

The Requisite Variety of Skills for IT Professionals

Kevin P. Gallagher

Northern Kentucky University

Kate M. Kaiser

Marquette University

Judith C. Simon

University of Memphis

Cynthia M. Beath

University of Texas at Austin

Tim Goles

Texas A&M International University

April 2008

I. Introduction

IT professionals are beset by ongoing changes in technology and business practices. Some commentators have suggested that, in order to stay competitive, IT professionals should retool themselves to gain competency in specific in-demand technical skills [1]. This paper argues that thriving in such a dynamic environment requires competency in a broad range of skills, including not only technical skills, but non-technical skills as well.

Our research shows that IT departments in non-IT companies¹ report that while both technical and non-technical skills are important, the skills most critical to retain in-house and most sought in new mid-level employees are non-technical skills such as project management, business domain knowledge and relationship skills. These skills are critical because they enable IT departments to work effectively with other departments, internal users, and external customers and suppliers. Non-technical skills leverage technical skills to augment the organization's overall effectiveness in designing and delivering solutions to meet an organization's challenges and opportunities.

These findings depart from previous articles emphasizing technical skills as a basis for valuing IT workers [2] and other research recommending business-oriented skills only for those managing IT workers, not for IT professionals themselves [2, 3]. Our findings lead us to the realization that in today's environment of continuous and fast-paced change, a mix of skills is essential for IT professionals.

We believe that the Law of Requisite Variety can help explain the need for greater breadth of knowledge and skills among IT professionals [3]. From cybernetics, the Law of Requisite Variety states that adapting to change requires a varied enough solution set to match the complexity of an environment [4]. In this case, IT workers need a broad enough range of knowledge and skills to meet the demands of their increasingly dynamic and complex profession. Based on our research, we offer a framework outlining six skill categories. We believe that all six skill categories are critically important for the career development of IT professionals.

II. Data Acquisition and Analysis

To investigate the premise that IT professionals should possess a varied set of skills, we used data drawn from a multi-year research project sponsored by the Society for Information Management (SIM), an association of senior IT executives. SIM members wanted to understand what skills IT managers consider to be critical, both presently and in the near future.

To gather the data, twenty researchers interviewed 104 senior IT managers in 94 non-IT companies. The data was collected through semi-structured interviews. Respondents identified skills from a list drawn from prior studies and validated through feedback from IT managers and an expert panel of practitioners and academicians. The skills are more general than specific, reflecting the rapidly evolving nature of the IT profession. For example, one of the technical skills listed is "programming," not "COBOL" or "Java."

¹ Non-IT companies are those not producing, selling or servicing IT-related products or services. In 2004, 79% of the IT workforce was employed in IT departments of non-IT firms (Anonymous, *Adding Value: Growing Careers; The Employment Outlook in Today's Increasingly Competitive IT Job Market*, Information Technology Association of America (ITAA), <http://www.ita.org>, September 2004, p. 7)

We base this paper on analysis of data generated by asking questions in the following three areas of inquiry:

- What skills are (1) critical to retain in your IT department today, (2) emerging as increasingly important in the future or (3) going away in the near future? (Data were collected in 2005 and used reference years of 2005 for what were then the respondents' needs at that time and used 2008 for future needs.)
- What skills do you consider critical when hiring (1) entry-level employees, and (2) mid-level employees?
- What skills do you currently source from (1) independent contractors, and (2) third-party providers?

In the initial analysis responses were tallied and rank-ordered lists were compiled. After rank ordering the responses based on their frequency, we analyzed the ranking of each skill across the areas of inquiry listed above following the methodology of thematic analysis [5]. Table 1 illustrates an example. Programming was the skill that received the most responses to our questions about skills sought when hiring at the entry level; skills sourced from independent contractors; skills sourced from third-party providers; and skills going away (e.g., because they would be sourced, automated or obsolete), and hence was ranked #1 in those areas. Programming was ranked much lower in all other questions. Because of its high ranking in the former categories and low ranking in the latter, it is one of several skills we categorized as a Foundational skill.

Insert Table 1 Here

This analysis identified clusters of skills, i.e., groupings of skills that ranked highly in just one, some or all areas of inquiry. The patterns revealed in this analysis led to identification of six categories of skills, three technical and three non-technical skill categories (see Table 2 for a list of skills and the areas of inquiry where skills ranked high in the frequency of responses).

Insert Table 2 Here

The analysis presented a striking difference between the technical and non-technical skills in our study. As shown in Table 2, technical skills were most likely to be outsourced, while non-technical skills were least likely to be outsourced. Furthermore, technical skills were noticeably absent among the skills identified as critical to keep in-house, while non-technical skills ranked very high.

The ranking patterns also presented differences among the technical skills when analyzed across the various areas of inquiry. These patterns led to the development of three additional skill categories: Foundational, Operational and Essential. For the non-technical skills, no additional differences in the patterns across areas of inquiry were found, but the skill categories we identify do differ based on their academic and practical foundations. Based on those differences, three non-technical skill categories were created: Project Management, Problem/Opportunity and Relationship skills. The next section outlines the resulting six categories of skills and offers support for them as logical constructs.

III. Skills Categories and Their Importance

The *Technical skill* categories are areas commonly considered core to the IT profession, yet the three categories are important in distinctly different ways.

We label the first technical category *Foundational* because these skills lay the groundwork for entrée to the field. Rudimentary skills in programming, testing, operating systems and database design are necessary for the development of more advanced capabilities such as systems analysis, systems design, and project management. Foundational skills in telecommunications are crucial in the Internet age, and support/helpdesk work is the foundation on which IT workers build an appreciation for the user experience and the role of IT in the business. We believe these skills to be Foundational because they establish the basic knowledge required for entrée into the profession and development of higher-level skills.

The second set of technical skills, which we call *Operational*, includes skills in operations, hosting, business continuity, and the mainframe/legacy area. These skills are often deep and specialized, but they are typically *not* firm-specific – though they may be specific to technology suppliers (e.g., IBM mainframes or Microsoft server products). For example, CICS skills are transportable across banking, healthcare or manufacturing firms, but they do not generalize well to the transaction processing technology commonly used in the airline industry. An appreciation of operational technology is key to developing cost-effective IT solutions, thus these skills also contribute to the long-term development of an IT worker's expanding skill set.

The third technical category includes what we call *Essential* technical skills. These skills are indispensable to an IT department's ability to develop IT solutions that align with an organization's objectives. Essential skills include proficiency in systems analysis, systems design, and IT architecture/standards. Essential technical skills build on Foundational skills and Operational skills, positioning IT workers to leverage firm-specific knowledge and to solve problems and identify opportunities for IT.

While we believe the Foundational skill category contains skills that are expected of IT workers, these skills are often not company-specific enough on their own to be critical to retain in-house (see Table 2). This category of skills is, therefore, important for novice workers to have obtained in IT-related educational programs. While it is important to have these skills to gain entry to the profession, their importance diminishes with the individual's experience and tenure in the profession.

Interestingly enough, in addition to being desired in entry-level hires, Foundational skills are often outsourced. This raises an intriguing question. Are these skills truly necessary for entry-level hires, or is this a legacy of past hiring practices? Our answer is that organizations do (or should want to) seek these skills in new hires, if for no other reason than to develop tomorrow's project manager or systems architect.

Our analysis also shows that Operational technical skills are not as critical to retain and are also not sought in new hires. Our study found these skills to be frequently sourced from independent contractors and third-party providers. IT managers may see some of these skills as widely available, in part because they are not firm-specific, and those that are firm-specific are easily developed within the practices of IT departments. Since these skills are often sourced, we believe that IT professionals should not rely on these skills as a basis for attaining or retaining employment in IT departments. Nevertheless, they are important to the development of skills in the Essential category, particularly IT architecture skills.

Alternatively, the technical skills in the *Essential* category are critical to the mission of IT departments. They are also critical to those selling IT services, as they too are frequently sourced. Moreover, they

are highly valued in new hires. All IT workers should therefore consider these skills critical to their professional development and job security. Those who want to work in IT *must* have these skills. They are the hallmarks of the IT profession.

With appropriate experience, the IT professionals who began as programmers or database specialists (Foundational skills), perhaps supporting operations or mainframe applications (Operational skills) will develop their systems analysis and design or architecture capabilities (Essential skills). IT workers who remain experts in Foundational skills or Operational skills and do not develop Essential skills may take the biggest hit from technical change. Entry-level candidates with formal training in the latest programming languages and tools or telecommunication innovations may offer more value to IT departments seeking value from new technologies than workers skilled in older technologies. And of course, candidates with current skills will also be more highly valued than those skilled in older technologies.

One can view the three categories of *Non-technical skills* as capabilities that give IT professionals the ability to understand, develop and deliver effective solutions to organization/business problems. We label the three categories Project Management, Problem/Opportunity and Relationship skills (see Table 2).

Projects are commonplace in the IT profession. Entry-level employees are typically involved in a single or small number of projects. As they climb the career ladder the size and number of projects they are involved in grows, and their responsibilities increase. *Project Management* skills enable an individual to plan, organize, lead, and control activities and personnel involved with projects. With the increasing spread of globalization, projects are expanding to include multiple locations, organizations, and often languages and cultures. This places a premium on integration and risk management skills.

The second set of non-technical skills is *Problem/Opportunity* skills. These involve understanding the business environment in terms of the company, the industry, and associated functional processes. They include company-specific knowledge, industry knowledge, the ability to understand, design, and re-engineer business processes, and other skills necessary for successfully managing change.

Understanding one's industry and organization is crucial for delivering successful systems. Understanding business processes and issues related to change management are similarly crucial to successfully solving business problems or taking advantage of opportunities with IT. IT professionals with these skills are therefore better prepared to diagnose problems, identify opportunities and estimate the value of IT-related solutions.

The third non-technical category, *Relationship* skills, includes skills in managing relationships and engaging non-technical personnel in IT-related activities of organizations. Communicating with and building relationships with users is key to negotiating and managing expectations regarding system requirements, project deadlines and delivery dates. We believe that with strong relationship skills, IT staff can communicate and work well with others, and thereby more effectively develop and deliver technical solutions.

As seen in Table 2, all three non-technical categories contain skills critical to retain in-house and highly desired in new hires. Not included in these categories are any of the skills identified as sourced. Thus, all of the non-technical skill categories are central to those who work in internal IT departments. If IT professionals want to succeed in non-IT firms, they should attain and develop these skills. Our

respondents put a very high value on Project Management skills, and preferred job candidates with relevant Problem/Opportunity knowledge. They also valued Relationship skills. Furthermore, many noted that relationship skills are usually missing from entry-level candidates.

IV. The Case for a Varied Set of Skills

Our findings indicate that IT workers need skills related to understanding a company's business, managing its projects, and communicating with others, in addition to ever-changing and advancing technical skills. These findings extend and reinforce the message that IT professionals are expected to possess both non-technical and technical skills and that their choices are "not either/or but both" [3, p. 114]. Furthermore, preliminary findings of a follow-up study with IT software and service providers indicate that these same skills are important for all IT professionals [6,7].

Technical and structural change is endemic in the business environment in general and the IT profession in particular. The Law of Requisite Variety suggests that in order to flourish in such a complex and dynamic environment, entities must possess a varied set of skills that enable them to adapt as differing conditions are encountered and as those conditions change. Our study suggests that organizations at some level know this. Hence, they value employees with varied skills, possibly because those employees can understand and resolve complex problems, identify important new opportunities, and have the adaptability and nimbleness necessary to change constantly.

In response to the Law of Requisite Variety, we offer the framework presented in Table 2 that outlines a range of knowledge and skills that IT professionals need to successfully adapt to the inevitable changes in technology, in organizations, and in job assignments that the future will surely bring. Our framework proposes six skill categories that IT workers need to consider as they develop into well-rounded professionals and that IT-related faculty who develop curriculum should consider to prepare these workers [8]. The framework offers insight into how individuals can become valued members of an organization's dynamically changing workforce.

IT professionals may choose to specialize within a certain skill category, but it will behoove them to have breadth across all six categories. There is no doubt that technical skills must be updated continually. But additionally, IT employees need to develop firm and industry-specific skills that allow them to take advantage of fleeting opportunities, respond to emerging threats, and to be more adept at collaborating with end-users, suppliers, and customers. IT professionals who possess skills in all six categories will be best prepared not only to survive but to prosper in a turbulent environment.

For example, the ability to manage Relationships and identify Problems/Opportunities will aid in the effective analysis and design of systems, while Foundational and Operational skills will aid in the Project Management required to deliver them. Alternatively, having acquired Project Management skills, IT workers will be more effective in managing user expectations, negotiating deadlines and communicating potential problems.

We consider our categories as complementary and reinforcing, not mutually exclusive or competing. As a case in point, IT workers often begin their careers by acquiring Foundational knowledge. We view Foundational knowledge as a valued step in building a broad set of skills. However, Foundational knowledge by itself is not sufficient to satisfy the Law of Requisite Variety. Operational skills, along with Problem/Opportunity and Relationship skills, are needed to supplement Foundational skills and enable individuals to develop their Essential skills.

Together, our six skill categories provide the individual with a broad base of technical and non-technical skills that lay the groundwork for what was recently termed a "versatilist," someone with a grounding in technology that also understands an organization's environment (Problem/Opportunity skills). A versatilist is able to deliver value adding IT initiatives (Project Management skills) and can build and maintain both internal and external relationships (Relationship skills) [9]. Our results indicate that individuals with the skills required to be a versatilist would fit within our framework of requisite skills. Individuals with a requisite variety of skills are therefore expected to be the most sought-after IT professionals.

To acquire this broad range of skills, we recommend that professionals evaluate their strengths and weaknesses across the six categories and pursue opportunities to round out their overall skill set. IT professionals must manage their own development using mechanisms such as job rotation, on-going training, and continuing education [10].

We recommend that IT workers be cautious about building a career on a single skill set, as these skills may be valued by a specific employer at a given point in time, yet a narrower range of skills is always more vulnerable to outsourcing. We believe that it is far better to develop a broad set of skills that position oneself as adaptable enough to respond to changes in technology and industry-related trends.

As an extension of our recommendations, we believe that basic knowledge in all six categories should be included in IT-related curricula [6]. Because participants in this study indicated they seek to fill their open positions from business schools and computer science programs in roughly equal measure, we suggest that academics must infuse curricula with a base of technical skills complemented with a set of non-technical skills, such as managing projects, relationships and clients.

REFERENCES

1. Prabhakar, B., Litecky, C.R. and Arnett, K. IT skills in a tough job market. *Communications of the ACM*, 48, 10, (October 2005), 91-94.
2. Lee, C.K. and Reichgelt, H. Skills required for IT management and the IT model curriculum, *Proceedings of the Sixth Conference on Information Technology Education*, (October 2005), 381-382.
3. Lee, S.M and Lee, C.K. IT Managers' Requisite Skills. *Communications of the ACM*, 49, 4 (April 2006), 111-114.
4. Ashby, W.R. *An Introduction to Cybernetics*, Chapman & Hall, London, 1956.
5. Boyatzis, R.E. *Transforming Qualitative Information: Thematic Analysis and Code Development*, Thousand Oaks, CA,
6. Bullen, C., Abraham, T., Galup, S. IT Workforce Trends: Implications for Curriculum and Hiring, *Proceedings of the Americas Conference on Information Systems*, (August 2007).
7. Goles, T., Hawk S., Kaiser, K.M. Information Technology Workforce Skills: The Software and Services Provider Perspective, *IS Frontiers*, (2008), 10, 12, 179-194.

8. Abraham, T., Beath, C., Bullen, C., Gallagher, K., Goles, T., Howland, Kaiser, K. M., Simon, J. IT workforce trends: Implications for IS programs, *Communications of the Association for Information Systems*, 17, 50 (June 2006), 1147-1170.
9. Collett, S. Hot Skills, Cold Skills, *Computerworld*, July 17, 2006,
<http://www.computerworld.com/action/article.do?command=viewArticleTOC&articleId=112360>,
accessed April 26, 2008.
10. Gallagher, K. P., Kaiser, K.M., Frampton, K., and Gallagher, V. Best practices for grooming critical mid-level IT roles, in Lending, D. and Vician, C., (eds.) *Proceedings of SIG-MIS Computer Personnel Research Conference*, St. Louis, (April 2007), 15-19.

Table 1 Rankings for Programming

	Ranking
Sought in entry-level hires	1
Sourced from independent contractors	1
Sourced from third-party providers	1
Going away	1
Sought in mid-level hires	16
Missing in entry-level	22
Emerging as important	24
Critical in house	28

Table 2. Skills Critical to Retain, Sought in New Hires, and/or Sourced

	Critical in-house	Sought in new hires	Sourced
Technical Skills			
<i>Foundational Skills</i>			
Programming		Entry Level	X
System Testing		Entry Level	X
Desktop Support/Helpdesk		Entry Level	X
Database Design/Management		Entry Level	X
Operating Systems		Entry Level	X
Voice/Data Telecommunications		Entry Level	X
<i>Operational Skills</i>			
Operations			X
Service Hosting			X
Continuity/Disaster Recovery			X
Mainframe/Legacy			X
<i>Essential Skills</i>			
Systems Analysis	X	X	X
Systems Design	X	X	X
IT Architecture/Standards	X	X	X
Non-Technical Skills			
<i>Project Management Skills</i>			
Project Leadership	X	X	
Project Planning/Budgeting/Scheduling	X	X	
Project Integration/Program Management	X	X	
Project Risk Management	X	X	
<i>Problem/Opportunity Skills</i>			
Company Specific Knowledge	X	X	
Functional Area Process Knowledge	X	X	
Industry Knowledge	X	X	
Business Process Design/Re-engineering	X	X	
Change Management/Organizational Readiness	X	X	
<i>Relationship Skills</i>			
User Relationship Management	X	X	
Communications	X	X	
Negotiation	X	X	
Managing Stakeholder Expectations	X	X	