Mapping the MIS Curriculum Based on Critical Skills of New Graduates: An Empirical Examination of IT Professionals

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ABSTRACT

MIS curricula research almost always focuses on either curriculum issues or the critical skills required of new MIS graduates, rarely both. This study examines both by determining the critical skills required of new graduates, from the perspective of IT professionals in the field, then uniquely mapping those skills into a comprehensive yet flexible MIS curriculum that could be used by any MIS department. Using a sample of 153 IT professionals from six organizations in the mid-South, the results are somewhat surprising. While personal attributes are important, IT workers clearly believe that technology skills are a critical component of an MIS education, in particular database skills (including SQL), computer languages (at least two), and web design proficiency. Results also stress the importance of foundational concepts and knowledge, preparing new graduates for careers and not merely their first job. The impact for MIS curriculum designers is clear: make the major technically robust while simultaneously providing a core foundation in both business and IT. The study strongly suggests that concentrations (two or more sequenced courses) are a must; four are recommended as a result of this study: programming/architecture, telecommunications/networks, database, and web design/e-commerce. Implications are discussed.

Keywords: MIS curriculum, IT critical skills, MIS curriculum development, technology education, IS pedagogy.

1. INTRODUCTION

Information technology (IT) and information system (IS) professionals constitute one of the greatest cadres of knowledge workers in modern organizations today. Knowledge workers in general make up over half the US workforce (Laudon and Laudon, 2007), which include IT professionals such as programmers, systems analysts, database administrators, web designers, and network specialists. The U.S. Department of Labor projects five out of the top twelve occupations expected to grow the fastest between 2004 and 2014 are computer related (U.S. Department of Labor, 2007). Despite the downturn after the dot.com bust, future employment in the IT profession appears vibrant.

The preparation and education of new IT professionals rests primarily with universities (Weber, 2004). In general, both computer science and Management Information Systems or Computer Information Systems (MIS/CIS and hereafter labeled MIS) majors provide new IT professionals, but only MIS integrates IT with business fundamentals and processes (Ehie, 2002). University MIS departments and faculty are responsible for providing a curriculum that effectively prepares future professionals for both first jobs and their subsequent careers (Noll and Wilkins, 2002; Weber, 2004). If the educator's double mandate is to prepare MIS graduates for both their first job and a successful career, then the curriculum must include both fundamentals and technologies, particularly the latest technologies. Fundamental business and IS concepts, theories and principles that underlie IT phenomena prepare graduates for long term employment (Weber, 2004). On the other hand, current technologies frequently provide the basis for first IT jobs (Williams and Pomykalski, 2004). Lightfoot (1999) suggests that choosing between fundamentals and technology, or IT education versus a mere training curriculum, is the real dilemma for curriculum designers. The implication is clear: both must be presented in the major to prepare new graduates for short and long term success. The ability to successfully provide such a curriculum is constrained by a number of important factors, including number of hours available in a college education and the portion dedicated to the business core and the MIS major, number of faculty and their area(s) of expertise, and student quality constraints.

The process of determining what skills employers want is hampered because the IT field is incredibly dynamic. With the rapid changes in technology and its evolvement as a strategic asset in many organizations, keeping up with new trends is critical for IT educators. IT is constantly changing, with shifting job descriptions, shifting industry patterns, greater competition, outsourcing, and rapid globalization, blurring both job requirements and which skills are in demand (Weber, 2004). In part because of the dynamic nature of the field, a growing number of studies report that educators are not doing a good job of preparing future IT workers and new graduates lack the skills necessary to prosper in today's environment (Cappel, 2001/2002; Fang, Lee, and Koh, 2005; Noll and Wilkins, 2002). Others report a widening gap between expected skill sets of graduates and actual skills (Tang, Lee, and Koh, 2000/2001). This suggests a need to frequently evaluate critical skill requirements for new IT workers, and the mandate to effectively teach those skills in the classroom.

This study is structured as follows. First we look at the two approaches researchers have taken, one based on the critical skills new graduates should possess and the other based on an examination of MIS curricula. We present a model of the research process, including constituents involved, methodologies, and their outcomes of critical skills and/or curricula. This study collects data from IT professionals in the field on the critical skills that new MIS graduates should possess, both technical and non-technical. We then take the resulting skills and design a flexible MIS curriculum that promotes these skills in graduates. We examine recommended courses and recommended concentrations. We also examine the optimum balance between foundational concepts and new technologies. Implications and direction for further research are discussed.

How do colleges and universities know what courses *should* be offered and/or required to prepare new IT graduates? What is an effective balance between technology and core fundamentals? There are some studies which examine the critical skills that new graduates should possess (and rapidly become out of date). Other studies examine MIS curriculum issues, mostly analyzing what is currently being taught. What is missing from current studies is the linkage between the two. This study provides that, by updating critical skill requirements (from the perspective of IT professionals) and then using a unique process to map these skills into a flexible curriculum. The resulting curriculum is particularly important for MIS curricula designers, MIS departments, and organizations that hire these graduates, providing a sound yet accommodating set of courses that should prepare new graduates for both first jobs and career employment.

2. CRITICAL SKILLS AND CURRICULA DEVELOPMENT

Entry-level IT professionals should have the ability to perform at an acceptable standard when hired and have the necessary skills for continued growth. This is important for organizations from both a training and a hiring perspective. The less they have to immediately train new hires, the more efficient the process of incorporating these new employees becomes. The better prepared they are in business and IT concepts and processes (i.e., fundamentals), the better able they will be in adapting to new tasks, jobs, and the changing environment as their career progresses. In order to examine what to teach MIS students, researchers have adopted two basic approaches: examine the curriculum itself in some way, or examine the critical skills required of IT professionals.

2.1 Curriculum-Focused Approach

Studies which examine university MIS curricula in some manner do so with the hope of clarifying how best to design an MIS curriculum. These studies may examine current courses, new trends, areas of concentration, or anything else which addresses actual MIS curricula. Some studies merely report what (many or most) MIS departments are currently teaching by examining catalogues, departmental websites, or even the faculty in different schools (Gill and Hu, 1998). Some do the same for graduate MIS curricula (Maier and Gambill, 1997). Others focus on what MIS departments are teaching in a particular emerging technology area, such as e-commerce (Moshkovich, Mechitov, and Olson, 2006). The implication seems to be that if numerous colleges teach certain courses, they must be important. Missing of course is the link between skills required and the curriculum, that is, what *should* be taught.

Methodologies in such studies vary; for example, one compares current findings in course offerings to previous studies to note trends (Kung, Yang, and Zhang, 2006). Others use a case study approach (Bhattacharya, DiRenzo, Merritt, and Smith, 2006; Ehie, 2002). One study, for example, stressed the use of area employers in designing their curriculum and even helping to teach some of their courses (Srinivasan, Guan, and Wright, 1999).

Another approach has been to compare university MIS curricula with what outside stakeholders recommend. Some studies use accreditation agencies in the comparison, including AACSB (2007) and ABET (2007). One study focused on business schools that are accredited by AACSB (Williams and Pomykalski, 2004) while another on MIS departments that are accredited by ABET (Kung et al., 2006). Still others compare curricula to established model curricula, especially IS 2002, which was developed jointly by ACM (Association of Computing Machinery), AIS (Association of Information Systems) and AITP (Association of Information Technology Professionals) (Gorgone et al., 2002). One study maps current IS curricula to IS 2002 (Williams and Pomykalski, 2004); another uses a case study approach for comparison (Daigle, Longenecker, Landry, and Pardue, 2003). Finally, some studies examine curriculum development from another discipline entirely, such as quality function deployment from quality assurance literature (Denton, Kleist, and Surendran, 2005) or competency-based curriculum design (Chyung, Stepich and Cox, 2006).

In each of these studies, the focus is on the curriculum, particularly *what* is being taught in MIS departments. The weakness in this approach is the difficulty in establishing what *should* be taught. While comparisons to documents such as IS 2002 can provide some objective standard, another tactic is to identify the critical skills required of new IT professionals in order to design a curriculum that will provide those skills.

2.2 Critical Skills Approach

The primary purpose of critical skills studies is to establish which skills are most important (or needed or useful) for new IT professionals. This approach does not examine MIS curricula directly; rather the implication is that what is critical ought to be taught. Studies of this type are valuable in that technology is changing rapidly and remaining abreast is a continuous process that needs frequent updates. Because of the rapid changes in the business and IT landscape, it does not take long for a study of critical skills to be dated.

Given the obvious importance of understanding which skills are important, it may be surprising that there is no general consensus on the best way to gauge skill importance, particularly since organizations can differ in which skills they deem are most important. Various methods have been used, including the examination of newspaper advertisements of employers (e.g., Todd, McKeen, and Gallupe, 1995), examining Fortune 500 company web sites' advertisements (e.g., Lee and Lee, 2006), as well as a variety of surveys eliciting responses directly from employers, faculty, or other stakeholders.

Of the studies which ask stakeholders which skills are important, they vary in two important ways: the stakeholder who is asked and the critical skills that are included. Most studies use one of two important stakeholders, MIS faculty and business organizations which do the hiring of new IT professionals. While both of these stakeholders can provide valuable input, each has limitations. Faculty members may not know current trends in IT or may be unduly influenced by their own areas of expertise. On the other hand, businesses may be guided by an interest in those skills important only for their particular business or department, with little regard for career skills. However, despite employer limitations, as a stakeholder they are a critical because they hire the graduates. Studies which include business constituents have used IT professionals (Noll and Wilkins, 2002), managers (Lee, Trauth, and Farwell, 1995), even recruiters (Fang et al., 2005). It should be pointed out that other stakeholders have been examined. One study examined students and their influence in curricula (Medlin, Dave and Vannoy, 2001). Another study listed state legislatures as a stakeholder in terms of funding for state schools (Lightfoot, 1999).

The second way studies vary is the critical skills that are included in the study. Most studies include a predetermined list for stakeholders to choose from, and what is included may predispose the findings. In fact, which skills to include has been the topic of much research. Most current studies classify and include two groups of skills: technical and non-technical skills. The non-technical skills included are usually communication skills, team skills, and critical thinking skills. Indeed, many studies report that these "soft skills" are more important than technical skills (Fang, et al., 2005; Kovacs, Davis, Caputo and Turchek, 2005; Lee, Yen, Havelka and Koh, 2001; Young, 1996). However, which technical skills to include are influenced by the rapid change noted in the field and requirements differences among businesses (Fang et al., 2005). This study established which skills are important to include by examining the literature (particularly recent studies) and garnering input from both faculty and business stakeholders. It should be noted that the term "skill" in this study is generic and includes more than "new" technologies or technology proficiencies. Skills also include foundational concepts and knowledge areas.

3. RESEARCH MODEL

The literature reveals that studies of MIS curricula and critical skills vary by three important dimensions. First they differ depending on who is providing the input, that is, the stakeholder. It could be business organization(s), with a variety of different individuals within that organization. Stakeholders could be MIS faculty (or indeed other faculty such as computer science); it could be outside agencies such as those sponsoring model curricula (e.g., IS 2002) or those that accredit business schools (AACSB) or MIS/IT departments (ABET). It could even be students or alumni. Second, they vary based on the methodology used to gather the input, including (as we have seen) job postings, college catalogues and/or departmental web sites, surveys, case studies, and even criteria from another discipline. Finally, these studies vary in focus; most focus either on critical skills or the curriculum itself. Figure 1 presents a view of this model.

Most studies examine either critical skills or curricula. Only one known study gathers data directly from stakeholders on critical skills and then applies it to MIS curricula (indicated by "Both" in Figure 1) (Noll and Wilkins, 2002). They used a survey to gather data on critical skills from managers in companies that hire their business school graduates. They used that data in a matrix approach to map it to MIS courses. Despite a relatively small sample size from businesses (n = 60), they concluded that the MIS major needed concentrations (they recommended programming, analyst, and end user support) and business knowledge was the most important critical skill.

Critical skills of IT professionals should drive course curricula; that is, skills are antecedent to curricula ("Influence" in Figure 1). The skills required should be included in the curriculum, given the constraints of number of allowable courses and hours available. The difficulty is determining with accuracy the actual critical skills, then designing a curriculum that supplies them. This process is never perfect, because it is dependent on subjective thought, incomplete data, and differences in organizations. If skills are antecedent to curricula, feedback does occur in the evaluation by stakeholders of the finished product, the graduate. This feedback consists of observations as to the quality and expertise of new IT workers, and how well prepared they are to assume their roles early (and later) in their professional career. Those who manage or work most closely with these graduates (typically businesses) are in the best position to provide accurate feedback and are why IT professionals in the field are such an important stakeholder in determining critical skills.

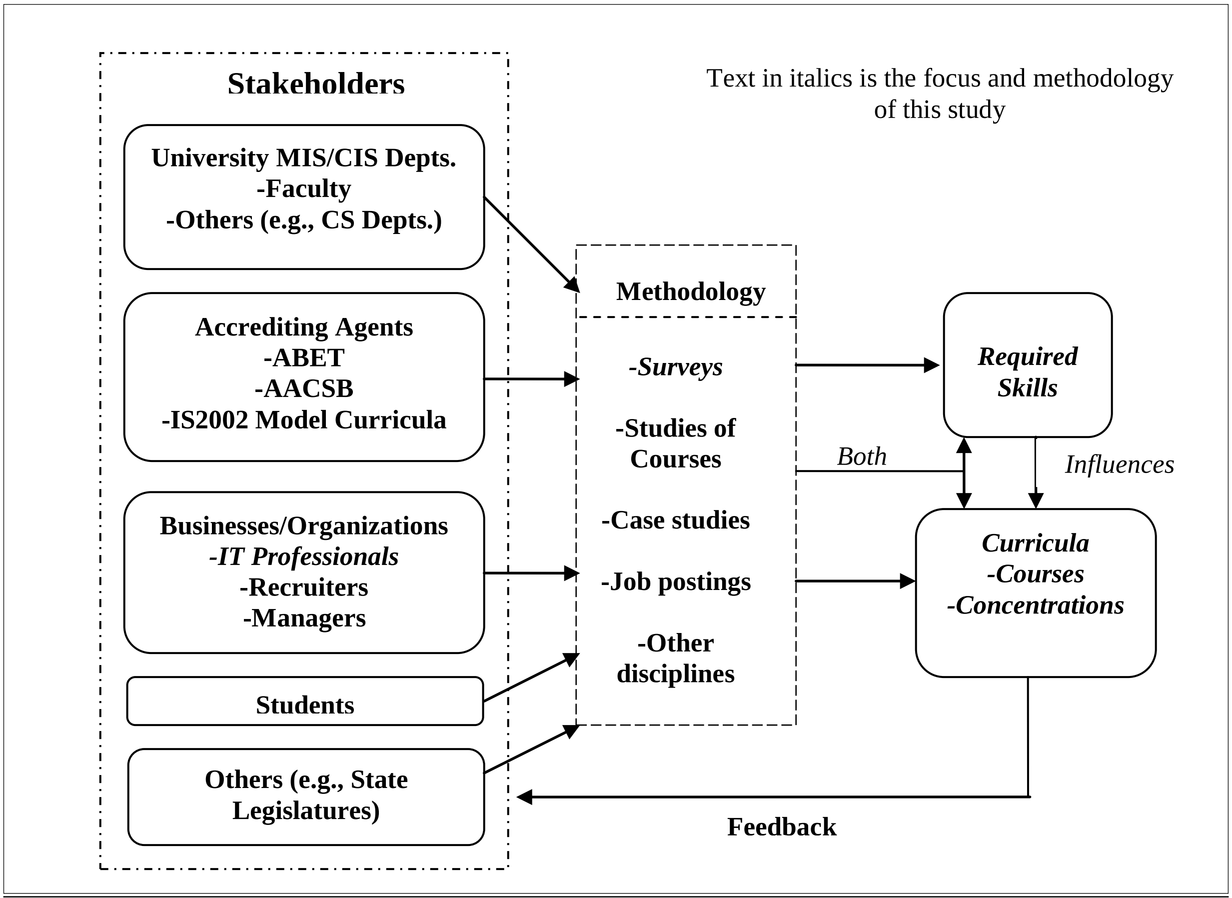

Figure 1. MIS Curricula Studies Dimensions

This study empirically investigates which IT skills are most important for IT personnel, using a sample of current IT professionals from six companies (five public and one private) from the mid-South. The results are then mapped to MIS curricula. This is indicated in Figure 1 by the portion in italics. The study had three primary goals. First, we wished to ascertain an updated ordering of the critical skills important for new IT professionals from the perspective of current IT workers in the field. Second, using these findings, we used a unique process to map these skills to an updated and flexible MIS curriculum which included a MIS core and four separate areas of concentration. Finally, we wished to empirically examine the extent that MIS departments should focus on the latest technologies for a graduate's first job or on fundamentals, which last a career. These are summarized in the following research questions:

1. Which actual skills are the most important for entry-level IT professionals?
2. Given an ordering of critical skills, what courses should taught and how (required? elective? part of a concentration?)
3. How much of the MIS curricula should be devoted to teaching IS fundamentals and how much should be devoted to teaching the latest technologies?

4. METHODOLOGY

4.1 Participants and Methodology

The participants chosen for this study represented a sample from six organizations in the mid-South (OK, AR, LA, TN, MS, and MO), including two Fortune-500 firms. This sample represents the major employers that recruit MIS and CS graduates from area universities. Although this is clearly a convenience sample, we wished to determine what our major constituents desired from our MIS graduates. Those IT professionals selected have a working knowledge of the strengths and weaknesses of new graduates as well as a vested interest in their professional preparation. While we recognize that generalizations will be limited from this methodology, the advantage is the findings will be directly applicable to MIS (and CS) programs in this area. Three of the organizations, though headquartered in this area, have offices nationwide (two are international as well), and hire nationally, allowing some generalizability in other locales. Industry segments included retail, insurance, telecommunications, logistics, IT consulting, and education. The organizations averaged $3.6 billion in revenues with an average of 13,700 employees (one firm was greater than 50,000 employees, one between 20,000-25,000, three between 1,000-10,000, and one less than 500). Their IT departments averaged 155 in size (except for the IT consulting firm, where most employees were IT personnel). All respondents were working IT professionals, including CIOs, programmers, analysts, IT project leaders or team members, and support staff (e.g., help desk, software support). Respondents were not recruiters as such, but many of them were involved in hiring for their respective departments.

The IT departments from these six companies were contacted and solicited for participation. Initial contact was made with high-ranking IT management personnel to gain their involvement and consent. Upon consent, an online survey was provided to each organization and the IT contact in the company distributed the survey link to IT personnel. Because of this format, it is difficult to gauge response rate, not knowing with any certitude how many actually received the survey.

4.2 Respondents

A total of 159 respondents returned the questionnaire. Six surveys were excluded because of incomplete data, resulting in a total of 153 usable surveys. Data on age, gender, highest degree, years in IT field, organizational level, and job function were gathered for each respondent. Data are provided in Table 1. The respondents represented a broad cross-section of experience, management levels, and jobs within their organizations.

Gender	Male: 99 (64.7%); Female: 50 (32.7%); Not Listed: 4 (2.6%)
Age	20-29: 26 (17.0%); 30-39: 53 (34.6%); 40-49: 42 (27.5%); 50-59: 27 (17.6%); 60+: 2 (1.3%); Not Listed: 3 (2.0%)
Highest Degree	High School: 1 (.7%); Some College: 18 (11.8%); 2-yr Degree: 6 (3.8%); Bachelor's: 96 (62.8%); Graduate Degree: 31 (20.3%); Not Listed: 1 (.65%)
Years in IT Field	5 or Less: 27 (17.6%); 6-10: 38 (24.8%); 11-19: 36 (23.5%); 20-29: 38 (24.8%); 30+: 14 (9.2%)
Organizational Level	CIO/CTO/Executive: 4 (2.6%); Director/Middle Mgt.: 36 (23.5%); Supervisory/ Team Leader: 30 (19.6%); Professional (no subordinates): 77 (50.3%); Other: 6 (3.9%)
Job Function*	Dev. Programmer: 79 (23.9%); Maintenance Programmer: 48 (14.5%); Dev. Analyst: 45 (13.6%); Other: 37 (11.2%); Project Leader: 30 (9.1%); Customer Support: 29 (8.8%); Maintenance Analyst: 25 (7.6%); Project Team Member: 12 (3.6%); DB Support: 10 (3.0%); Network Support: 10 (3.0%); Web Support: 5 (1.5%)
* Each respondent could choose up to three job functions	

Table 1. Respondent Data

4.3 Questionnaire

To determine which actual skills to include in a survey we consulted first the literature, then colleagues in various business disciplines, and IT departments of several major businesses that recruit in the mid-South, following standard survey development techniques (Churchill, 1979; Nunnally, 1967; Straub, 1989). Recent literature suggests skills were required in the four general classifications of IS core knowledge, IT proficiencies, business expertise, and personal skills (Cappel, 2001/2002; Fang et al., 2005; Lee et al., 2001). The IS 2002 model curriculum included similar skills (Gorgone et al., 2002). We kept these classifications to promote cross-study comparisons. Most of these studies, for example, in the personal skills area included communications (written and oral), team skills, and critical and creative thinking skills. All included programming or programming languages and other proficiencies. A proficiency is defined as a hands-on skill, while IS core knowledge is more conceptual or theoretical (education instead of training). For example, client-server database core knowledge is concerned with concepts such as database design, implementation, keys, referential integrity, optimal query structure, etc., while database proficiency is the ability to create tables, keys, queries, etc., using an actual database management system.

Using these studies, a list was made of all pertinent skills; these were then compared and collated. The collated list was then examined by university colleagues and by business organizations. In general, because there were almost fifty different skills, the list was comprehensive enough that few changes had to be made. However, there were some slight modifications (for example, "personal motivation" was eliminated as one of the personal traits after some businesses remarked that it was a "given"; we concurred). A preliminary questionnaire was given to seven IT workers from three industries (retail, insurance, and consulting); after some minor changes a pilot test was given to twenty others. Following another round of modifications, the final list of 42 skills included fifteen in the area of IS core knowledge, fourteen proficiencies, seven in business expertise, and six in personal attributes. For each of the 42 skills questions, respondents indicated its importance on a seven-point Likert scale with anchors at 1 (Not Important) and 7 (Very Important). In addition each skill had a separate response choice of "Don't Know". Besides the 42 skills, the survey included demographic information and another question that asked respondents to rank-order the three most important programming languages that new IT professionals should know. Respondents were asked to choose these skills or knowledge items important for **any new IT hire**, irrespective of the respondent's current organization or job description. We were interested in finding out the perspectives of IT professionals in general, not the skill requirements for a particular organization or job.

5. RESULTS

Results are divided into two sections, critical skills required of new IT professionals and mapping those skills to an MIS curriculum.

5.1 Critical Skills

To test which skills were most important to respondents, we examined each skill independently as well as in relation to other skills. Table 2 provides statistical information on each individual skill, including mean, standard deviation, and area (i.e., personal attribute = PA, etc.). The table also provides information used in later sections. Adjusted rank is the rank excluding personal attributes and is used in curriculum development; T/F designates a skill as either technical or foundational, used also in curriculum.

Testing was performed to determine which skills were most important, that is, had significantly higher means than other skills. T-tests were conducted which ranked the skills according to their mean, as indicated in the "statistical rank" column of Table 2. Skills with different numbers were significantly different in means while those skills with the same number (or rank) had means not significantly different. For example, the first three skills, all ranked #1, had significantly higher means than the other 39 skills. The three skills ranked #4 had statistically higher means than all the lower ones.

Combining all skills into their respective area, the personal attributes mean was 6.38. Respondents considered business expertise area the next most important (mean = 4.51), followed by IS core knowledge (mean = 4.26). Least important was the proficiencies area (mean = 3.15), in part because of the low means for some of the software tools (GIS, ES, GSS, DSS, etc.).

5.2 Mapping Skills to Curricula

The process by which these critical skills are mapped to the MIS curriculum involves determining how the skills are supported by the actual courses that make up the curriculum (Daigle et al., 2003). To determine the "actual courses", we entered the process with no *a priori* conceptions, but did have available the courses included in other studies. The IS 2002 model curriculum, for example, consists of ten courses (eleven including a beginning course in word processing, spreadsheets, email, and browsers). But ten or eleven courses is too many in almost all universities; in a study which included number of required MIS courses, Williams and Pomykalski (2004) found that no university required 9 or 10 courses, only 4% required 8 courses, and most required 5 (27%) or 6 (21%). In another study which examined all universities which offer a bachelor's degree in MIS (or IS or CIS) as part of the business school (n = 232), the authors found six "core courses" offered at most schools (with percentage of programs offering the course): systems analysis and design (94%), database (92%), telecommunications (71%), introduction to IS (61%), programming course (60%), and capstone course (47%) (Kung, Yang, and Zhang, 2006).

To carry out these guidelines, we used the following methodology:

1. The top six critical skills (all personal attributes) should be inserted into *every MIS course*.
2. The skills with a mean less than 3.0 (eight total and numbered 35-42 in Table 2) suggest a lack of critical importance; these skills can be mapped into elective courses.
3. Of the remaining 28 skills, the upper half (approximately 14 and **hereafter numbered 1-14**) should be inserted into required (or core) classes; the lower half (**numbered 15-28**) should be placed in either concentrations or elective courses
4. Concentrations (or tracks) are indicated when those skills in the lower half (15-28) are skills with deeper coverage than similar skills in the upper half. For example, #24 Data warehouse/data mart proficiency clearly indicates a higher mastery than #6 client-server database, and should be a concentration course (i.e., offered as a second course in a concentration or track, <u>with the first course a prerequisite</u>).

The methodology involved taking each skill (1-28) and mapping it to an appropriate course, resulting in a curriculum summarized in Figure 2. Mapping the most important skills (1-14) to courses suggests that six core or required courses are necessary: Introduction to MIS, Systems Analysis and Design, Programming 1, Telecommunications/Networking, Database, and Web Development. This does not include the prerequisite Personal Productivity course, which usually consists of basic proficiency in word processing, spreadsheets, email, personal database, etc. This course should be prescribed only when necessary (perhaps students could test out).

The mapping was not seamless. First, two skills (organizational knowledge (#12) and business functions (#16) in the business expertise area were not mapped to any particular course. Organizational knowledge, which is firm-specific, does not really belong in any course, while business functions (accounting, marketing, etc.) are covered in other required business courses. Secondly, two skills in the more important half (1-14) were moved into concentration courses, that is, courses which make up a track and have the first or core course a prerequisite (i.e., the 15-28 half). Both of these skills involved computer languages (#4 object oriented languages and #8 web languages). Finally, some skills were moved into core courses, where they were more suited, including #21 (network topologies and protocols) to the core Networks course, because it was an appropriate learning objective of that course (Gorgone et al., 2002). A few others (#15, #22, #23, #26, #28) were also moved down into core or stand-alone courses where they had a more appropriate fit.

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Rank	Adj. Rank	Skill or Knowledge Area	Mean	SD	Statistical Rank	Area	T/F*
1		Problem solving skills	6.69	0.70	1	PA	F
2		Critical thinking skills	6.59	0.82	1	PA	F
3		Team skills	6.52	0.86	1	PA	F
4		Communication skills (oral)	6.22	1.05	4	PA	F
5		Creative thinking skills	6.18	1.10	4	PA	F
6		Communication skills (written)	6.07	1.12	4	PA	F
7	1	Database Query Language (SQL)	5.51	1.69	7	IS	T
8	2	Ethics and privacy Issues	5.46	1.68	7	BE	F
9	3	High level languages	5.39	1.84	7	IS	T
10	4	Object-oriented languages	5.11	1.71	10	IS	T
11	5	Database design/development	4.98	1.66	10	IS	F
12	6	Client-server database proficiency (e.g., Oracle, DB2, etc.)	4.98	1.65	10	PR	F
13	7	Security issues	4.93	1.61	10	BE	F
14	8	Web development languages	4.82	1.76	14	IS	T
15	9	Office software proficiency	4.53	1.53	15	PR	F
16	10	Business environment (economics/legal, cultural)	4.52	1.59	15	BE	F
17	11	Web markup languages (html/xhtml/xml)	4.51	1.78	15	IS	T
18	12	Organizational knowledge (products, history, customers, etc.)	4.49	1.76	15	BE	F
19	13	Object-oriented systems analysis concepts and methodologies	4.47	1.70	15	IS	F
20	14	Project management concepts (scheduling, prototyping, etc.)	4.43	1.60	15	IS	F
21	15	Spreadsheet proficiency	4.41	1.51	15	PR	F
22	16	Business functions (marketing, finance, etc.)	4.39	1.64	15	BE	F
23	17	Mini/Mainframe OS knowledge	4.11	1.73	23	IS	T
24	18	E-Commerce (techniques/capabilities)	4.08	1.73	23	BE	T
25	19	OS knowledge (scheduling, memory, threads, etc)	3.97	1.55	23	IS	T
26	20	Hardware (CPU, I/O, memory, architecture, etc.)	3.84	1.50	26	IS	T
27	21	Network topologies & protocols	3.70	1.55	26	IS	T
28	22	Globalization issues/trends/requirements	3.70	1.56	26	BE	F
29	23	Project management tools	3.62	1.55	26	PR	T
30	24	Data warehouse/mart knowledge/proficiency	3.61	1.73	26	PR	T
31	25	Network hardware (servers, routers, hubs, etc)	3.45	1.38	31	IS	T
32	26	Personal database proficiency (e.g., Access)	3.43	1.53	31	PR	T
33	27	Mobile or wireless networks & systems	3.11	1.46	33	IS	T
34	28	Web design editor proficiency (e.g. FrontPage, Dreamweaver, etc.)	3.00	1.55	33	PR	T
35		CASE tools (use and understanding)	2.57	1.53	35	IS	T
36		Decision Support Systems (DSS)	2.53	1.67	35	PR	T
37		ERP systems (use and understanding)	2.53	1.62	35	PR	T
38		Group Support Systems (GSS)	2.51	1.43	35	PR	T
39		Statistical packages	2.26	1.53	39	PR	T
40		Simulation/optimization tools	2.25	1.60	39	PR	T
41		Artificial intelligence/Expert systems	2.24	1.40	39	PR	T
42		GIS systems	2.07	1.39	42	PR	T

Adj. Rank: rank excluding personal attributes, used in curriculum development and Figure 2. PA: personal attributes/skills; IS: IS core knowledge; BE: business expertise; PR: proficiency. Statistical rank tests the hypothesis that the mean of the current row is not statistically different than the row above. Those with the same rank are not different. *Technical or fundamental (see discussion section). n = 142 to 153 (depending on the number of "Don't know" responses)

Table 2-Critical Skills and Knowledge Areas

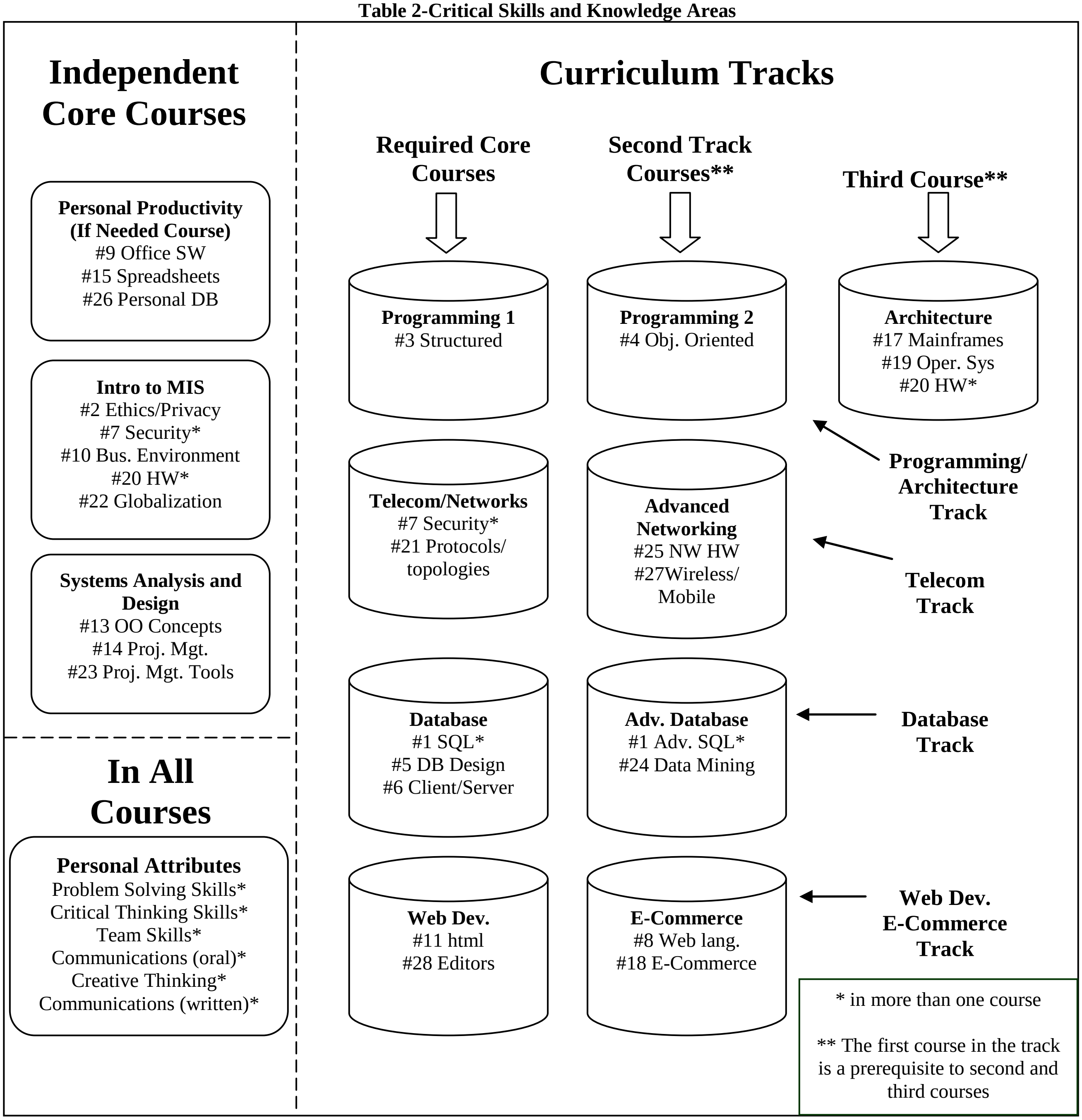

Figure 2. Recommended Curriculum

prerequisite Personal Productivity course, which usually consists of basic proficiency in word processing, spreadsheets, email, personal database, etc. This course should be prescribed only when necessary (perhaps students could test out).

The mapping was not seamless. First, two skills (organizational knowledge (#12) and business functions (#16) in the business expertise area were not mapped to any particular course. Organizational knowledge, which is firm-specific, does not really belong in any course, while business functions (accounting, marketing, etc.) are covered in other required business courses. Secondly, two skills in the more important half (1-14) were moved into concentration courses, that is, courses which make up a track and have the first or core course a prerequisite (i.e., the 15-28 half). Both of these skills involved computer languages (#4 object oriented languages and #8 web languages). Finally, some skills were moved into core courses, where they were more suited, including #21 (network topologies and protocols) to the core Networks course, because it was an appropriate learning objective of that course (Gorgone et al., 2002). A few others (#15, #22, #23, #26, #28) were also moved down into core or stand-alone courses where they had a more appropriate fit. Two core courses were stand-alone, that is, are not part of any concentration. Introduction to MIS included skills such as ethics/privacy (# 2), security issues (#7), business environment (#10), hardware (#20) and global issues (#22). Systems analysis and design included the skills object oriented analysis/design concepts (#13), project management concepts (#14), and project management tools (#23). We believe the two project management skills are best incorporated into this class, though many courses could include these skills (e.g., database courses).

This mapping mandated four concentrations. The primary difference between a core course and a concentration or track course is that the former is a prerequisite for the latter. Thus the web development class is a prerequisite for the e-commerce class; the database class is a prerequisite for advanced databases. The concentration courses provide depth and mastery that is not available in the core courses alone.

For the programming concentration, the first programming course ostensibly is a procedural or structured language (#3), but it could be an object-oriented language (#4) as well (there was not much difference in importance between these two skills). Conceptually, the difference between them is the approach; the object-oriented approach typically includes classes and their methods. This two-course sequence could also be the same language; for example a first C++ or Java course could use a structured language approach while the second course examines more intensively classes, methods, and data structures. In addition to the two programming courses, an architecture course was included because this seemed the most appropriate track in which to include operating systems, hardware, and mainframes. This track would therefore have eight courses (the only track to do so), although the architecture course could be eliminated if necessary to remain at seven courses. Telecommunications and networks mandated a concentration primarily because of mobile and wireless networks concepts (#27). Data mart and data mining skills led to a concentration in databases as well as SQL, the #1 rated skill. If the core database class consists of database design and implementation (in a client-server architecture like Oracle, DB2, or SQL Server), there is not much time left for anything but basic SQL. Therefore an advanced course should contain more advanced SQL. The last concentration was web design. The core required class consists of html (or xhtml) (#11) and web design using an editor such as FrontPage or Dreamweaver (#28). The advanced class includes a web language, such as JavaScript, Perl, or PHP (#8) and e-commerce fundamentals (#18).

This curriculum is quite flexible. A major could consist of just the six core courses, plus one (or more) elective(s), and all second or third concentration courses could be electives. Since many departments require a capstone course, this could be added as a seventh core course. Alternatively (and our recommendation based on these results), the MIS department could require a concentration in addition to the core classes, consisting of one (or possibly two) more courses, which provide added mastery and depth in a particular career path. There is also the possibility of other additional elective courses, such as a second language course (e.g., Java II), special projects, etc., which could be part of a concentration or a pure elective.

6. DISCUSSION, LIMITATIONS, AND CONCLUSION

6.1 Findings and Implications

The primary goal of this study was to examine the beliefs of IT professionals in the field concerning the most important technical and non-technical skills desired of new IT graduates, and from that devise an appropriate curriculum that takes into account those critical skills. While many studies examine critical skills from a faculty perspective or by observing what universities are actually teaching, we wished to provide an updated list of skills that IT workers in businesses and organizations say are important. Unlike the vast majority of studies, we used these findings to uniquely map those skills to an MIS curriculum that allows MIS departments some flexibility while simultaneously including all important skills. The implications of this study are somewhat surprising, particularly from a curriculum design point of view:

1. Technology is important! Despite reports that technology is moving offshore (Weber, 2004), that soft skills are most important (Lee et al., 2001), that technology can be taught on the job (Shuler, 2007), this study clearly emphasizes the importance of technology, both IT proficiencies and in the IS core knowledge areas. Professionals in the field believe technology skills are necessary. Even when the top six personal attribute skills are included, fifteen of the twenty-one skills in the upper half of the survey are based on technology. This study suggests that MIS curricula developers should focus on courses which enhance a student's understanding and proficiency for technology. Some examples:

- It isn't enough to teach database design and concepts. This study strongly suggests that SQL is critical (it was the most important skill not a personal attribute).
- An understanding of operating systems (OS) is important (ranked #17 and #19 for mainframe and PC OSs). Despite its inclusion in the model curriculum (as 2002.4), Williams and Pomykalski (2004) found that this course was the least represented of the ten IS 2002 courses in MIS curricula, with only 7% of colleges including it as a required course. These results suggest that IT professionals don't agree with its exclusion.
- The Internet, web design and development, and e-commerce technologies were highly rated by professionals. While this was one of the primary reasons for redesigning IS 2002 (from the previous 1997 version) (Gorgone et al., 2002), its high rating was relatively surprising since none of the organizations surveyed in this study has a large e-commerce presence. Respondents were instructed to rate skills and knowledge areas important for any IT graduate, not for any specific company, and they still considered web design important.

2. Languages are critical. Another surprising result was the importance placed on computer languages. This supports the first implication that technology in a curriculum is important. Even excluding the pseudo-languages of SQL and html, three of the top eight skills (not counting personal attributes) were computer languages. IT professionals were clear in their recommendation that new graduates know computing languages. In fact, they suggest that two (even three) languages be part of the core curriculum. This does not support other studies, which list one or perhaps two (Ehie, 2002; Kung et al., 2006). From these findings, we believe two language courses are important. That said, our curriculum recommends two language courses for only two tracks; the other two tracks, telecom and database, only require one (see Figure 2). Should departments desire, this could be changed by adding one more core language course to those tracks, so that like the programmer track, they have a third concentration course.

An additional item in the survey asked respondents to rate the top three languages they considered most important for new graduates. Using a scale of most important = 3 points, 2nd most important = 2 points and 3rd most important = 1 point, these are the results (with percentage of total in parenthesis): COBOL 266 (34.5%), Java 230 (29.8%), VB 129 (16.7%), C/C++ 82 (10.6%), JavaScript 42 (5.4%), Perl 16 (2.1%), PHP and PL-SQL both 3 (.4%). COBOL and Java were clearly the most important languages, with VB and C/C++ a distant third and fourth. This supports a recent study done in the practitioner press in which the top three programming languages in use were VB, COBOL, and Java (Mitchell, 2006). These results may not apply to other locations or industries; two of our organizations used COBOL extensively.

3. Personal attributes are still most important. The top six skills of respondent IT professionals were all personal attributes. These included problem solving, critical and creative thinking, oral and written communications and team skills. This supports previous findings that suggest non-technical skills are the most important (Fang, et al., 2005; Kovacs et al., 2005; Lee et al., 2001; Young, 1996) and clearly demonstrates the importance placed on individual traits and characteristics. This is not surprising, perhaps, since such traits allow an individual to more easily learn core knowledge concepts, proficiencies, and business expertise skills. A person's ability to learn and use proficiencies and other skills to some degree depends on personal attributes. Another factor is that the requirements for an IT job tend to be position-specific (for example, programming skills are important for software development, but not necessarily for network administrators), while non-technical skills tend to apply to all IT jobs (Kovacs et al., 2005). This challenges course designers to incorporate these into the curriculum courses. We recommend including these skills in all MIS classes. Team projects are one way to enhance all six of the skills, assuming an oral and written presentation is included as deliverables. These types of projects could be placed in every MIS class. Individual projects are another way to enhance some of the skills. Faculty should be encouraged to find ways to incorporate these skills in every class. Another possibility is to include a business communications class in the curriculum (as a required or elective course, or even in the business, not MIS, core) to stress these skills.

4. Concentrations or tracks are a must. This study confirms what a few have recommended, that the MIS field is no longer suited to one generic curriculum (Lee et al., 1995; Noll and Wilkins, 2002). The field changes so rapidly and has such diversity that different career paths require different mastery skills, even at the new graduate level. Concentrations allow a graduate to delve deeper into a particular area, providing a better qualified hire. This study suggests concentrations are needed in four areas, programming/architecture, telecommunications/ networks, databases, and web development. However these concentrations could be adapted to fit local business and organizational needs, faculty expertise and availability, and student numbers. Some schools, for example, may not have the faculty to offer a full range of career tracks and could base concentrations on local need (Lightfoot, 1999). But we suggest from these findings that each graduate be required to complete one concentration (thus having one "advanced" course which is based directly on a prerequisite core course).

5. Specific software packages can be learned on the job, not at school. The lowest eight skills were all proficiencies based on distinct software packages, such as decision support systems, group support systems, ERP, expert systems/artificial intelligence, and statistics or simulations packages. The low rankings suggest that these ought to be taught if needed on the job. If local interest dictates, these could be taught in an elective course.

6. Some business expertise skills are needed. A few of the business expertise skills were quite important, including ethics and privacy (#2, excluding the top six personal attributes), and security issues (#13). Ethics is important from an accreditation standpoint, required by both AACSB and ABET (AACSB, 2007; ABET, 2007). These topics could be inserted into several courses. Other skills in this category were not as important, such as globalization (#22).

6.2 Foundational Concepts versus Technology

The last research question concerned the amount of course material devoted to teaching fundamentals versus teaching the latest technologies. The literature suggests that new technologies prepare students for their first job, for immediate workforce requirements, while fundamentals prepare professionals for a career (Weber, 2004; Williams and Pomykalski, 2004). Despite one study that suggests new technology should not be the primary focus of curricula (Lightfoot, 1999), we believe it the mandate of curriculum designers to take both into account. But how much should be devoted to each? The ratio of concepts to new technology was determined by placing each skill into one of these two categories. Although the placing was somewhat subjective, all personal attributes and most business expertise items we considered foundational, while most proficiencies were considered technology-based. The IS core knowledge items varied depending on the skill. The classifications are recorded in the last column of Table 2. Our classification placed 18 of 42 skills (43%) into the fundamental or foundational concepts area, suggesting that only slightly more than half of all course material should be devoted to newer technology items. This finding was surprising, because we assumed IT professionals would clearly prefer new technology skills. Instead, they thought concepts and knowledge important, that MIS should have both.

6.3 Limitations and Conclusion

The most important limitation is the convenience sample used in this study. We used six business organizations that recruit MIS/CS graduates from schools in the mid-South. This clearly limits generalizability to other parts of the United States or other countries. As stated, we purposely used this population to directly aid us in determining the important skills for our graduates (and graduates of the area). That said, three of the companies are national and two global, mitigating to some extent this limitation. The extent to which these organizations are similar to other parts of the nation or world requires additional study. An additional limitation is that most of the organizations were relatively large, only one was under 500 employees. Smaller organizations may have different needs, requiring additional study. Another potential limitation concerns the job functions of the respondents. Development programmers (23.9%) and maintenance programmers (14.5%) constituted the largest percentage of respondents. That many held programming job functions could bias the ratings of critical skills towards the more technical skills. While we recognize this potential bias, respondents could choose up to three job functions (and most had two functions, if not three), and the majority of these IT professionals were between 30-50 years of age (62%) and the highest percentage had worked in the IT field between 20-30 years (25%). This suggests that most respondents were mature and experienced, not new, where technical skills might be more in demand, and mitigates to some extent a potential bias toward technical skills.

This study examined the skills that IT professionals considered most important for new MIS graduates, then took those skills and mapped them to a flexible yet encompassing curriculum. Results suggest that both technical and non-technical skills are important for entry-level hires. This study confirms previous findings that non-technical skills are considered most important, especially personal attributes. But it also clearly suggests that technology is absolutely critical. Database skills (including SQL) and programming languages (at least two, perhaps three) were highly rated by IT professionals in the field.

Additional study is needed in a number of areas. First, this survey was conducted of IT professionals in the mid-South and suggests that businesses there want technically-proficient graduates. This may not be the case elsewhere, so generalizing these results is very important for MIS departments everywhere. This study was focused in the U.S., but clearly there are MIS departments and IT professionals world-wide. Secondly, organizations of different sizes, particularly smaller ones, should be included. Third, this study only examined the IT professional as a stakeholder. While we believe this is probably the most important stakeholder, there are other key ones, including faculty members, who should be considered. Because of the rapid change in the field, the critical skills of new graduates must be reassessed on a continuing basis. Finally, given critical skills, the mapping process to actual courses could be done differently. While our mapping process is new, there are other conceivable ways to map skills to curricula which should be explored.

For MIS curriculum designers, the results are clear. MIS is not a watered down computer science curriculum, rather it is a highly technical major that incorporates business fundamentals and prepares graduates for the key roles of managing people and technology in business organizations. Technology, in the form of database skills, computer languages, and web design are among the critical skills new graduates should possess. While the offshoring phenomenon suggests technology may be less important in MIS departments in U.S. universities, it doesn't appear to be true in the mid-South and we wonder how prevalent it is elsewhere. If an MIS department does not have concentrations, we suggest they should, and one should be required of all students. The IS/IT career is segmented and graduates need the depth that a particular track will provide. MIS departments must ride successive waves of new technology, providing graduates with underlying fundamentals that support all waves, while preparing graduates with the particular technologies required for each wave. It is a daunting task, but a critical one if as a discipline we are to keep up with the ever-changing needs of businesses and organizations.

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