A Study of the Needs of the Information Technology Industry

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Abstract

The study examines the knowledge, skills, and abilities needed by employees in information technology industries. The study focuses on companies with headquarters in central Arkansas but has broad implications both for needs around the country and in terms of the processes used to do the study. This paper examines the strategies and procedures used to do the study, examines key results of the study, and curricula changes being made by the University of Arkansas at Little Rock in response to the study.

Introduction

In recent years, those companies in the information technology in Arkansas have found it increasingly difficult to hire enough qualified individuals to meet their needs to the extent that a few of them have found their growth limited by the lack of employees rather than a lack of business. James Hendren, founder and former CEO of ArksSys, did a survey of the five largest companies in the central Arkansas area for the university and found an estimated 1,300 employee shortfall will occur in 1999, primarily in the areas of information technology. Also fewer than 500 Arkansans are expected to be qualified and available to fill the job openings in high-tech companies. In their discussions with university officials, the leaders of information technology companies have intensified their emphasis on the need for the university to address this problem. As a result, Chancellor Hathaway of the University of Arkansas at Little Rock resolved to meet the needs of industry.

As the first step, Chancellor Hathaway established an Information Technology Committee to guide the University in meeting the information technology needs. Simultaneously, the University began the process of creating a new college: the Donaghey College of Information Science and Systems Engineering. As a result, a study of the needs in information technology was done and several new programs were started in the new college. The focus here will be on how the study was done, the results of the study and the effect on the curriculum.

The Information Technology Committee

An Information Technology Committee was composed of faculty from across the campus including two from psychology, two from engineering technology, one from computer information systems in management, and four from diverse areas on campus. The Committee developed six operational goals. These goals were as follows:

1. Develop a data gathering strategy to determine desired and needed competencies of employees in the information technology industry in Arkansas.

2. Determine the competencies that could reasonably be expected for a number of specific functions in the information technology industry and confirm these competencies with professionals in the industry.
3. Produce a formal report of the findings of the Committee on information technology work force needs. Prioritize the desired competencies into a list of those that might be included in a self-contained information technology minor for students involved in non-technical majors.
5. Coordinate, in cooperation with industry and partner universities, the development the minor in information technology.
6. Develop potential screening and admission processes for the information technology minor.

An additional key goal of the study was to truly determine the needs of the information technology industry and to absolutely assure the industry that the university was really listening to their needs and doing everything possible to respond to those needs. The University of Arkansas at Little Rock was in the process of creating several new degree programs and wanted to ensure that industry would be a full partner in this process.

To accomplish the goals, a data gathering strategy was developed to identify job clusters (types of jobs to be found in the industry), then determine the competencies required for each job, and lastly to establish the relative importance of the various competencies. In this way, once the data analysis was done the results could be used to design curriculum that would emphasize meeting the critical needs.

Information Technology Needs Study

A three-phase data gathering strategy was used to collect all of the information needed:

Phase 1: Company Site Visits
Phase 2: Focus Groups
Phase 3: World Wide Web Survey

The first phase consisted of company site visits to five key companies by teams of four or five faculty members:

Acxiom
Alltel
ArkSys
ESI Group
Inacom

During these visits the team met with first-line supervisors, training directors, and in a few cases senior management. While team members could participate in all the various roles needed in these interviews, to ensure that key roles were covered each team member was assigned a primary role such as facilitator, “what about” questioner, probe questioner, or recorder. These

visits were structured to allow flexibility in the discussions, but also organized so that certain standard issues were addressed in each case. The following five questions were always asked:

1. What type of work does your company do?
2. What kinds of jobs do you have in the company and what type of education would be appropriate for these positions?
3. If you had to divide each of the jobs into four or five major job functions, what would they be?
4. What type of person would you most like to see in this organization?
5. Thinking about the kinds of jobs that you think will be important in the next 5-10 years, what do you think will be the knowledge, skills and abilities needed for those jobs?

This phase allowed for the identification of eight generic job clusters that were of interest to the local companies:

1. Computer programmers write, test, and maintain programs that computers must follow to perform their functions. This cluster includes applications programmers for both mainframe and client/server systems, who write software for jobs within an organization, and systems programmers, who maintain and control computer systems software.
2. IT support/Business analysts study business, scientific, or engineering data processing problems and use computers to design solutions. The emphasis here is on the analysis of business needs rather than the traditional systems analyst. This person is seen as the liaison between the customer and the programmers.
3. Computer engineers design and develop new hardware and software including a significant amount of hardware/software integration. Also software engineers, who develop software systems for control and automation in manufacturing, business, and other areas, are included in this cluster.
4. Database administrators setup computer databases, test and coordinate changes to them, and determine ways to organize, store, and access data.
5. Computer support specialists provide technical assistance, support, and advice to clients and users such as in software services consulting.
6. Network specialists design, install, and support an organization's distributed computing (LAN, WAN, network segment, internet system, or intranet system).
7. Telecommunications analysts focus on the interaction between computer and communications equipment.
8. Internet specialists are involved in the design, development, and maintenance of Web sites and their servers. Typical jobs include webmasters, who are responsible for all technical aspects of the Web site, and web developers, who are responsible for site design and creation.

The second phase involved focus groups of employees involved in the various types of jobs. Phase two allowed for in-depth development of the knowledge, skills, and abilities for each job type. In order to rank the relative importance of the various competencies a survey was also developed using the data collected in phase two.

The focus groups met in the University's Baum Decision Support Center. It is an electronic meeting room with each participant sitting at a computer. The software allows each participant to type entries anonymously and to view everyone's entries. The focus groups were composed of individuals from the same companies visited in phase one. In this phase individuals were chosen who had a good understanding of the knowledge, skills, and abilities needed for entry-level information technology jobs at their companies. These individuals either worked in these jobs or directly supervised employees engaged in these jobs.

In each focus group, data was collected for each of ten categories: soft skills, business concepts, and each of the eight job clusters. For each category, we asked the participants to list first all of the knowledge that an entry-level employee needed to be effective. Then we asked them to list the skills and abilities an entry-level employee needed. These focus groups generated a large amount of data for the ten categories. After collecting the data from the focus groups the Committee used the Baum Center to consolidate and refine the data. The result became the basis for the survey used in phase three.

In the third phase, the survey was posted to the World Wide Web using WebSurveyor[1]. The survey consisted of four main sections: one to capture basic demographic information, the second on non-technical soft-skills (problem solving, teamwork, writing, etc.), the third on business concepts, and the fourth on technical knowledge. The fourth section was further divided into the eight job clusters: computer programmers, IT support/business analysts, computer engineers, database administrators, computer support specialists, network specialists, telecommunication analysts, and internet specialists. For each item participants were asked to choose one of five levels of importance: extremely important, very important, somewhat important, not very important, or not important at all. The survey lead participants through the first three sections and then presented them with a menu that allowed them to choose which job category they wanted to evaluate. At the end of each category, they could go to the end of the survey and submit their answers or return to the category menu and select another job category.

World Wide Web Survey Results

Key results from the study are presented in the following tables. The values in the second column are the combined number of responses at the level of extremely important and very important as a percentage of the responses in that category. Not all of the competencies for each category are shown. Frequently, the results are divided into three groups: highly desired, desired, and less desired competencies. In the tables below, the headings indicate whether just the highly desired competencies are listed or both the highly desired and desired competencies are listed.

All of the companies in phase one placed a particularly strong emphasis on the soft skills. As a result all of those competencies are listed. It should be noted that an argument can be made for including the numbers marked "somewhat important" by participants in the percentages listed, since they still want graduates to have these competencies. However, the effect is to give presentation skills an 87% rating, diversification (different cultures) a 78% rating, and raise the other categories so high that it becomes difficult to see the relative importance of the various competencies.

SOFT SKILLS	
Listening	94
Problem solving process	94
Team Work (long term)	93
Adaptability to new technology, new languages	91
Transferring knowledge to application	90
Time management	89
Verbal Communication	87
Visualize/conceptualize	87
Ability to multi-task	85
Business culture (priorities, schedules, self-initiating)	81
Inter-team communication	81
Interpersonal skills	79
Constructive criticism (delivery and receipt)	78
Organizational skills	76
Stress management	70
General writing skills	63
Leadership (interactions with peers, servant leadership)	58
Technical writing	51
Presentation skills	34
Diversification (different cultures)	34

In the category of business concepts, the upper half of the competencies are listed.

Business Concepts	
Be the customer mentality	78
Investigative skills (probing questions)	77
Idea initiation	65
Project Management	58
Interviewing skills	30
Mediation skills	24

In the category of computer programmer, the top competencies tend to fall into two groups: those general characteristics directly related to programming and those related to soft skills such as problem solving and writing documentation. More specific knowledge, such as programming in C or C++ fall into the “desired” competencies with ratings of 54% and 53% respectively.

Computer Programmer (Highly Desired)	
Ability to Read, Understand and Modify Programs Written by Others	96
Ability to Code Programs	96
Ability to Debug Software	95
Knowledge of Programming Languages	89
Ability to Implement Programs	89
Knowledge of Structured Programming Fundamentals	89
Ability to Read Design Specifications for Conversion Into Code	83

Computer Programmer (Highly Desired)	
Ability to Read Technical Documentation	81
Ability to Design Software Programs	80
Ability to Write Clear Documentation	79
Knowledge of Design Methodologies	77
Ability to Design User Friendly Applications	76
Ability to Research Language Syntax	73
Ability to Estimate Project Time	70
Knowledge of Design Specifications	70

In the category of IT support and business analyst, we see that the necessary interaction with the customer results in a much higher rating of competencies that link back to the soft skills.

IT Support and Business Analyst (Highly Desired)	
Ability to Ask Probing Questions to Determine Customer Needs	97
Ability to Maintain Open Communication with Customers	97
Ability to Determine Customer Needs	96
Ability to Communicate with Customers	96
Ability to Analyze Business Process	94
Ability to be Diplomatic	91
Ability to Prioritize Project Needs	89
Ability to Act as Liaison Between Customers and Programmers	87
Ability to Anticipate Future Needs	86
Ability to Conduct Needs Assessment	85
Ability to Analyze Systems Inputs and Outputs	85

In the category of computer engineer, there is a general preference for software over hardware. This result may be indicative of the predominance of local companies with a software emphasis. As in the category of computer programmer, there is a tendency for general items to be listed higher than specific ones. For instance, knowledge of C and C++ are rated at 61%.

Computer Engineer (Highly Desired)	
Ability to Design Solutions to Meet Specifications	91
Knowledge of Programming Languages	90
Ability to Debug Software	86
Ability to Program	84
Knowledge of How Coding Affects System Performance	81
Ability to Design	81
Knowledge of Operating Systems	80
Knowledge of Hardware/Software/OS Integration	75
Ability to Discern Effective Hardware/Software/OS Trade-offs	73
Ability to Research Technology	71
Knowledge of Most Effective Coding Styles	70
Knowledge of Software/hardware Interfaces	69
Ability to Test Integrated Hardware/Software Solutions	69

Computer Engineer (Highly Desired)	
Knowledge of Data Communication Fundamentals	69
Knowledge of Computer Engineering Foundations	68
Knowledge of Techniques used in Systems Engineering	68
Ability to Create Technical Documentation	68

Because there are fewer competencies listed in the database administrator category, items ranked as either highly desired or desired are included.

Database Administrator (Highly Desired and Desired)	
Knowledge of Database Management Systems	93
Ability to Build Tables and Indexes	86
Knowledge of SQL	85
Ability to Design Databases to Meet Specifications	85
Ability to Trouble Shoot	85
Knowledge of Database Optimization	83
Ability to Optimize Performance	83
Knowledge of Database Normalization	82
Ability to Manage Database	81
Ability to Import/Export Data	77

With the computer support specialist category, we once again see a strong emphasis on competencies related to soft skills.

Computer Support Specialist (Highly Desired and Desired)	
Ability to Visualize User Problems	98
Ability to Walk the User Through a Solution in Layman's Terms	97
Ability to Solve Problems	95
Ability to Exercise Patience	95
Ability to Listen Empathetically	94
Ability to Exercise Interpersonal Skills	92
Ability to Calm the End User	91
Ability to Improvise Solutions	91
Ability to Differentiate User Error/Hardware/Software Problems	89
Ability to Relate to Diverse Audiences	89
Ability to Think Fast in a Stressful Situation	88
Knowledge of Business Communication	80
Knowledge of Customer Software	79
Ability to Document Help Tasks	77
Knowledge of the Impact of Technology on Business	74
Knowledge of Customer's Industry	73

The category of network specialist is also small enough to allow both the highly desired and desired items to be shown.

Network Specialist (Highly Desired and Desired)	
Knowledge of Network Protocols	95
Knowledge of Networking Hardware	95
Ability to Troubleshoot	95
Knowledge of Communication Fundamentals	93
Knowledge of Connectivity Methods	92
Knowledge of Network Security Issues	92
Knowledge of Operating Systems	86
Ability to Manage/Schedule Time	83
Ability to Analyze Network Needs	81
Ability to Configure Network Components	81
Ability to Optimize Network Performance	81
Knowledge of Networking/Product Relationships	80
Ability to Monitor Networks	80
Knowledge of Basic Communication Debugging	76
Knowledge of Windows NT	75
Ability to Design LAN	73
Ability to Manage the Network	73
Ability to Use Test Equipment	69
Knowledge of Communication Media	68

There was much more interest in our community in the other categories than in the telecommunication analyst category. As a result the sample size is only 31 participants and these results may not be reliable.

Telecommunications Analyst (Highly Desired and Desired)	
Knowledge of Basics of Communications	93
Knowledge of Telecommunications Protocol	93
Ability to Understand Telcom System Flow	83
Knowledge of Signal Analysis	83
Knowledge of Telecommunication Hardware	83
Knowledge of Computing Fundamentals	80
Knowledge of Signal Encoding	80
Knowledge of Telecommunications Software	77
Ability to Research New Technologies	77
Knowledge of Evolving Telecommunication Technologies	77
Knowledge of Fundamentals of Electronics	73
Ability to Design Cost Effective Communication Networks	73
Knowledge of Telco Operations and Networks	73
Ability to Interface OS and Communication Devices	73
Knowledge of Signal Noise Analysis and Bit Rate Errors	70
Ability to Deal with Telcos and Vendors	63
Ability to Design Communication Network Using a Variety of Technologies	63

In the internet specialist category, we again see some of the soft skills appearing. It is interesting to note that while some specific items, i.e. knowledge of HTML, are ranked high, others such as knowledge of Java with a 64% ranking or knowledge of XML with a 47% ranking are significantly lower.

Internet Specialist (Highly Desired)	
Knowledge of HTML	98
Knowledge of Internet Browsers	95
Ability to Match Web Solutions to Customer Objectives	93
Ability to Meet Customer Needs	91
Ability to Meet Customer Design Specifications	91
Ability to Analyze and Troubleshoot	91
Ability to Communicate with User to Determine Needs	89
Ability to Design Esthetic and Functional Web Pages	87
Knowledge of Scripting Languages	87
Knowledge of Web Security	84
Knowledge of User Interface Design Principles	84
Ability to Write Efficient Code that Reduces Downtime	84
Ability to Design	84
Knowledge of Design Principles	82

Effects on the Curriculum

The University has started two new majors, one in Information Science and the other in Systems Engineering with options in Computer Systems and Telecommunications. In addition, it has started an Information Technology Minor aimed towards students majoring in non-information-technology fields such as psychology and biology. The minor in particular was designed directly to meet the needs identified in the study. An analysis of the data was used when designing curriculum to set priorities in allocating time and importance to topics.

Conclusion

The process used has been an effective way to identify industry's needs and reassure them that the University is really concerned with participating with industry to meet the community's educational needs. Of special note was the extremely strong emphasis that industry placed on the soft skills. While the individual job categories did not always list any specific soft skills, industry really wants employees in all job categories to have good soft skills.

The study also found results comparable to those found in Washington State by the NorthWest Center for Emerging Technologies and Regional Advanced Technology Education Consortium.[2] This study was also a cooperative effort of education and business. It was done on a larger scale than our study. We believe that our methodology, particularly the use of the web survey, can provide other universities with a relatively easy way to work with their local industry to identify needs and their relative importance in a way that can guide curriculum design.

Bibliographic Information

[1]Information on WebSurveyor can be found at www.websurveyor.com.

[2]Building a Foundation for Tomorrow: Skill Standards for Information Technology, NorthWest Center for Emerging Technologies and Regional Advanced Technology Education Consortium, 1997.

Biographic Information

Pete Tschumi is Coordinator of Computer Engineering Technology at the University of Arkansas at Little Rock. He received his BS with a double major in Physics and Mathematics at Tulane University and did graduate work in Physics at the University of Texas at Austin.

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