

7 EXPANDING THE HORIZONS OF INFORMATION SYSTEMS DEVELOPMENT

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Abstract

Advances in information systems technologies and applications and new realities in the business and economic climate are changing the nature of information systems development. In particular, the areas of electronic commerce and Web-based applications challenge our notions of the role of the information systems function in the development process. This essay explores the impact of several of these changes on information systems development, and on developers themselves, and suggests how developers must adapt to meet these new requirements.

1. Introduction

Much has been written about the continual changes experienced by the information systems field and the fact that these changes are occurring at an ever more rapid pace. According to Donald J. Listin, of Cisco Systems, “technology is moving so quickly that products are dead in 18 months” (Byrne 1999).

Organizations are changing to adjust to these dynamic business conditions. Changes are driven by commercial technology, particularly the demands of e-business, the globalization of markets, and the pressure for reengineered, quality-oriented organizations (Truex, Baskerville, and Klein 1999). These change drivers are pushing organizations to find new ways of doing business. Organizations are moving from functional, hierarchical management structures to team-based, networked structures. They are

moving from a product focus to emphasis on targeted services that meet market demand. Strategic alliances and integration across the supply chain are becoming commonplace.

Information technology is the strategic enabler of these changes. The vast majority of the new ways of doing business could not be accomplished without information technology. In fact, in some cases, the information systems are not merely *supporting* the organization, they *are* the organization (*e.g.*, Amazon.com). It is difficult to identify any area of the lives of those living in industrialized nations that has not been impacted by information technology. Information technology is central to healthcare, education, government services, manufacturing, transportation, financial services, entertainment, and retailing. More and more services and products are becoming information-based and there is no reason to expect this trend to end. The need to design the information technology components of these products and services, as well as designing the means to integrate them, not only puts great pressure on developers, but raises ethical issues as well. As more and more of our interactions, both business and social, take place in the virtual world of the Web, who are we: the flesh and blood being sitting at the keyboard, or the virtual presence on the network? And what happens to those who aren't "on the net"? Will we eventually have two parallel societies? Obviously there are many issues surrounding the trends in information technology that beg consideration. This essay addresses just a small segment of this; namely, that of the impact of these trends on business information systems development.

The purpose of this essay is to describe a number of the changes taking place in the information systems development environment and to discuss how these changes can be addressed in the education and training of systems development professionals. The remainder of the paper discusses the drivers of change in business information systems development, the impact of these changes on development and developers, and the manner in which educational systems can better prepare future developers.

2. Pressures on Systems Development

In addition to pressures from the business environment, there are technological and application-oriented advances that are changing both the process and product of systems development. Y2K preparations have drained substantial IS resources for the past several years. Coming out of this, IS departments are faced with backlogs of development projects, as well as with a shortage of IS personnel. Thus there is pressure to produce more with less resources, and to produce it quickly.

This push means that development groups are facing shortened time horizons. The focus is on small-scale, rapid development (Fitzgerald 1997, 1998). This new reality challenges some of the traditional assumptions about information systems development (Truex, Baskerville, and Klein 1999). Detailed, lengthy planning and analysis phases are no longer feasible in rapidly changing environments. Projects of long duration are not tolerable because the fast pace of change means that the underlying business could change dramatically during the time between analysis and implementation.

In addition to pressure to do more with less, developers in many organizations are responsible for applications on a growing number of platforms (Fitzgerald 1998; Russo, Hightower, and Pearson 1996). For example, IBM currently develops applications for

32 different hardware and software platforms. This adds not only to the difficulty of initial development, but also adds considerably to testing resource requirements. Additional complexity is added when applications and data are distributed across homogeneous or heterogeneous networks. Even with open systems interconnectivity, organizations still face tremendous problems with connecting and integrating disparate systems. This becomes an even greater challenge on a global scale. The Internet and the Web have served to stimulate greater global business activity. For IT departments in multinational companies, this means greater worldwide distribution of computing platforms, vastly increased global information flows, and many other technical, legal, and cultural issues (Stephens 1999).

Changes are occurring in the nature of software applications as well. Software vendors are moving away from selling shrink-wrapped software toward selling (leasing) applications as services on the Web. Through the influence of object-oriented methods and tools, development is becoming much more component-based. It is predicted that some developers will be component makers, while others are component users (Lyytinen, Rose, and Welke 1998). Web application development has had a tremendous impact on the field because it is different from traditional IS development, not only in terms of the characteristics of the applications themselves, but also in terms of the people involved in Web application development.

In a general study of Web development (Russo and Graham 1998), fewer than one third of the Web developers were employed in an information systems department. Most did not come from traditional computer science/IS backgrounds, although a few had some prior programming knowledge (not necessarily work experience). Less than 15% of the respondents received formal training in using hypertext markup language or other Web development tools or languages. Few of the developers worked as part of a formal development team in developing their Web applications. Most worked alone, and others worked informally with users. Web development in many organizations is decentralized and, because it is often not the responsibility of any one group, it is very difficult to monitor and control. In this study, over half of the respondents indicated that their organizations had no standards or guidelines for Web development. Although these results must be interpreted with some caution, due to the changes that have occurred since the data was collected (1996-1997), they do tell us that our concept of a "developer" must be broadened beyond the boundaries of the IS function and beyond the traditional end-user concept.

The hottest trend in the field, e-commerce, is a specialized type of Web application development. In e-commerce development, we see the convergence of cross-functional resources: telecommunications, databases, interfaces, marketing, graphic design, and others. These systems may appear simple to set up, but the cost to establish a functional e-commerce system can be quite high. Estimates range from \$10,000 to \$100,000 for an electronic catalog to \$1 million to \$10 million for a dynamic, interactive application (Forester Research).

As organizations move away from a brick and mortar existence, and into the virtual space of the Web, traditional approaches to systems development become less viable. When the goal is to create something brand new, rather than to build something to support an existing function or process, priorities change. Analyzing a current system in the "real" space, when designing a system for "virtual" space, is not very helpful because the

virtual space is not subject to the same limitations. When designing in the virtual, Web-based environment, the focus moves from merely meeting user requirements to devising new, innovative things that users haven't seen before. Not only do Web-based systems have to be functional and easy to use, they must also be creative, interactive, fun, and exciting.

Another trend is an increased level of package customization vis-à-vis new development (Fitzgerald 1997). Enterprise resource planning packages such as SAP and PeopleSoft are replacing in-house development. This move toward ERP systems raises questions about the impact that such a move will have on organizations' internal IS functions. Many organizations found that when they outsourced functions in the past, they lost access to a valuable resource. Organizations face a similar problem when moving to ERP. When one software product replaces all or most of the legacy systems in a firm, what happens to the IS department? Are fewer people needed? Are people with different skills required? Can maintenance be performed in-house, or will consultants from the software vendor be required? If the organization loses the flexibility of changing or replacing system functions, what will this mean to the organization's ability to respond to changing market needs? If the majority of organizations standardize on a few ERP packages, what will this mean for the ability to develop and use information systems for competitive advantage?

A small study (Russo, Kremer, and Brandt 1999) looked at some of these issues. The study found that in the firms examined, it was nearly as likely for the IS staff to grow as to decrease. The biggest change was in IS staff functions (and this was typically underestimated). Little streamlining in the operations of the IS department was realized and operating costs of the IS function were more likely to increase than to decrease. Productivity and efficiency benefits were slow to be realized. No overall conclusions can be drawn yet, but the impact of these packages should be monitored.

Most of the major ERP vendors reported slower growth in the second quarter of 1999. It may be that this represents a reversal of the trend, or it may simply mean that organizations are waiting for the Web-enabled versions of the packages to be released, or that they are switching to smaller vendors who have already made the migration to Web-enabled ERP systems. In any case, these enterprise-wide packages are a reality and they have had and will continue to have an impact on the IS function.

Table 1 summarizes the impact these factors are having on the information systems development environment. The following section will expand on these and other changes happening in IS development.

3. Changes in ISD Skill Requirements

Changes in the development environment call for changes in the skill sets of systems developers. Most of the skills described, which include both "hard" and "soft" skills, are not new. However, the importance of these skills is increasing and developers who can integrate them will be in high demand. This discussion addresses primarily developers of new business information systems, rather than those involved in maintenance of legacy systems or those developing large scale control systems, although some of the concepts may apply to those areas as well.

Table 1. Factors Impacting the ISD Environment

Economic Factors	Organizations continue to be pressured to do more with less. This is exacerbated by the shortage of technical personnel with the necessary skill sets. As organizations complete Y2K projects, there will be a backlog of other projects waiting to be addressed.
Globalization	Both the integration of mature markets and newly emerging markets are facilitated by the Internet, resulting in a wide variety of computing platforms and increased global information exchange. For IT departments in multinational organizations, this introduces a number of technical, legal, and cultural issues that must be addressed.
Technology	Development on diverse platforms is becoming the norm. Technology is changing rapidly and continues to provide capacity for faster, more powerful systems.
Applications	Applications development is becoming increasingly component-based and media-based rather than function-oriented. Rather than developing applications software, vendors are providing software services via the Web.
Business Requirements	The expectation is that applications will be available anytime, anywhere. Greater integration within and among organizations is necessary.
Pace of Change	Growth is more rapid. We have seen more change in the last few years, primarily related to the Internet, than we have seen in the last 20 years.

The technologies used to develop the application types most in demand today, Web-based and e-commerce systems, require developers do be knowledgeable in two relatively diverse areas: telecommunications and multi-media (Lyytinen, Rose, and Welke1998). On the one hand, developers need technical telecommunications skills to design and implement communications networks to support distributed, Web-based applications. But developers must also be able to design visually pleasing, fun to use, multi-media interfaces that effectively communicate the organization's message and make it easy for users to navigate and use the site. All of this is in addition to providing the necessary functionality and security behind the scenes.

On-line collaboration can speed software development and reduce costs. Collaboration may be between project team members, with external business partners, and with outside service providers. The Web can provide a place to post coding standards, the project repository, and up-to-date system requirements, and thereby enable faster and easier communication between clients and developers. The ability to update this project information simultaneously for all development partners should reduce delays and errors. The ability to integrate the work of developers from many different locations helps organizations to cope with personnel shortages and to utilize highly-skilled developers located in other parts of the world (often at a lower cost).

All of this collaboration, however, will require that developers have good teamwork skills. Not only do developers have to be able to communicate with other developers, but they also have to be able to work with other business professionals, graphic designers and artists, and others both inside and outside the organization.

In today's fast-paced environment, developers must be able to deal with ambiguity. Organizational culture, relationships, and decision processes are continually changing, following no predefined pattern (Truex, Baskerville, and Klein 1999). Therefore, it becomes impossible to define a static set of system requirements; instead, the point of departure must be incomplete and partially defined specifications. Developers (and their organizations) must be proactive, flexible, and adaptive to respond to the changing needs of the marketplace. The fact that many of the systems developed today are not merely extensions of the existing functions of organizations, but are in fact the totality of the organization, means that the creativity, aesthetic sense, and judgement of the developer become more important than it has been viewed in the traditional development arena (Stolterman 1999; Stolterman and Russo 1999).

There is a high demand for professionals with both business and IT skills (Mateyaschuk and Jaleshgari 1999). Bridging the gap between functional business areas and information technology requires a renewed focus on developing knowledge, skills, and abilities that will enable information systems developers to interface both with the technical specialists and with the users and to understand each group's problem-solving processes and structures (Hale, Sharpe, and Hale 1999.) The ability to leverage business knowledge and integrate it with IT knowledge can result in distinctive organizational competencies (Butler and Murphy 1999).

These skills are summarized in Table 2. The final section of the paper will discuss how educational institutions can help developers build these skills.

4. Building New Development Skill Sets

Admittedly, there are many developers today who have well-honed skills, including those discussed above. However, it does not appear to this author (nor to the recruiters with whom she has discussed this issue) that all new systems developers being "produced" by academic institutions are well prepared in all of these areas. It may be that no one developer can master all of the skills required. It seems imperative, though, that to meet the IS development needs of organizations today and in the future, educational institutions should seek to provide experiences that will develop these important skills.

Providing up-to-date courses on telecommunications technology is obviously required. The ability to integrate multiple platforms is essential. Many programs include some type of multi-media experience; however, this is typically taught from a technical "how to" perspective, rather than utilizing knowledge from the graphic design field. Broadening the focus of these courses could make our graduates much more effective, whether they are doing the graphic design themselves or interacting with graphic designers on the development team.

Cross-functional business knowledge should be a part of the education of any developer who intends to work in the business environment. The use of real-world cases and projects can aid in integrating business knowledge with technology knowledge.

Table 2. Developer Skills Required

Teamwork	Developers can expect to work with multi-skilled teams, with members drawn from not only functional business areas, but also from the art and graphic design fields. Collaboration will take place not only within organizations, but across organizational boundaries on a global scale.
Adaptability	Development organizations will need to become more proactive to keep up with the changing needs of the marketplace. This will require maximum flexibility and minimal bureaucracy. In a rapidly changing environment, it is impossible to know everything with certainty. Developers will have to accept ambiguity as they move away from the traditional notions of well-planned and thoroughly analyzed projects and into a world where change is constant and traditional development approaches may not apply.
Business Knowledge	It is the ability to leverage business organizational knowledge that will provide organizations with competitive advantage. Broad organizational knowledge, integrated with technical skills, provides the basis necessary for identifying current and future opportunities.
Multi-media Skills	In Web-based applications, such as e-commerce, the design of the user interface is critical. It is more, however, than just a nice looking screen. These applications are complex, multi-media structures.
Telecommunications Skills	As more and more systems go on the Web, developers will need to be well-versed in various telecommunications technologies.

It has become quite common for students to work on project teams. It is even more useful when these teams are geographically dispersed and from different educational and cultural backgrounds. This makes communication and cooperation more difficult, and thus forces teams to develop effective communication skills.

Flexibility, adaptability, and the ability to deal with ambiguity are harder to teach. However, by exposing students to a wide variety of development approaches and situations, and stressing the dynamic nature of the field, we can help prepare them. It is also important that we help our students develop their innovativeness, creativity, and judgement skills. We can move in this direction by having students evaluate different information systems and explore ways to identify what is good and what is bad in an information system design (Stolterman 1999).

How well do existing curricula meet these needs? As examples of IS curriculum models in the U.S., we can look at the IS'97 Model Curriculum (Davis et al. 1997) and the Information Systems-Centric Curriculum'99 Program Guidelines (Lidtke et al. 1999).

In both of these curriculum models, we see the traditional fundamentals of IS, programming, database, telecommunications, and analysis and design courses. Both models stress the importance of interpersonal (teamwork) skills, communication skills, and analytical skills (problem solving) in addition to the technical skills. The ISCC'99 model has in addition two ethics components, a course on the dynamics of change, and a comprehensive collaborative project (ideally in cooperation with industry). If all IS programs would move in the direction of these models, we would be closer to meeting the needs of today's organizations. However, some gaps remain. In particular, the weakest area of these curricula, and in most current IS programs, is in the area of design. We teach our students the proper way to use various design techniques to produce particular design documents, based on the results of the analysis of the existing system. Unfortunately, for many of them, the systems they will be designing aren't based on any existing system and traditional design techniques, even object-oriented ones, don't help very much when the most important part of the system is the look and feel of the interface.

To prepare our developers for the environment they will face in the future, we should strive to go beyond the technical skills, which are still required, and beyond the collaborative and communication skills, which have been added only in the past decade or so, to the creative realm, where judgement, innovativeness, and the ability to adapt and apply techniques and knowledge in new ways become possible.

5. Conclusions

Changes in technology, business functions, and market conditions are fueling tremendous advances in the systems development arena. A more diverse group of individuals are being drawn into information system development, particularly in the area of Web applications and electronic commerce, and a more diverse skill set is required of those traditional information systems professionals who are moving into these integrative areas. It is becoming more important for those involved in system development to be able to integrate business knowledge and technical knowledge, to possess strong technical skills in the areas of telecommunications and multi-media design, and to have "soft" skills in terms of collaboration, flexibility, creativity, and judgement.

It is becoming more and more difficult to strictly segregate information systems development itself from other activities. For example, as more and more people use information systems on a regular basis, and adapt them to meet their own specific purposes, the distinction between user and developer blurs. The development tools that allow us to move directly from our design to the production system have dissolved the border between design and delivery of a finished product. The whole area of Web application development challenges our notions of what is an information system life cycle, how users influence the development process, and what is the role of the IS function in the development process. Even now, our notion of who or what is an information system "developer" is changing as the process of system development becomes part of nearly all other activities.

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