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Communications of the Association for Information Systems

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Toward an IT Agenda

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Abstract:

The state of the information technology discipline is explored. A point of departure is a depiction of the IT field in a computing space along with computer science, computer engineering, software engineering, and information systems. This examination motivated a proposed distinctive anchoring theme for the IT discipline as deployment and configuration. Recommendations are made for advancing the research component of an IT agenda by seizing on jurisdictional vacancies, abstracting from professional practice, and drawing upon theoretical results from the systems sciences, serving as a reference discipline for IT. Five IT research thrust areas are proposed: IT artifacts, enterprise architectural infrastructure, interaction models, system performance, and domain induction. Appendices provide context by discussing viewpoints on the IS-IT relationship, perspectives on the role of artifacts in IS-IT research, and observations on the perceived standing of IT as a discipline or sub-discipline.

Keywords: IT discipline, IT research agenda, IS discipline, computing curricula, IT artifact

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Communications of the Association for Information Systems

I. INTRODUCTION

As the subject that gives meaning to such a familiar acronym, information technology is unsteady in the disciplinary ranks compared to its nearest neighbors like information systems (IS) and computer science (CS). This article explores the state of IT and its emergence as a distinctive field of study, beginning to set its own agenda. "The standing of the field may be measured by its capacity to set its own agenda. New disciplines emerge by acquiring that autonomy.… A field's agenda consists of what its practitioners agree ought to be done, a consensus concerning the field's problems, their order of importance, the means of solving them (the tools of the trade), and perhaps, most importantly, what constitutes a solution" [Mahoney, 2004, p. 9]. We address only selected elements of an agenda, namely, observations on IT practice and its challenges as they might motivate IT research initiatives. The goal of this article is to contribute to our understanding of the IT discipline by characterizing its relationship to other computing fields, by proposing an anchoring theme and reference discipline for IT, and by recommending thrust areas for IT research.

As a discipline, IT "… is concerned with issues related to advocating for users and meeting their needs within an organizational and societal context through the selection, creation, application, integration and administration of computing technologies" [Lunt et al., 2008, p. 8]. Consistent with this definition, an agenda about IT focuses on technologies and artifacts that lie at the center of the nomological net in [Benbasat and Zmud, 2003], rather than on the surrounding nodes that deal with managerial issues, human behaviors, and impacts related to the technologies. In the spirit of [Orlikowski and Iacono, 2001], a research agenda associated with IT reflects theorizing about IT artifacts and not taking them for granted. We will refer to IT researchers to mean any individuals whose investigations are technology-centric (as just characterized, for example, by these two references) and who may or may not consider themselves part of IS, CS, or other research communities.

This article refers to IT as a discipline, to denote a field of study, consistent with [Gowan and Reichgelt, 2010], which cites the emergence of IT as a separate discipline over the past decade. This disciplinary standing for IT is also recognized by curricular and accrediting bodies [e.g., Lunt, et al., 2008 and ABET, 2010 respectively], whose attention to the disciplinary content of IT has helped to render the subject sufficiently well-defined so that we can discuss IT research themes, as others have done [e.g., Reichgelt, 2004; and Ekstrom, et al., 2006].

A rationale for this exploration of IT (or the more globally recognized, information and communications technology, ICT) is that, with the critical role of IT in people's lives, it makes sense that communities of research and practice related to IT will want to understand the state of the field. The case made for the importance of establishing an IS disciplinary identity would seem to hold equally well for IT: "If influential stakeholders are unable to comprehend the nature, importance, and distinctiveness of the role being served by the … discipline, these stakeholders are unlikely to acknowledge its legitimacy within the organizational field" [Benbasat and Zmud, 2003, p. 185].

Section II begins with a depiction of the computing space and interprets IT and other computing disciplines as they address the what and how of computing. Themes are proposed for each computing discipline. Section III discusses the state of the IT agenda and recommends a strategy to advance it. Section IV proposes five IT research thrust areas. Section V offers concluding observations on the contribution of IT research and practice to the broader societal agenda. Appendix A discusses the relationship between IT and IS. Appendix B reviews multiple perspectives on IT artifacts and their centrality to IS/IT research. Appendix C presents viewpoints on IT as a discipline or sub-discipline.

II. IT IN THE COMPUTING SPACE

We begin our exploration of IT in the milieu of academic programs and model curricula, which have been recognized elsewhere as relevant to considerations of disciplinary status. As one who has studied extensively the history and evolution of computing, Michael Mahoney notes the role of a curriculum as "an important resource for tracing the emergence and development of a discipline" [Mahoney, 2002, p. 7].

IT not only has academic programs at the BS, MS, and Ph.D. levels, but also has a model curriculum and Body of Knowledge (BOK) at the undergraduate level [Lunt et al., 2008]. The IT model curriculum (and associated BOK) is one of a set of five under computing that includes computer science (CS), computer engineering (CE), software engineering (SE), and information systems (IS). The Joint Task Force for Computing Curricula (JTFCC), a cooperative project of the Association for Information Systems (AIS), the IEEE Computer Society, and the Association for Computing Machinery (ACM), oversaw the curricula and BOK creation efforts for all five computing disciplines. This central coordination and breadth of perspectives from the sponsoring societies are auspicious aspects of such development efforts. While another positive feature is that all three organizations are international, it is readily acknowledged that this article reflects largely North American experiences and perspectives of the author.

The Joint Task Force offered a graphical depiction of the five disciplines situated in the problem space of computing [JTFCC, 2005]. While the computing space was put forward to map curricula, the claim here is that it has additional value to support reasoning more generally about relationships among the disciplines. The computing space is proposed here as a representation of an interactional field of academic disciplines: "There are on the one hand bodies of potential academic work and on the other, bodies of people who do that work. At any given time, there are bundles of ties between various areas of work and various bodies of workers, bundles that make up a disciplinary settlement" [Abbott, 2001, p.137].

As reproduced in Figure 1, the vertical axis of the computing space ranges from hardware on the bottom, through systems, software, and applications, and, finally, organizations at the top. The horizontal dimension is the familiar span of theoretical to applied approaches.

Figure 2 shows how the five disciplines cover the computing space, as expressed in [JTFCC 2005]. The small size of the shapes in Figure 2 is intentional to convey visually the broad relationships among the five disciplinary shapes. While the words on the axes are not readable, they are the same as in Figure 1. Note that IT is situated on the applied side (x-axis), while covering a span from systems infrastructure to organizations (y-axis). This positioning of IT will be explored for its implications in representing the range of IT practice and motivating the identification of research thrust areas.

The What and the How of Computing

While academic curricula are the context for Figures 1 and 2, we suggest that a broader interpretation may stimulate discussion more generally about relationships among the fields in the computing space. By doing so, we are over-interpreting the figures in a way that was not the original purpose of the graphics. We are using the computing space as a point of departure to explore further the nature of IT as it relates to its cohabitants CS, CE, SE, and IS. The first observation is that the axes in Figure 1 may be thought of as the "what" (y-axis) and the "how" (x-axis) of computing. While admittedly an oversimplification, this what–how reference will be helpful in considering the scope of the fields. (Of course, there is no reason to restrict the computing space to two dimensions. Precisely because of advances in computing, we have tools to help us easily visualize 3D spaces, with perhaps a third "why" dimension to express the motivation for the "what" and the "how.").

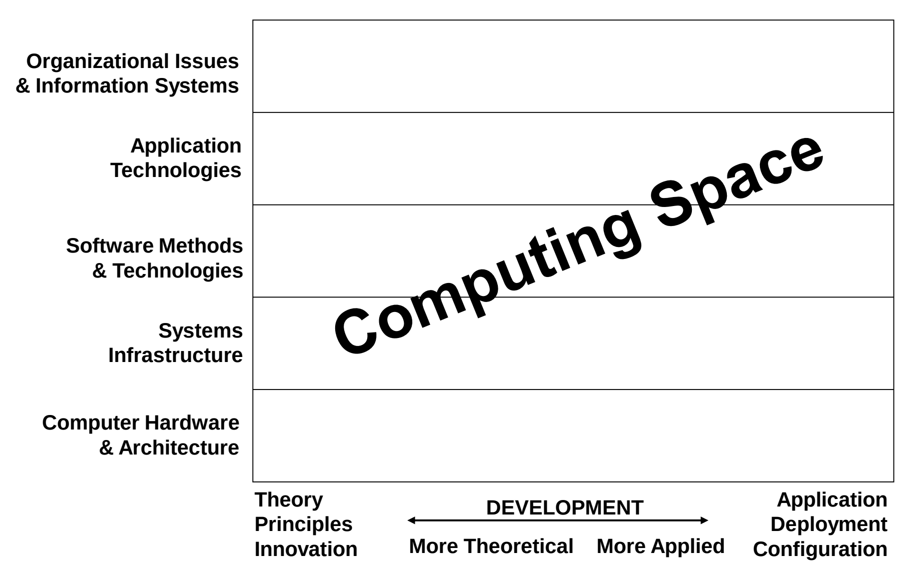

Figure 1. The Computing Space (from JTFCC, 2005)

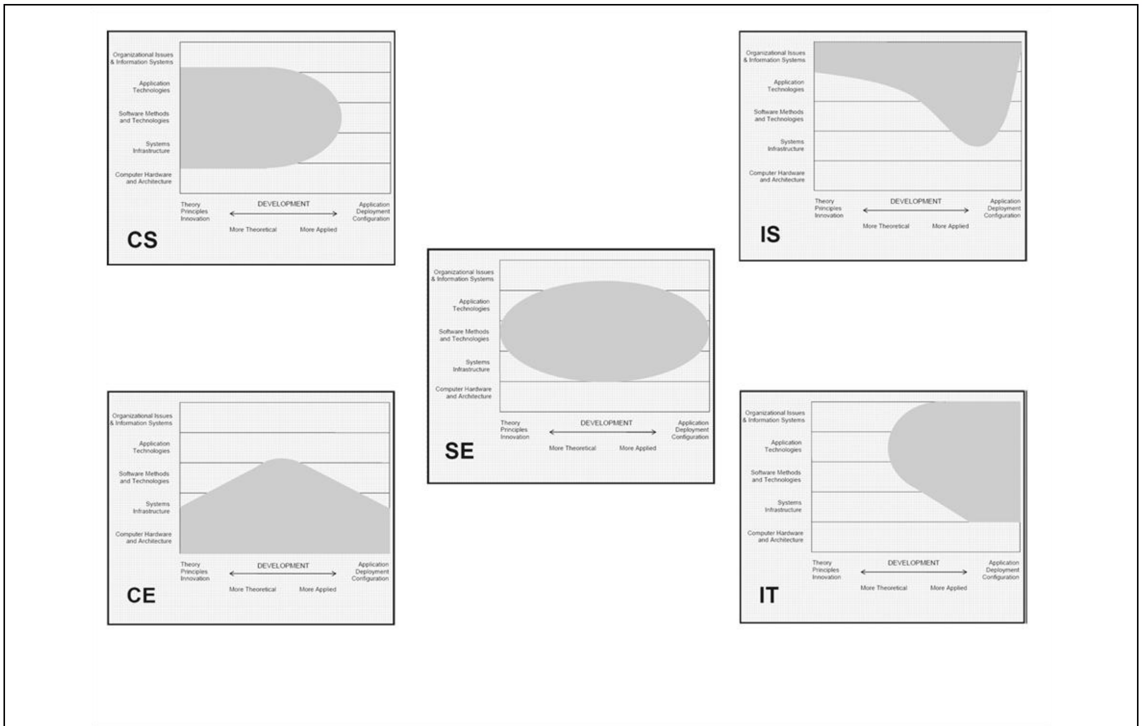

Figure 2. Discipline Shapes in the Computing Space (Adapted from JTFCC, 2005)

A computing field can be thought of in terms of the nature or focus of its concerns, the phenomena of interest (the “what”) and the way it engages that focus area (the “how”). Scanning the y-axis from bottom to top reveals whether a particular field tends to concern itself with hardware, with the way hardware elements are brought together into systems, with the challenge of making use of these systems by focusing on processes and methodologies to build applications, with the applications themselves and how they are used, and finally with the collectives of people and applications that are found in organizational settings. The spectrum from bottom to top may be seen as a continuum of objects of study and practice—moving from tangible hardware artifacts to the intangibles involved in building applications and information systems that meet the needs of individuals and organizations.

Moving from left to right along the x-axis spans a range of possible ways to engage these focus areas. Do researchers and professionals in the fields look for fundamental aspects—theories and principles that are broadly informative of the area—and contribute by establishing foundations for those areas? Or, further along the x-axis, do the means of engagement still have aspects of abstraction but are now more accurately characterized as fashioning frameworks that are useful generalizations and reference models for the areas of investigation? Moving still further to the right, are practitioners engaging with the area by working with instantiations associated with the focus areas: real hardware devices, particular software methodologies, extant Web technologies, users of systems, and real organizations?

Disciplinary Themes in the Computing Space

There will be no attempt here to dwell on the precise shapes of the disciplinary regions in Figure 2. Also, any such shapes will change over time. The only aspect of the shapes that will be used is the notion of each of the five fields having a thematic anchor owing to CS, IS, IT, and CE seeming to grow out from the four sides, and SE being centered in the space. Imagine each field represented by an elastic membrane that can take on variable shapes over time but must keep contact with its thematic home base. The elasticity of the shapes is purposeful, embracing the viewpoints of [Galliers, 2003; Gray, 2003; Holland, 2003; Myers, 2003; and Robey, 2003] on the need for flexibility as fields of study and practice are envisioned and as they evolve over time. As shown in Figure 3, the themes for each field are proposed as follows:

- CS—theory
- CE—hardware
- SE—development
- IS—organizations
- IT—deployment

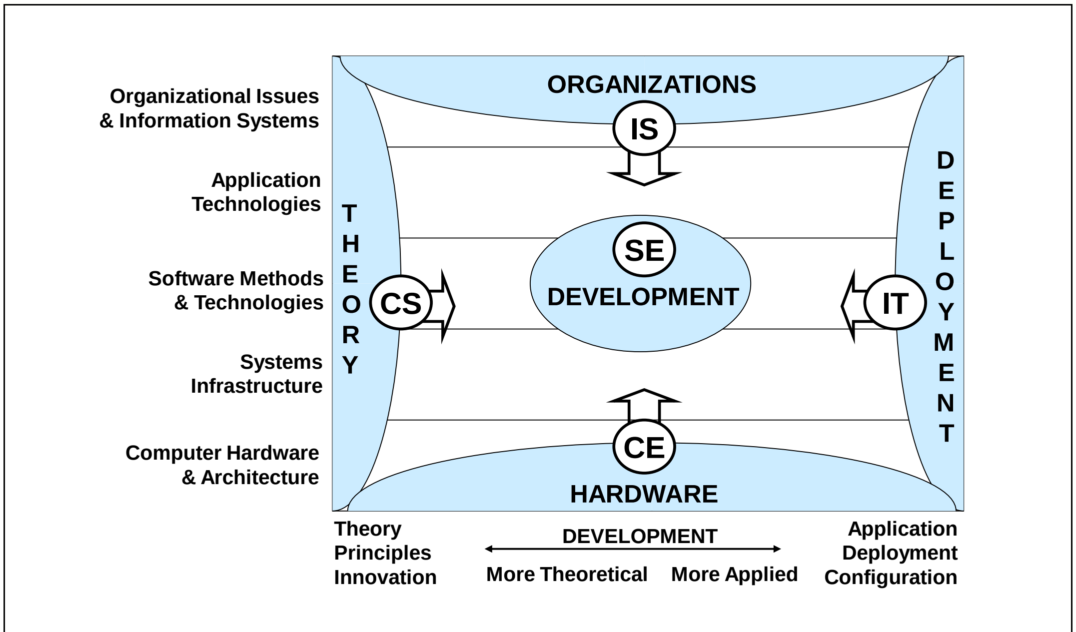

Figure 3. Disciplinary Themes

Admittedly, it is grossly inadequate to associate entire fields of study with single words. It is simply suggested that a disciplinary theme provides a context for the educational programs, research initiatives, and professional activities of each field. A theme is not meant to be the disciplinary core (as used in Benbasat and Zmud, 2003) nor to be overly restrictive, but rather to establish an overarching mindset and perspective that influences the objectives and approaches associated with each field, in particular, the ways in which the field engages the *what* and the *how* of computing.

Each field takes its theme directly from a single defining reference word on the coordinate axes and associated with the space occupied by the field. IS is at the top of the space and picks up "organization," which marks the top of the y-axis. Similarly, CE, at the bottom, picks up "hardware." The theme for CS, from the left side, is "theory." The SE region appears in the middle, picking up "development" from the middle label on the x-axis.

IT takes "deployment" for its theme because that term seems to capture most effectively the essential challenge of IT to place entities into position so they are ready for use and to investigate properties of deployed technologies. Deployment also has the needed breadth of scope; one can not only deploy hardware and networks, but also system software, applications, policies, procedures, standards, tools, methodologies, protocols, and services. None of the other four fields can be reasonably expected to engage the focus areas on the y-axis with the same perspective as IT professionals. The IT area in Figure 3 is anchored to the far right side, dealing with the realities of deploying actual computing artifacts and working with people and organizations that count on IT for them to be productive.

Once again, by a self-imposed attempt at conciseness in seeking to capture each theme with a single word, it does not convey the entire essence of the theme. For example, while claiming that "organization" provides a context for IS, the goal in information systems research and practice is more fittingly organizational impact. Similarly, more than simply "hardware," CE is identified with digital logic devices embedded in systems. In a more substantive treatment, the rationale for the anchor words of the five fields is as follows:

- *CS–theory.* Obviously, CS is not alone in having associated theory, and this point will be explored in Section III. The association with theory here is intended only to suggest that when the context is computing, there is a research tradition in CS to establish the mathematical and logical foundations, for example, related to algorithms, machine intelligence, and computability. While this theme is consistent with the view that the "… natural role for computer scientists … is the custodian of the intellectual and scientific core of the field" [Denning, 2001, p. 18], it is not meant to preclude the establishment of theory in other fields. As Figure 2 shows, the entire space is available as a canvas for drawing shapes of the fields. The CS theme of theory means only that there is an overarching mindset to seek mathematical and logical foundations of computing and information processing. The shapes of the other four computing fields can extend to the far left-hand side of Figure 2 as well.

- *CE–hardware.* Computer engineering has steadily emerged from electrical engineering with its own body of knowledge and has grown as so many digital logic chips are embedded in products and devices used today. Unquestionably, CE has a strong theoretical base in electrical engineering and physics, but the focus is on physical realizations of logic in chips and their use with other electrical and mechanical elements. CEs are skilled at designing hardware systems that are most effective for an intended purpose.

- *SE–development.* Software engineering has become more established as a field to match the increasing recognition of the challenges of fashioning complex multifunction software-intensive systems that operate and interoperate reliably. SE includes developing and applying processes, methods, techniques, and tools so these systems can be designed, implemented, and maintained effectively. Given the significance of these challenges, one cannot expect them to be addressed adequately within CS or IS alone.

- *IS–organizations.* The IS challenge is to use information and its associated technologies to create business value and to provide optimal support to organizational processes and decision-making. "Organization" is used broadly here to include collectives of people, such as groups, teams, and work units [Benbasat and Zmud, 2003]. The association of IS with the organization has been a consistent thread over the years. As Hirschheim and Klein [2003, p. 245] note, "Keen's [1987] articulation of the field's mission … [is] to study the effective design, delivery, use and impact of information technologies in organizations and society." The concern is less with computing systems themselves and more with how they enable transaction processing, record-keeping, inquiry, reporting, planning, controlling, and analytical support for the organization to function, succeed, and comply with legal and regulatory requirements.

- *IT–deployment.* Figures 2 and 3 portray IT as anchored in the world of deployment, structuring and configuring computing artifacts. As new technologies appear, they need to be integrated with existing systems to have any beneficial effect for users. While the shape of the IT space may be anchored on the right side of Figure 3, it may extend as far to the left as dictated by advances made in research and practice. Progress in IT can be plotted along the x-axis by defining distinctive frameworks and reference models that get closer to theory in the sense of possessing breadth in the ways they can be used to understand phenomena. For example, while neither constitutes theory, the Open Systems Interconnection (OSI) seven-layer networking model [International Organization for Standardization, 2009] and the Zachman framework for enterprise architecture [Zachman, 1987] have been valuable and influential reference models that can be considered core disciplinary content in IT. So, the placement of IT in this scheme does allow it to extend toward supporting theory. SE offers an example, in which central activities in the practice of software engineering are underpinned by theory, such as formal languages and theoretical results on program structure [e.g., Bohm and Jacopini, 1966] that were essential to the structured programming movement, that any program can be constructed from only three formation rules of sequence, iteration, and selection.

The visualization of the computing space is being used as a vehicle to understand IT as it relates to the other computing disciplines. It is only when a field is considered concurrently with other related fields that there is the potential to understand both the subject matter that may be distinctive for a particular field and the inter-relationships among the fields. "Until a field gains autonomy over its own agenda, its development depends on what other disciplines think its practitioners should be doing" [Mahoney, 2002, p. 6].

We are not the first to pursue a deeper understanding of IT by considering its relationship to other fields in the computing and information sciences. Several studies explored the relationships among CS, IS, and IT. One analysis compared the academic content of computing programs in these three disciplines. The required credit hours for the programs were divided among the following seven topical categories—business; electronics and signals; hardware; software; interpersonal communications; networks, Web systems, and databases; and physics, mathematics, and chemistry. The greatest category of credits was, for CS, software; for IS, business; and for IT, networks, Web systems, and databases [Lunt et al., 2005], thereby reinforcing the themes proposed here.

A second investigation examined the distribution of credit hours in required courses in sixty-one undergraduate programs, comprised of sixteen programs in CS, thirty-three in IS, and twelve in IT. Credit hours in the courses were assigned to one of three categories: business, mathematics, or computing. The distribution of credit hours by type of program was analyzed statistically. The results showed statistically significant differences in the higher number of business credits in IS compared to IT and CS; higher number of mathematics credits in CS compared to IS and IT; and higher number of computing credits in CS and IT compared to IS [Anthony, 2003].

More recently, Gowan and Reichgelt [2010, pp. 79–80] contrasted CS, IS, and IT academic programs this way:

- CS Programs: "… focus on the basic principles underlying computing … often include lower-level computing concepts … with significant emphasis on programming…."

- IS Programs: "… are heavily oriented toward business processes and focus on applications to support those processes."

- IT Programs: "… focus on IT infrastructure … most cover system support from hardware and software at the backbone all the way to end-user devices, as well as expansion and integration of technologies into the infrastructure."

The Accreditation Board for Engineering and Technology (ABET) has a special interest in wanting to distinguish the CS, IS, and IT disciplines so it can establish criteria that are appropriate for evaluating academic programs in each area. The Computing Accreditation Commission of ABET has defined program outcomes for graduates of the three programs, and these outcomes provide additional support for the disciplinary distinctions proposed in this article [ABET, 2010, pp. 5–7]:

- CS: "An ability to apply mathematical foundations, algorithmic principles, and computer science theory in the modeling and design of computer-based systems in a way that demonstrates comprehension of the tradeoffs involved in design choices."

- IS: "An understanding of processes that support the delivery and management of information systems within a specific application environment."

- IT: "An ability to use and apply current technical concepts and practices in the core information technologies; an ability to identify and analyze user needs and take them into account in the selection, creation, evaluation and administration of computer-based systems; an ability to effectively integrate IT-based solutions into the user environment; an understanding of best practices and standards and their application; an ability to assist in the creation of an effective project plan."

The analysis in Ekstrom and Lunt [2003] is notable because it contrasted IT with a different set of computing disciplines, CS and CE. A key distinguishing characteristic from that analysis, as summarized in Ekstom et al. [2006], was that CS and CE focused on the creation of components, while IT was concerned with how to integrate them. Integration of technologies and interactions among them should be major focus areas of the IT discipline [Ekstrom and Lunt, 2003].

Many of the observations on the essential nature of IT have focused more specifically on its relationship to IS, and those studies are summarized in Appendix A.

Now that IT has been discussed relative to other computing disciplines, we consider more broadly the state of the IT agenda.

III. THE STATE OF THE IT AGENDA

IT has some elements associated with an agenda, as defined at the start. However, this section shows IT academic programs, professional practice, and research traditions to be at different degrees of visibility and maturity.

IT has many and varied academic programs at the undergraduate and graduate levels, including a model curriculum at the baccalaureate level, as discussed in Appendix A.

With respect to practice, while there is an active community of IT practitioners, they are not always easily identifiable. They have a degree of visibility through job classifications, which struggle to keep pace with changes due to technological advancement and new business models, and through associations such as the Association for IT Professionals (AITP). But the world of IT professional practice is not neat and pristine. This is the environment of hardware that fails, software that doesn't interoperate as advertised, overloaded networks, systems rendered useless by malicious code, misdirected back-up tapes, vendors claiming to have all the answers, global development teams needing 24/7 support, demanding line-of-business managers expecting IT to create competitive advantage, executives looking to cut IT costs without affecting services, and users who would rather do their own thing. IT professionals face significant challenges to:

- Create effective configurations and productive platforms from the array of existing products and services.

- Address the myriad practical issues surrounding people and technology coming together.

- Establish nonburdensome policies and practices so the technology is maximally accessible, usable, and effective for people to do their jobs, while being secure and reliable at the same time.

When attention shifts to research, IT has not established a distinctive agenda. There is not an identifiable community of researchers, accepted research themes, conferences, and specialized journals. There has been progress on the IT research front, such as the recent attention given to understanding the spectrum of existing outlets for IT research [Christofferson and Lunt, 2009] and the launching of several new journals that are more oriented to IT research. One aim of this article is to contribute to an understanding of this current condition and to offer recommendations for promising lines of IT research. IT falls short in not having a tradition of a coherent research enterprise and a research agenda that is strictly associated with IT and not with related disciplines. "The likelihood of IT surviving as an academically sound discipline is greatly enhanced if it can establish a distinct research agenda" [Ekstrom et al., 2006, p. 19].

This characterization of elements of the IT agenda is consistent with [Reichgelt, 2004], which noted that the visibility of IT in academic programs and with accreditation bodies is not matched by its academic respectability. Reichgelt proposed crafting of a research agenda as a step toward attaining that respectability. Recommendations for IT research themes were to address the cost and value of IT applications; to establish principles for reconciling conflicting demands of users; to assess multiple trade-offs among applications, organizations, and users; and to investigate the ways that IT applications interact with their environments [Reichgelt, 2004].

Another approach toward understanding IT research was an examination of seventy IT master's theses to identify thematic subject areas [Ekstrom, et al., 2006]. The analysis showed five clusters: Development (building, integrating, and delivery of a system into a context); Education (concept learning and application of IT in an educational setting); Information Assurance; Project Management; and Technology (including evaluation and testing). As noted in [Ekstrom, et al., 2006], these clusters reflect the research interests of the faculty sponsoring the theses and should not be expected to represent IT in its entirety. However, the clusters do reinforce themes in IT of systems integration and technology-focused studies along with attention to specialty areas like security and project management that are critical concerns in deployment and integration.

There is no ready reference that chronicles the evolution of an IT research tradition. However, IT research may be becoming more visible because of the i-school movement, the establishment, within universities, of entire schools studying information and its many aspects. In late 2010 there are twenty-seven members of the i-schools organization (www.ischools.org), as well as other similarly oriented schools and colleges that are not in the organization. I-schools raise the prospect of a new locus for an IT research community that will become more distinctive. For example, the i-school at Syracuse University launched in 2009 the *Journal of Research on Information and Technology*, focusing on rapid developments in technology. Research projects at i-schools show attention to more distinctively IT research, for its focus on deployed technologies, as indicated by the following examples:

- Reengineering software for network-centric computing, addressing the challenges of architecture-level reengineering, platform independence, authentication, integrity, and privacy [University of Toronto, 2009]

- Electronic voting technology, addressing transparency and access to source code [University of California–Berkeley, 2009]

- Technology-mediated collaboration, studying communication and computing technology to enhance interaction among both collocated and dispersed teams [University of Michigan, 2009]

Two points deserve attention in discussing the relevance of i-schools to IT research. First, i-schools are diverse in their origination, evolution, and interests. For example, several schools evolved from library science to embrace more broadly informatics and the information sciences. Second, we do not imply that all IT research and all development of IT curricula will be done within i-schools. The observation here is simply that the existence and growth of i-schools is providing more visibility for IT educational and research activities.

That IT merits a distinctive research agenda is given encouragement by the U.S. National Research Council's commissioning of a study by distinguished scientists and technologists to assess the status of the IT research and development ecosystem and to make recommendations to enhance it. Their report concluded that, "The ever-increasing capabilities of computing systems (including both hardware and software) have managed to keep pace with the ever-increasing aspirations that users have for these systems. However, this remarkable progress has been accomplished by ever-increasing complexity. As a result, today's computer systems are tremendously difficult to design, install, configure, operate, and maintain" [National Research Council, 2009, pp. 2–11].

The main impediment for IT to set forth a distinctive theory-driven research agenda may be inferred from its positioning in the computing space in Figure 3. Within the computing and information sciences (and this contextual constraint is significant), IT is blocked by computer science in being able to claim a body of abstract computing knowledge that is essential to academic respectability as a peer discipline: "This medium of academic competition—abstract knowledge—is no different in academic disciplines than in law or medicine. It is primarily a competition in knowledge" [Abbott, 2001, p.137].

Abstract knowledge is the foundation for a community of specialists who offer their expertise to the lay public [Abbott, 1988]. For IT, that abstract knowledge is already claimed by computer science, as implied in Figure 3. Such instances are not unique [Abbott, 1988]. In established professions, such as medicine and engineering, there is a derivational chain of legitimacy from professional practice "upwards" to its supporting abstract knowledge. Tracing that derivation for IT runs into a roadblock; the corresponding abstract knowledge is in the agenda of another discipline, namely CS. In short, IT runs into a dominant discipline. In a way that could not be anticipated, Figure 3 serves to illustrate this phenomenon, with IT pushing its abstractions to the left, only to find its relevant theories already claimed by CS.

Even with the dominant abstract-knowledge position of CS with respect to IT, the following three strategies may guide the articulation of a more distinctively IT research agenda:

- *Seize on jurisdictional vacancies.* By jurisdiction is meant the extent to which there is a defined practitioner community that has control over its activities, namely, who practices, how they are educated and trained, what activities are included, and how practices are performed. Jurisdiction is the "defining relation in professional life" [Abbott, 1988, p. 3], referring to establishing control over practice that is rooted in a body of abstract knowledge. While, admittedly, Abbott was examining the patterns of jurisdiction in professions, this notion of vacancy is relevant to fields of study that are not professions: "Competition between academic disciplines is fundamentally similar to that between law, medicine, accounting, and the rest" [Abbott, 2001, p. 137]. Vacancies appear because of new knowledge and practice, and also because "… an earlier tenant has left them altogether or lost its firm grip on them" [Abbott, 1988, p. 3]. Such is the case with IT artifacts, which are a vacancy for both reasons. As confirmed in [National Research Council, 2009], the growing number, diversity, and complexity of existing IT artifacts is challenging professional practice to understand their properties, deploy them most effectively, and bring them together to interoperate as part of infrastructure and service-delivery systems.

  Appendix B summarizes analytical studies and opinions that IT artifacts have not been prominent in IS research. And this relative inattention to IT artifacts may be seen as part of a broader pattern of IS research not engaging with IS practice [Gill and Bhattacherjee, 2009, p. 228]. "A profession that has yet to grow out of a limited area of work, possibly in tutelage under a dominant profession, will strengthen its current jurisdictions if it wins a new jurisdiction that justifies and encourages its developing a more abstract foundation" [Abbott, 1988, p. 104]. Through investigations of artifacts, IT can fill a jurisdictional vacancy in the milieu of computing and information science disciplines.

- *Abstract from current practice.* Given that IT is blocked by CS from the top-down (abstraction to practice), one approach to building a research agenda is bottom-up, from practice. This strategy is consistent with the way new populations address the learning issue as they attempt to carve out a niche for themselves by developing "… their own organized knowledge structures through experience, and they use those structures as templates—schemata—to give information form and meaning" [Aldrich, 1999]. There is an opportunity to coalesce around core IT practice areas that can benefit from focused research leading to more theoretical treatments and the establishment of more abstract knowledge. While IT is anchored to the right-hand-side of Figure 3, with users and real systems, it does not imply that IT necessarily lacks rigor or can't be helped by abstractions. The IT region can advance to the left, reflecting how IT professionals make sense of technologies by developing frameworks and constructs that provide order and rationale. One path toward strengthening the research component of the IT agenda is to pursue modeling and abstraction to establish principles with broad applicability. Increasingly complex global enterprise architectures, providing both infrastructure and strategic advantage, stand out as opportunities for exploration and inquiry.

- *Strengthen theoretical ties with the systems sciences as a reference discipline.* If we revisit the computing space, a principal underlying reason for the much stronger research foundations for the disciplines on the other three sides of the space is that they carry the banner of legitimacy from well established reference disciplines, as shown in Figure 4:

- Information Systems: Social Sciences (including the organizational sciences)
- Computer Science: Mathematical Sciences
- Computer Engineering: Physical Sciences

This identification of reference disciplines is likely not surprising. These attributions have been supported in research investigations. For example, as reported in one study, the leading reference discipline for CS was mathematics, while the leading disciplines "whose theories formed a basis for the research" [Glass, et al., 2004, p. 91] in IS were (in order) management, economics, cognitive psychology, and social and behavioral science. (We also note the ongoing discussion in [Niederman, et al., 2009] on whether IS has, or has not, outgrown the need for reference discipline theories.)

One reason for the weak disciplinary position of IT with respect to a theoretical research base can be attributed to its lack of derivational legitimacy when compared to its cohabitants in the computing space. In Figure 4, CS, CE, and IS bring theories and principles from their authoritative reference disciplines to bear upon research questions in the computing and information sciences. We propose the systems sciences as a reference discipline for IT. While not nearly so entrenched as the other reference disciplines, the systems sciences are developing and maturing. Those who investigate information technologies should continue looking to the theories and models of the systems sciences for theoretical grounding to build an IT research tradition. From an evolutionary perspective, the association of IT with the systems sciences is natural, reflecting the relatively recent development of both. The appeal to the systems sciences is consistent with the orientation of IT to deployment of extant technologies and the challenges of creating architectural infrastructures that deliver multiple functionalities with strict operational and performance constraints. Regarding the core of a discipline, Weber cites the key to creating the core is "building theory that is novel—theory that colleagues in other disciplines will acknowledge as belonging to the … discipline" [Weber, 2003, p. vi]. The systems sciences offer a path toward novel theory that is distinctive for IT. The systems sciences embrace developments in complexity theory, systems theory, chaos theory, complex adaptive systems, dynamical systems theory, system dynamics, network theory, and related areas. Organizations associated with the systems sciences include the Santa Fe Institute (www.santafe.edu), the International Society for the Systems Sciences (www.isss.org), and the International Federation of Systems Research (www.ifsr.org), which includes twenty-six member societies worldwide.

If IT can constructively draw upon the systems sciences, it may build a stronger theoretical foundation for addressing contemporary challenges and opportunities presented by societal needs that increasingly integrate elements of the computing and information sciences. IT will invoke concepts and models that have their own theoretical supporting structures. We may expect such adaptations by an IT-focused research community to contribute to problems raised by the sheer dynamics of modern network-enabled interaction [Denning, 2009]. IT research, informed by the systems sciences, may be a source of progress in addressing scalability issues and in modeling operations as an evolution of representations [Denning, 2003]. The pursuit of the systems sciences to strengthen IT seems consistent with the observation by Joel Moses, "…while I applaud the attempt to create multiple paths to IT in academia, I urge research on foundational issues, such as complexity, flexibility, and robustness, in cooperation with like-minded colleagues from other parts of engineering, management, and science" [Moses, 2003].

IV. PROPOSED IT RESEARCH THRUST AREAS

The discussion to this point has prepared us to propose research thrust areas for IT. The elaboration from the computing space in Section II motivated the identification of a distinctive role and anchoring theme for IT. Section III outlined three strategies for defining IT research. When these results are combined with our experience and perception of the field, five research thrusts emerge as candidate elements for an IT research agenda:

- IT Artifacts
- Enterprise Architectural Infrastructure
- Interaction Models
- System Performance
- Domain Induction

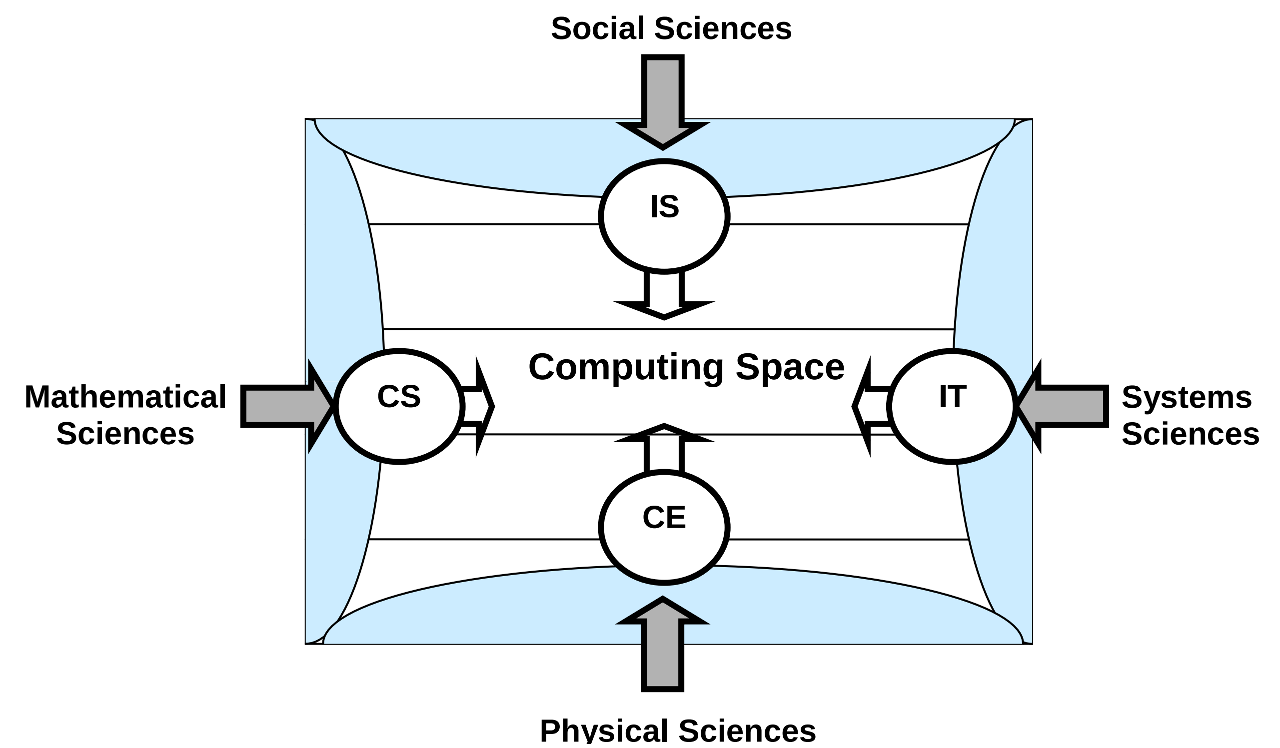

Figure 4. Principal Reference Disciplines in Computing

The proposed research thrust in IT artifacts follows directly from pursuing a jurisdictional vacancy as discussed in Section III. The other four thrust areas are motivated by the other two strategies from Section III: as suggested by the arrows around IT in Figure 4, *push* from practice to abstract knowledge and *pull* from the systems sciences as a reference discipline. Identifying these topics as IT research thrusts is not intended to be exclusionary. The claim here is simply that IT practitioners and researchers will have unique and valuable perspectives on these challenges, while working with colleagues with complementary talents and viewpoints:

- *IT Artifacts.* IT artifacts present challenging research questions that are not being addressed in a substantive manner within IS research [Orlikowski and Iacono, 2001]. Appendix B captures some of the many perspectives on IT artifacts and their potential role in IS and IT. As noted in [Gray, 2003] and [Alter, 2003], the term *IT artifact* has its shortcomings, and Alter reviews its multiple meanings. We use it here closest to the first definition in [Alter, 2003], simply, "something created by humans usually for a practical purpose" [Alter, 2003, p. 497]. IT artifacts include physical systems, hardware, software, tools, techniques, methods, policies, protocols, methodologies, and practices—the unifying element being that the artifact "provides specifiable information processing capabilities" (Rob Kling, quoted in [Orlikowski and Iacano, 2001, p. 123]). Attention to IT artifacts has grown with the elaboration of the design science paradigm in which knowledge and understanding are attained through the building and evaluation of artifacts [Hevner et al., 2004]. IT professionals need to understand information technologies at the most basic and, ultimately, necessary levels, such as, How do they work? How do they interact with the rest of the world? What do they claim to do? What do they really do when tested and used? Based on the kind of technology, more specific questions are appropriate; for example, for a physical component, what resources does it require (e.g., power, space, and bandwidth), and what are its operational characteristics (e.g., heat dissipation, electrical emanations)? While these topics may seem to have devolved to the technician level, their understanding by an IT professional may be essential in certain circumstances to support the comprehensive evaluation of an IT artifact for possible deployment.

  The steady introduction of new information technologies presents a continuing and vital need for IT professionals to maintain an ongoing window on the world of vendors offering new products and services, and to assess their maturity and risks. Given the need to sustain operations, IT professionals operate staging laboratories to try out new technologies and are well-positioned to understand the cycles of technology refreshment, new technology introduction, obsolescence, cut-over, and phase-in issues. Along with the technological dimension is the need to be expert in conducting feasibility and benchmarking studies and in evaluating costs, benefits, risks, and returns on investments in technology acquisition. The importance of IT being the disciplinary home for cost–benefit research is emphasized in [Reichgelt, 2004], which identifies research questions on the cost and value of IT applications.

If it appears that IT artifacts are too mundane to serve as the basis for a research theme, we should find some encouragement from the history of technology and science that, "The arrow of derivation runs from the technology to the applied science, not the other way around … thermodynamics owes much more to the steam engine than the steam engine ever owed to thermodynamics" [Price, 1984, p. 7].

- *Enterprise Architectural Infrastructure.* IT is intimately involved in addressing enterprise-wide challenges and opportunities for organizations:

  - Challenges: Disaster recovery, enterprise resiliency, business continuity, unified threat management, telepresence, content management, cost reduction, platform transparency and virtualization, multitenancy of data in cloud computing paradigms

  - Opportunities: knowledge sharing, global collaboration and teaming, IT for strategic advantage, market-transformative products and services, breakthrough service delivery

  IT professionals have the combination of systems orientation and practical experience to provide leadership in efforts to design effective enterprise architectures that meet the needs of global organizations. IT delivers the infrastructure platforms for organizations, the substrates that enable them to communicate and collaborate. It is reasonable to look to IT researchers to produce advances in architectural representation to manage complexity as organizations evolve organically, through mergers and acquisitions, and connect externally, with trading partners and supply chain entities. IT professionals may likely be the most informed about the roles of standards and the nuances related to open and proprietary aspects of architectures and technologies. IT researchers can bring to bear analytical approaches and formalisms such as the use of graph grammars [LeMateyer, 1998] to address complexity and structural characteristics of architectures. Indeed, graph grammars stand as an example of extending to the far left-hand side of Figure 3, drawing upon theory to formalize an IT-centric challenge.

  A primary thrust area for IT research is to investigate and experiment with infrastructures for computing and communications. Infrastructure provides the platforms for applications and access. Some of the timeliest issues in computing today, such as cloud computing, involve the challenges of configuring scalable, on-demand, off-premises infrastructure services that are demonstrably sufficient to support operations while being secure and robust as well. To provide infrastructure, IT professionals must first understand underlying technologies in data communications, storage, and processing, and then specify the components and their connections that will combine to meet an organization's requirements. There is a pressing need for experimental and theoretical research leading to principles that will guide infrastructure definition and evolution. As a prime and timely example, consider the challenge of nations to develop strategies and controls to guard against cyberattacks. Because a majority of the critical infrastructure in the U.S. is controlled by the private sector, "The Defense Department depends on the overall information infrastructure of the United States" [Lynn, 2010, p. 105]. Such motivations highlight the need for theoretical research on computing and communication infrastructures, their architectures and properties (such as robustness and agility).

- *Interaction Models.* IT professionals face the reality of needing to succeed amid diverse and multiple interactions among people, devices, software, hardware, networks, and services. Of course, the interaction of people and information technologies has been a long-term primary research focus in the human-computer interaction (HCI) and computer supported cooperative work (CSCW) communities. The contributions of these researchers and developers also may be perceived as representing another—human—dimension in the computing space.

  Interaction, used here in the broadest sense, has been recognized for its foundational nature as a computing principle [Wegner, 1997; Denning, 2005], along with the need to address the challenge of interaction design [Winograd, 1997]. Interactions take many forms, such as the layout of touch screens that steer interactions between people and applications on smart phones, the critical timing of signals between processors and devices being controlled, and hand-shaking protocols between systems across networks that integrate supply chains. IT professionals can contribute to advances in interaction design because they have direct exposure to it. They can reflect on the experiences of users (what works, what doesn't, and why), on the accessibility issues of new mobile devices, on the interoperability of systems, on the interactions during requirements elicitation—and draw insights that can be valuable contributions. This identification of interaction as a distinctive role is consistent with the observation in [Reichgelt, 2004] that "meeting the needs of users" is the central phrase in the definition of IT. So much of the challenge to effectively use information is tied to interaction issues; IT researchers can contribute to meeting this challenge.

- *System Performance.* IT professionals have a vantage point at the systems level, enabling observation and evaluation that can be highly beneficial to advances in system performance, such as new ways to characterize quality of service, improved performance benchmarking techniques, more comprehensive system-wide performance models, more effective system administration, and new models of scalability. IT professionals' system-level view positions them well to mine for patterns in operational data, potentially leading to insights that can improve enterprise-wide performance.

- *Domain Induction.* IT is the gateway to domains, where innovation thrives. Physicians and nurses ensure that mobile devices and access modalities are realistically designed to work in the daily practice of patient care. Game-designers are leading the way in interactive systems, imaging, virtual reality, and simulation, notably by tackling new levels of complexity in state and timing issues in the design of multi-player interactive games. Specialists in every domain are imagining new systems and devices to improve quality and productivity. With its breadth of awareness, the IT unit in an organization can leverage its enterprise-level perspective to propose the extension of domain-specific innovations to more widespread use across the enterprise, through advances such as domain modeling [Pahl and Casey, 2003]. Abstracting from experiences in domains can be part of an inductive process by which IT researchers can formulate principles with broad applicability.

In all five areas above, IT researchers and professionals are uniquely prepared and situated to take leadership roles and make significant contributions. These recommended research thrusts are only one proposal for IT to fill out its agenda by strengthening its research portfolio. As interested researchers begin to define critical IT research questions, from the suggested thrusts here or other sources, a more distinctively identifiable IT research agenda may emerge.

V. CONCLUSION—THE BROADER AGENDA FOR IT

What does all this suggest about areas in which IT research and practice can have the most impact in the future? Even a cursory examination of the state of computing in society encourages optimism that IT research and practice can contribute in unique ways, based on trends such as the following few examples:

- Computational Science—IT is essential to computation, and computation is essential to modern scientific advances, such as designing and configuring the data and processing grids used in computational biology [Venugopal et al., 2006]. "It is generally acknowledged that the third leg of scientific investigation, joining theory and experiment, is computation" [National Research Council, 2009, pp. 2–5].

- XaaS—whether it is [Software, Platform, Infrastructure] as a Service or cloud computing, IT is the keeper of the infrastructure substrate, expected both to enable service delivery and to exploit opportunities to provide backbone services effectively, economically, and securely.

- Nano-Peta—the twin challenges of excruciatingly fine, nano-scale granularity across every domain—such as with molecular level systems, proteomics, and narrowcasting—require massive petabyte-level data sets to store everything—and IT is intimately involved at every stage of data capture, processing, access, storage, inquiry, analytics, and deep mining.

- Cyber-Physical Systems—achieving the goal of this National Science Foundation initiative, "to usher in a new generation of engineered systems that are highly dependable, efficiently produced, and capable of advanced performance in information, computation, communication, and control," will call for advances from the IT research community in the form of "… new scientific foundations and technologies to enable the rapid and reliable development and integration of computer- and information-centric physical and engineered systems" [National Science Foundation, 2006]; we also recognize the need for more direct attention to human and social concerns, thus constituting intelligent enterprises of cyber-physical-social-systems or CPSS [Wang, 2010].

- Internet of Things—as the Internet evolves from being internetworked computers to being an Internet of things (devices, appliances, sensors, objects with radio frequency identification tags), the challenges abound for intelligent interoperation, security, and privacy; computer professionals with strong technological skills will be needed to reason about the largely self-configuring wireless networks that will proliferate.

- Universal Access—advances in IT can enhance the participation of people with physical impairments and are essential to providing broad-based broadband Internet access to people of the world, a challenge that draws on the abilities of IT professionals to devise innovative approaches and to address unique architecture and infrastructure demands that involve computing, communication, networking, telephony, security, cost analysis, and access device modalities; see, for example, addressing the needs of the world's "bottom billion" [Heeks, 2009].

There will be an increasing need for teams of researchers and practitioners who can marshal the entire spectrum of computing toward the advancement of these trends and the realization of the benefits they may offer.

While this discussion of the emerging IT agenda began by extrapolating from a depiction of the computing space, it is the space beyond the computing space that really matters. It is the power of all of computing brought to bear to serve humanity; such as the computing paradigms and platforms that are revolutionizing the sciences, benefiting from the confluence of significant advances in all five computing fields to create discovery platforms in the biological and space sciences.

Information processes are foundational in our world. Advances in understanding information and computing hold the promise of improving the lives of people. IT researchers and professionals are poised to bring unique talents and make essential contributions toward that goal.

REFERENCES

Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the article on the Web, can gain direct access to these linked references. Readers are warned, however, that:

1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
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Abbott, A. (1988) *The System of Professions*, Chicago, IL: University of Chicago Press.

Abbott, A. (2001) *The Chaos of Disciplines*, Chicago, IL: University of Chicago Press.

ABET (2010) *Criteria for Accrediting Computing Programs,* Accreditation Board for Engineering and Technology, Baltimore, MD.

Agarwal, R. and H. Lucas (2005) "The Information Systems Identity Crisis: Focusing on High-Visibility and High-Impact Research", *MIS Quarterly* (29)3, pp. 381–395.

Aldrich, H. (1999) *Organizations Evolve*, London: Sage Publications.

Alter, S. (2003) "Sidestepping the IT Artifact, Scrapping the IS Silo, and Laying Claim to 'Systems in Organizations'", *Communications of the Association for Information Systems* (12), pp. 494–526.

Anthony, E. (2003) "Computing Education in Academia: Toward Differentiating the Disciplines", *Proceedings of the Third Conference on Information Technology Education* (SIGITE '03), Association for Computing Machinery, Lafayette, IN, Oct. 16–18, pp. 1–8.

Australian Computer Society (1997) "Core Body of Knowledge for IT Professionals", Sept. 1997, Australian Computer Society, Sydney, Australia.

Benbasat, I. and R. Zmud (2003) "The Identity Crisis Within the IS Discipline: Defining and Communicating the Discipline's Core Properties", *MIS Quarterly* (27)2, pp. 183–194.

Bohm, C. and G. Jacopini (1967) "Flow Diagrams, Turing Machines, and Languages with Only Two Formation Rules", *Communications of the ACM* (9)5, pp. 366–371.

British Computer Society (2008) “Chartered Information Technology Professionals Program and the International IT Professional Practice Program”, British Computer Society, Swindon, UK.

Cassel, L. et al. (2008) “Using a Computing Ontology as a Foundation for Curriculum Development”, *Proceedings of the Sixth International Workshop on Applications of Semantic Web Technologies for E-Learning* (SWEL'08), Montreal, Canada, June 23–27.

Christofferson, L. and B. Lunt (2009) “Ranking Scholarly Outlets for Information Technology”, *Proceedings of the Ninth Conference on Information Technology Education* (SIGITE ’09), Association for Computing Machinery, Oct. 22–24, pp. 115–126.

Denning, P. (2001) “Who Are We?” *Communications of the ACM* (44)2, pp. 15–19.

Denning, P. (2003) “Great Principles of Computing”, *Communications of the ACM* (46)11, pp. 15–19.

Denning, P. (2005) “Is Computer Science Science?” *Communications of the ACM* (48)4, pp. 27–31.

Denning, P. (2007) “Computing Is a Natural Science”, *Communications of the ACM* (50)7, pp. 13–18.

Denning, P. (2009) “Computing: The Fourth Great Domain of Science”, *Communications of the ACM* (52)9, pp. 27–29.

Ekstrom, J. and B. Lunt (2003) “Education at the Seams: Preparing Students to Stitch Systems Together: Curriculum and Issues for 4-Year IT Programs”, *Proceedings of the Third Conference on Information Technology Education* (SIGITE ’03), Association for Computing Machinery, Lafayette, IN, Oct. 16–18, pp. 196–200.

Ekstrom, J. et al. (2006) “A Research Agenda for Information Technology: Does a Research Literature Already Exist?” *Proceedings of the Sixth Conference on Information Technology Education* (SIGITE ’06), Association for Computing Machinery, Minneapolis, MN, Oct. 19–21, pp. 19–24.

Galliers, R. (2003) “Change as Crisis or Growth? Toward a Trans-Disciplinary View of Information Systems as a Field of Study: A Response to Benbasat and Zmud’s Call for Returning to the IT Artifact”, *Journal of the Association for Information Systems* (4)6, pp. 337–351.

Gill, G. and A. Bhattacherjee (2009) “Whom Are We Informing? Issues and Recommendations for MIS Research from an Informing Science Perspective”, *MIS Quarterly* (33)2, pp. 217–235.

Glass, R., V. Ramesh, and I. Vessey (2004) “An Analysis of Research in Computing Disciplines”, *Communications of the ACM* (47)6, pp, 89–94.

Gowan, A. and H. Reichgelt (2010) “Emergence of the Information Technology Discipline”, *IEEE Computer* (43)7, pp. 79–81.

Gray, P. (2003) “Editorial: Introduction to the Debate on the Core of the Information Systems Field”, *Communications of the Association for Information Systems* (12), pp. 629–632.

Hardaway, D., R. Mathieu, and R. Will (2008) “A New Mission for the Information Systems Discipline”, *IEEE Computer* (41)5, pp. 81–83.

Heeks, R. (2009) “IT and the World’s Bottom Billion”, *Communications of the ACM* (52)4, pp. 22–24.

Hevner, A. et al. (2004) “Design Science in Information Systems Research”, *MIS Quarterly* (28)1, pp. 75–105.

Hirschheim, R. and H. Klein (2003) “Crisis in the IS Field? A Critical Reflection on the State of the Discipline”, *Journal of the Association for Information Systems* (4)5, pp. 237–293.

Hislop, G. (2003) “Comparing Undergraduate Degrees in Information Technology and Information Systems”, *Proceedings of the Third Conference on Information Technology Education* (SIGITE ’03), Association for Computing Machinery, Lafayette, IN, Oct. 16–18, pp. 9–12.

Holland, C. (2003) “The IS Core IX: Information Systems Research and Practice: IT Artifact or a Multidisciplinary Subject?” *Communications of the Association for Information Systems* (12), pp. 599–606.

International Organization for Standardization (ISO) (2009) “Open Systems Interconnection Reference Model”, Standard ISO/IEC 7498-1:1994, International Organization for Standardization, Geneva, Switzerland.

JTFCC (2005) “The Overview Report”, Joint Task Force for Computing Curricula, Sept., Association for Computing Machinery, New York, NY.

LeMetayer, D. (1998) “Describing Software Architecture Styles Using Graph Grammars”, *IEEE Transactions on Software Engineering* (24)7, pp. 521–533.

Lunt, B. et al. (2005) "Defining the IT Curriculum: The Results of the Past 3 Years" in Cohen, E. (ed.) *Issues in Informing Science and Information Technology*, *Volume 2,* Santa Rosa, CA: Informing Science Press, pp. 259–270.

Lunt, B. et al. (2008) "Information Technology 2008: Curriculum Guidelines for Undergraduate Degree Programs in Information Technology", Nov., Association for Computing Machinery, New York, NY.

Lynn, W. (2010) "Defending a New Domain", *Foreign Affairs* (89)5, pp. 97–108.

Mahoney, M. (2002) "Software as Science—Science as Software" in Hashagen, U., R. Keil-Slawik, and A. Norberg (eds.) *History of Computing: Software Issues*, Berlin: Springer-Verlag, pp. 25–48.

Mahoney, M. (2004) "Finding a History for Software Engineering", *IEEE Annals of the History of Computing* (26)1, pp 8–19.

Moses, J. (2003) "Multiple Paths to IT", ABET IT Colloquium, National Academy of Sciences, Washington, DC, Jan. 20–22.

Myers, M. (2003) "The IS Core VIII: Defining the Core Properties of the IS Disciplines: Not Yet, Not Now", *Communications of the Association for Information Systems* (12), pp. 582–587.

National Research Council (2006) "Research Doctorate Programs", National Research Council, National Academy of Sciences, Washington, DC, July 28.

National Research Council (2009) "Assessing the Impacts of Changes in the Information Technology R&D Ecosystem: Retaining Leadership in an Increasingly Global Environment", Computer Science and Telecommunications Board, National Research Council, National Academy of Sciences, Washington, DC, Jan.

National Science Foundation (2006) Workshop on Cyber-Physical Systems, Austin, TX, Oct. 16-17.

Niederman, F. et al. (2009) "ICIS 2008 Panel Report: IS Has Outgrown the Need for Reference Discipline Theories, or Has It?" *Communications of the Association for Information Systems* (24), pp. 639–656.

Orlikowski, W. and C. Iacono (2001) "Research Commentary: Desperately Seeking the 'IT' in IT Research—A Call to Theorizing the IT Artifact", *Information Systems Research* (12)2, pp. 121–134.

Pahl, C. and M. Casey (2003) "Ontology Support for Web Service Processes", *Proceedings of the 9th European Software Engineering Conference,* Helsinki, Finland, Sept. 1–5, pp. 208–216.

Price, D. (1984) "The Science/Technology Relationship, the Craft of Experimental Science, and Policy for the Improvement of High Technology Innovation", *Research Policy* (13)1, pp. 3–20.

Reichgelt, H. (2004) "Towards a Research Agenda for Information Technology", *Proceedings of the Fourth Conference on Information Technology Education* (SIGITE '04), Association for Computing Machinery, Oct. 28–30, Salt Lake City, UT, pp. 248–254.

Robey, D. (2003) "Identity, Legitimacy and the Dominant Research Paradigm: An Alternative Prescription for the IS Discipline", *Journal of the Association for Information Systems* (4)7, pp. 352–359.

Sidorova, A. et al. (2008) "Uncovering the Intellectual Core of the Information Systems Discipline", *MIS Quarterly* (32)3, pp. 467–482.

Topi, H. et al. (2010) "IS 2010: Curriculum Guidelines for Undergraduate Degree Programs in Information Systems", *Communications of the Association for Information Systems* (26), pp. 359–428.

University of California—Berkeley (2009) "Transparency and Access to Source Code in e-Voting", http://www.ischool.berkeley.edu/research/publications/2006/317/0 (current Feb. 24, 2009).

University of Michigan (2009) "Technology Mediated Collaboration", http://www.si.umich.edu/research/area.htm?AreaID=3 (current Feb. 24, 2009).

University of Toronto (2009) "Reengineering Software Systems for Network-Centric Computing", http://www.cs.toronto.edu/~eric/IRISdesc.html (current Feb. 24, 2009).

Venugopal, S., R. Buyya, and K. Ramamohanarao (2006) "A Taxonomy of Data Grids for Distributed Data Sharing, Management, and Processing", *ACM Computing Surveys* (38)1, pp. 1–53.

Vogel, D., M. van Genuchten, and C. Saunders (2009) "IS Innovation: Thinking Beyond the Silo", *IEEE Computer* (42)9, pp. 96–98.

Wang, F-Y. (2010) "The Emergence of Intelligent Enterprises: From CPS to CPSS", *IEEE Intelligent Systems* (25), pp. 85–88.

Weber, R. (2003) "Editor's Comments: Still Desperately Seeking the IT Artifact", *MIS Quarterly* (27)2, pp, iii–xi.

Wegner, P. (1997) "Why Interaction Is More Powerful than Algorithms", *Communications of the ACM* (40)5, pp. 80–91.

Whinston, A. and X. Geng (2004) "Operationalizing the Essential Role of the Information Technology Artifact in Information Systems Research: Gray Area, Pitfalls, and the Importance of Strategic Ambiguity", *MIS Quarterly* (28)2, pp. 149–159.

Winograd, T. (1997) "From Computing Machinery to Interaction Design" in Denning, P. and R. Metcalfe (eds.) *Beyond Calculation: The Next Fifty Years of Computing*, Berlin: Springer-Verlag, pp. 147–162.

Zachman, J. (1987) "A Framework for Information Systems Architecture", *IBM Systems Journal* (26)3, pp. 276–292.

APPENDIX A: THE IS-IT RELATIONSHIP

IS and IT are obviously closely related, to the extent that it has prompted the observation that perhaps the discipline that evolved from data processing (DP) to Management Information Systems (MIS), and later IS, "has been undergoing another subtle name change to IT, particularly in industry" [Hirschheim and Klein, 2003, p. 247]. With IS and IT so close, the perspective of this article is that their identities are marked by different *relative* emphases, rather than by claiming that there are absolute boundaries between the two disciplines. The observations in Whinston and Geng [2004] are helpful in this regard when they propose that there can be benefits to explicitly recognizing that there are gray areas of IS/IT research, including research with IT artifacts.

Understanding the relationships between IS and IT is useful both to those who operate within the disciplines and to external stakeholders. A shared responsibility is for skilled professional practitioners in both fields to characterize what they do and how it differs from the routine use of computers by the public, for example, by reference to the progressive understanding of computing through literacy, fluency, and competency [Moses, 2003]. Having an established identity as a field of study and practice is a foundation for a variety of activities that are important to society, such as developing and accrediting educational and training programs, establishing funding priorities, identifying hard problems, fashioning research agendas, defining criteria for professional certification, adapting to changes in scope and focus, and keeping job classifications useful and current so that employment needs and trends can be identified.

IS-IT as Reflected in Model Curricula and BOKs

In recognizing IS and IT as distinct undergraduate curricula, the Joint Task Force on Computing Curricula made several observations that help to differentiate the relative emphasis of each field. At its simplest, IS and IT may be seen as complementary based on which word in "information technology" is stressed: IT focusing on the technology itself, with IS emphasizing the information being conveyed [JTFCC, 2005, p. 14]:

- "Information systems specialists focus on integrating information technology solutions and business processes to meet the information needs of businesses and other enterprises, enabling them to achieve their objectives in an effective, efficient way. This discipline's perspective on information technology emphasizes information and views technology as an instrument for generating, processing, and distributing information."

- "Information technology specialists address the needs for systems to … work properly, be secure, and upgraded, maintained, and replaced as appropriate."

The observation above that IS specialists work with information technology *solutions* further encourages attention to IT artifacts, and their presumed role in the IS and IT areas of practice and research agendas. IT artifacts have been a focal point for discussion, and Appendix B highlights some of the thoughtful observations offered by various researchers on the desirability and centrality of IT artifacts as objects of research in IS.

While published IS and IT curricula serve as one way to discuss disciplinary relationships, rapid and continual change is the order of the day in computing. There are ongoing activities by those in the education interest groups of academic and professional associations to keep the curricula relevant in the face of dramatic changes in the ways that computing and information technologies are influencing society. The most recent significant change to one of the academic programs has been the major revision of the IS curriculum, IS 2010 [Topi et al., 2010].

Comparing the defined IS and IT bodies of knowledge associated with the curricula may further illuminate the relationships between the two fields. Because of the coordinated, broad-based, international effort and the unifying orientation to model curriculum development in [JTFCC, 2005], those BOKs are being used as references in this article. There are many other notable contributions to BOK development that could have been used as well, such as, for IT, the BOKs created by the Australian Computer Society [1997] and the British Computer Society [2008], and for IS, the very constructive discussion in [Hirschheim and Klein, 2003] on the different types of knowledge that are relevant to its BOK.

The IT and IS BOKs use different ways to structure the knowledge in each discipline. The IT BOK [Lunt et al., 2008] is organized as a hierarchy with thirteen knowledge areas at the highest level. Each knowledge area is then broken down into units, which are then further divided into topics. The IS BOK [Topi et al., 2010] has twenty knowledge areas organized into four categories: general computing, information-systems specific, foundational, and domain-specific. Because of these different structures, comparisons are at different levels of granularity.

To convey a sense of the overlap and distinctiveness of the BOKs, Table 1 shows the thirteen knowledge areas from the IT BOK and the twenty knowledge areas of the IS BOK. To facilitate a comparison, Table 1 shows the knowledge areas that are most similar between IS and IT as higher in the listings. Even with the different levels of detail, the table makes it clear that there is overlap, such as the coverage of programming fundamentals by both IS and IT. There are also key differences between IS and IT that reinforce the earlier distinction:

- The IS BOK shows more attention to domains and to organizational and management concepts by having knowledge areas such as leadership and communication, project management, and IS management and leadership.

- The IT BOK shows seven of its thirteen knowledge areas are focused on technology: information technology fundamentals, information assurance and security, integrative programming and technologies, networking, platform technologies, system integration and architecture, and Web systems and technologies.

So this comparison of BOKs reinforces the focus of IS toward organizational and management issues and IT toward technology.

Table 1: IS and IT BOKs

The IS BOK 20 Knowledge Areas [Topi et al., 2010, p. 420]	The IT BOK 13 Knowledge Areas [Lunt et al., 2008, p. 68]
Programming Fundamentals	Programming Fundamentals
Architecture and Organization	Information Technology Fundamentals
Data and Information Management	Information Management
User Experience	Human Computer Interaction
Professional Issues in Information Systems	Social and Professional Issues
Operating Systems	Platform Technologies
Net Centric Computing	Networking
Enterprise Architecture	System Integration and Architecture
Programming Languages	Integrative Programming and Technologies
Graphics and Visual Computing	Web Systems and Technologies
Algorithms and Complexity	Mathematics and Statistics for IT
Intelligent Systems	Information Assurance and Security
IS Management and Leadership	System Administration and Maintenance
Systems Analysis and Design	
IS Project Management	
Leadership and Communication	
Individual and Org. Knowledge Work Capabilities	
General Models of the Domain	
Key Specializations with the Domain	
Evaluation of Performance Within the Domain	

IS and IT in the Computing Space

The depiction of IS and IT in Figure 2 as two distinct sides in the computing space is indicative of each field having its own point of departure and thematic home (IS: organizations and IT: deployment) in investigating the what and how of phenomena surrounding computing. While the IS field engages strongly with an organization both strategically and tactically to advance its mission, to define its information requirements, and to enable and automate its business processes, IT provides the deployed internetworked infrastructure and applications for that to occur. Further, IT empowers individuals, with a goal of maximizing their personal and interpersonal productivity in organizations. The IT challenge is to configure and deploy processing, networking, storing, and accessing elements into optimal productivity platforms for people and organizations.

The location of IS in the computing space of Figure 2 is consistent with the recent identification of five core research areas for IS (IT and organizations, IT and individuals, IT and markets, IT and groups, and IS development) [Sidorova et al, 2008]. The shape of IS in Figure 2 reveals its association with development, individuals, and organizations on the y-axis, and overlaps some of the IT region. So, many of the same concepts are used in defining the IS core and in locating the IS region in the computing space.

Other research studies have reached conclusions that are supportive of these themes for IS and IT, such as the observations that, in IS, "… the primary emphasis is on the organization" [Reichgelt, 2004, p. 251] and "MIS research has increasingly focused on organizational and behavioral issues since 1985" [Gill and Bhattacherjee 2009, p. 228]. Alter, responding to the IT artifact being proposed as the IS research focus, proposed a different focus: systems in organizations, thereby also noting the importance of an organizational context [Alter, 2003].

IS and IT relationships can also be interpreted in light of the nomological net introduced in [Benbasat and Zmud, 2003] as a way to define the core of the IS field. Keeping in mind the acknowledgement in this article that IS-IT overlaps exist, IT may be viewed as having more focus on properties of the artifact itself, which is the center node of the nomological net, and IS more focus on the questions and issues, which are the nodes that surround the center. So, while both IS and IT may involve an IT artifact, the IS questions are more likely to concern "managerial, methodological, and operational capabilities …," "managerial, methodological, and operational practices for directing and facilitating IT artifact usage and evolution," "human behaviors," and "the impacts … of these artifacts on the humans who directly (and indirectly) interact with them, structures and contexts within which they are embedded, and associated collectives (groups, work units, organizations)" [Benbasat and Zmud, 2003, p. 186].

Several observations by Hislop about the differences between IS and IT are consistent with the themes in this article of deployment for IT and organization for IS [Hislop, 2003, p. 11]:

- "IT seems to place relatively more emphasis on activities during the rollout and production phases of a system's life. This includes more attention to operational support and administration of various system types.

- IT encompasses application development but with more emphasis on development by integrating existing components or products and less emphasis on development in which most of the product is coded from scratch. IT programs seem to put less emphasis on organizational issues such as information use in organizations, information strategy and policy, and management of information."

In summary, there are many perspectives on the various relationships between IS and IT. Emerging from these observations is encouragement for the characterization of the relative differences that are represented in this article.

APPENDIX B: PERSPECTIVES ON IT ARTIFACTS AND THEIR ROLE IN IS AND IT

The IT artifact serves as an object lesson on the IS-IT relationship. IT artifacts have been widely discussed in the IS literature for their role in the IS research agenda. This appendix offers a summary of viewpoints on IT artifacts as objects of research, especially to support the claim in the body of the article that the relative lack of attention to investigating IT artifacts constitutes a jurisdictional vacancy.

The attention of IS research away from artifacts and toward organizational issues has been traced, in part, to explicit recommendations from the IS research community. Participants in a 1985 symposium on the IS research challenge "concluded that the discipline was overly obsessed with technology and insufficiently concerned with organizational issues, and, hence, asserted that the discipline's research priorities should be shifted toward the organizational problems facing MIS managers" [Gill and Bhattacherjee, 2009, p. 228].

Based on an analysis of IS research articles, that shift away from technology has occurred: 63 percent of the articles engaged IT artifacts only minimally or solely for their external effects, in contrast to "broader and deeper conceptualizations" of them [Orlikowski and Iacono, 2001, p. 130]. The [IS] field "… has not deeply engaged its core subject matter—the information technology (IT) artifact. Instead, we find that IS researchers tend to give central theoretical significance to the context (within which some usually unspecified technology is seen to operate), the discrete processing capabilities of the artifact … The IT artifact itself tends to disappear from view, be taken for granted, or is presumed to be unproblematic once it is built and installed" [Orlikowski and Iacono, 2001, p. 121].

There continues to be support for IS researchers not to focus on IT artifacts. Gray notes that technological phenomena come and go, but the "social, organizational, international, and societal aspects of these technologies" persist and "are ... legitimate areas for IS research" [Gray, 2003, p. 631]. Holland [2003] finds the IT artifact too limiting as a core construct for IS research, noting the multi-disciplinary nature of information systems, and the breadth of considerations from management and information perspectives. Myers contends that "defining the core of the IS field as the IT artifact is potentially life-threatening for the field as a whole" [Myers, 2003, p. 583]. Weber observes that "for those of us who seek the core of the information systems discipline, there is one line of enquiry that I believe will be unproductive and thus should be avoided. Specifically, I believe the core, if one exists, will not lie in theories that account for information technology-related phenomena. The two sets of phenomena are not the same. They are fundamentally different" [Weber, 2003, p. vi].

Related to the lack of IS research attention to IT artifacts is the reported disconnect between IS research and practice, with special attention to the failure of IS research to inform practice. "Sometimes it looks like the IT revolution has moved on and left many IS researchers behind" [Vogel et al., 2009, p. 96]. Five recommendations in [Gill and Bhattacherjee, 2009] are aimed at enhancing the interaction with practice and increasing the impact of IS research on practice. Given the centrality of IT artifacts to practice, such recommendations, if implemented, will likely increase the attention of IS research to engage IT artifacts.

The disconnect between IS research and IT artifacts is confirmed when viewed from the other direction as well. "Industries that employ IT do not appear to consult the top research journals when innovating and advancing their product and service lines.... Why are for-profit IT research firms successful, yet at the same time industry largely ignores IS academic research?" [Hardaway et al., 2008, p. 82].

In recognition of this disconnect, there are recommendations that the IS research community should change its focus toward more engagement with IT artifacts, for example, by tackling modern challenges posed by the smart phone revolution and IT innovations that more than likely originate outside the CIO's office [Vogel et al., 2009] and by not treating IT artifacts as black boxes [Benbasat and Zmud, 2003].

Perhaps some number of IS researchers will shift their priorities to engage more directly with artifacts in response to these encouragements or other motivations, such as sources of external funding targeted to this objective. However, it also seems reasonable to expect that current IS faculty research interests that largely don't address IT artifacts will continue to influence the subject matter of future doctoral theses, thus spawning future IS researchers with similar interests. As Myers notes, "… IS researchers do not do IT research; IS researchers do 'IS research.' The two are fundamentally different" [Myers, 2003, p. 583]. "Before research agendas with an applied focus can be realistically achieved, Ph.D. programs must make the necessary changes to adequately prepare new Ph.D. faculty with the proper training and education to conduct research that involves the application of IT in practice" [Hardaway et al., 2008, p. 82].

The body of this article proposes IT artifacts as one of the core subjects in an IT research agenda. In the spectrum of computing and information sciences research and practice, there is a continuum defined by the extent to which it is necessary to understand the inner-workings of artifacts in order to address the research question or design challenge. At one end of the continuum are researchers who need to understand more of the artifact's operational characteristics; such as, how does it work, interoperate with other technologies, adhere to technology standards, fit with an architecture, introduce new technological risks, and affect overall security and performance?

At the other end of the spectrum, IT artifacts are considered solely for their external characteristics. However, even at this end, when the research objective is the organizational impact of technology, having a deep knowledge of the technology will enable moving beyond a "a black-box characterization of the technology to explain the mechanism of a technology-enabled transformation" [Agarwal and Lucas, 2005, p. 395].

In summary, while there is evidence that investigations involving operational and performance details of IT artifacts have not always been prominent in IS research to date, there are various opinions on the extent to which these investigations should figure prominently in future IS research or be more aptly characterized as IT research.

APPENDIX C: IT AS A DISCIPLINE OR SUB-DISCIPLINE OF COMPUTING

The viewpoint in this article is that, as a field of study, IT satisfies the definition of a discipline. The existence of many of the disciplinary trappings (e.g., model curricula, educational programs, accreditation criteria [ABET 2010] and

BOKs) provide encouragement that IT can be perceived in this way. One perspective on what it means to have firmer footing as a discipline follows the elaboration by Aldrich [1999] that a discipline must solve the learning and legitimacy issues. Benbassat and Zmud [2003] discuss IS from this viewpoint, and Reichgelt does the same for IT [2004]. The learning issue refers to the sources and uses of knowledge as they are distinct from what is found in other fields. Legitimacy is concerned with the acceptance of the field's existence by stakeholders, governmental entities, and the public. Reichgelt [2004] concludes that IT has made progress in legitimacy, as indicated by educational programs and accreditation criteria, but is challenged by the learning issue to define its domain of inquiry and investigation.

We also acknowledge a view that computing should be recognized as the discipline with IS, IT, CS, CE, and SE as subdisciplines. In support of this structuring, computing, and information are increasingly recognized as a broad-based and foundational natural science [Denning, 2007]. The effort to define a computing ontology has been helpful in understanding and representing the various knowledge relationships [Cassell, 2010]. Computing, or computing and information sciences, may be viewed more as a single rich and diverse discipline or a meta-discipline. Analogously, over the same sixty-year period of explosive development, what was once, simply, biology, is more widely referred to as the biological sciences or life sciences, also embracing many fields of study. Notably, the American Institute of Biological Sciences is an umbrella society for 87 professional biological science societies, totaling 240,000 members (www.aibs.org).

Another perspective on this disciplinary question comes from an organization that is motivated to try making sense of it. The National Research Council (NRC) of the U. S. National Academy of Sciences regularly rates doctoral programs in the U.S. As part of this effort, it developed a taxonomy of fields of study. While the NRC taxonomic structure may be influenced by the overall objective of rating doctoral programs, it may still lend some insight into the perception of fields of study related to IT and computing.

In support of our observation about the biological sciences, the NRC's current public taxonomy [National Research Council 2006] shows 19 fields under the major heading of "Life Sciences." The major heading of "Physical Sciences, Mathematics, and Engineering" also lists nineteen fields, showing Computer Sciences, Computer Engineering, and Electrical and Computer Engineering as three of them. Relevant to this article, Information Science is listed as an emerging field, which may be a recognition of the growing number of doctoral programs. Among the nine subfields of Computer Sciences are Databases/Information Systems and Software Engineering. So, while the baccalaureate level recognizes five computing disciplines [JTFCC, 2005], four of these are cited at the doctoral level by the NRC: CS and CE as fields, SE and IS as subfields. IT has not had prominence as a doctoral program, but that is changing. While the Ph.D. degree program in IT was pioneered at George Mason University in 1985, the growth in IT doctoral programs was slow until the late 1990s, when more universities started forming school or college-level academic units that were oriented to the study of information, often with multidisciplinary perspectives. Currently doctoral degrees may be titled as a Ph.D. in IT (e.g., at the University of Nebraska at Omaha), or some variation, such as a Ph.D. in Information Science and Technology (e.g., at Syracuse University and Pennsylvania State University). Regardless of the exact naming of the degrees, the increase in such doctoral programs can be expected to produce more research in information sciences broadly, to include projects that are technology-based and considered IT research.

In addition to the various perceptions of IT as a discipline, it also has been discussed as an emerging profession (e.g., Denning, 2001). We defer any consideration here of whether IT is more properly a discipline or profession and refer readers to Denning's synopsis of how IT fares when compared against criteria for a profession.

The perspective in this article is to view IT as a discipline, and there is support for this position in light of baccalaureate programs, BOKs, and accreditation criteria. While IT is not as visible among doctoral programs, the number of such programs is increasing. The recognition by NRC of the broad area of information science as an emerging field seems appropriate, with IT perhaps on a trajectory to be one of its subfields.

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William W. Agresti is a professor and associate dean at the Carey Business School, Johns Hopkins University. His research interests are in IT measurement, discovery informatics, and information security economics. He held senior technical leadership positions at CSC, MITRE Corporation, and Noblis Inc., and was a program director at the National Science Foundation for experimental software systems. He has published two books and over one hundred papers. He is on the editorial board of *Expert Systems with Applications* and the *Encyclopedia of Software Engineering*, and served previously with the journals *Empirical Software Engineering, IT Professional,* and *Information Systems Security.*

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