probably due to the indirect nature of questionnaire distribution to this group, and it is similar to the response rate reported in the earlier study by Brancheau and Wetherbe (1987). A comparison of the survey respondents to a profile of the SIM Chapter membership did not reveal any systematic biases between the respondents and nonrespondents.

The IS and non-IS manager respondents in our sample came from both the manufacturing and service sectors. The majority of them worked for medium to large companies and most held senior management positions in their organizations: among the IS managers, 85 percent were either corporate or divisional IS executives, while among the non-IS managers, 44 percent were senior executives.

The IS managers had an average of 19.4 years of professional experience, the user (non-IS) managers had an average of 15.2 years, and the IS consultants had an average of 20.3 years. Among the user managers, about half worked in cross-functional areas. The IS consultants were engaged in diverse consulting and job placement activities for different industries; 77 percent were involved with business/systems consulting, while 23 percent were involved primarily with training, education, and job placement.

While the survey sample was somewhat limited and the response rates from the different stakeholder groups were lower than expected, the survey nonetheless solicited input from a very experienced group of senior managers and IS consultants.

Data collection

The data collection method used in our survey differed somewhat from those used in several prior studies of critical IS issues reported in *MISQ*. The prior studies relied primarily on Delphi surveys for issue generation and ranking/rating (e.g., Brancheau and Wetherbe, 1987; Dickson, et al., 1984; Hartog and Herbert, 1986; Niederman, et al., 1991). From discussions with various industry participants, we found that more concrete data regarding IS human resource issues and critical knowledge/skill needs could be obtained by using a survey formulated in terms of specific activities or planned actions in the respondents' organizations. This focus on planned changes in IS human resource practices also has direct bearing on the recruitment and hiring of IS graduates, and therefore clear implications for the educational preparation of future IS professionals.

In this study, the changing nature of IS human resource needs is captured in terms of (1) the IS staffing pattern (i.e., the allocation of IS staff to various categories of IS jobs); (2) the portfolio of critical IS activities (i.e., the daily job functions of IS staff); and (3) the specific skills and knowledge requirements of IS professionals (i.e., skills and knowledge required for IS staff to do their jobs effectively). Respondents were asked to provide input about current IS human resource needs and perceived needs in three years. The three-year time horizon was chosen based on extensive discussions with a number of focus group participants and on feedback from pretesting of the survey instrument. The research objective was to obtain a time trend for *expected changes* in IS human resource issues. There was consensus among IS managers interviewed that a four- or five-year time frame was too far away to provide an accurate assessment of what might happen in their organizations, and a one- or two-year time frame was too short to cover some of the expected or planned changes.

Table 1. Profile of Respondents

	IS Managers (n=52; Response Rate=42.3%)		User Managers (n=16; Response Rate=13.0%)	IS Consultants (n=30; Response Rate=20.7%)	
Average Prof. Experience:	19.4 Yrs.		15.2 Yrs.	Average Prof. Experience:	20.3 Yrs.
Industry:				Nature of Consulting:	
Manufacturing:	58%		56%	Planning/Implementation/ Bus. Consult	77%
Service:	42%		44%	Education/Training/Placement	23%
Company Size:				Types of Consulting Activities Involved:*	
Small (< $250 Million)	18%		31%	Strategic planning	83%
Medium ($250 M–$1 Billion)	45%		38%	Needs assessment	73%
Large (> $1 Billion)	37%		27%	Systems procurement	43%
				Systems implementation	33%
Size of IS Staff:				Systems design	33%
Small (< 50 People)	27%		69%	Market analysis/forecasting	20%
Medium (50–500 People)	52%		25%	Contract programming	20%
Large (> 500 People)	21%		6%		
				Types of Job Position Placement for Clients:*	
Organizational Position:				Director of IS	17%
Corporate IS executives	58%	Senior executives	44%	Middle level IS positions	13%
Divisional IS executives	27%	Middle managers	44%	Project managers	13%
Middle level IS managers	15%	Other	12%	Systems analysts	13%
				Programmer analysts	13%
				Programmers	13%
				Telecommunication, networks	13%
				Database managers	10%

*Categories are not mutually exclusive.

Measurement

IS Staffing Pattern

IS staff allocation data were obtained by asking respondents to provide a breakdown of their current IS staff and their expected future staffing needs across five categories of IS jobs (see Table 2): (1) programmers, i.e., people doing software development, coding, software maintenance, etc.; (2) technical specialists, i.e., people with technical knowledge of specific hardware, operating systems, communication systems, database management systems, networks, etc.; (3) business analysts/systems analysts, i.e., people responsible for planning, analysis, design and implementation of business applications, (4) end-user support consultants, i.e., IS staff providing end-user computing support such as information centers, hotlines, help desk, and data retrieval; and (5) computer operators and data entry clerks.

These job categories are consistent with the classifications used in previous studies related to IS human resource needs (e.g., Nunamaker,

Table 2. Multivariate Analysis of IS Staffing Allocation Pattern

	Group I: IS Managers (n=38)				
	Job Category				
	Programmers	Technical Specialists	Bus./Sys. Analysts	End-User Support	Operators & Data Entry Clerks
Now	40.18%	13.17%	13.75%	7.88%	25.05%
Future	36.07%	15.69%	16.18%	12.41%	19.62%
	Group II: User Managers (n=13)				
	Job Category				
	Programmers	**Technical Specialists**	**Bus./Sys. Analysts**	**End-User Support**	**Operators & Data Entry Clerks**
Now	23.85%	20.96%	19.02%	5.82%	30.37%
Future	30.32%	13.22%	23.80%	7.96%	24.69%
	Group III: IS Consultants (n=26)				
	Job Category				
	Programmers	**Technical Specialists**	**Bus./Sys. Analysts**	**End-User Support**	**Operators & Data Entry Clerks**
Now	41.32%	14.53%	18.84%	11.22%	14.10%
Future	32.40%	16.11%	24.89%	17.40%	9.20%

Multivariate Analysis of Variance Results

Test involving Between-Subjects Effects:
GROUP Effect: Wilk's Lambda = .80; F=1.67; Not Significant, p >.05

Test involving 'TIME' Within-Subjects Effects:
TIME Effect: Wilk's Lambda = .49; F = 14.50; p <.001
GROUP BY TIME Effect: Wilk's Lambda = .60; F = 4.08; p <.001

et al., 1982), but they have been modified to reflect recent changes in business and computing trends by including "end-user support consultants" and adding "business analysts" in the "systems analysts" category. Overall, our respondents could easily map the IS employment patterns in their organizations to this job classification scheme.

Critical IS Activities

A modified systems development life cycle (SDLC), which provided a common framework linking IS professional activities and IS curriculum planning (e.g., Nunamaker, et al., 1982), was used to develop a list of critical IS activities. This framework included the traditional SDLC activities of (1) plan/manage; (2) analyze; (3) develop; (4) implement; and (5) support; as well as two additional categories of (6) integrate; and (7) train/educate. After several rounds of focus group discussions with IS practitioners and in-depth interviews with a group of 15 knowledgeable IS executives and managers, using these seven broad categories of IS activities as a guide, an initial list of 25 specific IS activities was generated. The final wording of these individual items was refined based on feedback from the survey pretesting.

Survey respondents were asked to rate the importance of these activities now and in the future (three years from now) using a five-point scale (with 1 indicating not important and 5 indicating extremely important). Preliminary factor analysis of these IS activities data found that there was no meaningful way to reduce these IS activities into a small number of factors (i.e., there were a large number of factors, and the factor loadings tend to differ by response groups, and for now vs. future). Three groups of scale items, however, were found to be highly correlated (i.e., "analyze business problems" and "analyze IS solutions to business problems" ($r=.66$ for now and $r=.73$ for future); "integrate existing business applications" and "integrate new business applications with existing applications" ($r=.78$ for now and $r=.82$ for future); "manage/plan corporate IS strategies," "identification of corporate strategy," and "manage/plan IS technology architecture." (Alpha = .91 for now and Alpha = .89 for future). The items in these groups were combined into single scales during the data reduction process. The means and standard deviations of the resulting 21 critical IS activities are provided in Table 3.

Critical Knowledge/Skills

Several approaches may be used to develop measures for different types of critical IS knowledge and skills. The first approach is to derive the different perceived dimensions of knowledge/skills empirically, i.e., by using exploratory factor analysis, based on responses to a set of questionnaire items. In this study, we were soliciting responses for the critical knowledge/skills for both a current and a future period. Since the perceived relationships among questionnaire items might differ over time, the empirical approach was deemed not feasible for this study.

A second approach is to define a priori the different constructs of the knowledge/skill set based on a specific theory. Building upon earlier work by Zmud (1983), Nelson (1991) used such an approach to develop a list of items to measure the knowledge/skills of IS professionals as well as general end users. Although the researcher attempted to distinguish between different concepts such as knowledge versus skills and education versus training, the relationships between the concepts and the empirically obtained factors were not always obvious.[5]

A third approach is to classify the critical knowledge/skill set according to content or domain of knowledge to which IS practitioners and educators can easily relate. For example, the ACM curriculum planning recommendations on IS education developed over the last two decades have been based on a taxonomy of knowledge/skill contents classified according to (1) IS technology; (2) IS process; and (3) AACSB

[5] The important conceptual distinctions between knowledge versus skills and training versus education were also discussed extensively during our focus group meetings. However, we found no simple way of mapping these constructs to the relationships among a list of empirically generated knowledge/skills requirements that are couched in the context of specific IS jobs or functions, i.e., many IS tasks require a combination of knowledge and skills, and the perceptual relationships among the knowledge/skill items do not correspond neatly to these theoretical constructs.

Table 3. Importance of Critical IS Activities (n=96)

Activity	Now Mean (Std. Dev.)	Future Mean (Std. Dev.)	t-Statistic	Inc/Dec
Support existing portfolio of appliations	3.77 (1.09)	3.89 (0.96)	1.53	—
Develop in-house applications	3.76*** (0.90)	3.33*** (1.10)	- 4.48	↓
Manage/plan systems development/implementation	3.64*** (0.88)	4.00*** (0.81)	4.64	↑
Analyze business problems and IS solutions	3.62*** (0.93)	4.47*** (0.57)	10.77	↑
Integrate existing and new business applications	3.52*** (1.09)	4.30*** (0.71)	7.74	↑
Develop application software—purchase and tailor	3.50*** (0.94)	3.94*** (0.91)	4.38	↑
Develop databases	3.45*** (1.02)	4.29*** (0.77)	8.87	↑
Implement new or changed computer-supported business processes	3.44*** (0.88)	4.25*** (0.67)	9.86	↑
Support hardware	3.43 (1.03)	3.47 (1.11)	.05	—
Analyze software packages—evaluation & selection	3.38*** (0.87)	3.90*** (0.84)	6.01	↑
Manage/plan feasibility/approval process for new systems and technology	3.34*** (0.93)	3.79*** (0.91)	5.28	↑
Train and educate IS professionals	3.29*** (1.00)	4.03*** (0.90)	8.53	↑
Support information access and security	3.28*** (1.00)	4.25*** (0.87)	10.83	↑
Manage/plan corporate IS strategies, strategic applications, technology architecture	3.24*** (0.95)	4.16*** (0.66)	10.25	↑
Integrate networks	3.18*** (1.13)	4.38*** (0.89)	11.26	↑
Support end-user computing (e.g., info. center, hot line)	3.16*** (1.03)	3.96*** (1.04)	7.92	↑
Train and educate end users	3.07*** (1.01)	4.10*** (0.88)	10.69	↑
Implement data management procedures	2.99*** (0.97)	4.13*** (0.78)	12.01	↑
Implement system evaluation processes	2.93*** (1.00)	3.48*** (1.01)	7.50	↑
Support user-developed systems	2.60*** (0.97)	3.55*** (1.06)	10.87	↑
Integrate data types (e.g., video, voice)	2.41*** (1.03)	3.66*** (1.06)	11.80	↑

***p<.001; based on pairwise t-test

Common Body of Knowledge (on business management) (e.g., Nunamaker, et al., 1982). As discussed below, numerous management articles and research reports have grouped critical IS knowledge/skills according to the technology knowledge/skills content, the business knowledge/skills content, or the behavioral knowledge/skills content. We adopted this approach for this study because of its content validity, conceptual simplicity, and the ease of relating our findings to both management and curriculum planning needs.

Based on a review of the literature, discussions at the focus group meetings, and in-depth interviews with IS managers, four broad categories of critical IS knowledge/skills are included in this study.

1. **Technical Specialties Knowledge/Skills:** The rapid rate of technology change in the IS field implies that a variety of technical skills is needed (e.g., Anonymous, 1993; Sullivan-Trainor, 1988b). The measure for IS technical knowledge included 18 items covering a range of IS technical specialties (e.g., operating systems, programming languages, database management systems, networks, telecommunication, etc.), each measured on a 5-point scale (from "not important" to "extremely important"). Pretesting of these items included interviews with a group of IS managers to ensure that no important technical specialty had been left out of the list. The mean of these 18 items was used as a composite score for the technical knowledge measure, with a reliability coefficient (Cronbach's Alpha) of .90 for now and .91 for the future.

2. **Technology Management Knowledge/Skills:** In contrast to the emphasis on specific technical specialties, technology manage-ment knowledge/skills are concerned with where and how to deploy information technologies effectively and profitably for meeting strategic business objectives (e.g., Cash and Konsynski, 1985; McFarlan, 1984; Parsons, 1983; Swanson, 1994; Tucker, 1988). The composite measure for technology management knowledge included three items, with a reliability coefficient of .71 for now and .65 for the future.

3. **Business Functional Knowledge/Skills:** The increasing emphasis on applying information technologies to serve business goals and the need to reengineer business processes before the adoption of new information technologies require IS professionals to possess in-depth business functional knowledge and skills (e.g., Ball, 1988; Davenport and Short, 1990; Farmer, 1987; Hammer, 1990; LaPlante, 1986; Sullivan-Trainor; 1988a). The composite measure for business functional knowledge/skills included four items which cover both general business knowledge/skills (e.g., Nelson, 1991) as well as knowledge of and ability to learn about business functions (e.g., Connolly, 1988a; Rouse and Hartog, 1988). This measure has a reliability coefficient of .85 for now and .80 for the future.

4. **Interpersonal and Management Knowledge/Skills:** There is a long line of research which has argued that behavioral knowledge/skills are critical for IS professionals (Carlson and Wetherbe, 1989; Cheney, et al., 1989; Connolly, 1988b; Couger and Zawacki, 1978; Freedman, 1987; Gupta, 1974; McCann, 1992; Reeves and Bussom, 1979; Young, 1988). Others have also pointed more specifically to the growing importance of the boundary-spanning role which IS professionals must assume in organizations (e.g., Farwell, et al., 1992; Keen, 1988b; Maglitta, 1993). The interpersonal and management knowledge/skills composite measure adopted in this study included 11 items with a reliability coefficient of .91 for now and .86 for the future.

Appendix 2 provides the mean and standard deviation for the individual items used for the four measures.

Results

The changing patterns of IS staff employment, critical IS activities, and knowledge/skill requirements were examined in order to provide insight into the changes occurring in the IS profession. This section considers the changes in IS staffing pattern, activities, and critical knowledge/skills. It then investigates the implications of changes in IS staffing and activities on the knowledge/skill requirements of IS professionals. These results provide the basis for the curriculum issues raised in the next section.

Changing IS staffing pattern

In terms of the overall employment pattern, our respondents reported an expected average annual growth rate of about 7.9 percent over a three-year planning horizon. However, there were some interesting differences in the estimated growth rates of

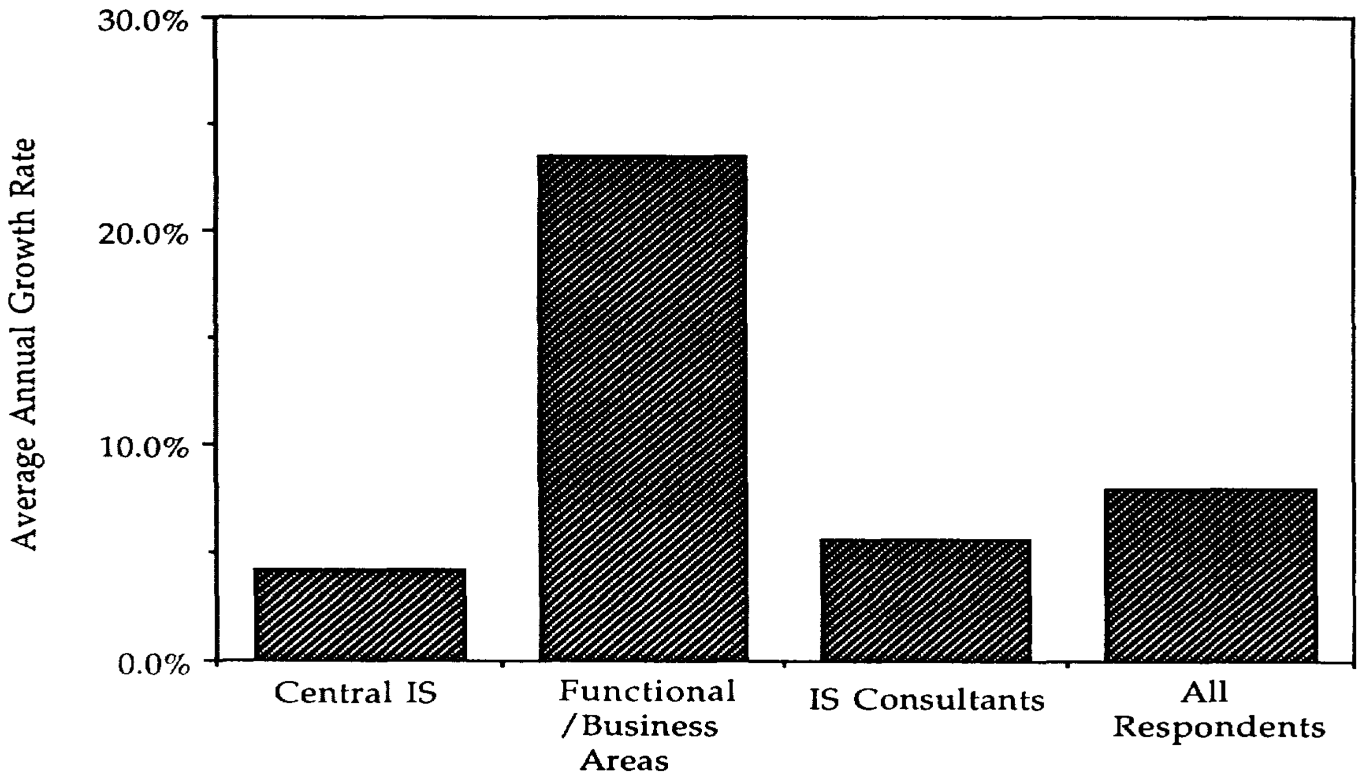

Figure 1. Expected IS Staff Growth Rates by Respondent Groups

IS staff across the three respondent groups (Figure 1). While the IS managers estimated an average growth rate in IS staff of only 4.2 percent, IS consultants estimated an average rate of 5.6 percent, and user managers estimated an average growth of 23.5 percent! The sharp contrast in the reported hiring pattern between IS and user managers is fully appreciated when one remembers the different references to which these two groups were asked to respond. While IS managers answered the questionnaire with respect to IS human resource needs of the *traditional, centralized IS department* within an organization, user managers answered the questionnaire with respect to IS human resource needs in the *functional, business areas.* These results, therefore, show a clear pattern of increased IS personnel growth outside the traditional, centralized IS department and a modest level of IS personnel growth within it.

Consistent with this overall pattern of personnel deployment is the shift in the demand of various IS jobs. Figure 2 shows the allocation of human resources to different types of IS jobs over the three-year horizon. IS staff employment was broken down into five major job categories: (1) programmers; (2) technical specialists; (3) business/systems analysts; (4) end-user support personnel; and (5) operators/data entry clerks.

All three respondent groups (i.e., IS managers, end-user managers, and IS consultants) reported that they planned to reduce the number of operators and data entry clerks. This finding corroborated the general technology trends and was supported by comments from several IS managers. Mass data entry through such technologies as bar codes has eliminated large numbers of data entry clerks, and the application of automation technologies such as robots for loading tapes has reduced the need for computer operators (Berkeley and Robins, 1989). In addition, respondents also noted that the data entry and computer operator functions related to desktop computing are increasingly being accomplished directly by end users. Overall, we found that the decrease in lower-skilled com-

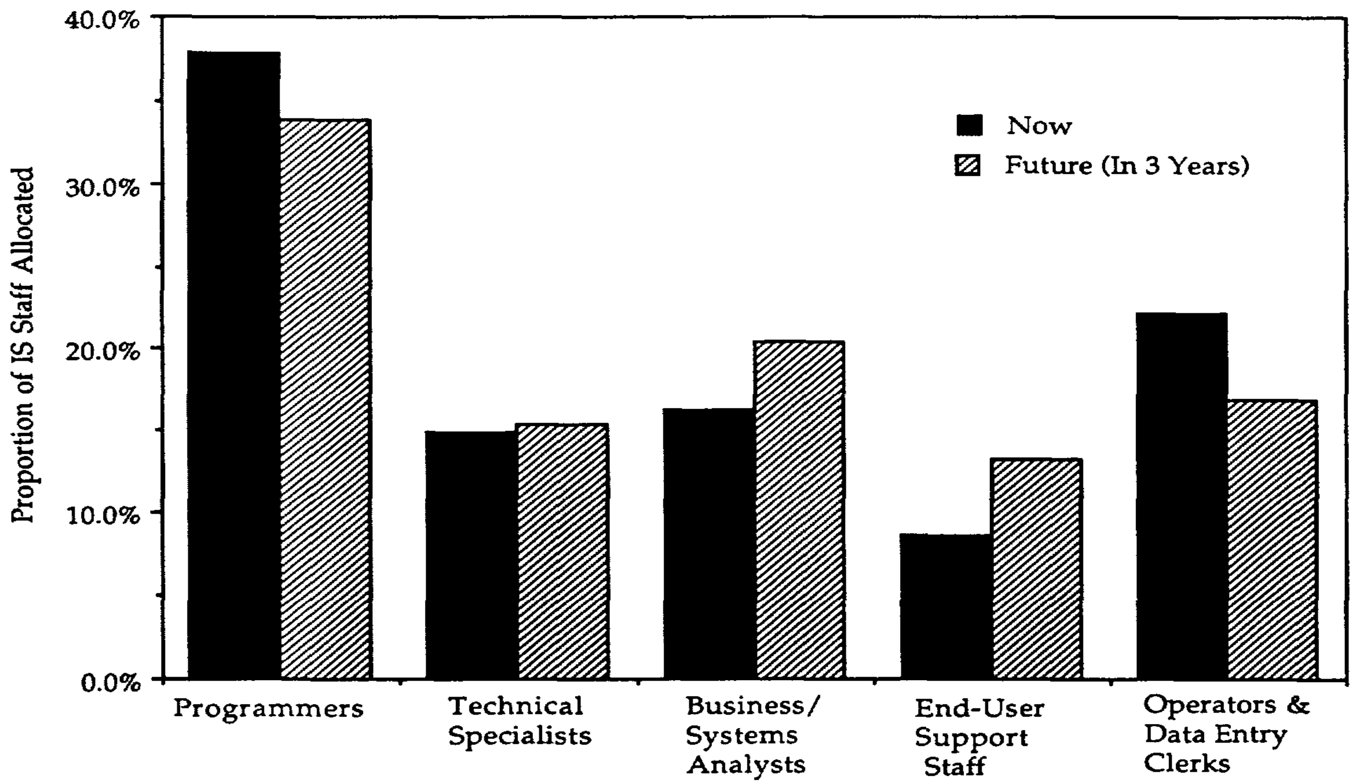

Figure 2. IS Staff Allocation Trend

puter operators and data entry jobs is being replaced by an increase in higher-skilled IS jobs.

All three groups of respondents also reported that they planned to increase their business/systems analysts and end-user support staff. This, again, is consistent with the numerous comments we heard in the focus group meetings emphasizing the demand for IS personnel who can understand business requirements and who are able to support the needs of end users.

The shifts in IS staff pattern for programmers and technical specialists are more complicated since both factors of TIME (i.e., now versus three years later) and GROUP (i.e., respondents), as well as the interactions between TIME and GROUP, appeared to affect the IS staff allocation pattern. These multiple factors were tested using a multivariate analysis of variance procedure, as shown in Table 2.[6]

[6] The MANOVA model for this test considered the TIME factor as repeated measures.

As expected, we found that TIME has a significant effect on the pattern of IS staff allocation (Wilk's Lambda = 0.49, F=14.50, p<.001). Interestingly, the GROUP effect was not significant (Wilk's Lambda = 0.80, F=1.67, p>.05), but there was a significant interaction effect between TIME and GROUP (Wilk's Lambda=.60, F=4.08, p<.001).

The multivariate analysis of variance test results indicate that demand for the different types of IS jobs will change significantly over time. Moreover, there will be significant *re-alignments* of job functions among the central IS, user/business areas and consulting firms in the future. The specifics of job re-alignment become clearer when the cell means are examined in Table 2. In the future, programmers are still expected to account for the largest share of IS jobs. However, both IS managers and IS consultants foresee declines in the allocation of staff to programming jobs, while user managers expect an increase in the staff allocation to programmers. The opposite trend of staff allocation appears to hold for IS technical specialists. While both IS managers and IS consultants expect to see a slight increase in the allocation of human resources to technical specialists, user managers plan to decrease in their staff allocation to this job category. These results suggest that the job functions of programmers, and technical specialists in particular, will be realigned within the organization. As central IS departments reduce the amount of in-house application development—historically the main activity of programmers—functional areas expect to increase the level of programming carried out in their individual areas. This points to the activity of programming increasingly becoming the purview of functional areas due to the growth of end-user-developed and maintained systems. At the same time, however, *both* centralized IS departments and user/business areas are recognizing the role of the centralized IS function as the provider of technical support through technical specialists. Focus group participants noted technical services (data administration and telecommunications) as growth areas. They also predicted that as users become more computer literate, they will demand higher levels of technical support from the central IS. Finally, outside IS consultants also expected major growth in the demand to provide special technical expertise and end-user support to supplement their clients' in-house capabilities.

Changing portfolio of critical IS activities

Overall, the assessment of critical IS activities seemed quite consistent across the three respondent groups, as suggested by a multivariate analysis of variance test of the five most important IS activities. (Results not shown.) The results are thus grouped together for all respondents.

Table 3 shows the present and future importance attributed to 21 key activities carried out by IS professionals. The results show some major shifts occurring in the priority placed on certain IS activities as well as some general themes about the changing importance of various IS activities, as discussed below:

Growing Importance of IS Activities in Organizations: Overall, the respondents indicated that 18 out of the 21 IS activities would become significantly more important ($p<.01$) in the future. This might be dismissed as response bias associated with a professional group rating most of its work activities as more important in the future. But a general theme that clearly emerged from the comments of our focus group participants was that IS activities will become more pervasive and important within their organizations. Their comments suggest that increased attention will be paid by organizations to the role of information systems and resources, which in turn will result in greater emphasis being placed on the activities needed to realize information system's promise.

Decreasing Priority of Applications Development and Support: According to the respondents, the priorities of IS activities are changing radically. Supporting the existing portfolio of applications and developing in-house applications are ranked as the two most important activities in the present. However, along with supporting hardware, these are also the only activities that are not shown to increase in importance in the future. These are, in fact viewed as becoming *noticeably lower* priorities in the future. Supporting the existing portfolio of applications, an activity that is considered to be most important for the present, is given a ranking below 14 other activities in the future. Together with supporting hardware, it is one of only two activities that are not expected to be significantly more important in the future. Even more telling is the observation that the only IS activity that is expected to *decrease significantly* in importance is developing in-house applications, even though this activity was ranked second in the present.

The decline in importance of these IS activities seemed to be related to the computing trends discussed earlier. In line with the downsizing of computing platforms and the migration of business application systems from the central IS to the business areas, users are assuming more direct control for their systems. As packaged software for an increasing array of business applications is becoming available, there is much less need for costly in-house development. The rapid growth of database management systems with easy data access, 4GL and other user-friendly programming languages, and client-server computing architecture now accord users with new capabilities to develop their own business applications. All these computing trends reduce the need for in-house development of the traditional, centralized business systems. Finally, as end users become more sophisticated, there is less need for day-to-day, operational support from the IS staff.

Increasing Priorities to Align IS with Business Problems and Integration: While applications development and support are dropping in importance, new types of IS activities are rising in importance. The most important IS activity in the future is to analyze business problems and IS solutions, which is rated as fourth in importance now. This finding is not surprising because it echoed the most prevalent theme we heard from IS managers and consultants—the top priority in the future is to align IS with business goals. IS projects must demonstrate their value and relevance to vital business needs. Analyzing business problems and finding effective IS solutions will hence become the single most important activity for IS in the future.

After aligning IS with business needs, a group of closely related IS activities, all ranked below the top four in importance now, will become of prime importance in the future. These are integrate networks (second), integrate existing and new business applications (third), and develop databases (fourth). The implications are clear both from our survey and the focus group comments that IS professionals will play a central role of integration in organizations, not only because of their technical expertise in networks and databases, but also because of the organization's need to link various business applications together for more effective operations.

Changing needs for critical IS knowledge/skills

Significant differences were found in the perceived importance of the four categories of critical IS skills and knowledge, as revealed by a multivariate analysis of variance test procedure[7] (see Table 4). But the GROUP effect, again, was not significant (F=2.39, p>.05), indicating that there was reasonable agreement among the three groups of respondents.

TIME was found to have a significant effect on the importance of critical IS skills and knowledge (F=141.35, p<.001), because all four categories of skills and knowledge were rated as more important in the future. Again, response bias could have played a role in these results. The issue of possible bias in rating all IS knowledge/skills as more important in the future was raised in our focus group meetings as well as during the interviews with selected respondents. There was a genuine belief among these practitioners that IS jobs were indeed becoming more demanding along multiple dimensions of knowledge/skill requirements, and these IS managers and consultants readily provided examples of how the requirements for specific jobs in their own organizations were changing. For example, a job in end-user support would need not only knowledge of microcomputer software packages and good interpersonal skills, it would also demand more in-depth technical knowledge of networks. Similarly, another job in systems analysis and design would need more in-depth knowledge of business operations and strategic management of technologies, in addition to the possession of excellent behavioral skills as a change agent. The specifics of how the multidimensional requirements of knowledge/skills will change for specific types of IS activities is explored further in the next two sections.

While all four categories of IS knowledge/skills were rated as more important in the future, there were significant differences in the *relative* importance assigned to the four categories (Wilk's Lambda = .38, F=50.22, p<.001). All three groups of respondents considered technical specialties knowledge to be the least important, for both now and in the future. At the same time, business functional knowledge and interpersonal/management skills were considered the most important in the future. Moreover, there were shifts in the relative importance of the four skills and knowledge sets in the future, as indicated by the significant interaction effect between TIME and SKILLS (Wilk's Lambda = .65, F=16.61, p<.001). But the interaction effect between GROUP and SKILLS is again not significant (Wilk's Lambda = .88, F=2.01, p>.05),

[7] The MANOVA model used for this test considered the four categories of critical skills and knowledge for now and the future (i.e., the SKILL and TIME factors) as two sets of repeated measures.

supporting the convergence of assessments by these three respondent groups.

The de-emphasis of the importance of technical specialties knowledge is an interesting result that we wanted to examine further because it relates directly to a number of courses taught in the typical IS curriculum. We found that, as expected, some traditional IS technical knowledge, such as assembly language, 3rd GL languages, and mainframe operating systems are declining in importance. But a surprising finding was that a number of topics emphasized in the typical IS curriculum, such as decision support systems, expert systems/AI, and computer-aided software engineering (CASE) technology, all received relatively low scores from our respondents (see Appendix 2, A). Practitioners indicated that these technologies simply have not had as much impact as others at the work place. At the same time, they indicated that the most important emerging areas of technical knowledge are

Table 4. Multivariate Analysis of Critical IS Skills and Knowledge Among Practitioner Groups

	Technical Specialties Knowledge	Knowledge of Technology Management	Business Functional Knowledge	Interpersonal & Management Skills
IS Managers (n=52)				
Now	3.01	3.77	3.85	3.87
Future	3.72	4.26	4.49	4.30
User Managers (n=16)				
Now	2.76	3.63	4.13	3.97
Future	3.47	3.94	4.59	4.27
IS Consultants (n=30)				
Now	2.90	3.44	3.38	3.56
Future	3.52	4.08	4.42	4.16

Multivariate Analysis of Variance Results

Tests of Between-Subjects Effects:	
GROUP Effect:	F = 2.39, Not Significant, p>.05
Tests involving 'TIME' Within-Subject Effect:	
TIME Effect:	F=141.35; p<.001
GROUP by TIME Effect:	F = 1.79; Not Significant, p >.05
Tests involving 'SKILLS' Within- Subject Effects:	
SKILLS Effect:	Wilk's Lambda =.38; F=50.22; p<.001
GROUP by SKILLS Effect:	Wilk's Lambda=.88; F=2.01; Not Significant, p>.05
Tests involving 'TIME by SKILLS' Within-Subject Effect:	
GROUP by TIME by SKILLS Effect:	Wilk's Lambda = .91; F=1.43; Not Significant, p>.05
TIME by SKILLS Effect:	Wilk's Lambda = .65; F=16.61; p<.001

networks, telecommunications, relational databases, and 4GL programming languages.

Overall, the findings from this multivariate analysis of critical IS knowledge/skills are consistent with the comments heard from our focus group meetings, which suggested that selected areas of emerging technologies, together with a much broader set of knowledge/skill requirements, will be demanded of IS professionals. The question of how the multidimensional knowledge/skill requirements will change for specific types of critical IS activities is further explored next.

Relation between changing IS staffing pattern and knowledge/skills requirements

We found earlier that an important trend in IS staffing is the expected personnel shift to end-user support and business/systems analysis. It is thus of interest to examine how these expected changes in IS jobs might impact the knowledge/skill requirements. Table 5 shows a multivariate analysis of variance comparing the *changes* in the importance of the four categories of IS knowledge and skills. The comparisons were between the respondents from organizations that planned major increases (i.e., 15 percent) in the staff allocation to business/systems analysts and end-user support and respondents from organizations with stable or decreases in staff allocation to these areas. Again, the results showed the CHANGE GROUP effect to be significant (F=3.43, p=.021). Moreover, results of the univariate F-test comparisons suggest that organizations that planned major staff allocation increases to business/systems analysts and end-user support would place significantly more emphasis on (1) interpersonal/management

Table 5. Relationship Between Staffing Trend and Changes in IS Knowledge and Skills

	Change in Importance of:			
Change Groups	**Technical Specialties Knowledge**	**Knowledge of Technology Management**	**Business Functional Knowledge**	**Interpersonal & Management Skills**
Org. with increase in IS staff allocation to business/systems analysts & end-user support (n=19)	.71	.63	1.09	.63
Org. with stable or decrease in IS staff allocation to business/systems analysts & end-user support (n=14)	.49	.17	.28	.15

Multivariate Analysis of Variance Results

CHANGES IN SKILLS Effect: Multivariate Tests of Significance

Wilk's Lambda = .67; F=3.43, p = .021

CHANGE GROUPS Effect: Univariate F-tests

Variable	F	Significance of F
Δ Technical Specialties Knowledge	1.20	p>.05, Not Significant
Δ Technology Management Knowledge	7.45	p=.010
Δ Business Functional Knowledge	6.61	p=.020
Δ Interpersonal Skills	8.25	p=.007

skills (p=.007), (2) technology management knowledge (p=.01); and (3) business functional knowledge (p=.02). These results confirm that the growing IS job opportunities in the areas of business/systems analysts and end-user support will require a cadre of IS professionals with all three types of knowledge/skills. At the same time, it also reveals that these IS jobs will not be as demanding for technical knowledge.

Relation between critical IS activities and IS knowledge and skills

With the emphasis on business process reengineering and integration, we may also expect the corresponding shifts in critical IS activities to lead to changes in knowledge and skill requirements of IS professionals. We found earlier that the two most important IS activities in the future were (1) aligning IS solutions with business needs; and (2) integrating networks. It is thus logical to explore how these changes in critical IS activities might affect the knowledge and skills requirements of IS professionals. Table 6A shows a multivariate analysis of variance comparing the *changes* in the four categories of knowledge and skills requirements. This time the comparisons were between respondents from organizations with increasing emphasis on the alignment of IS with business needs and respondents from organizations that did not expect such activities to become more important. The results suggest that those organizations that were planning greater business focus would also demand greater emphasis on IS knowledge and skills, i.e., the CHANGE GROUP effect is

Table 6. Relationship Between Critical IS Activities and Changes in IS Knowledge and Skills

	A. Change in Importance of:			
Change Groups	**Technical Specialties Knowledge**	**Knowledge of Technology Management**	**Business Functional Knowledge**	**Interpersonal & Management Skills**
Org. with increasing emphasis on the alignment of IS solution with business needs (n=23)	.85	.96	1.27	.86
Org. with stable emphasis on the alignment of IS solution with business needs (n=28)	.62	.26	.49	.34

Multivariate Analysis of Variance Results

CHANGES IN SKILLS Effect: Multivariate Tests of Significance

Wilk's Lambda = .68; F=4.00; p = .001

CHANGE GROUPS Effect: Univariate F-tests

Variable	F	Significance
Δ Technical Specialties Knowledge	2.47	p>.05, Not Significant
Δ Technology Management Knowledge	18.24	p<.001
Δ Business Functional Knowledge	10.19	p=.002
Δ Interpersonal Skills	12.02	p=.001

significant; F=5.42, p=.001. And, as indicated by the univariate F-tests, the most important differences would be in (1) technology management knowledge (p<.001); (2) interpersonal/management skills (p=.001); and (3) business functional knowledge (p=.002).

Finally, with the rapid growth of client/server computing and telecommunications, we may also expect the increasing emphasis on network integration to impact IS skills and knowledge. A comparison is thus made between *changes* in the four categories of IS knowledge and skills for organizations that plan to emphasize network integration versus organizations that don't (Table 6B). Again, significant differences are found between the two groups, i.e., the CHANGE GROUP effect is significant (F=3.72, p=.009). Here, the univariate F-tests reveal that the most significant differences are for (1) technology management knowledge (p=.014); and (2) technical specialties knowledge (p=.033).

A comparison between the findings in Tables 6A and 6B suggests two different patterns of knowledge/skills requirements, and perhaps two distinct IS career tracks, for the two most important types of IS activities in the future. The first locus of IS activities centers around the effective application of IS to meet business needs. Successful IS professionals within this career track must possess in-depth knowledge of business as well as excellent interpersonal skills. The second locus of IS activities centers around the integration of the organization's technological infrastructure. For the IS professionals within this career track, technical competence is an absolute necessity. Finally, IS professionals in either

Table 6. Continued

	B. Change in Importance of:			
Change Groups	**Technical Specialties Knowledge**	**Knowledge of Technology Management**	**Business Functional Knowledge**	**Interpersonal & Management Skills**
Org. with increasing emphasis on the importance of integrating networks (n=35)	.78	.66	.80	.52
Org. with stable emphasis on the importance of integrating networks (n=29)	.53	.31	.54	.44

Multivariate Analysis of Variance Results

CHANGES IN SKILLS Effect: Multivariate Tests of Significance

Wilk's Lambda = .80; F=3.72, p<.01

CHANGE GROUPS Effect: Univariate F-tests

Variable	F	Significance
Δ Technical Specialties Knowledge	4.73	p=.03
Δ Technology Management Knowledge	6.38	p=.01
Δ Business Functional Knowledge	1.67	p>.05; Not Significant
Δ Interpersonal Skills	.35	p>.05; Not Significant

track must also have good technology management knowledge to effectively link technology with business and user needs.

Summary and Discussions

This study was initiated to investigate anticipated changes in the information systems profession, to study the impact of these changes on the skills and knowledge required, and to relate these requirements to the academic preparation of future IS professionals. To provide as broad a perspective as possible, the investigation was conducted by a team of people from industry and academia.

Overall, our study suggests that industry will demand a cadre of IS professionals with knowledge and skills in technology, management, and interpersonal skills to effectively lead organizational integration and process reengineering activities. The lower-level IS jobs (e.g., data entry, computer operator) are rapidly disappearing, and the requirements for IS professionals are becoming more demanding in multiple dimensions. Our results also found some clear patterns in IS staffing and activity trends that point to the shift in emphasis from a traditional, central IS organization toward a more decentralized, end-user-focused business orientation. Aligning IS solutions with business goals and needs as well as building the infrastructure for technological integration are becoming the top priorities for IS activities. Finally, our results also suggest these changes will likely lead to different career tracks with differing emphasis on the multidimensional knowledge/skills for IS professionals.

The three stakeholder groups in this study, IS managers, IS consultants, and end-user managers, showed remarkable consistency in their vision of the skills and knowledge required by the successful IS professional of the future. It is less clear, however, where and how these IS professionals will receive the education and training that will prepare them for the increasing challenges they will face. This section discusses the key findings regarding the changing IS human resource needs and the educational implications. It ends with several recommendations regarding curriculum planning.

Changing human resource needs of the IS profession

The flat growth in the expected demand for personnel working in the central IS organizations coupled with the steep growth in the expected demand for IS personnel working in functional areas signals a dramatic change occurring in the profession. This trend shows a shift away from a centralized IS department that controls all hardware, software, data, personnel, and procedural aspects of the information system toward realigning the information system resources with the central IS organization and the business areas.

The broad restructuring of IS activities is having major impacts on both the centralized IS organization and the business areas. The mission of central IS will shift from one of developing and supporting information processing applications to one of developing, managing and supporting the information technology infrastructure for the entire organization. One impact will be that central IS must become more technically specialized. At the same time, central IS is being relied upon to play a leading role in the integration and technology management for the entire organization.

The shifting focus of a wide range of IS activities toward the user domain will create the greatest growth opportunities for IS jobs. While the people who fill these new jobs need to have technical competence, the profile of skills required for success will differ significantly from those who work in traditional IS jobs. These new jobs will focus more on the application of information technology to solve business problems. Hence, in-depth knowledge of business operations is a prerequisite. Moreover, as reengineering becomes more necessary in organizations, the ability to function effectively as change agents may become even more important than business analysis skills and technical competence.

Challenge for IS education

The restructuring of IS activities in organizations is expected to lead to basic changes in the career paths of IS professionals. The old reality of a single career path of programmer - analyst - project manager - IS manager is being replaced with a new reality in which there are a diversity of IS career paths. IS graduates who plan to work in the central IS organization might require in-depth knowledge of specific technologies as well as possess a broad technology management background. IS graduates who intend to work in user areas might require a strong background in business management and human relations. The challenge for educators and educational institutions is to parallel this diversity of career paths in curriculum design.

Our findings suggest that the current IS curricula in many universities are not well aligned with business needs. For example, many of the technical subjects emphasized in the typical IS curriculum (e.g., decision support systems, expert systems, etc.) are considered low priorities by the respondents in our study, and university curricula often lag in updating critical new technologies such as networks and telecommunications. Moreover, our results also indicate that IS graduates will require both more breadth and depth of education across the dimensions of technology, business, and human relations.

Since there are practical limits to what can be included in a single curriculum, the challenge for educational planners is to design a diversity of IS curricula to meet the different career path goals of IS professionals. The concept of a generic curriculum to meet the educational needs of all future IS professionals is obsolete. We would thus argue that more flexibility is needed for the design of IS curricula. Moreover, IS educators should convince influential university accreditation bodies such as the AACSB, or professional groups such as the ACM and DPMA that provide IS curriculum guidelines, about the need for more freedom in IS curricula design.

Recommendations for curriculum design

One important implication of our findings is that IS curriculum design must be driven by a clear vision of the career path for the graduates. For example, one curriculum might prepare IS graduates to work in the central IS organization. Such a curriculum would focus on technology specialties and technology management. Alternatively, another curriculum might focus on the rapidly growing area of integrating information technologies with business needs (i.e., reengineering). Such a curriculum would require a radically different combination of courses in technology, business, and behavioral science.

In addition, we argue that the content of various courses in each curriculum must be designed specifically to meet the program's particular career path objectives. For example, the teaching of programming would take on different meanings in different IS curricula. Programming for careers in a software house or a central IS organization might require skills in specific programming languages, while programming in a functional area might require skills in fourth-generation languages. Similarly, the content of a systems analysis course would also differ significantly for these two types of programs. Systems analysis for the central IS organization would place new emphasis on business planning and integration, whereas systems analysis for the users would shift from the traditional systems development life cycle to business analysis and rapid prototyping. Moreover, some topics, such as systems integration, would be emphasized across different IS curricula, but with different orientations. If a program is preparing people for careers in the central IS organization, then the topic would focus on integrating the components of the information technology infrastructure: hardware, software, data, and systems. If, on the other hand, students are preparing for careers in functional areas, the topic would focus on integrating solutions across facets of the business operation. In both cases, they would require increased attention to behavioral and management skills to accomplish the needed organizational change.

These career-driven IS programs will place new demands that might be beyond the capabilities of what can be offered by a single, discipline-oriented academic department within a university. The design of more relevant IS programs will require cooperative efforts and multidisciplinary approaches that cut across university departments or even colleges. For example, the planning of a technical career-track IS curriculum might require the joint effort between an IS department in a business school and departments/schools like computer science or electrical engineering outside of the business school. Similarly, the design of a business applications IS curriculum might require joint effort between an IS department and other business departments such as marketing, finance, accounting, or operations. In addition, both the content and delivery of specific courses might differ according to the program's objectives. For example, an effective approach to teach technology-oriented students, even those in technical subjects such as networks or telecommunication, the critical business and organizational dimensions is via the use of Harvard Business School-type, in-depth case analysis. Alternatively, another program designed to prepare managers or executives for the central IS organization might be modeled after the approach by M.I.T.'s Sloan School of Management, which incorporates more technical courses to provide the students with in-depth understanding of information technology.

Given the many resource and academic accreditation constraints, universities must be more innovative in designing their IS programs in order to add breadth, depth, and relevance to the curriculum. Trauth (1988) suggests that a variety of mechanisms such as a joint degree, an interdisciplinary degree or a combined undergraduate/graduate degree could be explored to achieve these goals. Many of the nation's leading IS programs are adopting various innovative approaches in redesigning their IS curricula. For example, the University of Minnesota is considering career paths for its graduates that rotate between IS and functional groups. New York University has developed a curriculum that integrates IS with specific functions such as finance, marketing, and operations to produce "cross-trained technology tri-athletes" (Krass, 1990). All these programs serve to illustrate how university planners must consider their educational missions carefully and must not be constrained by traditional academic biases in designing more effective and relevant curricula to match the needs of the targeted students.

Limitations of the study and implications for academic/industry collaboration

This study was initiated to investigate anticipated changes in the information systems profession based on concerns by the membership of the Boston SIM Chapter. Our data collection was limited to one region of the U.S. Our findings might not be representative of the entire country, and major differences might exist in other countries. Our response rates, particularly from the user managers, were lower than desired. These limitations not withstanding, we hope that by focusing on IS human resource trends at the work place, we have raised some critical issues as well as some specific suggestions regarding the need to restructure IS curricula for educational planners to consider carefully.

Perhaps more important than any specific finding in this study is our argument that industry and academia must work together more closely to face the transformation of the IS profession. For example, we found that future IS professionals should be strengthened in interpersonal and team leadership skills, as well as in the basic understanding of business operations. These are areas where universities can provide effective continuing professional education to industry. By the same token, we also found that many of the technical courses emphasized in academic programs are not considered high priorities in industry, while universities, because of limited resources, often struggle in keeping up with critical new technologies in such areas as networks and telecommunications. These are examples of areas where industry can provide effective advice and perhaps resource assistance to universities.

Ultimately, the critical human resource needs of our profession are moving targets. It is hoped that via this example of a collaborative project, we have demonstrated how practitioners and educators can maintain a continuing dialogue and can work productively together to address these critical issues of common concern in the profession.

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Appendix 1

Structure of Questionnaires (Using the Sample Item: Telecommunications Skill)

Form A: IS Managers

Please indicate below how important the following IS knowledge or skills are in supporting the computing needs of your company, now and in three years:

	Now					Three Years from Now				
	Not Important			Extremely Important		Not Important			Extremely Important	
Telecommunications	1	2	3	4	5	1	2	3	4	5

Form B: User/Business Managers

Please indicate below how important the following IS knowledge or skills are in supporting the computing needs of your department now and in three years:

	Now					Three Years from Now				
	Not Important			Extremely Important		Not Important			Extremely Important	
Telecommunications	1	2	3	4	5	1	2	3	4	5

Form C: IS Consultants

Please indicate below how important the following IS knowledge or skills are in supporting the computing needs of the companies with which you work, both now and three years from now

	Now					Three Years from Now				
	Not Important			Extremely Important		Not Important			Extremely Important	
Telecommunications	1	2	3	4	5	1	2	3	4	5

Appendix 2

IS Knowledge/Skills Measures[8]

	Now		Future	
	Mean	**Std. Dev.**	**Mean**	**Std. Dev.**
A. Technical Specialties Knowledge				
COBOL, or other third generation language	3.69	(1.16)	3.24	(1.17)
Telecommunications	3.53	(0.99)	4.38	(0.85)
Network	3.44	(1.03)	4.43	(0.80)
Operating systems: Mainframes	3.27	(1.32)	3.08	(1.28)
Operating systems: Minis	3.11	(1.04)	3.22	(1.24)
4th generation languages	3.19	(1.00)	4.15	(0.89)
Systems integration	3.18	(1.01)	4.13	(0.99)
Operating systems: Micros	3.01	(0.91)	3.36	(1.09)
Systems analysis/structured analysis	2.97	(0.95)	3.55	(0.98)
Systems life cycle management	2.97	(0.96)	3.43	(1.06)
Relational databases	2.94	(0.96)	4.37	(0.69)
Distributed processing	2.81	(1.06)	3.90	(1.07)
A specific programming language	2.79	(1.21)	3.34	(1.37)
Data management (e.g., data modeling)	2.77	(0.98)	3.88	(0.98)
Structured programming/CASE methods or tools	2.49	(0.96)	3.69	(1.10)
Decision support systems	2.47	(0.87)	3.64	(1.00)
Assembly language	2.06	(1.02)	1.82	(1.03)
Expert systems/AI	1.98	(0.92)	3.25	(1.19)
B. Technology Management Knowledge				
Ability to learn new technologies	3.68	(0.75)	4.12	(0.68)
Ability to focus on technology as a means, not an end	3.63	(1.00)	4.28	(0.83)
Ability to understand technological trends	3.62	(0.95)	4.05	(0.80)
C. Business Functional Knowledge				
Ability to learn about business functions	3.76	(1.01)	4.50	(0.63)
Ability to interpret business problems & develop appropriate technical solution	3.83	(1.01)	4.39	(0.73)
Ability to understand the business environment	3.83	(1.03)	4.61	(0.57)
Knowledge of business functions	3.40	(1.00)	4.50	(0.63)

8 Based on data collected from IS managers, user/business managers, and IS consultants.

	Now		Future	
	Mean	**Std. Dev**	**Mean**	**Std. Dev.**
D. Interpersonal and Management Skills				
Ability to work cooperatively in a one-on-one and project team environment	4.04	(0.82)	4.33	(0.70)
Ability to plan and execute work in a collaborative environment	3.85	(0.88)	4.37	(0.68)
Ability to deal with ambiguity	3.76	(1.06)	4.30	(0.75)
Ability to work closely with customers and maintain productive user or client relationship	3.88	(0.98)	4.51	(0.63)
Ability to accomplish assignments	4.35	(0.66)	4.50	(0.60)
Ability to teach others	3.47	(0.88)	3.94	(0.77)
Ability to plan, organize and lead projects	3.84	(0.91)	4.22	(0.78)
Ability to develop and deliver effective, informative, and persuasive presentations	3.43	(0.92)	4.02	(0.81)
Ability to plan, organize & write clear, concise, effective memos, reports, and documentations	3.51	(0.88)	4.03	(0.79)
Ability to be self-directed and proactive	3.81	(0.96)	4.34	(0.72)
Ability to be sensitive to organizational culture/politics	3.76	(1.01)	4.20	(0.79)