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A Personal Perspective on a Conceptual Foundation for Information Systems

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Abstract

In this paper, I propose a conceptual foundation for information systems based on three propositions:

P1: Information systems improve an entity's ability to attain its goals
P2: Information systems improve the ability of entities to cooperate on shared goals
P3: Information systems transform entities in intended and unintended ways.

I apply an evolutionary-historical analysis, a variation of historical analysis, to the emergence of humans' major information processing capabilities to trace the development of information systems to establish the propositions. I identify some research questions directly arising from the three propositions and advance a case that these propositions are potentially a sufficient conceptual foundation for IS research.

***Keywords**: Propositions, Information, Information Systems, Goal, Cooperation, Consequences.*

* Shirley Gregor was the accepting senior editor. This article was submitted on 19th November 2013 and went through two revisions.

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A Personal Perspective on a Conceptual Foundation for Information Systems

1. Preamble

As a LEO award winner in 2011, I was delighted to accept the invitation of the then JAIS Editor-in-Chief, Shirley Gregor, to present a personal viewpoint on the information systems (IS) field. For some years, I have been concerned that the field has failed to develop a distinctive image, and this is the issue I address. I offer my views for how we might create a distinctive identity for IS by focusing on three crucial propositions that I will argue are central to our field.

My eldest child studied biology, and I soon discovered that I was receiving books on evolution for Christmas and my birthday. I started my education on evolution with writers such as Pinker (Pinker, 1994, 1997, 2002) and Dawkins (Dawkins & Dennett, 1999; Dawkins & Wong, 2004), which led to my reading about evolutionary psychology (Badcock, 2000; Buss, 1999; Dennett, 1995) and the work of Wilson (1975, 1998, 2000, 2004, 2012). I found Lawrence and Nohria's (Lawrence, 2007; Lawrence & Nohria, 2002) derivation of the four human goals, or drives as they see it (the drives to acquire, to bond, to comprehend, and defend), from evolutionary psychology research highly insightful. I was also much influenced by my reading of Diamond's (1997) *Guns, germs, and steel: the fates of human societies*. It was on this journey into understanding the origin of humans, their behavior, and the emergence of civilization that I also started to see information systems differently. I began seeing information systems everywhere once I took off the digital blinders that limited IS to computers. I could visualize spoken language as a form of information system, and then writing, mathematics, and so on as I realized that humans had been developing various forms of information systems for tens of thousands of years. With hindsight, this should not be a surprising epiphany because a key distinguishing feature of Homo sapiens is that we are a cooperative social species with exceptional information processing capability. Cooperation requires the development of systems for mutually sharing information to convey intent.

My new perspective on IS fueled my lament for the heavily derivative nature of our research, both in foundational theories and methodologies. IS can be viewed, as I am sure some non-IS scholars do, as simply field X (e.g., management, economics, marketing) applied to a context in which information systems play a role. We study general problems (e.g., constraining opportunism, effectiveness of various types of economic investments, or the impact of communication mechanisms on consumer decision making) identified by other fields in a particular setting. We borrow their theories and methods, and the contributions we glean from our work often advance another field. The practice of IS quite different in that there are special tools (e.g., data and process modeling) and approaches (e.g., systems analysis and design) that distinguish IS from other practitioner fields. It is my contention that the academic field of IS lacks an appropriate conceptual foundation that uniquely situates it as focused on a specific set of questions not addressed by other academic domains. In this personal perspective, I advance the case for establishing IS as a distinct field by presenting three propositions that can form a conceptual foundation.

Some will likely perceive the conceptual foundation that I present as rather idiosyncratic because it embraces few strands of existing IS research, but therein lies what I think is our fundamental problem. As a new field, we have not put sufficient effort into examining the history of IS prior to digital computers. Consequently, we have not established a distinctive set of generalized IS questions that cover the full range of information systems. We have focused on digital computers and have become established as context-oriented examiners of problems embraced by other fields. Once a community is set on a path, it is hard for it to change because the new is judged by the established based on the implicit standards it has created. Collections of essays and commentaries examining the state of the field (e.g., King & Lyytinen, 2006) subliminally position IS as something that emerged in practice and academia with the development of digital computers. There is minimal recognition that the Roman Empire, the British East India Company, or Ford Motor Company in the days of the T-model had information systems. The field is caught in a time trap, in my perspective, that does not enable it to see our field's long history, which, as I reveal, has thus failed to see its true conceptual foundations.

I contend that information systems have existed as a phenomenon for millennia. Of course, IS did not emerge as a distinctive area of organizational practice and an academic field until the practical problems of applying digital computers to manage information became sufficiently common and complex to require scholarly attention. Similarly, biological life has existed for billions of years on earth, but biology in its modern form did not enter the academic domain until the 18th century. In both cases, the phenomenon (the use of information systems and biological life) existed well before their scientific study became the focus of scholars. Indeed, I contend in this paper that failing to look at the historical emergence of information systems has constrained the field's search for a conceptual foundation. Not surprisingly, the impetus for converting a phenomenon into an academic domain is likely to establish the foundational questions and issues of the field. Thus, problems surrounding the application of digital computers to common organizational problems fashioned the initial path of IS. The current state of the field, I contend, is a result of this initial focus. Path dependency can mean that an early decision can have important consequences for resource allocation, even in the presence of market forces (Liebowitz & Margolis, 1995). Because the phenomenon exists before the field, it is likely to be instructive to understand what the conceptual foundations might look like if the initial path determining conditions were set aside.

By starting afresh with the birth of human information processing and following its early development, I was able to discern a new way of thinking about IS, which I believe helps us to more clearly establish our conceptual foundation. In the following sections, I outline my personal path of discovery to understanding the core concepts of information systems.

2. The Need for a Conceptual Foundation

Many fields have a set of core principles that guides theoretical development and commercial application. Yet, information systems has for nearly half a century failed to create a coherent set of principles. It borrows heavily from the social sciences and business disciplines to advance knowledge of these areas in the context of one or more information systems. As a result, the field has often wrestled with justifying its existence and establishing itself as a legitimate academic endeavor. For example, there are business schools without an information systems unit (e.g., University of Chicago), and information systems is sometimes combined with other fields in an inconsistent fashion (e.g., accounting at the University of Wisconsin and operations management at Wharton). This might not be particularly disconcerting if it were not for the critical importance of information systems to the economy. Over the last half century, information systems has played a key role in productivity growth (Stiroh, 2002, p. 72) and enabling globalization. I contend that, by developing a conceptual foundation, information systems will advance more rapidly as a field and, as a result, have greater consequential societal benefits.

Because we have not developed a clearly identified and unique conceptual foundation, I assert that IS has made little advance as a distinct academic field. We have not built a theory of information systems or at least agreed on a core set of propositions we should test. Rather, we extend the knowledge of other fields. We don't have any core ideas that we are testing and refining to make IS distinctive and theoretically differentiated. By testing the theories of other fields or developing theories for other fields, we advance them while our own field is bereft of something we can claim as our own. A social network analysis of journal citations reports that "IS is receiving an increasing number of citations from other fields, but that these citations make up a relatively small proportion of any one non-IS journal's overall citations, even for top-rated journals from other fields" (Polites & Watson, 2009, p. 616). We appear to have set off on a derivative journey during the emergence of the field when, at the first ICIS conference, the question of appropriate reference fields was raised (Keen, 1980), and yet, at the same time, we recognized our identity crisis (Dickson, Benbasat, & King, 1980). The question of identity and academic credibility still concerns the field today (Firth et al., 2011).

Some examples illustrate how we have neglected creating our core. We have devoted considerable resources to the technology acceptance model (Davis, 1989), but we can view this model as an extension of the theory of reasoned action (Ajzen & Fishbein, 1980) and the theory of planned behavior (Ajzen, 1991) to phenomena related to technology. We can also paint the TAM as an elaboration of innovation theory (Rogers, 1983). On another front, media synchronicity theory (Dennis, Fuller, & Valacich, 2008), which was developed by IS scholars, could be viewed as contributing to the development of the communication field, particularly as it points out how it differs from prior media theories. While in this case new theory is built by IS scholars, it could be argued that it advances communication more than IS. Our best scholars are strengthening other fields, while our own field languishes for a lack of a clear set of ideas that embraces our raison d'être. These are not two isolated examples, but are typical of what is currently lacking in our journals, irrespective of where they sit in the pecking order.

It is generally accepted that information systems has it origins in the 1960s (Dickson, 1968) after enterprises adopted computers to automate business processes. The term management information systems (MIS) became widely adopted and MIS departments emerged at several universities. Early journals in the field selected a management focus, with *Information & Management* and *Management Information Systems Quarterly* both first published in 1977. This early identification with management was, I believe, a blinder that possibly constrained thinking about the core principles of this new field. It resulted in us looking to the management literature and its foundations in areas such as social psychology as the source of theory. The less demanding road for scholars was to test a management theory or some integrated selection of management theories in an IS content. The vast majority of IS scholars ignored the need to build a distinctive core set of principles to guide the nascent field. Those who tried found it difficult. For example, the work on the deep structure of information systems that aimed to provide a foundation based on systems analysis and design (Wand & Weber, 1995) gained some traction, but not to the extent that is foundational to a large percentage of IS research. Unfortunately, the search for an underpinning has been intermittent, and, while there are the occasional panels and editorials raising the issue, a concerted effort is missing. This paper is another attempt to fuel the foundational fires. I believe that, in addressing the conceptual foundations, we must be willing to start with a broader canvas. In my case, I start well before computers existed and do not accept the common contention that IS began in the 1960s.

In this paper, I take an evolutionary and historical perspective to first define information and information systems, and then develop three propositions as potential core questions for IS research; namely:

Proposition 1: *Information systems improve an entity's ability to attain its goals.*

Proposition 2: *Information systems improve the ability of entities to cooperate on shared goals*.

Proposition 3: *Information systems transform entities in intended and unintended ways.*

Of course, I do not intend to have the last word on what these propositions should be and how many there might be.

2.1. A Starting Point

Information systems existed before computers (Brown & Duguid, 2000). The Roman and British Empires managed a vast swag of the world with papyrus and paper reports, respectively, with long transit times from sender to receiver. All long-lived major human endeavors need an information system to manage their resources. For example, China created a system of civil administration, with entry controlled by examination. These exams were the core of the administrative information system from 622 to 1905 (Kracke, 1947). Thus, IS is not something that was suddenly switched on in the 1960s. We have been building information systems for tens of thousands of years and over time accumulated a wide range of information systems for supporting human life. As Davenport (1994, p. 120) notes, "Effective information management must begin by thinking about how people use information—not with how people use machines". I am guided by similar thinking. A foundation for information system must begin by thinking about how people have used information for tens of thousand of years—not with how people use machines today to process information.

For this work, I primarily use the historical analysis research method to establish a basis for understanding current or emergent issues (Gardner, 2006). Historians typically examine critical prior events in order to inform their study of the present and the near future. My approach might be more accurately labeled evolutionary-historical analysis because I identify critical developments in information systems during prehistory human evolution and historical times. The sweep of human endeavor and the use of information systems cover tens of thousands of years and not just recorded history. The approach is also at variance with historical analysis in that I analyze the emergence of information systems not just in recent times, but over the full expanse of human existence. This broad swath of time underscores the assertion that information systems have complemented human life since the evolution of Homo sapiens and have contributed significantly to our success in becoming earth's dominant species, as I show in the following pages.

We evolved from information-processing species. Even very simple forms of life need to process information in order to survive. Something as simple as C. elegans, which is a 1 mm long worm with 302 neurons and 95 muscle cells, has the capability to sense details of its environment (such as CO_2 levels) and change behavior as a result (Bretscher et al., 2011). Many animals have the capacity to communicate among their species. Bees and ants, for example, exchange information using pheromones. Of all the species, humans have developed the most complex and manifold system for cooperation, which started with gestures and has progressed to digital technology. If we are going to build a conceptual foundation for information systems, then examining our biological heritage is a valid starting point. Species have been processing information for eons, and we are descendants of those who became efficient (detected and processed signals quickly) and effective (made a correct decision based on the information perceived) at handling information. Along the evolutionary journey, species that did not process information well did not survive, and those who were more efficient and effective information processors displaced their genes. In addition, information itself gives an advantage. Those with better information were more able to solve survival and reproduction problems. Knowing the location of waterholes enables today's bushmen to survive in the Kalahari, just as it did for their ancestors.

The process of evolution has sharpened humans' ability to process information more than any other species. Thus, I believe that an appropriate starting point for framing the conceptual foundations of information systems is to consider the biological adaptations that shaped our innate drives, information processing capabilities, and the information systems we created. I begin with reflecting on the most fundamental and most critical of information systems, human information exchange, which is the common ancestor of both the communication and IS fields. Whereas communication theory now spotlights the understanding of information exchange between humans (e.g., media richness theory's attention to equivocality reduction), IS is more concerned with the outcome of information exchange, typically the performance of one or more goal-oriented tasks. Thus, enterprises invest in information systems to lower logistics costs, improve customer service, and so forth. Individuals, for example, use information systems to keep in contact with friends and set up meetings. It is task-orientation that differentiates IS from communication, which we see in some IS research, such as task-technology fit (Goodhue & Thompson, 1995) and the socio-technical model (Bostrom & Heinen, 1977).

2.2. Human Communication and Evolution

It seems our first information system might well have been a collection of facial expressions and body movements because human communication originated as gestures, pointing, and pantomiming (Tomasello, 2008, p. 11). It is also the case that these forms of information exchange emerge before speech in the development of a human infant. Babies gesture innately before they talk, but parents make an effort to teach speech. Some gestures are universally understood, and we often revert to them when there is not a common language (e.g., pointing to an item in a store).

Mastering of gesturing, and later language, likely increased the survival prospects of early humans because it enabled them to collaborate. Mutual cooperative information exchange enabled humans to coordinate their actions when hunting, building, fighting, and so on. Human cooperation using information, such as gestures and language, is dependent on a psychological infrastructure of shared goals or intentionality to support collaborative efforts (Tomasello, 2008, p. 12). We evolved to both communicate and interpret mutual goals to complete a joint task. We are an evolved, highly social, and very competent information processing species skilled in task creation and completion.

During human evolution, sexual selection (i.e., the choice of mate) favored intelligence, an inheritable trait (Miller, 2008). Certain types of information exchange possibly enhanced the likelihood of reproductive success because women show a proclivity towards selecting intelligent men as their partners (Lawrence, 2007). A male's ability to use gestures and voice to entertain is a way of demonstrating intelligence and attracting female partners. This process of sexual selection likely led to the enhancement of information exchange skills in our progenitors.

Evolution provided us with a collection of innate modules (Pinker, 2002)—intuitive theories for making sense of the world and surviving in the African savannah. For example, some have postulated that we have innate modules for economics, which is useful for trading, and physics, which is handy for throwing a spear. As evolutionary psychology demonstrates, these innate modules provide the basis of how we process information today (Abraham, Boudreau, Junglas, & Watson, 2013; Abraham, Junglas, Watson, & Boudreau, 2009; Buss, 1999). In particular, we developed modules to communicate and share intentions, which created the foundation for sharing information, performing cooperative tasks, and creating information systems.

2.3. Information and Information Systems Defined

From a biological perspective, information is something that our senses detect. For our ancestors, it could have been the smell of a food source, the sight of a predator, or an unrecognized rustle in the bushes. Additionally, the lack of something (e.g., silence) can also be information. A jungle without the sound of normally squawking parrots is information because it can indicate the presence of a predator. Thus, I formally define information as "an input that stimulates recognition in a sensing mechanism".

If we consider humans, this definition covers the five senses because they can each contribute to our understanding of the environment. It excludes, for example, sounds outside our hearing range or light in the human non-visible part of the spectrum. For other species, these might be sources of information, as in the case of bats detecting high-frequency sounds or snakes sensing infrared light. The definition also fits the computer age. A barcode reader senses a barcode, magnetic storage is based on sensing the direction of magnetization, or a keypad senses the depressing of a key. The definition covers both analog and digital inputs, and is not locked into the notion that information is associated with bits, as per Shannon and Weaver's (1949) thinking.

Information might be sensed, but it is another step to make sense of it as the sender intended. For instance, you might see someone holding a flag in a particular manner (Figure 1). You will likely see the flags, but unless you have been trained in semaphore code, you will not know that the sender is signaling a "T". If trained in the sender's semaphore code, the receiver will both sense the information and make sense of it. We can think of the set of semaphore codes as an information system because it supports the exchange of mutually understood information. We often use signals, or predetermined patterns of information exchange, to make inputs intelligible.

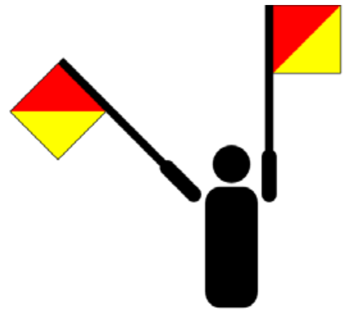

Figure 1. A Semaphore Signal

Information exchange is not the end point for an information system; rather, it is a means for enabling information processing to improve task performance in the pursuit of a goal. Our forebears, those who survived evolutionary pressures and reproduced, were more adept at processing information and found ways to use information to enhance their chances of survival. For the ancient trader in the Fertile Crescent, the cuneiform was a medium for tallying inventory or obligations and ensuring success as a trader. The Greek alphabet became a mechanism for developing logical thinking, information processing, and enabling debate about the governance of society, which resulted in democracy. Information systems are directed at goal attainment through the processing of information.

Formally, an information system is a set of entities, shared patterns, and information processing capabilities that support goal attainment.

The key elements of this definition of an information system include:

- An information system serves the goals of entities, which include people, collections of people, organizations, and other species.
- There is a need for a shared set of patterns such as the position and color of flags, a sequence of phonemes to make a word, or a standard for defining a sequence of 16 bits so that the entities have a platform for information exchange.
- Shared patterns can include procedures that enable cooperative information exchange and processing: for example, a protocol for sending and receiving messages or cultural norms for cooperative work.
- There is a capability for processing information. Initially, humans were restricted to using their brains to process information, and now we augment our brains with computers.
- Information systems are connected to goals. They are purposeful, though the purpose can be utilitarian (e.g., better customer service) or hedonic (e.g., playing a computer game). In order to support goal attainment, information processing must be both efficient (detect and process signals quickly) and effective (identify an appropriate action based on the information perceived).

This definition covers communication by humans, other species, and computers. Other species also have information systems. A particular species of ant, for example, will emit between 10 to 20 different pheromones, and members of that species are able to interpret instinctually the meaning of each pheromone. Scientists have gained valuable insights by studying biological systems, which are often the result of millions of years of evolution (140 million in the case of ants). Thus, we can think of developing the idea of infomimicry, an imitation of biomimicry (Benyus, 2002), by studying the information systems of other species. For instance, some scholars are applying knowledge from studying ants' information systems to grid computing (e.g., Xu, Hou, & Sun, 2003). The definition of an information system also clearly describes computer-based information systems.

For centuries, the human invention of information systems has been driven by the need to find ways to process information to improve goal attainment, and I now examine some of these critical developments in the history of information systems.

2.4. Critical Developments in Information Systems

A few innovators among our ancestors recognized that some tasks, such as skinning a beast (a task), could be done more easily by using the sharp edge of a rock as a proto-knife (a technology). The new technology spawned another task, creating proto-knifes with sharp-edges using a hammerstone. A new technology creates a need for a supporting information system, or an extension of an existing information system, because the required skill (e.g., cutting up a carcass with a sharp-edged rock) needs to be transmitted in and across generations. We can imagine a sequence of gestures and demonstrations were developed to transfer the expertise, and, as a result, another new task arose: teaching the process of butchering an animal. It might also be that others learned by imitating the actions of others, but imitation is rarely exact, and so we can envision imitation leading to some formalization of knowledge transfer. This newly established pattern of gestures and procedures, an information system, needed to be imparted to others. Thus, a new task, teaching the use of a proto-knife and hammerstone, was created. Once the cycle was started, humans began accumulating technology and information systems to tackle the growing range of tasks we have invented over the ages.

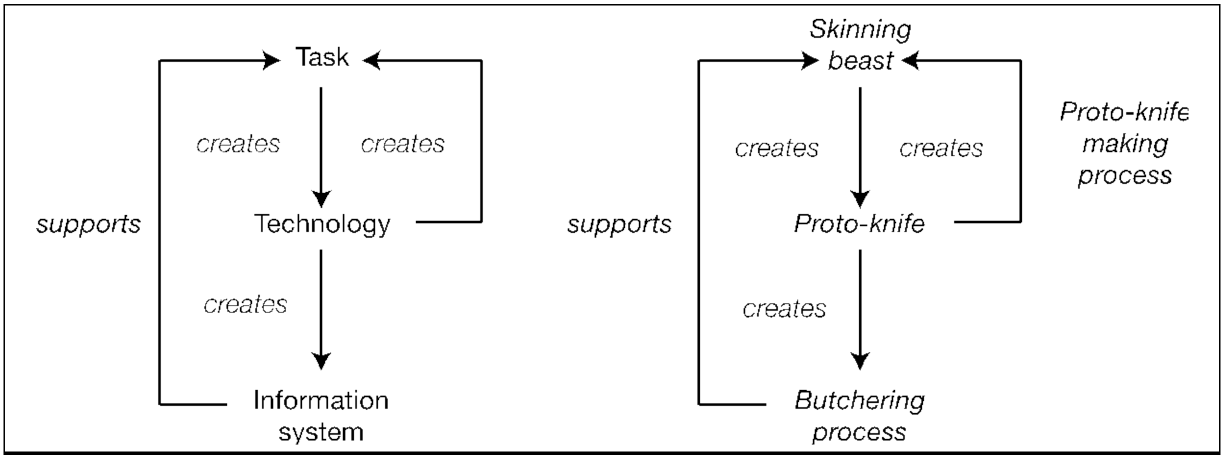

Figure 2. Task, Technology, and IS Triad for Innovation with Example

There are two types of task, technology, and IS triads. The one just discussed is an innovation model, a relative rarity in human civilization as few people are inventors. Most people rely on information systems to support their use of a technology (e.g., a help menu). Of course, those highly skilled in a particular technology may rarely consult the supporting information system. This phenomenon is depicted in Figure 3, which shows that a technology and an information system combine to enable or enhance task performance. The ancient hunter used a proto-knife to butcher an animal following the process he had been taught by a skilled butcher.

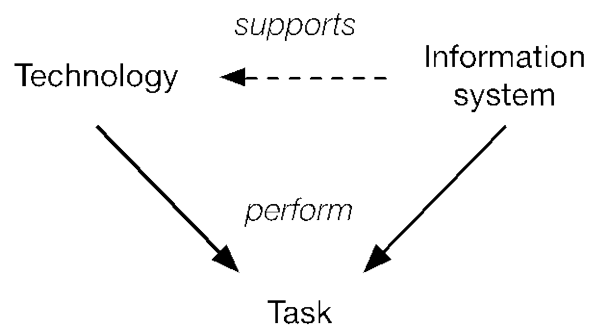

Figure 3. Task, Technology, and IS Triad for Performance

In the IS field, there has been a tendency to merge information systems and digital information technology (IT), the dominant technology of our age, and treat the two as interchangeable. For me, they are very distinct. While an information system might use information technology, it need not. Information technologies can be purchased or imitated, but information systems are something created in and around shared patterns, such as the multiple layers of professional, organizational, and regional cultures, which are not easily replicated because of their social underpinnings. As a result, information systems have a higher failure rate than information technologies.

The symbiotic relationship between task, technology, and information systems is very evident in the beginning of civilization. As Goody (1986, p. 48) notes, "The economy was dependent on writing and writing dependent on the economy". Traders needed a means of recording and counting their belongings, obligations, and business activities. Writing arose to meet that need and, as the economy developed, so did writing and other forms of information systems. For example, tables, which are the foundation of today's relational databases and spreadsheets, emerged fairly soon in the cuneiform system of writing because they facilitated counting. Money also arose out of the needs of traders. For us, it is appropriate to flip the maxim "information is money" to say "money is information". Traders needed an information system for storing and exchanging value to support trading. Our monetary system today is entirely information based. A five euro note has little intrinsic value, but the information on the note creates its value. Because manifold parties mutually understand the meaning of the information, it enables trading.

Clearly, our ancestors' early information systems were rudimentary, and so were their tasks and technologies by our standards. We of this modern world might well dismiss a set of organized and repetitive gestures and pantomimes as not deserving the information system title. However, a computer program is a set of organized and repetitive instructions. Today's technologies and information systems are the cumulative product of hundreds of thousands of years of applying the cycle captured by Figure 2. Thus, yesterday's information system, such as a process for training others in a new technology, pales in comparison with what we think of an IS today. Nevertheless, the definition of an IS set forth in this paper holds true across the years. Whether gestures or bits are used to exchange information, parties process information to attain their goals. While tasks, technologies, and information systems developed in parallel, my focus is the major breakthroughs in information systems that had a significant societal impact (see Table 1).

Table 1. Major Information Systems Developments

Development	Key feature
Gesturing	Exchange of information
Speech	Major extension of information exchange
Cuneiform script	Recording of information
Greek Alphabet	Phonetic recording of information
Mathematics	Manual processing of information
Moveable type printing	Efficient reproduction of information
Morse code	Digitization of information
Marconi's wireless	Wireless transmission of information
Turing's machine	Machine processing of information

The preceding discussion reveals three key elements that comprise an information system. Humankind first developed an ability to exchange information through gesturing (Tomasello, 2008) and language appears to have emerged later, and only once, about 100,000 years ago in southwestern Africa (Atkinson, 2011). Next came the capability to record information, such as cave art, but caves are not very accessible or transportable, and the invention of cuneiform script gave us the first method for mass recording information. Its invention parallels the development of civilization and the movement by some from hunting and gathering to a settled life. Evidence of information processing appears as early as 2000 BCE, with the appearance of calculations, diagrams, and solutions to problems recorded on cuneiform tablets (Robson, 2000). Thus, the three major elements of an information system (information exchange, recording, and processing) emerged more than four thousand years ago.

Bartering and trading, the foundations of a simple economic system, begat the need for recording and processing transactions. In terms of Figure 2, the new tasks of an emerging economy created a need for a technology to record a transaction, first with clay tokens and then later using cuneiforms (Schmandt-Besserat, 1992). There was a concomitant need for an information system for making sense of these recordings (reading) and teaching others how to make them (writing).

The Greek alphabet, building on earlier Semitic writing systems, was a major information systems breakthrough because it is a basic phonemic system. Each letter represents a sound. Earlier scripts had no symbols for vowels. The Greek alphabet, because of its phonemic units, made it easier for people to learn to read and write than earlier scripts. As a result, Goody and Watt (1963) propose that the Greek alphabet enabled the rise of the Greek civilization. It was the first largely literate society, and the Greeks created an intellectual repertoire that was widely adopted by later literate societies, such as the Romans. The Greeks developed logical thinking and the categorization of fields of knowledge. A new standard for information recording, a phonetically based alphabet, gave birth to major cultural developments.

Another important byproduct of the Greek alphabet was mathematics, likely the first fully developed information system because it provided a means of exchanging, recording, and processing information that extended well beyond the rudimentary cuneiform efforts. Mathematics is a universal information system that overcomes language differences and permits humans to manually process information. It introduced symbols that can be manipulated to process information and describe processes for manipulating information (e.g., finding the area of a circle). Mathematicians who might not understand each other's spoken language can interact and process information because mathematics is a complete information system. In the early days of computing, mathematics was seen as a prerequisite for computer programming, possibly because, at that time, it was the most well developed information system for exchanging, recording, and processing information.

Machines did not enter the information systems scene in any significant way until Gutenberg invented the moveable type printing press around 1450, which provided an efficient means of recording and exchanging information. The Koreans and Chinese had invented block printing centuries earlier, but Gutenberg created a printing system that had a revolutionary impact on early modern Europe (Eisenstein, 1993). The next major developments come in the 19th century when information was first digitized by Morse, who defined a set of on-off clicks for communicating upper-case characters and numbers across wires. In a similar vein, Marconi put together a system for transmitting information without wires by modulating electromagnetic waves. In the middle of the 20th century, Turing provided the intellectual foundations of the computing age by describing how a machine could process information.

Information systems have a long history. There was an extended period, likely over 100,000 years, during which humans developed a capability to exchange, record, and process information. In the last two centuries, we have seen the development of the technologies that laid the foundation for the era of computer-based information systems. While we now have vastly powerful and pervasive information systems, the earlier breakthroughs were revolutionary for those living in that time. Humans are an information processing species, and we long ago established the major characteristics of today's information systems and our expectations of them.

2.5. Core Conceptual Foundations of Some Other Fields

Some fields have a clear idea of their fundamental research issues. Let us start by examining Darwin's theory of evolution, arguably the most important theory we have developed at this stage of our civilization (Dennett, 1995, p. 21). The theory of evolution has two central propositions; namely:

- That we descend from a common ancestor
- That natural selection modifies populations over time.

These ideas are encapsulated as "Go backwards and, no matter when you start and you end up celebrating the unity of life. Go forwards and you extol diversity" (Dawkins & Wong, 2004, p. 6). Modern biology and offshoots such as evolutionary psychology are built on these propositions.

If we look at finance, we find that much of its research has been focused on the efficient market hypothesis (EMH), which states: "In an efficient capital market, security prices fully reflect available information in a rapid and unbiased fashion and thus provide unbiased estimates of the underlying values" (Basu, 1977, p. 663). The EMH, though strictly a proposition because it deals with relationships between concepts rather than variables (Bacharach, 1989), has been tested frequently in the finance literature and remains of continuing interest to both academics and practitioners. An issue of the *Economist* (Buttonwood, 2011), for example, discusses research that reveals market imperfections in the bond market (Ilamen, 2011). Finance scholars are concerned with both when EHM holds and does not. They can gain insights into investors' behavior, which is not always apparently rational, from when the hypothesis does not hold. EMH is a clearly expressed concept that provides a foundation for finance and supports the often-espoused philosophy that markets can solve many problems. While EMH is not the only area of finance research, it is a well-identified and explicit central theme.

Consider accounting: the *Journal of Accounting Research* simply reports that it "publishes original research using analytical, empirical, experimental, and field study methods in all areas of accounting research"[1]. We gain further insight when we review the U.S. Federal Accounting Standards Board document titled "Conceptual Framework", which states that "The objective of general purpose financial reporting is to provide financial information about the reporting entity that is useful to existing and potential investors, lenders, and other creditors in making decisions about providing resources to the entity" (Financial Accounting Standards Board, 2010, p. 1). Thus, it is not surprising that much of accounting research addresses issues such as the measurement of financial transactions and

[1] http://research.chicagobooth.edu/arc/journal-of-accounting-research

resources, verification, and the impact of financial reports. An implicit proposition appears to be that financial information provided by accountants improves the performance of investors, lenders, and so forth. However, financial crashes suggest that there are situations where this proposition does not hold, and thus this becomes an area for accounting research.

MIS Quarterly sets forth its mission as:

> *The enhancement and communication of knowledge concerning the development of IT-based services, the management of IT resources, and the use, impact, and economics of IT with managerial, organizational, and societal implications. Professional issues affecting the IS field as a whole are also in the purview of the journal.*[2]

This statement would appear to focus attention on information technology, rather than information or information systems, a misgiving I express earlier. It does not explicitly state what central questions IS research should address, but it does provide a set of topics that are considered appropriate for IS scholars.

This brief consideration of different fields' core themes and propositions is by no means definitive; however, the preceding discussion shows a contrast in the way fields organize their scholarship. Biology and finance academics have a clear idea of the major propositions in their field. Accountants and IS scholars know about the topics of concern. As IS scholars, we describe what we think are valid areas of concern, but we do not identify the critical questions we need to answer. The topic list is broad, however, and thus it is difficult for IS to communicate its uniqueness and to establish the value of its research in the academic environment. We would be better served, in my opinion, by clarifying the questions we think are important.

3. Three Propositions

The purpose in commencing this personal view with an evolutionary and historical analysis of information systems is to present three fundamental propositions that provide a potential foundation for the information systems field. As information systems have been part of human life for centuries and played a major role in the development of civilization, it would be remiss, I assert, to fail to put forward foundational ideas that embrace and explain the full history of our long relationship with information systems. Considering the historical and biological foundations of information systems and observing computer-based information systems result in the recognition of three propositions that can explain the sequence of events that led to today's information age.

3.1. The Information Goal Attainment Proposition

Society has long recognized the value of information and its capability to improve an entity's ability to accomplish a goal. Maxims such as "information is power" capture this cognizance. Advanced economies understand the relationship between information and goals and have laws to reduce information asymmetry. For example, insider trading is illegal in many countries because of the information advantage that someone in a corporation has when it comes to buying and selling shares. The legal system in some countries requires both parties to share knowledge gained during a process known as discovery. Societies with fairness goals have laws and customs to preserve information equity.

Credit-reporting agencies, which provide details on individuals' and businesses' creditworthiness, are another example of how information can improve performance. Many developing economies lack such agencies. As a result, businesses are reluctant to extend credit or else charge high interest rates to mitigate the unknown risk. Credit reporting services make an entire economy more efficient because they lower the cost of capital for all parties. Macro economic growth, a goal sought by nearly all countries, is positively affected by the presence of credit reporting agencies (Kallberg & Udell, 2003).

In recent years, corporations have invested in business analytics in order to learn about their business, and they use this information to improve financial performance. Many have become familiar

[2] http://www.misq.org/about/

with Harrah Casino's use of business analytics to determine which patrons generate greater profits and thus should be encouraged to revisit its casinos (Lal, 2002). UPS has invested in a telematics system to learn about its drivers' behavior during daily deliveries. Analysis of these data has enabled it to achieve outcomes such as increased safety, reduced fuel consumption, and decreased maintenance costs (Watson, Boudreau, Li, & Levis, 2010). Individuals might use information systems for non-financial goals, such as finding a mate (fitting given the evolutionary origins of information systems), investigating health problems, and keeping in contact with friends. These are purposeful actions with the intention of achieving a goal, such as increasing the chances of getting a suitable spouse, being healthier, and maintaining social relationships.

Enterprises embark on the development and implementation of information systems because they believe that the additional information gained will enhance organizational goals' realization. Much IS research implicitly assumes that information improves goal attainment, and it seems we should surface this premise and recognize that it is one of the conceptual foundations of the field. Thus, we arrive at the first proposition.

Proposition 1: *Information systems improve an entity's ability to attain its goals.*

Human endeavors at all levels across the ages and all levels of economic development could not and cannot operate successfully without information. Information enables humans, other species, groups, organizations, and societies to be more efficient and effective in fulfilling their goals. Industrial and post-industrial societies have invested vast sums in developing a wide range of information systems in the belief that high-quality information leads to superior achievement of intended outcomes.

While this proposition is stated in a deterministic manner and might well appear self-evident once made explicit, this does not diminish its value because it is the point of embarkation for exploring the IS field's core features. Once we acknowledge that this is a basic proposition, we can then start to formulate questions specifically designed to test the proposition, its boundaries, and contingencies. For example, here are just a few questions we might ask:

- What type of information has the most impact on a particular type of entity successfully achieving a goal?
- How does the processing of information improve goal fulfillment?
- How do we design information systems to improve sought outcomes?
- How much value does information add to performance and under what conditions?
- How do you use information to accelerate goal achievement?
- How does the transformation of information improve desired outcomes?
- Under what circumstances can information decrease goal accomplishment?

Such questions can be studied broadly and contextually, and, most importantly, the answers advance the field of IS and not some other field. We can judge a proposition by the quality of the questions it provokes, the theoretical development that follows, and the insights for practice that emerge.

3.2. The Information Systems Cooperation Proposition

Our ancestors learned that, by cooperating, they increased their chances of survival. As a result, the "cooperative gene" thrived. Cooperation only occurs when the parties have a mutual goal and, by exchanging information, they can communicate their shared intentionality (Tomasello, 2008). For our ancestors, cooperation was enhanced when chunks of information were linked temporally to describe actions. Thus, a series of gestures might have been strung together to indicate picking up a rock, a hammerstone, and then hitting it against another rock at a particular angle to create a sharp-edged flake for cutting. As gestures, and later sounds, were braided together to describe a task, a rudimentary information system emerged. In the case of speech, we linked basic sounds, phonemes, to create words, and then started to accrete a syntax and grammar, which reduced ambiguity, to fashion a language, a highly effective information system for achieving common goals.

For social insects, such as ants, cooperation facilitated by information sharing makes them the dominant insects in some ecosystems (Wilson, 1990). Indeed, they follow decision making models that are not unlike those used by groups. When selecting a new colony site, ants perform information gathering, evaluation, deliberation, consensus building, choice, and implementation (Dennis et al., 2008). The management of the information flow from the physical and social environment is crucial to the success of social insects. For example, they will change roles based on the information sensed and exchanged so that the colony's health is maintained, the dominant shared goal of a social species.

The history of humanity is populated by the creation of many information systems that enabled groups of people to cooperate, with the major developments captured in Table 1. In today's world, individuals use email to coordinate activities efficiently, corporations use enterprise resource planning systems to minimize supply chain costs, and governments manage a medley of mass transport systems for safety and efficiency. We can think of Facebook as an IS that enables friends to build and maintain social relationships. However, we should not ignore the information systems of yesterday that still have value today, such as maps and timetables, which enable parties to plan and coordinate their movements, respectively. Coordination does not exist without information systems, and thus we have evolved a society where we are constantly seeking to create new types of information systems to enhance cooperative goal seeking.

Proposition 2: *Information systems improve entities' ability to cooperate on shared goals.*

Proposition 2, as you might expect, is the genesis for a range of research questions, including:

- What are the critical elements of an information system that enhance cooperation?
- What are effective means for correctly identifying the shared goals of the various stakeholders in an information system?
- How do the characteristics of various information technology options contribute to coordination?
- How do we create societal, or even global, information systems to address broadly shared goals, such as reducing green house gas emissions?

One feature of Proposition 2 is its emphasis on cooperation, and thus it then impels us to think about how an information system supports mutual goal accomplishment at multiple levels. It suggests a strong focus in systems development, such as the requirements determination phase, on discovering the shared goals of the various parties.

3.3. The Information Systems Transformation Proposition

In the 1930s, linguists Sapir and Whorf proposed that speakers of different languages (i.e., people using different information systems from my perspective) thought differently about the world. During the 1970s, many linguistics rejected the Sapir-Whorf argument and argued that all languages were equally expressive and thought patterns were universal. Recent research has reinstated the Sapir-Whorf proposition (Boroditsky, 2011). For example, members of the Pormpuraaw, an Australian aboriginal tribe, orient themselves using compass points (e.g., you are standing north of me), whereas most other languages use the equivalent of left and right. When asked to arrange a sequence of cards showing different events, English speakers order them so time proceeds from left-to-right, while Hebrew speakers order from right-to-left, the direction in which Hebrew is written.

Pormpuraaws arrange the cards from east-to-west (Boroditsky, 2011). Similar language related findings arise when one studies numbers and colors. Some languages have only words for few and many, and others are restricted to black and white for describing colors (Deutscher, 2010).

As I mention in Section 2.4, the introduction of the Greek alphabet preceded many changes in Greek society, and some scholars attribute these transformations to the transition from an oral to a widely literate society (Thomas, 1992, p. 16). The difficulty of learning to read and write using earlier scripts resulted in literacy being confined to a small elite. The phonetic foundations of the Greek alphabet made mastering reading and writing simpler, and Greece became the first literate society (Goody & Watt, 1963). Learning to read and write teaches people new information processing skills, and the widespread diffusion of literacy results in new forms of social organization and communication (Goody & Watt, 1963).

The information systems we have at hand impact the way we converse and think about a situation. Writing was once a new information system, and it is still a new information system for all of those who learn to write. Writing changes the way we cogitate and communicate. It restructures our consciousness because, as we write, we conduct an internal dialogue, clarify our thinking, and logically connect concepts. Writing helps us to escape context, to which conversation is often inherently enslaved, and separates speaker and listener in time and space. This paper, for example, is not a casual conversation, but the result of much reflection and revision. Compared to an oral exchange, a written report should be logically sharper, grammatically more correct, and represent thoughtful reflection on a point of view. Interestingly, when people have to give an important oral presentation, they usually write the speech first and then later deliver it orally because writing transforms the information exchange a person has with herself. As a result, today we can read Lincoln’s Gettysburg address or we can, ironically, review Plato’s writings about the deleterious impact of writing on memory and the traditions of an oral society.

If we examine other eras, the printing of books is reckoned to have accelerated the European reformation because books facilitated the development of science and broadened the audience for religious discourse (Eisenstein, 1979). In 2001, SMS messages directed 700,000 demonstrators to Manila's People Power shrine to insist (successfully) on the removal of President Joseph Estrada (Adelman, 2004). The 2011 revolution in Tunisia was partially facilitated by social media such as Facebook and Twitter (Kirkpatrick, 2011). Indeed, the U.S. Department of State is using social networks to support its foreign policy (Shactman, 2009) because it sees that these information systems have the capacity to transform society as we saw in Tunisia and Egypt.

Measurement has become a central element of modern management, and there is an oft-quoted adage along the lines of “If you can’t measure it, you can’t manage it”. Organizations have been developing and implementing elaborate information systems for centuries, from accounting to web analytics to measuring the nature of their operations. Measuring is an act of information creation that is central to the genesis of many information systems. For instance, accountants are concerned with measuring the value of assets and liabilities, and the e-commerce site manager with the conversion of visitors to customers. The information generated by these new information systems creates a new platform for management dialog and a new set of expressions (e.g., click through rate or look-to-book ratio). Managers can now talk about something that was previously indeterminate and debate actions to manage and change the now measurable. The availability of new types of information creates new conversations.

New information systems are designed with certain intentions, but they can spawn a multitude of destinations that their designer did not anticipate, from extension (logical incremental improvements) to aspersion (undesirable social outcomes) (Berthon, Pitt, & Watson, 2008). The general malleability of information and information systems enables reinvention and repurposing to occur. Recall that the web has its origins as a system for information sharing among a team of physicists at CERN. Information systems are appropriated in ways never intended by their inventors, and it is this manifold transformational capability that has been a dynamic for organizational, social, and environmental change over the millennia. Early information systems evolved slowly (e.g., language). Today, we see more deliberative action, and designers will typically achieve their narrow goals of changing information exchange in a particular manner to support the achievement of specific goals. It is the broader unintended consequences of a new type of information system, however, that are often the most interesting, profound, and influential. As scholars, we need to understand and explain how to transform information exchange for a specific goal and to predict the broader consequences of such a transformation. While the latter is the more difficult task, general guidance exists (e.g., Berthon et al., 2008).

I capture the ideas discussed in this section in the following proposition:

Proposition 3: *Information systems transform entities in intended and unintended ways.*

Proposition 3, like those preceding it, raises some critical questions for IS scholars to address:

- How do we design an information system to transform the nature of information exchange in a specified manner?
- What information systems characteristics transform information exchange and what detract from it?
- What is the relationship between the characteristics of an information system, the information exchange created, and the transformations produced?
- Can we predict the potential changes resulting from specific transformations?
- What is the impact of changes in the time and place of information delivery on the wireless society?

Proposition 3 highlights the transformational role of IS, which is of considerable concern today at multiple levels of society. Enterprises look to IS to transform their relationship with customers, suppliers, and other stakeholders to give them a competitive advantage. Governments introduce electronic health records and associated information systems with the goal of transforming the cost structure of healthcare, which is a significant segment of many advanced economies' budgets. Globally, we need to harness the transformative power of IS, among other actions, to reduce CO_2 emissions (Watson, Boudreau, & Chen, 2010).

4. Why Three Propositions?

It is possible to present multiple propositions as a foundation for information systems, and there needs to be a strong case for defending the chosen three. In order to be a conceptual foundation, the set of propositions needs to relate to the fundamental manner in which humans use information and the impact of information systems on their behavior. Thus, Proposition 1 is directed at the general principle that information enables an entity to achieve its goal more efficiently or effectively. Our ancestors took advantage of information to increase their survival skills; for example, knowing which berries were edible or recognizing a life-threatening event. Those who survived learned how to use information to improve their survival prospects, the ultimate goal of most humans. This human propensity to use information for beneficial outcomes did not disappear when we left the African savannah. Indeed, collections of individuals, such as groups and societies, which we generically label as entities, learned how to use information to promote their success and create cultural systems, such as education, to promote the relationship between information and goals. Thus, one core requirement is that the set of propositions must include a statement about the relationship between entities and information.

Humans are a social species, so a set of propositions must include some statement about the exchange of information among humans, and, by extension, entities, to embrace the current world. We became a social species because those who learned how to share information to achieve mutual goals enhanced their survival prospects. Non-social humans did less well as hunters because they hunted alone. The advantages of cooperation most likely drove the development of information systems so that, by developing a system for mutually processing information, early humans became more effective gatherers, hunters, and partners, and increased their chances of survival and reproduction. Thus, a set of feasible propositions must consider how information systems are used for mutual advantage and enhance cooperative actions, and I present Proposition 2 to cover this angle.

As I already note, the advantages of cooperation likely drove the development of information systems to support collaboration. Once humans started down this path with gesturing, they later incorporated speech, writing, and so on. Each extension of an information system changes the nature of the information exchange. Adding a new mutually understood gesture, a sign for silence for instance, might have enhanced success when hunting or defending. More dramatics shifts, such as from gesturing to speech, significantly enhanced our ability to cooperate and transform the exchange of information. For instance, the need to record transactions led to the creation of cuneiforms, and this set us on the path to writing systems. Thus, we need a proposition that captures the fundamental transformative power of information systems. Systems are designed or evolve with a certain intention in mind, but it is often the unforeseen consequences that are more profound and impactful. A new information system, such as the Web, can unleash massive transformations that become central themes in IS scholarship. Hence, I include Proposition 3.

A set of propositions should have an intrinsic logical connection to describe the IS landscape as fully as possible. I use an evolutionary and historical analysis to create such a linkage. The capability to use information increased the likelihood of the survival goal (P1), and our species became proficient information processors to the point where we started to invent information systems to enhance cooperation (P2). These systems accumulated and generated effects beyond the solution of the initial problem (P3) to promote transformations that created today's society.

A set of propositions should be both a lodestone for a more fundamental approach to our field and also be magnetic in their ability to attract existing IS research to coalesce and synthesize around them. While I earlier argued that the lack of core propositions has diminished the prospects of the domain, I do not assert that our prior efforts have been less than worthy. Rather, a set of IS propositions should provide a scaffold for rebuilding to show that our decades of work have resulted in creating a distinctive IS field. A valid and useful set of propositions enables IS to re-express its past and current research as being principally about IS. A valid set of propositions is a new lens for viewing our accumulated scholarship.

An ensemble of propositions should uniquely distinguish the problems a field investigates. Problem solving, however, nearly always requires collecting and processing information. Nevertheless, while nearly all problems have an information element, other fields do not focus centrally on information. Consider some of the problems other fields incorporate in their domain. Economics addresses scarce resource allocation, finance is concerned with efficient markets, and marketing aims to meet customers' needs. The general nature of Proposition 1 (information improves an entity's ability to attain its goals) shows how IS could be a mother field. The economist's scarce resource allocation goal requires information for its solution. Efficient markets are concerned with ensuring that all parties have equal access to critical price establishing information. Customer information is critical to achieving the goal of serving the customer. Other fields focus on specific goal seeking, whereas we can view IS as being concerned with general goal attainment. Thus, IS could be potentially positioned as akin to mathematics in that it provides a cross-functional set of general knowledge for addressing specific domain problems.

While I can justify the choice of three propositions and their general nature, it is much harder to argue that this is a sufficient set to explain the full range of IS related phenomena. Exploring this initial set of propositions and finding where they fall short will answer the question of sufficiency. However, I would caution against trying to go beyond a handful. In my opinion, a well-defined field should be synthesized by a small set of propositions that can be used to explain the vast majority of situations by extensions of the basic propositions and by identifying the limits of their applicability. For instance, Darwin's explanation of evolution is based on two ideas: descent from a common ancestor and natural selection modifies populations over time. Newtonian physics is useful for a very wide spectrum of everyday human activity, and we can invoke quantum physics when beyond Newton's ken. The challenge for a social field such as IS is that the variability of human behavior is unlikely to be fully captured by a small set of propositions. Let us start by trying to define the breadth of the field with a few key tenets and then establish the exceptions.

5. A Fruitful Future

If the information systems field is to become an established field, it must move beyond being an offshoot of other domains. We cannot be treated as an equal when we stand on the shoulders of others; rather, we need to find a way to stand shoulder to shoulder. Our failure to develop a conceptual foundation limits our ability to flourish and provide a clearly defined contribution to the advancement of knowledge. A field that has no consensus about its very purpose can hardly expect to be treated as a distinctive field that should be unquestionably preserved as a unique area of research in a university. As a result, in tough times, information systems departments are dissolved or amalgamated. We are dispensable because we are undifferentiated.

Einstein observed that “It is the theory which decides what can be observed” (Heisenberg, 1989, p. 10). I submit that, because we lack of a set of core IS propositions, we are undecided about what we should observe. Consequently, we discern what others have decided we should see. We use others’ theories, or elaborations of them, to understand IS phenomena. We need to establish a core set of propositions so we can consciously decide what we should observe and not leave this critical decision to others.

We need to have a serious conversation about our core propositions. This paper has put forward three for consideration. It will not fail if these are rejected out of hand and a different set is put forward, but it will fail if the very idea of a core set of propositions evokes no interest. Our future will be far more fruitful, in my opinion, if these propositions are accepted as a challenge for identifying the core ideas of our field and that academic discourse over the next few years results in the emergence of a set of questions that are the core consideration of IS scholars and no other academic group. A successful outcome would be the establishment of a distinctive and socially valuable foundation for information systems that supports theoretical development, empirical research, and advances practice.

If we continue to ignore searching for our heart, we will remain mere, hopefully useful, appendages to other fields. We can forgo such a somewhat dismal future by commencing the search for the conceptual foundations of IS, and I present this perspective on information systems as a stepping-stone to a more fruitful future for IS.

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