Changing Patterns in IT Skill Sets 1988-2003: A Content Analysis of Classified Advertising

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Abstract

This paper examines trends in required job skills for IT professionals. Through an empirical study of classified job advertising for IT professionals over the past 17 years, we evaluate whether the observed trends support earlier predictions offered by researchers who sought to anticipate future job and skill demands (Leitheiser 1992; Trauth, Farwell, & Lee 1993). Many of the findings are consistent with previous studies and support the notion that employers are seeking an ever-increasing number and variety of skill sets from the new hires. In addition, we found ongoing evidence of a recruitment gap (Todd, McKeen & Gallupe 1995) where, despite many firms' stated emphasis on well-rounded individuals with business knowledge and strong "soft skills," the job advertising aspect of the recruiting process continues to focus on "hard skills". The changing demand patterns for IT professionals necessitate life-long learning skills not only for IT practitioners but also for the academics who teach them.

ACM Categories: K4.3, K6.1, K7.1

Keywords: Career paths, IT professionals, job skills, IT careers, content analysis

Introduction

The importance of information technology (IT) is well established in organizations today. Not only does IT help to improve the efficiency of a multitude of work processes, but it can also enable workgroups and organizations to radically redesign work processes by leveraging IT's communication and coordination capabilities. IT supports all critical front- and back-office functions (Quinn et al., 1996) and, due to adoption of new technologies, such as wireless communication, its influence is expected to grow ten-fold in the near term (Joyner, 2000; National Research Council, 1999). In recent economic reports, IT has been credited with triggering growth in the global economy – fueling a rapid rise in worker productivity (Gilpin, 2000), while keeping inflation in check (Roach, 2000; Uchitelle, 2000). Recent research has underscored the fact that IT does not exist in a social vacuum, but that the only sustained competitive advantage to using IT derives from the *human capital* of talented employees who know how to fit technology to the organization's needs and who can skillfully partner with business users to manage organizational change (Mata et al., 1995; Ross et al., 1996). Firms that are best able to recruit and retain qualified IT professionals will gain a decisive edge over their competition (Agarwal & Ferratt, 2000; Niederman, 2001). Recently, corporations have even resorted to litigation in retaliation for other firms "stealing" their best IT workers – as evidenced in Wal-

Mart's lawsuit against Amazon and Drugstore.com (*InformationWeek* 1999; Hibbard 1999).

Several studies published over the past decade have examined the changing nature of IT professionals' jobs, including changes in job roles, required skills, and the personal attributes required for successful IT employees (Keen, 1988; Markus, 1996; Segars & Hendrickson, 2000; Stokes, 1995; Wynekoop & Walz, 2000). Building upon this literature, our study examines trends in required job skills for IT professionals. Through our empirical study of classified job advertising for IT professionals over the past 17 years, we consider the extent to which the earlier predictions are supported. Specifically, we examine trends in the frequency of job titles advertised and the required skills specified during three time periods between 1988 and 2001, as advertised in two leading publications. We also provide post hoc analysis of the leading online job site (Monster.com) to augment our analysis of the newspaper job ads. We evaluate whether the observed trends support earlier predictions offered by researchers who sought to anticipate future job and skill demands (Leitheiser, 1992; Lee et al., 1995; Todd et al., 1995).

Literature Review

There has been continued interest in understanding the evolving nature of IT jobs, as well as anticipating growth in particular job categories and skills required for the future. Over a dozen studies identifying trends in the IT job market have been published, featuring various research methodologies, including surveys, interviews, focus groups, Delphi studies, and analysis of classified job advertising. In this section, we review the key studies and emphasize the most important trends – specifically looking for similarities and contradictions across studies. We begin by defining the various research methods employed in these studies and then we summarize the leading studies.

First, traditional surveys assess the beliefs of a particular respondent group (usually IT managers, but sometimes also IS academics or consultants) with regard to anticipated trends in the IT job market. Second, interviews and focus groups seek face-to-face input from a specific target population, which may be either a homogeneous respondent group (e.g., IT managers) or a diverse mix of respondents with different backgrounds (e.g., IT managers, academics, consultants, and business unit managers). Third, Delphi studies employ successive rounds of written surveys with the same respondent group, allowing researchers to summarize results from each round of study to identify convergence of experts' opinions over time (Niederman et al., 1991). Finally, borrowing a technique commonly used by economists, historians, and political scientists (Walsh et al., 1975), IS researchers have increasingly used content analysis of classified job advertising to identify shifts in the patterns of skill demands over time (Athey & Plotnicki, 1992). On occasion, studies have combined two or more approaches in order to triangulate results. Below, we review leading studies that employed each of these research methods.

Traditional Surveys

Leitheiser (1992) surveyed 300 IT managers in the Midwestern U.S. to identify the anticipated growth in various job categories and skill requirements between 1990 and 2000. The average growth rate for all IT positions was estimated to be about 4% per year compounded, which was expected to result in a 50% increase in demand for all types of IT employees over the ten-year period. There was, of course, tremendous variation anticipated among different IT specialty areas. For example, Leitheiser projected that the fastest-growing job categories would be data communications, database specialists, end-user support, and system programmers. He also projected that the role of systems analyst would continue to be the largest single job category, with anticipated growth of 87% during the 1990s. In contrast, his results showed that the number of programmer jobs would grow much more slowly.[1] Other positions that were common in the late 1980s, such as data entry and system operators, were expected to decline throughout the 1990s. In terms of specific skills, Leitheiser anticipated the highest growth in demand for data communications, end user support, object-oriented design, and C++. The only technical skills expected to *decline* in importance were mainframe-related programming skills and 3GLs, including COBOL.

Green (1989) also surveyed over 800 systems analysts and users to identify which skills, job roles, and "non-salary incentives" each group perceived to be most important for systems analysts. Curiously, he found that users tended to focus on the importance of systems analysts' technical skills and the technical roles they performed (e.g., *programmer* and *service provider*), whereas the analysts themselves focused much more on importance of interpersonal skills and their non-technical roles (e.g., *diplomat, change agent, communicator* and *salesman*). This discrepancy may, at first glance appear surprising: users primarily valued the systems analysts' technical skills whereas the analysts themselves ascribed greater importance to

[1] Leitheiser noted that these anticipated growth trends probably underestimated IT job growth, because his data focused on job growth in *existing* firms, and did not take into account jobs created in *new* firms. For example, the job and skill projections would ignore IT jobs created in new firms, such as Cisco, and in all the "Dot Com" firms established during the mid-to-late 1990s.

their non-technical roles and skills. This anomalous result has been subsequently identified in other studies, however. For example, in their study of the determinants of webmasters' job performance, Wade & Parent (2001/2002) similarly found that users focused on the importance of technical skills, whereas the webmasters themselves emphasized "organizational skills" as far more important to their successful job performance.

Multi-method Studies (Interviews, Surveys, and Focus Groups)

In their study sponsored by the Boston chapter of the Society of Information Management (SIM), Trauth et al. (1993) combined a traditional survey approach with focus groups and telephone interviews involving IT educators, practitioners, consultants, and business unit managers. Using this multi-method approach, they identified what they labeled an *expectation gap*, i.e., significant discrepancies between the skill priorities identified by practitioners versus the skills taught in most academic programs. This diverse group of practitioners was asked to identify which IT skills and job tasks were most important at the present time and to also project three years into the future. The questions asked of the educators were slightly different, focusing on the emphasis presently given to specific skills and tasks in their academic curricula, as well as how important educators perceived these skills would be three years in the future. While the practitioners and the IS educators largely agreed about the importance of IS skills and job tasks in the *future*,[2] there were significant discrepancies between the *existing* IS curricula described by educators and current skills demanded by IT practitioners. Trauth et al. interpreted these results as showing that practitioners and educators shared a common vision for the future; the problem, however, lay in the discrepancy between current skill needs and the outdated curricula of many academic programs in the early 1990s.

Trauth et al. (1993) labeled this the *curriculum gap*, which they defined as consisting of two dimensions: there was one set of skills valued by IT practitioners but not emphasized in IS curricula, and another skill set that had lost its practical importance, but which was still strongly emphasized in academic programs.[3] Based on their results, the tasks not sufficiently emphasized in academic programs were all related to issues of "integration". These included integrating networks, integrating data types, integrating existing business applications, and integrating new with existing applications. The authors concluded that the future role of the IT professional would be less that of a software developer, and more of an "integrator". Trauth et al. (1993) described this role as follows:

> a new type of IS professional …. will be focused on integration rather than systems development … The ability to carry out enterprise-wide tasks, such as business process reengineering, will become the defining characteristics of this future IS professional, replacing traditional systems development. [These employees] will devote as much effort in analyzing business problems as in developing technical solutions. They will integrate technologies and applications to provide better access to corporate data. But they must also maintain a strategic orientation…. [T]he future IS professional will need a strong *contextual orientation*. This will include a deep understanding of the business units within which they will work, interpersonal skills necessary to work with the end users, and an ability to effectively apply technology in seeking solutions to business problems (Trauth et al., 1993, p. 299).

Trauth et al. compared each group's rating of the importance of specific tasks and skills over time (at present, compared to three years in the future). We report several of their key predictions regarding projected changes in skills and tasks over time, however, before doing so, it is important to note that, on average, a greater baseline set of *more* skills was believed to be necessary three years in the future. Consistent with Leitheiser's (1992) earlier results, the importance of *nearly all* skills was expected to increase over time. Given this perceived "skill inflation" over time, it was possible for the results to show that a given skill would stay the same in terms of respondents' beliefs about its *absolute* level of importance in the future (i.e., importance as rated on a 5-point Likert scale), while declining in relative importance, that is, relative to other skill sets (i.e., in terms of relative rank order of importance). Against this general backdrop of skill inflation, Trauth et al. identified three sets of trends: a) tasks and skills that were expected to decrease both in terms of their absolute and relative importance; b) tasks and skills that were expected to stay the same (or increase just slightly) in terms of their absolute importance, while *declining* in terms of their relative importance; and c) tasks and skills that were expected to *increase* both in terms of their absolute and relative importance.

An interesting aspect of their findings was that the first category contained only a few items, including one job task ("developing in-house applications") and three technical skills (assembly language, 3GLs, and mainframe operating systems).

[2] The authors presented data showing that correlations among academics' and practitioners' beliefs about the importance of job tasks three years hence were very high (ranging from 0.7-0.9).

[3] The skills emphasized in IS educational programs but which were not highly important to practitioners in the early 1990s included structured analysis and design, plus COBOL and other 3GLs.

Table 1. Predicted Trends in Job Types and Required Skills

Study	Increased Demand	Declining Demand	Stable Demand
Leitheiser (1992)	Job types: Systems analyst, end-user support, database specialists, data communications Skills: RDBMS, C, C++ and other object-oriented languages, data communication, AI/ expert systems, interpersonal skills	Job types: computer operators. Skills: JCL, COBOL, mainframe systems, hierarchical and network DBMS, working alone	Job types: application programmers. Skills: structured program design, design data structures, ADA language, algorithms
Trauth, Farwell, Lee (1993)	Skills: analyzing business problems, integrating systems, integrating telecom. networks, 4GLs, relational DBMS, distributed processing (client/server), CASE tools, AI/expert systems	Skills: developing in-house applications; mainframe operating systems, 3GLs, COBOL, Assembly language	Skills: Structured analysis, specific 3GLs, Mid-range operating systems (AS/400), PC operating systems (Windows)
Todd, McKeen & Gallupe(1995)	UNIX, client/server, 4GL, overall number of skills, technical skills	Mainframe, 2GL, 3GLs	
Lee, Trauth, Farwell (1995)	Job types: programmers working in line business areas Skills: business knowledge, interpersonal skills	Job types: programmers working in centralized IS departments	
Prabhakar, Litecky & Arnett (1995)	Networking, client/server skills, C, C++, other object oriented languages, UNIX systems		Relational DBMS, SQL, PC skills, COBOL
Prabhakar, Litecky & Arnett (1996)	Networking, Windows, object-oriented languages, PC skills	UNIX, relational DBMS (other than PC-based)	
Litecky, Prabhakar & Arnett (1996)	Networking, Visual Basic, PC skills, C, C++, other object-oriented languages, Windows	UNIX-based systems	

Thus, very few skills were anticipated to undergo a decline in their importance. In the second category, Trauth et al. identified many tasks and skills that were expected to undergo a *relative* decline in importance (relative to other tasks and skills), while still increasing in *absolute* importance – due to the "skill inflation" effect mentioned above. It appeared that, over time, the various stakeholder groups simply expected IT professionals to know more and be able to do more than at the present time. Their predictions are summarized in Table 1, showing the name of each job task or skill and the direction of the forecasted trend (whether an expected increase, decrease, or expected stable demand).

While Trauth et al. did not report the overall correlations between the educators' and practitioners' ratings of the importance of various skills, such divergence was the basis for the *expectation gap* that they identified. We conducted our own analysis of the raw data reported in their study,[4] and our results indicated very low correlations between practitioners' and educators' ratings of skill and job task importance. The correlations between practitioners' and academics' ratings of the *present* importance of various IT skills and job tasks was very low (the correlation coefficients were 0.23 for required skills and 0.34 for job tasks), although there was somewhat greater convergence of opinion for their projections three years in the future (the correlations were 0.51 and 0.43 for required skills and job tasks, respectively).[5]

Trauth et al. concluded that future roles of IT employees would diverge – with some jobs becoming more business-oriented – the specific "integrator" role, with a focus on business process reengineering, with other jobs becoming more technically-focused (e.g., designing and supporting computer networks). Given that their data were collected during the early-1990s, when business process reengineering (Hammer &

[4] These correlation values are based upon our reanalysis of raw data from Trauth, et al. (1993). Although their study identified a gap between IT practitioners and academics, the authors did not show formal measures of correlation to demonstrate the degree of similarity or dissimilarity across the three respondent groups.

[5] These correlation coefficients are between the *absolute* ranking scores reported by IS academics and practitioners on the five-point Likert scales. The analogous correlation coefficients, when using the *ordinal* priority ranking scores (based on five-point Likert scales) are even lower. The correlation between practitioners' and educators' *present* ratings on the absolute rank ordered scale was extremely low: 0.19 for IS job tasks and 0.05 for skills; and only 0.38 and 0.22 for job tasks and skills three years in the future.

Champy, 1993), client/server computing, and computer networking were critical innovations attracting attention, such a divergence in IT career paths toward separate business-oriented and technically-oriented positions makes a great deal of sense (Keen, 1988).

In a follow-up to their earlier study, Lee, Trauth & Farwell (1995) employed the same multi-phase, multi-method approach as in their prior study. One important difference was that the prior study (Trauth et al,. 1993) focused on differences between perceptions of IT practitioners and educators, while the later study examined perceptual differences among three groups of practitioners – IT managers, consultants, and business unit managers. In addition, rather than examining skill trends for just one or two job categories (as most prior studies had done), their follow-up study examined projections for five job categories, based on job classifications defined by the *ACM* (Nunamaker et al, 1982). These categories were: programmers, business systems analysts, technical specialists, end-user support (help desk, information center), and computer operators/data-entry clerks. The results demonstrated several important shifts in the composition of the IT workforce and skill requirements. First, many of the low-skilled IT job positions (such as data entry operators and computer operators) were disappearing. Second, many IT jobs were migrating from traditional, centralized MIS divisions out to the business units, requiring employees to have more business knowledge and stronger interpersonal skills for working with users. There was much stronger expected growth in the number of IT jobs that would report to functional business areas (20% projected growth over the three-year period), compared to much slower growth for IT jobs located in centralized IT departments (5% projected growth over three years).

Overall, the follow-up study by Lee et al. (1995) revealed that the number and breadth of job requirements was escalating, with more skills expected to be needed for each IT job type in the future, compared to at present. In general, business knowledge, interpersonal skills, and management knowledge were perceived as increasing in importance, whereas technical specialties skills and technology management knowledge were expected to remain constant in the future (neither increasing nor decreasing in importance).[6] All three practitioner groups concurred in rating technical specialties knowledge and skills to be the *least* important of the four general skill categories (both at present and three years hence). Conversely, the three groups of respondents consistently predicted that business knowledge and interpersonal/management skills would become the most important skills in the future.[7]

Analysis of Classified Job Advertising

Whereas the research methods described above examined respondents' expectations for which skills and job tasks would increase in importance over time, the next method we examine – analysis of classified job advertising – collects data on *actual* trends over time. Several sets of authors have collected and analyzed newspaper classified job advertising, in order to assess actual shifts in required IT skills and job types. In these studies, researchers sampled a specific number of job ads per newspaper issue. Most studies combined data from two or more different sources (Slaughter & Ang, 1995; Todd et al., 1995) and occasionally from as many as ten different sources (Arnett & Litecky, 1994). Slaughter & Ang (1995) analyzed classified job ads in order to identify trends in the movement of IT jobs from traditional or permanent employment status to other "alternative" employment categories, such as contract work and jobs where employment agencies act as intermediaries for hiring IT employees. They found that such "alternative" practices were rare during the early 1990s, but that, starting in 1993, this trend had rapidly accelerated in the U.S., but not in Singapore (Slaughter & Ang, 1995). Moreover, they also found that non-IT firms and public sector firms were more likely to use alternate employment strategies, as were firms seeking leading-edge technical skills (for which demand exceeded supply). Conversely, private-sector firms, IT specialist firms (e.g., Microsoft), and firms seeking "legacy" skills (for which there was abundant supply) were more likely to hire permanent, full-time employees (Slaughter & Ang, 1996).

Todd et al. (1995) evaluated newspaper job ads over a 20-year period (1970-1990) at five-year intervals. They examined the trends in job skills demanded for three job types: programmers, systems analysts, and IT managers. Of the three job types, they noted the most dramatic changes in the skills required for systems analysts, compared to only minor changes for programmers and IT managers. They analyzed changes in the mix of skills required, showing that, over time, the job ads for systems analysts became more technically focused. By 1990, the systems analyst job ads demanded nearly as many technical skills as the programmer ads, while also continuing to emphasize non-technical skills (e.g., business knowledge, interpersonal skills, and system development

[6] The four skill/knowledge categories these authors identified were: 1) technical specialties, 2) technology management, 3) business functional knowledge, and 4) interpersonal/ management skills.

[7] Note that Lee, et al. (1995) did not separately evaluate the importance of the four knowledge and skill categories for their different job types. Therefore, it is impossible to know which job types were most responsible for the shift in the importance of knowledge and skill sets (i.e., whether it was due to changes in skills for programmers, end user support personnel, etc.).

methodologies). Todd et al. (1995, p. 15) interpreted this representing as a convergence of skill sets between analysts and programmers, concluding that "the ad profile for an analyst, which was quite different from the ad profile for a programmer in 1970, had become quite similar by 1990".

Their findings confirmed those of many prior studies, namely that over time, IT professionals were required to know more, in terms of number and diversity of different skills (Leitheiser, 1992; Trauth et al,. 1993). The *total* number of skills mentioned per systems analyst job ad had increased from a mean of four skills in 1970 to 7.8 skills in 1990 – nearly a doubling of the number of required skills. Conversely, the results from Todd et al's study differed from several prior studies in one critical area: for systems analysts, specifically, they concluded that technical skills were *more* important than non-technical skills (such as business, interpersonal, and communication skills). This finding contradicted many prior studies of skill requirements for systems analysts (Cheney et al., 1990; Green, 1989; Watson et al., 1990), which had reported *greater* emphasis on non-technical skills and *less* emphasis on technical specialist skills. This newer finding from Todd et al. challenged the conventional wisdom regarding an increased focus on non-technical skills for IT employees – and specifically for systems analysts. Todd et al. (1995) claimed that the analyst position:

> … appears to have become *more*, not less, technical over time. The commonly discussed increase in emphasis on business and communication skills was not as strongly reflected in the job ads as one might expect. These results are somewhat perplexing and are certainly at odds with those generally reported in the IS literature (Todd et al., 1995, p. 13).

Todd et al. concluded that systems analysts would face a tough set of job demands in the future, given the apparent trend toward greater demand for technical skills, accompanied by ongoing demand for business, interpersonal, and communication skills. In contrast, they concluded that the job ads for programmers had remained stable over the 20-year period, with approximately 60% of the total phrases in these ads referring to technical skills. In terms of trends regarding specific technical specialties, the authors found a shift in hardware requirements from mainframe to non-mainframe platforms (including UNIX and client/server), as well as a progression from 2GLs to 3GLs to 4GLs over time. Between 1980 and 1990, the relative proportion of job ads mentioning different "generations" of programming languages declined for 2GLs (from 6%-2%) and for 3GLs (including "C") (from 32%-24%), while increasing for 4GLs (from 0%-6%).

In related work, researchers from Mississippi State University conducted yearly analyses of newspaper classified advertising appearing in ten major metropolitan newspapers for the years 1993-1995 (Arnett & Litecky, 1994; Prabhakar, Litecky & Arnett , 1995, 1996). Tracking the relative importance of various technical skills mentioned in these job ads, the authors found the demand for most technical skills to be relatively constant. The one significant exception was skills related to computer networking, which increased in the proportion of job ads that specified this skill rising from 21%-35% of all job ads between 1993-1995. Other skills that were in high demand (although remaining stable in importance) were UNIX, relational DBMS, C, PC-related skills, Windows, and object-oriented programming. Contrary to many earlier predictions, even COBOL appeared to be relatively stable in terms of demand, with about 11% of all job ads consistently specifying COBOL skills between 1993-1995. There were some anomalies in their findings with regard to specific DBMS skills.[8] The same researchers have updated their results more recently (Litecky et al., 1998), and have even developed an "unobtrusive methods" (Webb et al. 1966) to automate the process of extracting and coding classified job ads from nine leading, geographically-dispersed newspapers (Litecky & Arnett, 2001).

We note the fact that the methodology employed by the Mississippi State University researchers did not consider the *absolute* level of change in skill requirements, but simply the *relative* change, in terms of the proportion of all job ads specifying a particular skill. Thus, it is possible in their data that, over time, there was a larger *absolute* number of ads requiring a specific skill set (e.g., UNIX), while this same skill set may have declined in importance relative to other skill sets. Thus, we cannot infer anything about the absolute demand for particular skill sets, based on their results. The absolute demand level for a given skill set is complicated by other external factors, including the general economic climate.[9]

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[8] The Mississippi State University researchers found that, while relational DBMS remained a highly-desirable job skill (21-25% of total ads mentioned DBMS each year), there was a decline in the relative proportion of ads for mainframe DB/2 and SQL – two popular relational DBMS skill sets. This may be explained by the decline in the relative importance of *mainframe* systems (and hence mainframe DBMS software), but it was offset by the increased demand for client/server platforms and associated DBMS products. Thus, while relational DBMS remained a critical skill, the platforms for relational DBMS was migrating from mainframes to client/server or PC platforms.

[9] For example, the proportion of ads that mentioned UNIX may have increased from 20%-40% during the 1993-1995 time period, however, when the proportion of *total ad phrases* that mentioned UNIX may have declined from 5%-3% during the same period. This is because, while UNIX was mentioned in a larger number of ads, other skills were growing even faster in their importance. Moreover, another factor that influenced the results was that, during the 1993-1995 study period, the actual number of job ads placed in the ten major metropolitan newspapers dropped precipitously from 500 to 290. This decline

Cross-Study Comparisons

Taken as a whole, these studies present interesting although, at times, contradictory results. Table 1 summarizes many of the detailed predictions offered in these prior studies. The only commonality across these prior studies was the general expectation that IT personnel should possess *more* skill sets and more *varied* skill sets over time. Few researchers have considered the challenge this would pose for IT professionals or IT educators seeking to "keep up". One study that *did* consider the burden that "keeping up" places on IT professionals and their managers was a study by Benamati & Lederer (2001). Perhaps the greatest source of contradiction in the prior studies concerns the relative importance of technical versus non-technical skills for IT professionals. There appears to be a long history of IT skill studies revealing that non-technical skills were believed to be more important by a variety of stakeholders. This finding first emerged over 20 years ago (Benbasat et al., 1980), and has been consistently supported in numerous subsequent studies (Cheney et al., 1990; Leitheiser, 1992; Lee et al,. 1995; Misic, 1996). The only study that did *not* support this conclusion was the study by Todd et al. (1995). The latter researchers explicitly noted and discussed the contradiction between their findings (based on classified job ads) and the many preceding studies – which we cited in the prior section. We note, however, that Todd et al's study was based on actual job ads, whereas the other studies were based on other research methods (including interviews, surveys, and focus groups). In one recent study that combined both types of methods, Wong, von Hellens & Orr (2000) concluded that non-technical skills continue to be more important than technical skills. Their study, sub-titled "The soft skills matter most", noted that:

> There was a general consensus evident from job advertisements and questionnaires that non-technical or "soft" skills … were more important for [recent] graduates than technical skills in terms of employment prospects…. The interviews confirmed the relative importance of non-technical skills in the current IT workplace, with references made towards [attributes such as] flexibility, adaptability, motivation, and good communication skills (Wong et al., 2000, p. 6).

One other area of disagreement among the various studies concerns the fate of traditional 3GL skills – specifically the demand for COBOL programmers. Some researchers observed the ongoing importance of COBOL in terms of continued, but flat demand (Prabhakar et al., 1995), while other studies predicted declining demand (Trauth et al., 1993). How do we reconcile these differing results? The first step, obviously, is to recognize that different trends – even contrary ones – may occur in different business context. For example, it may be that private-sector and public-sector firms have different skill requirements (Green, 1989), or that IT specialist firms and other technology-oriented businesses differ from non-technology firms in their hiring needs (ITAA 2000). Other potential differences may reside in differences between firms seeking to hire experienced IT professionals versus hiring recent college graduates (Wong et al., 2000) or differences among firms at various stages of "IT organizational maturity" (Benbasat et al., 1980; Gibson & Nolan, 1974). Beyond recognizing different needs across different business contexts, a second step to resolve conflicting findings and predictions is to conduct ongoing research to identify which prior trends or predictions have been borne out by recent developments. This is the primary challenge that we undertake below.

Research Questions

In this study, we empirically examine the predicted trends identified in earlier studies by analyzing classified job advertising for IT professionals. The research questions that inform this analysis are as follows:

- What have been the most dramatic trends, in terms of positions for which IT professionals are sought?
- What have been the most dramatic trends, in terms of required skills for IT professionals?
- Have the forecasts offered by researchers in earlier studies proven to be true?

Given our awareness of certain contradictions and limitations in prior studies, we believe that these questions warrant further investigation. Moreover, given the fact that over a decade has passed since the data were collected in the 1980s and early 1990s for many of the studies reviewed above (Lee et al., 1995; Todd et al., 1995; Trauth et al., 1993), we believe it important to understand whether the earlier forecasts have been supported.

Data Collection and Analysis

This study employed a content analysis of advertised job positions placed in a major national IT publication (*Computerworld*) and the Sunday classified jobs ads section of a major metropolitan newspaper in the southeastern U.S. (the *Atlanta Journal-Constitution*). All job ads from a sample of four issues in each of the years 1988, 1995, 2001, and 2002 were content analyzed.

Economists have long used job ads as a non-obtrusive measure of skill demand in the job market. Over the past decade, IS researchers have frequently used content

was most likely a consequence of the general economic recession of the early-1990s.

analysis of job ads (Athey & Plotnicki, 1992; Slaughter & Ang, 1996; Todd et al., 1995). Research has demonstrated that at least 80% of job seekers use job advertisements as at least part of their job search strategy (Dawson & Dawson, 1988). Moreover, as we argue below, job ads also provide information about employers' expectations of its potential employees and other information about evolving skill sets.

Sampling choices and rationale

We collected and analyzed 2,108 IT job ads from *Computerworld* and the *Atlanta Journal Constitution*, initially at seven-year intervals (1988, 1995, and 2001). We later updated the sample with additional ads from 2002-2003 in order to compare current trends from print-based advertising with online ads from a popular Internet job site, Monster.com. The distribution of these ads and the number of IT jobs for which these ads sought to hire are shown in Table 2. The weekly publication, *Computerworld*, was selected as one of our data sources for several reasons. First, it is widely read by technology workers, and it represents an established and respected vehicle for IT classified advertising. According to Slaughter & Ang (1995, p. 25), *Computerworld* "is the premier national trade journal in IS where IS job opportunities are widely advertised". Second, it is published and distributed nationally, and thus represents a single window on IT hiring and recruitment attempts for the U.S. as a whole.

Table 2. Sample size of Ads Coded by Year

Year	Number of ads coded	Sources
1988	686	Computerworld, AJC
1995	899	Computerworld, AJC
2001	341	Computerworld, AJC
2002	238	Computerworld, AJC
2003	133	www.Monster.com
Total	**2297**	

Third, *Computerworld* had developed a uniform nomenclature for identifying IT skills, job types, and system types. Fourth, we had a relationship with an executive in *Computerworld*'s advertising department, which facilitated our gathering of information about distribution, advertising policy, content and placement of ads and shifting trends over time. Fifth, *Computerworld* also has regionally targeted job announcements sections that could be tracked so that we might identify any potential regional differences in skill needs (if any differences in the types of job ads existed between the southeast and national editions). Thus, *Computerworld* provides a rich and accessible source of advertising data and meta-data about the advertising process. Some additional details about the specific issues that we sampled from *Computerworld* and our procedure for aggregating data from southeast regional and national *Computerworld* editions are described in Appendix A.

The *Atlanta Journal Constitution* (*AJC*) newspaper was selected because it is the premier news publication in the southeastern region of the U.S. (where all authors were located when this study was initiated), and it services a geographic region of over five million people. The Atlanta region is rich in high-tech firms, and was one of the fastest-growing technology regions in the U.S. during the 1990s (Arnett & Litecky 1994). In addition to leading employers such as Coca-Cola, UPS, and Delta, the region also features six universities and 17 colleges in its readership area. The third source we examined was the leading Internet job site, Monster.com (Hallowell & Reavis, 2001). We coded a 2% sample of the nearly 7,000 IT-related job ads that were listed on the website during late January 2003. We decided to expand our initial research design to examine online job ads, specifically to identify whether there were any differences between the online ads and those in the print media during a comparable timeframe (January 2002-January, 2003).

Sampling Strategy

For each print publication, we selected four periods over the course of each of the sample years from which to examine and review classified ads. We coded all ads in the first issue of each quarter (January, April, July, and October). In our analysis, we acknowledged that one classified ad could identify multiple, different job positions. Unlike other IS studies that only sampled specific ads *within* each issue, we examined the entire population of ads for each target issue.[10] Hence we omitted fewer ads than did any of the previous studies. However, it was essential that we be able to identify the specific skills sought for each job position by mapping the specified skills to each job title. Our unit of analysis was the *job* for which the employer was advertising, and not the individual classified ad itself. We therefore scrutinized each ad for a clear match between the advertised job and the skills required for the position. Therefore, if an employer's ad announced the hiring of "project managers, programmers, systems analysts", and listed an array of skill requirements that were not mapped to specific job titles, then we excluded this ad from our sample. Conversely, if the employer was explicitly hiring for multiple job types in a single ad, but the ad clearly specified which skills were sought for which job titles, we retained the ad and treated it as multiple units of analysis, corresponding to the various

[10] For instance, Slaughter & Ang (1996) omitted multiple position ads, as well as ads placed by executive search firms. Todd et al. (1995) eliminated consulting and temporary agency ads. Ads by the Mississippi State University researchers deleted ads for certain job categories, including analyst, scientific programmer, and others.

job titles. In addition to excluding those ads for which we could not identify a clear relationship between the job type and required skills, we omitted ads for international assignments and redundant ads (e.g., the same ad double-listed in a single issue). Based on these criteria, we eliminated fewer than 5% of ads from the 1988 and 1995 issues that we coded, but nearly 17% of the ads in the 2001 and 2002-2003 time periods. By 2001, a much larger fraction of classified ads merely listed one or more job titles and a phone number or URL to contact for additional information.

For our second publication, the *Atlanta Journal Constitution (AJC)*, we coded the entire population of ads in issues drawn from the exact same dates as chosen for *Computerworld* (i.e., the first Sunday issue in January, April, June and September). Under the "Help Wanted" section, we analyzed all ads under headings for IT, computers, data processing, and programmers. Similar to the comparisons between the East coast and nation-wide listings in *Computerworld* (see Appendix A), after various comparisons of the skill requirements between the ads in *Computerworld* and in the *AJC,* we did not find differences indicating a sample bias. We then combined the content results into a common pool for further analysis. We used paired t-tests to examine potential differences in the distribution of coded phrases between the *AJC* and *Computerworld* ads, and finding no differences, we combined them into a single dataset. This pooling of ads from multiple sources is consistent with the approach used in the various studies reviewed above (Slaughter & Ang, 1995; Todd et al., 1995; Hardin et al., 2002; Prabhakar, et al., 1995).

Content Analysis: the technique and coding scheme employed

Content analysis is a technique used for making replicable and valid inferences from data to their context. One of the most famous applications of this technique led to the publication of Naisbitt's best-selling *Megatrends* books (Naisbitt, 1984; Naisbitt & Aburdene, 1991), in which the author systematically coded newspaper articles from selected newspapers in several U.S. regions.

Given that the ratio of space allocated to news versus income-generating advertising remains stable over time, the premise in Naisbitt's work was that space assigned to various news topics was a type of zero-sum game. That is, when one topic receives coverage in print media, another topic is displaced. Therefore, by tracking the relative frequency, and longevity of topics in a large sampling of news media, Naisbitt was able to track various social and political trends. By identifying what he calls certain 'bellwether' regions' and publications, he was able to anticipate the importance and lifecycle of various trends.

Similarly, in traditional job announcements in classified sections of print media, the ads are placed and paid for by the word count, or the size of the ad. Given a fixed allocation of advertising spent on these ads, the inclusion of certain skills either necessitates displacing other skills or incurring additional costs to specify more skills in the same job ad. In either case the inclusion of certain requirements in the ad is a signal of relative importance to an employer.

We employed a traditional form of content analysis whereby we approached the data with a predefined set of content variables through which the data were interpretively filtered (Andren, 1981; Carney, 1972). We developed content variables to describe various technology job types, skill sets and technology platforms, and we counted job ads to determine whether the specific content was present. We also note that the approach used in this study was *not* a grounded theory approach. Further methodological details on content analysis for the interested reader may be found in a variety of sources on content analysis (Krippendorff, 1980; Lindkvist, 1981; Stone et al., 1966).

We began coding the ads with an initial set of predetermined variables. We identified the content codes through a series of iterative stages beginning in 1996. We were aware of three extant studies (Leitheiser, 1992; Todd et al., 1995, Prabhakar et al., 1995) and made an initial coding scheme that included the common and the most salient attributes described in those articles. We then compared that list with a set of job skill characteristics as presented in a *Computerworld* ad on employment classified advertising.[11] A further source of content codes came from a second study in which two of our colleagues were conducting funded research on employment patterns for the State of Georgia's Governor's Office (McLean & Schneberger, 1997). These lists yielded a second candidate set of content variables. These were pooled into an initial list of skills which was then further refined by a two-stage Delphi study wherein 28 IS faculty and Ph.D. students from Georgia State University reviewed and commented on the accuracy and completeness of the list. Next, we further enhanced the set of codes by referring to the terminological guide used by the editors of *Computerworld* itself (Hodges, 1996). Finally, when terminological differences or ambiguities appeared in coding, the Hodges' manual was used as a guide to arbitrate the difference. The refined list of coding

[11] The ad listed 36 skills from Access to VSAM, which were mapped those to a product category, such as data management, LAN, programming language, etc. The ad then provided a count of the number of readers who had worked with the product (120,063 for Access; 197,697 for Visual Basic; and so on for each product). This list provided an initial skill-to-category schema, which we later refined.

variables that we derived appears in the first column of Appendix B.

After the content variables were developed and tested against the texts for efficacy, we examined each individual ad and assigned frequencies to the content codes. Content coding is a brute force and labor-intensive activity.[12] The ads were reviewed iteratively by the coder and then by the lead researcher to check for agreement and coding accuracy. Even when using a well-developed set of content variables, such coding requires making judgment calls. We employed a single coder, rather than dual coders, consistent with prior studies (Slaughter & Ang, 1995; Slaughter & Ang, 1996), although we employed various measures to ensure reliability and validity of results. In some cases where there were possible ambiguities regarding the appropriate code, the coder collaborated with the lead author to negotiate a proper code assignment. There were times a particular skill did not fit exactly in our classification, because it was too new or not clearly enough defined. In those cases, we used our judgment whether to add a new skill category, or simply to code it as "other". In all cases, we sought to maintain consistency in the code assignments. In terms of frequency, the number of these ambiguous skills was less than 1% of total coded items. Moreover, whenever we could not classify a skill under the specified categories, we counted it as an instance of the "other" code of each category – for example, Appendix B shows that for each of our major categories there is an "other" category (e.g., other operating system, other programming language, etc.).

Results

First, we summarize changes in the types of job positions for which employers are hiring. We do so by examining changes in the number of ads, and in the structure of the ad. Next, we focus on changes in the absolute number of skills, types of skills, and the mix of skills that employers are requesting. Finally, we discuss the extent to which these changes in demand for IT job skills are consistent with the forecasts offered by researchers in earlier studies.

Trends in Job Positions

To answer the first research question regarding the most dramatic trends in the types of jobs advertised, we examined changes in job opportunities, job titles, and workforce composition.

Changes in Job Opportunities. The number of advertised IT career opportunities was on the rise between 1988-1995, and then declined between 1995-2001. Table 3 shows a doubling of the number of job ads from 1988-1995 in the issues we sampled, however, the 2001 data reflect a reversal of that trend. By 2001, the absolute number of ads had fallen to only 38% of the 1995 total. Moreover, the number of job positions represented by these ads declined to **o**nly 21% of the 1995 value. The first and most obvious reason was that in 2001, we were experiencing a changed economic and employment climate for IT employees, mirroring the general economic slowdown and the post "dot com" mania.

Table 3. Summary of Job Ads

Year	Total number of ads (n = 1926)	Total number of jobs advertised (n = 3557)	Average number of jobs per ad
1988	686	1088	1.60
1995	899	2045	2.27
2001	341	424	1.24

We also noted changes in the types of ads that appeared. For instance, based on our analysis of the 2001 data, we found that for many ads, the mapping of skills required to job titles was not clear (e.g., where the ad specified either no specific skills, or a list of job titles and a range of skills). In these cases, we eliminated the ads from our analysis, because we could not link a specific job type to a set of required skills for that job. Thus, both the absolute number of counted ads per issue decreased in 2001, and the average number of job positions per ad moved much closer to a one-to-one mapping compared to prior years. Moreover, there has been a shift in the manner in which employers are advertising. Today, many employers are placing simple ads in the classified advertising section which specify neither the skills required nor job titles, but simply a very brief description followed by a link to the company's website or phone number.

Moreover, by 2001 the ads that *did* specify particular skills were more focused on a single job position. For

[12] There is a substantial literature on early attempts at automated coding of content variables. The earliest of the computer-aided content analysis tools, a mainframe based system called *The General Inquirer* (Stone et al. 1966) required the development of extended lists of concordances against which words and short idiomatic phrases were tested. The system then mapped the occurrence of the words or idioms to content buckets. However, it was quickly established that because words, like tools have meanings established in use, the context of any but the most trivial coding exercises required human interpretation. One of the study's authors, despite having worked with the early systems, was involved in a later effort to use the pattern matching abilities in C++ to speed the coding process for electronically available job ads found that the lessons learned ten years earlier still applied. In the present study, for instance, the applicability of an ads mention of the Windows OS, had different meaning when the ad also mentioned Com, ASP, ODBC and other protocols or technologies signaling a client/server context as opposed to a stand-alone environment. The state-of-the-art using tools such as Excel has aided in the management, recall, organization and analysis of the data once coded. But the coding of text to content variables remains a labor-intensive process requiring human intervention.

instance, the average number of job positions mentioned per ad increased from 1.5 in 1988 to 2.3 in 1995, but then declined to 1.25 in 2001. This decline in the number of positions specified per ad is partly explained by changes in the content of the ads. Ads in the most recent time period tended to be shorter, with many simply directing the reader to a company website.

We recognized that the changes that we were observing between the 1995 and 2001 data were likely due to a variety of causes, including (1) the economic recession which began in late 2000, (2) the migration of classified job advertising to online sources, such as Monster.com, Cnet, and HotJobs, and (3) the passing of the Y2K milestone and the resulting decline in the number of jobs for COBOL programmers and other "legacy" skills. The migration of job ads from printed sources to electronic sources has been observed in prior studies. For example, Litecky & Arnett observed in 2001 that "the number of newspaper ads has fallen … and the number of Monster.com ads for the same period more than doubled. This finding provides additional evidence that the Internet has probably become the most used medium for ads for IT jobs" (Litecky & Arnett, 2001, p. 1923).

In order to isolate the effect of the migration of job advertising from print media to online media from other economic and technological trends, we conducted an additional analysis of online ads jobs that were advertised on Monster.com in early 2003 and compared them with ads in the same two print publications (*Computerworld* and *AJC*) for a comparable time period. This part of our analysis was designed *post hoc* to provide some additional informal insights into the most recent trends in job advertising – specifically, to understand whether there were differences in the nature of the IT jobs being advertised online versus ads in the print media during 2002-2003. We provide the results of this additional analysis at the very end of our results section, following our analysis of other trends in the 1988, 1995, 2001, and 2002-2003 sample of print media ads.

Changes in Job Titles. In addition to identifying the frequency in terms of the total number of ads, we also analyzed trends in the frequency with which different job titles were mentioned in job ads. Based on the prior studies that we reviewed, we expected the job titles to follow technology trends, such as an increase in client/server and data architecture skills, and a decrease in mainframe-oriented skills. Our results did in fact support these expectations (Table 4). For instance, the job titles with the largest proportional gains were for software engineers, network designers, and database administrators.

Table 4. Job Titles by Year

	1988		1995		2001		Percent Change	
	Number of jobs	% of jobs	Number of jobs	% of jobs	Number of jobs	% of jobs	1988-1995	1995-2001
Systems Analyst	14	1.3	50	2.4	30	7.1	+1.1	+4.7
Software Engineer	39	3.5	128	6.3	73	17.2	+2.8	+10.9
Network Design	9	0.8	47	2.3	19	4.5	+1.5	+2.2
Sales/ Education	29	2.7	50	2.4	15	3.5	-0.3	+1.1
Management	68	6.3	133	6.5	39	9.2	+0.2	+2.7
Database Admin	29	2.7	109	5.3	25	5.9	+2.6	+0.6
Technical Support	50	4.6	202	9.9	30	7.1	+5.3	-2.8
Programmer/ Analyst	697	64.0	863	42.3	101	23.9	-21.7	-18.4
System Admin	7	0.6	105	5.1	8	1.9	+4.5	-3.2
Project Leader	27	2.5	28	1.4	2	0.5	-1.1	-0.9
Consulting	118	10.8	327	16.0	12	2.8	+5.2	-13.2
Web developer	--	--	--	--	20	4.7	--	--
All other	1	0	3	0.1	50	8.5	+0.1	+8.4
Total	1088	100	2045	100	424	100		

Table 5. Analysis of Permanent versus Contractor/Consultant Positions

	1988		1995		2001	
	Number of positions	**% of positions**	**Number of positions**	**% of positions**	**Number of positions**	**% of positions**
Permanent	1008	92.7	1831	89.5	404	95.3
Contractor	21	1.9	66	3.2	8	1.9
Consultant	58	5.4	148	7.2	12	2.8
Total	1088	100.0%	2045	100.0%	424	100.0%

Ads for positions with the title of system administrator and technical support experienced a sharp increase from 1988-1995, followed by a sharp decline from 1995-2001. This pattern coincides with the rise of networked computing in organizations. One unanticipated finding was the relatively small proportion of jobs appearing in print media in 2001 requiring web development skills (4.8% of ads). We believe that this occurred because web development jobs would tend to be more heavily advertised in online outlets, a hypothesis that we examine in the later section, which compares ads in Monster.com with the print ads.

Shift in Workforce Composition. Next, we examined the fraction of ads that were for permanent positions versus consulting or contractor positions (Table 5). Based on trends reported in the literature (Slaughter & Ang, 1995; Slaughter & Ang, 1996), we expected to see a higher proportion of consulting and contractor positions over time, particularly as firms continued to rely on outsourcing to a greater degree. We assumed that positions were permanent positions unless the ad explicitly stated the contrary. While the vast majority of jobs were for permanent employees in all three time periods, there was a shift toward more consultants and contract employees between 1988 and 1995. While non-permanent positions accounted for only 10% of the total ads in 1995, nevertheless, this represented a significant increase over the 1988 figures. This upward trend was not reflected in the 2001 data however. The 2001 data reflects a decline in those positions identified as consulting or contractor below the 1988 levels. Given that not all job ads specified whether the position was permanent or not, we must interpret these findings cautiously. The proportion of contractor or consultant jobs may be much larger than the small number of ads that mentioned this fact explicitly.

Changes in IT Job Skills

In order to answer our second research question ("What have been the most dramatic trends, in terms of required skills?"), we examined changes in the frequency with which specific skill sets were mentioned. We began by examining the results at a high-level, comparing the frequency with which five general categories of skills were mentioned (operating systems, programming languages, networks/ communications, software development tools, and non-technical skills), and then we examined trends *within* each of these general categories. After identifying trends in overall patterns, we examined changes within each of the five skill categories.

Summary of Skill Categories. Employers continue to specify more technical skills per hire: increasing from an average of 3.0 technical skills per ad in 1988, to 3.5 skills per ad in 1995, and finally to 4.2 required technical skills per ad in 2001. This represents a 40% increase in the raw numbers of skills mentioned per ad between 1988 and 2001. In our analysis, we also counted the occurrence of phrases in each ad that mapped to a particular job skill (i.e., operating systems, programming languages, networks/ communications, software development tools, and non-technical skills). For instance, if C++ and C were mentioned in an ad for one job position, we counted two programming languages for that position. As shown in Table 6, the general trends reflected an steady decline in the proportion of all ad phrases related to programming languages and operating systems, a steady increase in the proportion of ad phrases related to networks/communications, and other fluctuations in the remaining two skill categories (software development tools and non-technical skills).

Details in Skill Categories

The remainder of the results present trends *within* each of the skill categories listed above, beginning with Operating Systems. This means that we examined, for each skill category separately, the proportion of ad phrases that required a specific technical or nontechnical skill. Following our analysis of operating systems skills, we repeat the same analysis for programming languages, networks/communications, software development tools, and non-technical skills.

Table 6. Summary of Job Skills

	1988		1995		2001		Percentage Change	
	Total # of times mentioned	% of all skills	Total # of times mentioned	% of all skills	Total # of times mentioned	% of all skills	1998-1995	1995-2001
Operating Systems	844	26.0	1553	22.7	210	14.1	-3.3	-8.6
Programming languages	1397	43.0	2435	35.6	500	33.6	-7.4	-2.0
Networks/ Communications	634	19.8	1493	21.8	501	33.6	+2.0	+11.8
Software Development Tools	188	5.9	907	13.3	174	11.7	+7.4	-1.6
Non-Technical Skills	147	4.6	449	6.6	71	4.8	+2.0	-1.8
ERP systems/SAP	-	-	-	-	33	2.2	-	-
Total skills	3250	100.0	6837	100.0	1489	100.0	-	-

Operating Systems Skills. As shown in Table 6, the proportion of ads specifically mentioning operating systems (OS) skills declined continually from 26%-23%-14% over the three coding periods. Based on the prior studies, we expected that demand for large OS (mainframe) would decline in frequency while small OS (PCs and client/server) would increase during the 14-year period. Our results did not completely support this expectation. As shown in Table 7, below, demand in 1988 for mainframe OS was twice as large as the demand for small OS, however by 1995, the demand for small OS had surpassed the demand for large OS. This trend reversed through 2001, with the demand for mainframes OS increasing, possibly due to Y2K staffing and the need to convert "legacy" systems to modern platforms.

Demand for UNIX skills first increased slightly and then fell rapidly over the 14-year period. Prabhakar, Litecky & Arnett (1996) also reported a small decline in the proportion of ads that specified UNIX skills, compared to their 1995 data. These authors argued that the decline did not mean that demand for UNIX skills was declining, but merely that demand for other skills was growing more rapidly. They further speculated that this was due, in part, to the ascendance of Windows NT as a direct competitor to UNIX. So, based on their results and prediction, we contend that demand for UNIX skills was still increasing, but demand for Windows NT (and more recently, Linux) has grown much faster.

Table 7. Trends in Operating System Skills

	1988		1999		2001		Percent Change	
	Total	% of category	Total	% of category	Total	% of category	1988-1995	1995-2001
Hardware specific	59	6.7	187	12.0	108	51.4	+5.3	+39.4
Small OS (e.g., Windows)	218	27.2	486	32.3	8	3.8	+5.1	-28.5
Large OS (e.g., mainframes)	501	56.7	436	28.1	87	41.4	-28.6	+13.3
UNIX	66	7.5	444	28.6	7	3.3	+21.1	-25.3
Total	884	100.0	1553	100.0	210	100.0		

Table 8. Trends in Programming Language Skills

	1988		1995		2001		Percent change	
	Total	% of category	Total	% of category	Total	% of category	1988-1995	1995-2001
4GL	497	35.4	1057	43.4	66	22.3	+8.0	-21.1
COBOL	292	20.9	270	11.1	18	6.1	-9.8	-5.0
C	92	6.6	285	11.7	98	32.5	+5.1	+20.8
Compiler	313	22.4	192	7.9	4	1.35	-14.5	-6.55
OOP	2	0.1	314	12.9	76	25.8	+12.8	+12.9
Other	201	14.4	317	13.0	54	18.3	-1.4	+5.3
Total	1397	100.0	2435	100.0	295	100.0		

Programming Languages. Table 8 shows a gradual decrease in the proportion of total ad phrases mentioning specific programming (from 44%-36%-34%) over the three coding periods. When examining programming languages, our findings support the trends posited for COBOL, C, and object-oriented language skills (Prabhakar et al., 1996). The demand for COBOL skills declined over the three periods (from 21%-11%-6%), whereas demand for C and object-oriented languages both consistently increased over the same period. In 2001, more than half of all programming languages mentioned in the ads specified either "C" (32.5%) or object-oriented languages (25.8%). 4GLs (including SQL) initially rose from 1988-1995, but then rapidly declined from 1995-2001.

Networks/Communications. As predicted, the most explosive growth has been in the area of communications. Table 6 showed a rapid increase in the proportion of total ad phrases mentioning communications/networks from 20%-22%-34%. Moreover, Table 9 shows that in 1988, there was virtually no demand for skills in EDI, email and the Internet/web, and little demand for LAN or network operating system skills. By 1995, the skills related to communications/networks were widely required. LAN skills increased to nearly half of all communications skills solicited in ads, and network operating systems doubled to 21.4% over the sample period. By 2001, however, there was little demand for EDI, as the Internet was becoming highly commercialized. Finally, email growth dramatically increased from a negligible 0.2% to 27% of communication and networking skills, while demand for CC-mail declined from a high of 79% to the phrases in the networks/communication category in 1988 to less than 1% over the three time periods (not surprisingly, since Lotus Corporation had discontinued its CC-mail product in 2001).

Software Development Tools. As shown in Table 6, software development tools demonstrated an initial increase from 1988-1995, but then reached a plateau over the subsequent interval. Within this general skill category, the greatest growth was in skills for particular "Application Development Environments", including tools such as PowerBuilder, Visual Studio, and

Table 9. Trends in Networks/Communications Skills

	1988		1995		2001		Percent change	
	Total	% of category	Total	% of category	Total	% of category	1988-1995	1995-2001
LAN	34	5.4	230	15.4	118	46.8	+10.0	+31.4
Network O/S	57	9.0	352	23.6	54	21.4	+14.6	-2.2
EDI	3	0.5	34	2.3	3	1.2	+1.8	-1.1
WWW	0	0	19	1.3	5	2.0	+1.3	+0.7
CC-mail	498	78.6	701	47.0	2	0.8	-31.6	-46.2
Other email	1	0.2	25	2.3	69	27.4	+2.1	+25.1
Other	41	6.5	132	8.8	1	0.40	+2.3	-8.4
Total	634	100.0	1493	100.0	252	100.0		

Table 10. Trends in Software Development Tools

	1988		1995		2001		Percent change	
	Total	% of category	Total	% of category	Total	% of category	1988-1995	1995-2001
Application Develop. Envt.	54	28.7	565	62.3	141	81.0	+33.6	+18.7
End-User Appl. Tools	91	48.4	222	24.5	28	16.1	-23.9	-8.4
CASE Tools	31	16.5	118	13.0	4	2.3	-3.5	-10.7
Other	12	6.4	2	0.2	1	0.6	-6.2	+0.4
Total	188	100.0	907	100.0	174	100.0		

RationalRose, as shown in Table 10. While Application Development Environments grew from 29%-81% of skills in this category over the three periods, all other skill areas within this category declined.

Non-technical Skills. As shown in Table 6, demand for non-technical skills as a proportion of all skills has been relatively stable, although with a slight, initial increase following by a decline (representing 4.6%, 6.6%, and 4.8% of all ad phrases over the three time periods. Taken as a whole, there were few dramatic trends in the non-technical skills category, and these non-technical continued to represent a small proportion of the total skills mentioned. Even by 2001, less than 5% of the total ad phrases were concerned with non-technical skills, whereas the other 95% of ad phrases specified various technical skills. This provides support for the notion of a recruitment gap described above (Trauth et al., 1993; Todd et al., 1995), where, despite many firms' emphasis on well-rounded individuals with business knowledge and strong "soft skills," the job advertising aspect of the recruiting process continues to focus on "hard skills".

We counted the number of times that the six most common non-technical skills were mentioned (see Table 11). These included communication, inter-personal, leadership, organization, self-motivation, and creativity. While the ability to communicate was clearly the most frequently mentioned non-technical skill, interpersonal and leadership skills were also important to hiring organizations. There were few shifts *within* the non-technical skill category, as most of these non-technical skills retained relatively stable rankings. Notably, the number of ads that mentioned "interpersonal skills" declined between 1995-2001, while the proportion of ads mentioning "other" non-technical skills increased steadily between 1988-2001.

Differences between Online Job Advertising and Print Ads

Recently, online job sites have begun to pose a serious competitive threat to the classified sections of traditional newspapers. Websites such as Monster.com, CNet, HotJobs and others have become leading contenders for classified job advertising. Our analysis above showed that the number of IT job ads in the print media declined by 62% between 1995-2001, but we were unable to specify whether this was due to the weak economy in 2001 alone, or whether the increasing migration of advertising to the Internet was also a factor. Thus, we conducted an additional, informal analysis of IT jobs advertised on Monster.com – the leading web-based job site.

Table 11. Trends in Non-Technical Skills

	1988		1995		2001		Percent change	
	Total	% of category	Total	% of category	Total	% of category	1988-1995	1995-2001
Communication	67	45.6	195	43.4	26	36.6	-2.2	-6.8
Interpersonal	23	15.7	112	24.9	4	5.4	+9.2	-19.5
Leadership	6	5.4	23	5.1	4	5.4	-0.3	+0.3
Organization	11	7.8	37	8.2	3	4.2	+0.4	-4.0
Independence /Motivation	14	9.5	20	4.5	3	4.2	-5.0	-0.3
Creativity	10	6.8	8	1.8	0	0	-5.0	-1.8
Other	16	10.9	54	12.0	31	43.7	+1.1	+31.7
Total	147	100.0	449	100.0	71	100.0		

Specifically, we used stratified random sampling to content analyze 2% of the 7,000 IT-related Monster.com ads that were available online during the last week of January 2003.[13] This 2% sample yielded 133 online ads in three job categories: computer/software (97 ads sampled from a population of 4,850 ads), computer/hardware (19 ads sampled out of 950), and Internet/ecommerce (17 ads sampled out of 850). We then compared these 133 Monster.com ads to an additional 238 ads that were available in *Computerworld* and the *AJC* for the same quarterly issues in 2002-2003, which we had previously coded in 1988, 1995, and 2001. This additional analysis was designed specifically to identify any differences between the two media. Although the results of our analysis are preliminary, we identify several propositions for subsequent researchers to verify.

Among other anomalies, we noticed that there was some ambiguity on Monster.com's website, in terms of whether the ads were classified according to the type of *position* or type of *company*. For example, we found several non-IT jobs that were included under the three categories of computer/software, computer/hardware, and Internet/ecommerce positions (e.g., such as sales/marketing or finance-oriented positions), because these job were located within software, hardware, or ecommerce firms, respectively. Thus, we concluded that ads listed under the category, computer/software, could refer to positions related to software development or to non-IT positions in a software firm (e.g., a financial analysis position at Oracle).

> *Proposition 1: It is difficult to directly compare classified ads listed on Internet sites (such as Monster.com) to ads in print media, because in the online job ads, the category under which the job is listed may refer either to the nature of the job position or to the industry in which the organization itself competes (e.g., computer /software).*

Secondly, we found a huge difference in the proportion of jobs that specified non-technical skills – with 73% of the Monster.com ads specifying one *or more* non-technical skills. Each online ad mentioned on average, 2.5 non-technical skills, with those most frequently mentioned being communication skills (mentioned in 48% of ads), ability to collaborate (23% of ads), leadership skills (14% of ads), interpersonal skills (11% of ads), and being self-motivated (10% of ads). Non-technical skills represented 26% of the total skills mentioned in these online ads.

The Monster.com figures contrast very dramatically with the overall pattern that we found for non-technical skills in the print media, as shown in Table 6 (where non-technical skills represented only about 5% of total ad phrases). By differing so dramatically, the Monster.com results raise questions about why non-technical skills continue to receive scant attention in the print-based media. On average, each print ad mentioned only 0.4 technical skills, with those most frequently mentioned being communication skills (mentioned in 9% of ads), leadership skills (mentioned in 7% of ads), interpersonal skills (mentioned in 6% of ads), and creativity (mentioned in 4% of ads). Non-technical skills represented only 5.1% of the total skills mentioned in the print-based ads in 2002-2003, and only 17% of the print-based ads mentioned one or more non-technical skills. Thus, there appears to be a substantial divergence between the online job ads and the print-based ads, since the frequency with which non-technical skills are mentioned on Monster.com is roughly six times as much as in the print-based ads. We are unsure of the reason for this enormous difference, although we posit that it has to do with the fact that, in print-based ads, employers are charged a fee on a "per word" or "per line" basis and thus, they seek to economize by limiting the number of words in the ad. In contrast, ads on Monster.com are not subject to the same word constraint, since employers are charged by the overall ad (Hallowell & Reavis, 2001), and thus, they are free to specify their needs more fully – including the types of non-technical skills required.

> *Proposition 2: Employees who advertise on Internet sites (e.g., Monster.com) are much more likely to specify non-technical skills, particularly if the economics of classified advertising do not depend on fees charged "per word" or "per line". In contrast, print-based ads are less likely to specify non-technical skills, because employers seek to minimize the variable costs they pay to advertise "per word" or "per line".*

One other distinction that we noticed was in the frequency of mention of 3GLs – including COBOL and C. Whereas these languages were very rarely mentioned on Monster.com (representing only 1.9% and 5.8% of the programming languages mentioned in Monster.com ads in January 2003), COBOL and C were responsible for 12.3% and 14.5% of the programming languages mentioned in the print-based ads, respectively. In contrast, more current programming languages, such as Java, Visual Studio, Visual C++, and C-sharp accounted for just over 50% of the programming languages mentioned in the Monster.com ads, but only 27% of the programming languages mentioned in the print-based ads during 2002-2003. Thus, there appears to be some preliminary evidence that the types of technical skills specified in online job ads may represent more leading-

[13] Most job ads on Monster.com appear for a total of 60 days, and therefore the specific set of ads changes only 1.5% each day.

edge skill sets, compared to the technical skills specified in the print-based ads, which may represent a broader mix of both traditional and leading edge technical skills. We thus posit that the IT-related ads from the two types of advertising media may not be directly comparable, given the possibility that they are serving different target audiences. It appears that the online job ads serve a more Internet-savvy population of job candidates, while the print media serve a broader cross-section of traditional and leading edge job seekers.

> *Proposition 3: Being an online advertising medium, Internet-based classified advertising sources are more likely to specify Internet-related job skills (e.g., web-based programming languages), relative to print-based classified advertising. This is due to the differences between the types of job applicants being sought: employers seeking Internet-savvy applicants with web-related skills will more likely advertise online, relative to employers seeking more traditional IT skills.*

Given the increasing importance of web-based classified job advertising and the threat posed to print-based advertising (Moses, 2002), we believe that the trends described above are critical to job seekers and media corporations. Our propositions and their underlying insights are derived from limited data from one popular website, and therefore these preliminary analyses call for additional, comparative research to probe these differences between the print-based and online job ads in greater detail.

Assessing the Accuracy of Past Predictions

In terms of the final research question ("Have the forecasts offered by prior researchers proven to be true?"), we found that most of the predictions were indeed accurate. A result consistent with many of the previous studies, for instance, is that employers are asking for an ever-increasing number and variety of skill sets from the new hires. The absolute number of skills demanded per position increased from 3.0 to 3.5 between 1988-1995 (an increase of 17%), and from 3.5 to 4.2 between 1995-2001 (an additional 20% jump). Whether this is realistic for IT professionals to continue expanding their skill repertoire is an open issue. Other researchers have suggested that employers do not necessarily expect candidates to have all the technical skills mentioned in the job ads, but that in some cases, they are merely conducting "fishing expeditions" (Arnett & Litecky, 1994) to inquire whether candidates indeed have these skills.

It is also clear that certain job types are ascending in importance while others remain in constantly high demand, and a few job types have declined in relative importance. Programming and software development skills remain important. Network and web development skills continue to be the fastest-growing job categories (as shown in Table 4). On the other hand, it is surprising to note that ads for project managers have declined continuously in the sample of ads we coded. Further analysis is required but we posit that generalized project management may be considered a base-line skill for all software developers. Emerging technologies such as Java and SAP, and new job titles such as "webmaster" were not included in the earlier studies but are strongly reflected in the 2001 data. This reflects the continually changing nature of the IT profession.

Recognizing this divergence in the job roles of IT professionals helps to lessen the tremendous increase in knowledge and skills which our results have shown IT professionals will need. Thus, rather than any single IT professional needing to have *all* of the job skills and knowledge reflected in Tables 7-11, it is possible for individuals to specialize in a given domain – for example, some employees becoming more business-oriented and others more focused on emerging technologies and IT infrastructure, as predicted by Trauth et al. (1993). One implication of this is that educational institutions need to allow for flexibility in curriculum design to allow the educational program to better match the diverse career objectives of students, rather than forcing a one-size-fits-all approach to IS education.

The relatively small demand for non-technical skills in the print-based ads is consistent with earlier findings reported by Todd et al. (1995). Along these lines, Litecky & Arnett (2001, p. 948) noted, "The media of newspaper position ads is of itself responsible for a bias towards the immediate and easily identifiable technical skills that could be reported within the brevity of a typical job ad". Perhaps employers are merely using the classified ads as a first line of screening for technical skills, and then they intend to assess the levels of non-technical skills during the interview process. There are many potential reasons why employers emphasize technical skills in their ads, even if they do not realistically expect that candidates will have the full complement of these skills. We also believe that job ads have certain semiotic value such as a preliminary and self-screening device. By listing a large set of skills desired, employers may effectively screen out weak applicants or those candidates not truly committed to changing jobs. It may also be that employers seek to create the impression that they run a state-of-the-art IS shop, by liberally sprinkling the names of leading-edge skills throughout their ads, in the belief that this will attract candidates (Todd et al., 1995). Todd et al. concluded:

> It is reasonable to question whether newspaper ads constitute an accurate reflection of the nature of actual IS jobs. While we would argue that ads should reflect organizational skill requirements, it is also clear that organizations may employ ads for other purposes, such as image enhancement and self-promotion…. [T]here are a variety of purposes for writing a job ad … [and] just as we would not expect that managers' perceptions of skill needs perfectly reflect actual skills demanded of employees, job ads may have similar limitations (Todd et al., 1995, p. 19).

Limitations, Unexpected Findings and Continuing Research

Before concluding this study, it is important to acknowledge its limitations. We also mention findings that appeared even if not specifically arising from an analysis of the actual content coding but from related inquiry and meta-data about the ads themselves.

Limitations

One limitation is that in counting classified job ads, the use of contract employees and consultants may be underreported. All positions were assumed to be full-time and permanent unless the ad explicitly stated the contrary. The nature of the sampling and coding procedures may also be a limitation. We acknowledge that these ads do not necessarily represent the population of all ads in all print sources, but we know of no reason to suspect that the ads in a national publication (*Computerworld*) and a major metropolitan newspaper (*AJC*) would be skewed by bias toward particular technologies, systems, or skill sets. With respect to sampling, we know of no specific regional differences in the nature of skills represented in job ads. The readership of the publications was not specific to a certain niche of IT personnel. In the case of the *Atlanta Journal-Constitution* newspaper, the metropolitan area in which it is situated has firms representing a broad cross-section of both small and large-shop software development houses and enterprise IT operations. It is, in short, a mirror of the 'typical' IT employee/employer pool, rather than a highly specialized locale, such as Silicon Valley. However, while the sample of classified ads that we analyzed was both large and longitudinal, we acknowledge that our sample does not represent the entire population of IT jobs. Other approaches – such as that followed by the Mississippi State Researchers – may result in a more balanced cross-section of job ads (Litecky & Arnett, 2001; Prabhakar et al., 1995).

In terms of the coding scheme, one general weakness across studies is that the various skill classifications examined have been inconsistently defined, a problem acknowledged by other researchers (Computing Research Association, 1999; Litecky & Arnett, 2001). For example, most authors distinguish between "business knowledge" and "interpersonal skills", however some studies (e.g., Todd et al., 1995) merge interpersonal and communication skills into their category of "business skills". Moreover, some prior studies differentiated between "technical" or "technical specialist" skills and "technology management" skills, but what some authors label "technology management" correspond to what others call "technical skills" or "project management" skills. Thus, it becomes very difficult to compare findings across studies, because terminology is used inconsistently. While we summarize various classification schemes used in prior studies (see Appendix B), we have made no attempt to analyze how the different coding scheme may have influenced the earlier findings.

Unexpected Results Leading To Further Inquiry

During the process of developing our coding scheme, we had ongoing communication with the Advertising staff at *Computerworld*, where we learned of some interesting trends regarding advertising policies that aided our understanding of the accuracy of the skill sets included in job ads. The first insight concerned who was placing the advertising. They explained that corporate employers and search firms (i.e., headhunters) accounted for less than 50% of the ads, while over 50% of ads originate from consulting firms seeking workers for temporary positions. This provided anecdotal support for to the "temping" of the IT workforce (Kraft & Truex, 1994), although curiously the fact that many employers were actually employment agencies or "body shops" was not immediately evident when we coded the ads. Second, we learned that some employers from specific geographic regions where demand was especially high would target other regions, seeking to "pirate" talent from other regions. The chronic IT labor shortage during the 1990s led to unprecedented efforts by the technology industry to persuade the U.S. Congress to fast track visa applications for foreign nationals with specialized IT skills. This culminated in a "green card lottery" in which IT workers had special treatment and to an environment where U.S. firms advertised aggressively abroad. We sense that this ties into an interesting development in the classified job add – the appearance of employment ads with all the charm of a legal announcement.

Third, we noticed that there was an increasing proportion of what are termed "legal" ads in the classified advertising industry. These ads are small type, unattractive ads and are difficult to read. When contrasted with larger, more attractively formatted and worded ads, we noticed that the more attractive ads are

designed to encourage a response from a potential job seeker, whereas the dry and unappealing "legal ads" simply sought to comply with a government regulation that the job be advertised. The advertising staff at *Computerworld* suggested that these legal ads were an indication that companies exerted the minimum effort required by law to seek qualified U.S. workers before hiring less expensive foreign nationals. The requirements to have a foreign national hired under an H-1B visa do not easily allow replacement of U.S. workers (Hafner & Preysman, 2003). In fact, regulations were specifically established to limit the ability to displace domestic IT employees with foreign workers. The regulations require that employers must first try to fill the position with a U.S. citizen and certify that they are unable to do so. Therefore, the *Computerworld* staff assessment seemed a plausible explanation to us. It appears that the legal ads may distort the job market characteristics by artificially increasing the apparent number of available jobs.

Curiously, however, starting in mid 2001 the number of the "legal" ads had declined to but a handful of such ads. One explanation might be the decline in demand in IT personnel resulting from the economic downturn. Or it might have been a backlash to foreign workers following the 9-11 attacks. We can only speculate as to the motives for the appearance and then relative decline of these ads but we suspect that one factor leading to this decline in legal ad frequency represents the fundamental changes in immigration policy and labor laws. Those changes involve the aggressive recruitment of foreign nationals for IT jobs, the fast tracking of visa applications with high-tech skills, and the increase in quotas for trained professionals passed by the U.S. Congress in 1999. Visa regulations were further relaxed in 2001, changes which are having a very interesting impact. The changes in immigration policy and visa classifications were initially enacted to help alleviate the shortage in technology workers, but the rules governing the granting of H-1B visas were supposed to protect American workers. These protections came by including requirements for first advertising and attempting to fill vacancies with U.S. workers before going to less expensive, foreign labor. However even with the dot.com fallout and the higher rates of unemployment in the technology sector there has been a rise in foreign technology hiring, albeit through a new rules and a new visa class. The new visa, the L-1, allows the hiring of workers with "special knowledge" who may be granted rights to work and displace U.S. workers if they are part of intra-company transfers by multinational companies. Trade unions have interpreted this change as a move to outsource to lower cost foreign workers (BusinessWeek, 2003). The new L-1 visa provisions do *not* require the same procedures to locate U.S. workers first and do not have the same requirements to advertise for those skills. We speculate that it is possible, that the relative decline in the 'legal ads' is a result of this change in immigration policy and a reportedly lax enforcement of both the H-1B and L-1 provisions under the present administration and given the altered priorities under the "War on Terrorism". We intend to follow this thread in future research.

Further Research. On-line versus Print-based Job Ads

Based on our content analysis of a sample of ads available on the leading web-based job site (Monster.com), versus ads appearing in *Computerworld* and *AJC* during 2002-2003, we noted that technical skills still dominate the print-based ads, whereas the online ads present a more balanced picture of technical and non-technical skill needs. We offer the following ideas for future research: one of the key concepts of print media content analysis derives from the page space real estate. The size of the print publications is generally fixed with regard to the news content and variable with regard to ads. In traditional content analysis of print media, the zero sum nature of print media means that the allocation of space to news items displaces the space allocated to other items. We believe that the same principle holds in the case of the classified ads in the following way: print ads are purchased by column inch or by word. So, by tradition, the advertiser seeks to be parsimonious in the choice and number of words describing the required job skills within a given ad limit or ad size. Thus, print space is a limited resource. In the online world however, bandwidth is plentiful and cheap, leading to a different advertising revenue model and different advertiser behavior. Ad size is less a concern, since one online ad does not displace another. Due to the lack of space constraints online, the information provided in the on-line job ad is far more detailed and inclusive than in the typical print version.

There are, of course, other noticeable and perhaps important differences between the two forms of advertising media. One is that the online sources do not provide the ability for the job seeker to scan the whole of the listing set in a single glance. In the print world one could get a general sense of the gestalt of the jobs available (by visually scanning the number of listings) before delving into particular ads. However, with the on-line sources, the job seeker must first enter specific search criteria such as position title, skill type or other keywords, before being presented with a list of possible ad titles from which to choose. These observations and our analysis of the on-line data lead us to conclude that the on-line sources are richer and may rely less on the self-selection process more typical in print job ads. Because the ads are longer and context rich, they can provide a better picture of how, why and in what circumstances certain job skills may

be used and required. In contrast, the print ads have a greater tendency to simply list an inventory of required skills with little context. We sense that the print ads used this technique in part to have job seekers self-screen for technical skills, such that only the most confident will contact the potential employer. Anecdotal data from interviews with employers and Computerworld staff seemed to suggest that the employer would then assess the applicants' "soft skills" via other means, such as interviews, aptitude tests, and reference checking.

Conclusion

There are several interesting findings despite the aforementioned limitations. Our study provides a structure and framework for following technology job advertising trends. By examining the accuracy of predictions related to IT job and skill classification frameworks of previous studies, our current study provides empirical support for previously hypothesized relationships, and adds to the growing baseline of knowledge about the skill set trends. We have also identified a recruitment gap, whereby, despite many firms' emphasis on hiring well-rounded employees with good business knowledge and "soft skills," the recruiting staff continues to focus on "hard skills" because they are easier to screen. Moreover, at least on the face of the classified ads, recruiters expect a great deal of the new hires. Perhaps most importantly, the changing demand patterns for IT professionals necessitate life-long learning skills not only for IT practitioners but also for the academics who teach them.

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Appendix A: Additional Methodological Details about Sampling from *Computerworld*

For the trade magazine, *Computerworld*, the most heavily subscribed and advertised issues occur in January and September. The January issue contains the annual technology forecast and the September issue contains the annual salary survey. We determined that a 'first issue of the month' sampling strategy would benefit by providing both a 40% higher ad rate and higher readership on those two dates, compared to other issues. We also chose two other first of the month issues equidistant through the year (April and June) to provide a fair stratified sampling of the advertising data with known seasonal variations. We further confirmed with the executive office at Computerworld that there were no known issues that would specifically or overtly bias the advertising sample such as technology skill variation, or regional variation.

We initially coded ads in both the regional and national *Computerworld* editions; however, based on additional information provided to us by the *Computerworld*'s Director of Classified Advertising, we combined the data sets. The process of regionalization of *Computerworld* advertising began in 1987. At that time, they added the East, Midwest, and West regional advertising sections on a weekly basis, as well as periodic "regional scope" sections. For instance in 1996 there were bi-weekly regional focus sections. In 1995, there were 18 regional focus sections, a huge increase from only six the year before. It is the advertiser himself who chooses whether to advertise in the National forum where the job is listed in all the North American issues or instead to list the job in the East only, Midwest only or West only sections. *Computerworld*'s advertising staff informed us that primary reason a company would choose to list their job in a regional only section, rather than in the generic, nationwide section was due to corporate relocation practices. That is, if a company is unwilling to pay the higher cost of relocating an employee from the U.S. west coast to the east coast then they would not advertise in the nationwide section, instead targeting their ad to the East regional section.

We conducted a geographic comparison of the regional scope of job listings. The only sample bias we detected was a possible regional bias where there was a slightly larger proportion of systems development job listings in the West and East regions, compared to the Midwest editions. We observed that the West edition serviced both Silicon Valley and the Redmond Valley in Washington State regions, and the Eastern edition serviced the high-tech nucleus of firms around Boston and the Research Triangle area of North Carolina. Each of these areas was a hotbed of systems and applications development.

Appendix B: Comparison of Job and Skill Coding Schemes

OUR CODING SCHEME	LEITHEISER (1992)	TODD, McKEEN & GALLUPE (1995)	PRABHAKAR, LITECKY & ARNETT (1995)
TECHNICAL SKILLS • Hardware Knowledge • Operating Systems • Progr. Languages • Communication • Apl. Dev. Environ. • Application Use • CASE Tools • Other **NON-TECHNICAL SKILLS** • Communication • Interpersonal Skills • Leadership • Organization • Indep./Motivated • Creativity • Other DETAILED SKILL SUBGROUPS OPERATING SYSTEMS • Small (PC, Windows) • Large (Mainframe) • UNIX PROGRAMMING LANGUAGES • 2GL (Assembler) • COBOL • C • 4GL • Compiler • Object Oriented • Other COMMUNICATIONS • Local Area Networks • Network Operating Sys • Commun. Control • Edi • E-Mail • Www • Other **JOB TYPES** • Progr./Analyst • Software Engineer • Sales/Education • Systems/Data Architect • User/Tech. Support • Network Design • Systems Admin. • Database Mgmt. • Project Leader • Management • Other (Incl. Consultants)	**JOB CATEGORY** • Systems Analysts • Application Programmers • Operators • Systems Programmers • End-User Support • Data Communications • Database Specialist • MIS Planners • AI Specialists • Other **SKILL CATEGORY** JOB CATEGORY: 54 skills were assigned to the following: • Analysis & Design • Programming • Interpersonal • Business • Environment • Languages • Applications	**TECHNICAL SKILLS** **HARDWARE** • Mainframe • Mini • Desktop • Other **SOFTWARE** • 2GL • 3GL • 4GL • COBOL • Database • CASE • Operating Systems • Packages • Other **BUSINESS** FUNCTIONAL • Industry Specific • Function Specific • Other MANAGEMENT • General Management • Leadership Skills • Organization Skills • Project Management • Planning • Monitor / Control • Training • Other Social • Communication Skills • Independent/Motivated • Interpersonal Skills • Other SYSTEMS • Problem Solving • Quantitative/Logical • General Problem Solving • Technical Expertise • Creative/Innovative • Other Develop. Methodology • Analysis • Design • Programming • Implementation • Operations / Maintenance • General Development • General Technology • Other	**TECHNICAL** **HARDWARE** • Mainframe • Mid-Range • PC **SOFTWARE** • C • COBOL • 4GL • Object-Oriented • Relational DBMS • DB2 • SQL **OPERATING SYSTEMS** • NETWORK • UNIX • Windows/Pc